Corporate Finance Core Principles and Applications 6th edition Ross Solutions Manual

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End of Chapter Solutions
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CHAPTER 1
INTRODUCTION TO CORPORATE FINANCE

Answers to Concept Questions

1. The three basic forms are sole proprietorships, partnerships, and corporations. Some disadvantages of sole proprietorships and partnerships are: unlimited liability, limited life, difficulty in transferring ownership, and hard to raise capital funds. Some advantages are: simplicity, less regulation, the owners are also the managers, and sometimes personal tax rates are better than corporate tax rates. The primary disadvantage of the corporate form is the double taxation to shareholders on distributed earnings and dividends. Some advantages include: limited liability, ease of transferability, ability to raise capital, and unlimited life. When a business is started, most take the form of a sole proprietorship or partnership because of the relative simplicity of starting these forms of businesses.

2. To maximize the current market value (share price) of the equity of the firm (whether it's publicly traded or not).

3. In the corporate form of ownership, the shareholders are the owners of the firm. The shareholders elect the directors of the corporation, who in turn appoint the firm's management. This separation of ownership from control in the corporate form of organization is what causes agency problems to exist. Management may act in its own or someone else's best interests, rather than those of the shareholders. If such events occur, they may contradict the goal of maximizing the share price of the equity of the firm.

4. Such organizations frequently pursue social or political missions, so many different goals are conceivable. One goal that is often cited is revenue minimization; i.e., provide whatever goods and services are offered at the lowest possible cost to society. A better approach might be to observe that even a not-for-profit business has equity. Thus, one answer is that the appropriate goal is to maximize the value of the equity.

5. Presumably, the current stock value reflects the risk, timing, and magnitude of all future cash flows, both short-term *and* long-term. If this is correct, then the statement is false.

6. An argument can be made either way. At the one extreme, we could argue that in a market economy, all these things are priced. Thus, there is an optimal level of, for example, unethical and/or illegal behavior, and the framework of stock valuation explicitly includes these. At the other extreme, we could argue that these are non-economic phenomena and are best handled through the political process. A classic (and highly relevant) thought question that illustrates this debate goes something like this: "A firm has estimated that the cost of improving the safety of one of its products is $30 million. However, the firm believes that improving the safety of the product will only save $20 million in product liability claims. What should the firm do?"

7. The goal will be the same, but the best course of action toward that goal may be different because of differing social, political, and economic institutions.

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8. The goal of management should be to maximize the share price for the current shareholders. If management believes that it can improve the profitability of the firm so that the share price will exceed $35, then they should fight the offer from the outside company. If management believes that this bidder or other unidentified bidders will actually pay more than $35 per share to acquire the company, then they should still fight the offer. However, if the current management cannot increase the value of the firm beyond the bid price, and no other higher bids come in, then management is not acting in the interests of the shareholders by fighting the offer. Since current managers often lose their jobs when the corporation is acquired, poorly monitored managers have an incentive to fight corporate takeovers in situations such as this.

9. We would expect agency problems to be less severe in other countries, primarily due to the relatively small percentage of individual ownership. Fewer individual owners should reduce the number of diverse opinions concerning corporate goals. The high percentage of institutional ownership might lead to a higher degree of agreement between owners and managers on decisions concerning risky projects. In addition, institutions may be better able to implement effective monitoring mechanisms on managers than can individual owners, based on the institutions' deeper resources and experiences with their own management. The increase in institutional ownership of stock in the United States and the growing activism of these large shareholder groups may lead to a reduction in agency problems for U.S. corporations and a more efficient market for corporate control.

10. How much is too much? Who is worth more, Larry Ellison or Tiger Woods? The simplest answer is that there is a market for executives just as there is for all types of labor. Executive compensation is the price that clears the market. The same is true for athletes and performers. Having said that, one aspect of executive compensation deserves comment. A primary reason that executive compensation has grown so dramatically is that companies have increasingly moved to stock-based compensation. Such movement is obviously consistent with the attempt to better align stockholder and management interests. When stock prices soar, management cleans up. It is sometimes argued that much of this reward is due to rising stock prices in general, not managerial performance. Perhaps in the future, executive compensation will be designed to reward only differential performance, i.e., stock price increases in excess of general market increases.

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CHAPTER 2
FINANCIAL STATEMENTS AND CASH FLOW

Answers to Concept Questions

1. Liquidity measures how quickly and easily an asset can be converted to cash without significant loss in value. It's desirable for firms to have high liquidity so that they have a large factor of safety in meeting short-term creditor demands. However, since liquidity also has an opportunity cost associated with it, namely that higher returns can generally be found by investing the cash into productive assets, low liquidity levels are also desirable to the firm. It's up to the firm's financial management staff to find a reasonable compromise between these opposing needs

2. The recognition and matching principles in financial accounting call for revenues, and the costs associated with producing those revenues, to be "booked" when the revenue process is essentially complete, not necessarily when the cash is collected or bills are paid. Note that this way is not necessarily correct; it's the way accountants have chosen to do it.

3. The bottom-line number shows the change in the cash balance on the balance sheet. As such, it is not a useful number for analyzing a company.

4. The major difference is the treatment of interest expense. The accounting statement of cash flows treats interest as an operating cash flow, while the financial statement of cash flows treats interest as a financing cash flow. The logic of the accounting statement of cash flows is that since interest appears on the income statement, which shows the operations for the period, it is an operating cash flow. In reality, interest is a financing expense, which results from the company's choice of debt/equity. We will have more to say about this in a later chapter. When comparing the two cash flow statements, the financial statement of cash flows is a more appropriate measure of the company's operating performance because of its treatment of interest.

5. Market values can never be negative. Imagine a share of stock selling for –$20. This would mean that if you placed an order for 100 shares, you would get the stock along with a check for $2,000. How many shares do you want to buy? More generally, because of corporate and individual bankruptcy laws, net worth for a person or a corporation cannot be negative, implying that liabilities cannot exceed assets in market value.

6. For a successful company that is rapidly expanding, for example, capital outlays will be large, possibly leading to negative cash flow from assets. In general, what matters is whether the money is spent productively, not whether cash flow from assets is positive or negative.

7. It's probably not a good sign for an established company, but it would be fairly ordinary for a start-up, so it depends.

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8. For example, if a company were to become more efficient in inventory management, the amount of inventory needed would decline. The same might be true if it becomes better at collecting its receivables. In general, anything that leads to a decline in ending NWC relative to beginning NWC would have this effect. Negative net capital spending would mean more long-lived assets were liquidated than purchased.

9. If a company raises more money from selling stock than it pays in dividends in a particular period, its cash flow to stockholders will be negative. If a company borrows more than it pays in interest and principal, its cash flow to creditors will be negative.

10. The adjustments were purely accounting changes; they had no cash flow or market value consequences.

Solutions to Questions and Problems

NOTE: All end-of-chapter problems were solved using a spreadsheet. Many problems require multiple steps. Due to space and readability constraints, when these intermediate steps are included in this solutions manual, rounding may appear to have occurred. However, the final answer for each problem is found without rounding during any step in the problem.

Basic

1. To find owners' equity, we must construct a balance sheet as follows:

Balance Sheet			
CA	$6,400	CL	$5,100
NFA	29,300	LTD	11,800
		OE	??
TA	$35,700	TL & OE	$35,700

We know that total liabilities and owners' equity (TL & OE) must equal total assets of $35,700. We also know that TL & OE is equal to current liabilities plus long-term debt plus owners' equity, so owners' equity is:

Owners' equity = $35,700 – 11,800 – 5,100 = $18,800

NWC = CA – CL = $6,400 – 5,100 = $1,300

2. The income statement for the company is:

Income Statement	
Sales	$517,400
Costs	296,300
Depreciation	42,300
EBIT	$178,800
Interest	20,400
EBT	$158,400
Taxes (21%)	33,264
Net income	$125,136

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One equation for net income is:

Net income = Dividends + Addition to retained earnings

Rearranging, we get:

Addition to retained earnings = Net income – Dividends
Addition to retained earnings = $125,136 – 27,000
Addition to retained earnings = $98,136

3. To find the book value of current assets, we use the NWC equation, that is:

NWC = CA – CL

Rearranging to solve for current assets, we get:

CA = NWC + CL
CA = $340,000 + 1,125,000
CA = $1,465,000

So, the book value balance sheet will be:

Book Value Balance Sheet	
Current assets	$1,465,000
Fixed assets	3,900,000
Total assets	$5,365,000

The market value of current assets is given, so the market value balance sheet is:

Market Value Balance Sheet	
NWC	$ 380,000
Fixed assets	5,600,000
Total assets	$5,980,000

4. Taxes = .10($9,700) + .12($39,475 – 9,700) + .22($84,200 – 39,475) + .24($160,725 – 84,200)
+ .32($189,000 – 160,725)
Taxes = $41,796.50

The average tax rate is the total tax paid divided by taxable income, so:

Average tax rate = $41,796.50/$189,000
Average tax rate = .2211, or 22.11%

The marginal tax rate is the tax rate on the next $1 of earnings, so the marginal tax rate is 32 percent.

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5. To calculate OCF, we first need the income statement:

Income Statement	
Sales	$32,400
Costs	14,300
Depreciation expense	2,200
EBIT	$15,900
Interest expense	1,160
EBT	$14,740
Taxes (23%)	3,390
Net income	$11,350

Using the equation for OCF, we get:

OCF = EBIT + Depreciation – Taxes
OCF = $15,900 + 2,200 – 3,390
OCF = $14,709.80

6. The net capital spending is the increase in fixed assets, plus depreciation, so:

Net capital spending = $NFA_{end} - NFA_{beg}$ + Depreciation
Net capital spending = $4,630,000 – 3,820,000 + 405,000
Net capital spending = $1,215,000

7. The long-term debt account will increase by $7.6 million, the amount of the new long-term debt issue. Since the company sold 3.2 million new shares of stock with a $1 par value, the common stock account will increase by $3.2 million. The capital surplus account will increase by $17.6 million, the value of the new stock sold above its par value. Since the company had a net income of $12.24 million, and paid $2.48 million in dividends, the addition to retained earnings was $9.76 million, which will increase the accumulated retained earnings account. So, the new long-term debt and stockholders' equity portion of the balance sheet will be:

Long-term debt	$ 37,200,000
Total long-term debt	$ 37,200,000
Shareholders' equity	
Preferred stock	$ 1,680,000
Common stock ($1 par value)	10,320,000
Capital surplus	50,400,000
Accumulated retained earnings	69,960,000
Total equity	$ 132,360,000

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8. The cash flow to creditors is the interest paid minus the change in long-term debt, so:

Cash flow to creditors = Interest paid – Net new borrowing
Cash flow to creditors = \$168,000 – (LTD_{end} – LTD_{beg})
Cash flow to creditors = \$168,000 – (\$2,280,000 – 2,160,000)
Cash flow to creditors = \$48,000

9. The cash flow to stockholders is the dividends paid minus any new equity purchased by shareholders, so:

Cash flow to stockholders = Dividends paid – Net new equity
Cash flow to stockholders = \$245,000 – [($Common_{end}$ + $APIS_{end}$) – ($Common_{beg}$ + $APIS_{beg}$)]
Cash flow to stockholders = \$245,000 – [(\$536,000 + 5,560,000) – (\$486,000 + 5,040,000)]
Cash flow to stockholders = –\$325,000

Note: APIS is the additional paid-in surplus.

10. We know that the cash flow from assets must be equal to the cash flow to creditors plus the cash flow to stockholders, so:

Cash flow from assets = Cash flow to creditors + Cash flow to stockholders
Cash flow from assets = \$48,000 – 325,000
Cash flow from assets = –\$277,000

Now, we can use the relationship between the cash flow from assets and the operating cash flow, change in net working capital, and capital spending to find the operating cash flow. Doing so, we find:

Cash flow from assets	= OCF – Change in NWC – Net capital spending
–\$277,000	= OCF – (–\$59,000) – 575,000
Operating cash flow	= \$239,000

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Intermediate

11. *a.* The accounting statement of cash flows explains the change in cash during the year. The accounting statement of cash flows will be:

Statement of cash flows	
Operations	
Net income	$191
Depreciation	92
Changes in other current assets	–14
Change in accounts payable	8
Total cash flow from operations	$277
Investing activities	
Acquisition of fixed assets	–$252
Total cash flow from investing activities	–$252
Financing activities	
Proceeds of long-term debt	$48
Dividends	–58
Total cash flow from financing activities	– $10
Change in cash (on balance sheet)	$ 15

b. The change in net working capital is the ending net working capital minus the beginning net working capital, so:

$$\begin{aligned}\text{Change in NWC} &= NWC_{end} - NWC_{beg} \\ &= (CA_{end} - CL_{end}) - (CA_{beg} - CL_{beg}) \\ &= [(\$112 + 318) - 362] - [(\$97 + 304) - 354) \\ &= \$68 - 47 \\ &= \$21\end{aligned}$$

c. To find the cash flow generated by the firm's assets, we need the operating cash flow, and the capital spending. Since there are no interest payments, EBIT is the same as EBT. Calculating each of these, we find:

Operating cash flow	
EBT	$245
Depreciation	92
–Taxes	54
Operating cash flow	$283

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Next, we will calculate the capital spending, which is:

Capital spending	
Ending fixed assets	$988
–Beginning fixed assets	828
Depreciation	92
Capital spending	$252

Now we can calculate the cash flow generated by the firm's assets, which is:

Cash flow from assets	
Operating cash flow	$283
–Capital spending	252
–Change in NWC	21
Cash flow from assets	$10

Notice that the accounting statement of cash flows shows a positive cash flow, but the financial cash flows show a negative cash flow. The financial cash flow is a better number for analyzing the firm's performance.

12. To construct the cash flow identity, we will begin with cash flow from assets. Cash flow from assets is:

Cash flow from assets = OCF – Change in NWC – Net capital spending

So, the operating cash flow is:

OCF = EBIT + Depreciation – Taxes
OCF = $138,393 + 59,862 – 24,310
OCF = $173,945

Next, we will calculate the change in net working capital which is:

Change in NWC = $NWC_{end} - NWC_{beg}$
Change in NWC = $(CA_{end} - CL_{end}) - (CA_{beg} - CL_{beg})$
Change in NWC = ($59,656 – 33,831) – ($51,323 – 26,408)
Change in NWC = $910

Now, we can calculate the capital spending. The capital spending is:

Net capital spending = $NFA_{end} - NFA_{beg}$ + Depreciation
Net capital spending = $448,481 – 373,760 + 59,862
Net capital spending = $134,583

Now, we have the cash flow from assets, which is:

Cash flow from assets = OCF – Change in NWC – Net capital spending
Cash flow from assets = $173,945 – 910 – 134,583
Cash flow from assets = $38,452

The company generated $38,452 from its assets. The cash flow from operations was $173,945, and the company spent $910 on net working capital and $134,583 on fixed assets.

The cash flow to creditors is:

Cash flow to creditors = Interest paid – New long-term debt
Cash flow to creditors = Interest paid – (Long-term $debt_{end}$ – Long-term $debt_{beg}$)
Cash flow to creditors = $20,952 – ($152,400 – 148,700)
Cash flow to creditors = $17,252

The cash flow to stockholders is a little trickier in this problem. First, we need to calculate the new equity sold. The equity balance increased during the year. The only way to increase the equity balance is through addition to retained earnings or selling equity. To calculate the new equity sold, we can use the following equation:

New equity = Ending equity – Beginning equity – Addition to retained earnings
New equity = $321,906 – 249,975 – 67,931
New equity = $4,000

What happened was the equity account increased by $71,931. Of this increase, $67,931 came from addition to retained earnings, so the remainder must have been the sale of new equity. Now we can calculate the cash flow to stockholders as:

Cash flow to stockholders = Dividends paid – Net new equity
Cash flow to stockholders = $25,200 – 4,000
Cash flow to stockholders = $21,200

The company paid $17,252 to creditors and $21,200 to its stockholders.

Finally, the cash flow identity is:

Cash flow from assets = Cash flow to creditors + Cash flow to stockholders
$38,452 = $17,252 + $21,200

The cash flow identity balances, which is what we expect.

13. With the information given, we have the capital spending, change in NWC, and cash flow to stockholders. The cash flow to creditors is:

Cash flow to creditors = Interest paid – New long-term debt
Cash flow to creditors = $2,460 – 19,800
Cash flow to creditors = –$17,340

Now we can use the cash flow identity to calculate the OCF:

OCF – Change in NWC – Net capital spending = Cash flow to creditors + Cash flow to stockholders
OCF – $3,380 – $23,100 = –$17,340 + $8,520
OCF = –$17,340 + 8,520 + 3,380 + 23,100
OCF = $17,660

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14. *a.* The interest expense for the company is the amount of debt times the interest rate on the debt. So, the income statement for the company is:

Income Statement	
Sales	$529,900
Cost of goods sold	174,800
Selling expenses	102,200
Depreciation expense	60,900
EBIT	$192,000
Interest expense	28,800
EBT	$163,200
Taxes	39,168
Net income	$124,032

b. And the operating cash flow is:

OCF = EBIT + Depreciation – Taxes
OCF = $192,000 + 60,900 – 39,168
OCF = $213,732

15. To find the OCF, we first calculate net income.

Income Statement	
Sales	$315,000
Costs	208,600
Other expenses	8,600
Depreciation expense	21,400
EBIT	$76,400
Interest expense	15,700
EBT	$60,700
Taxes	12,747
Net income	$47,953
Dividends	$13,600
Addition to retained earnings	34,353

a. The operating cash flow was:

OCF = EBIT + Depreciation – Taxes
OCF = $76,400 + 21,400 – 12,747
OCF = $85,053

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b. The cash flow to creditors is the interest paid minus any net new long-term debt, so:

CFC = Interest – Net new LTD
CFC = $15,700 – (–$11,900)
CFC = $27,600

Note that the net new long-term debt is negative because the company repaid part of its long-term debt.

c. The cash flow to stockholders is the dividends paid minus any net new equity, or:

CFS = Dividends – Net new equity
CFS = $13,600 – 8,400
CFS = $5,200

d. We know that CFA = CFC + CFS, so:

CFA = $27,600 + 5,200
CFA = $32,800

CFA is also equal to (OCF – Net capital spending – Change in NWC). We already know OCF. Net capital spending is equal to:

Net capital spending = Increase in NFA + Depreciation
Net capital spending = $28,600 + 21,400
Net capital spending = $50,000

Now we can use:

CFA = OCF – Net capital spending – Change in NWC
$32,800 = $85,053 – 50,000 – Change in NWC

Solving for the change in NWC yields $2,253, meaning the company increased its NWC by $2,253.

16. The solution to this question works the income statement backwards. Starting at the bottom:

Net income = Dividends + Addition to retained earnings
Net income = $6,240 + 9,420
Net income = $15,660

Now, looking at the income statement:

EBT – (EBT × Tax rate) = Net income

Recognize that EBT × Tax rate is the calculation for taxes. Solving this for EBT yields:

EBT = NI/(1 – Tax rate)
EBT = $15,660/(1 – .21)
EBT = $19,823

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Now we can calculate:

EBIT = EBT + Interest
EBIT = $19,823 + 2,460
EBIT = $22,283

The last step is to use:

EBIT = Sales – Costs – Depreciation
$22,283 = $69,480 – 34,320 – Depreciation
Depreciation = $12,877

17. The balance sheet for the company looks like this:

Balance Sheet

Cash	$117,600	Accounts payable	$300,300
Accounts receivable	165,900	Notes payable	118,000
Inventory	269,500	Current liabilities	$418,300
Current assets	$553,000	Long-term debt	1,389,500
		Total liabilities	$1,807,800
Tangible net fixed assets	$2,387,000		
Intangible net fixed assets	579,000	Common stock	??
		Accumulated ret. earnings	1,458,800
Total assets	$3,519,000	Total liab. & owners' equity	$3,519,000

Total liabilities and owners' equity is:

TL & OE = CL + LTD + Common stock

Solving this equation for equity gives us:

Common stock = $3,519,000 – 1,807,800 – 1,458,800
Common stock = $252,400

18. The market value of shareholders' equity cannot be negative. A negative market value in this case would imply that the company would pay you to own the stock. The market value of shareholders' equity can be stated as: Shareholders' equity = Max[(TA – TL), 0]. So, if TA is $14,900, equity is equal to $1,400, and if TA is $10,700, equity is equal to $0. We should note here that the book value of shareholders' equity can be negative.

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19. *a.* The income statement for the company is:

Income Statement	
Sales	$890,000
Costs	604,000
Administrative and selling expenses	151,000
Depreciation expense	93,000
EBIT	$ 42,000
Interest expense	74,000
EBT	–$32,000
Taxes	0
Net income	–$32,000

b. OCF = EBIT + Depreciation – Taxes
OCF = $42,000 + 93,000 – 0
OCF = $135,000

c. Net income was negative because of the tax deductibility of depreciation and interest expense. However, the actual cash flow from operations was positive because depreciation is a non-cash expense and interest is a financing expense, not an operating expense.

20. A firm can still pay out dividends if net income is negative; it just has to be sure there is sufficient cash flow to make the dividend payments.

Change in NWC = Net capital spending = Net new equity = 0 (Given)

Cash flow from assets = OCF – Change in NWC – Net capital spending
Cash flow from assets = $135,000 – 0 – 0 = $135,000

Cash flow to stockholders = Dividends – Net new equity
Cash flow to stockholders = $95,000 – 0 = $95,000

Cash flow to creditors = Cash flow from assets – Cash flow to stockholders
Cash flow to creditors = $135,000 – 95,000
Cash flow to creditors = $40,000

Cash flow to creditors is also:

Cash flow to creditors = Interest – Net new LTD

So:

Net new LTD = Interest – Cash flow to creditors
Net new LTD = $74,000 – 40,000
Net new LTD = $34,000

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21. *a.* The income statement is:

Income Statement	
Sales	$53,520
Cost of goods sold	36,800
Depreciation	5,560
EBIT	$11,160
Interest	1,260
Taxable income	$ 9,900
Taxes	2,475
Net income	$ 7,425

b. OCF = EBIT + Depreciation – Taxes
OCF = $11,160 + 5,560 – 2,475
OCF = $14,245

c. Change in NWC $= NWC_{end} - NWC_{beg}$
$= (CA_{end} - CL_{end}) - (CA_{beg} - CL_{beg})$
= ($9,260 – 5,780) – ($8,210 – 5,490)
= $760

Net capital spending $= NFA_{end} - NFA_{beg}$ + Depreciation
= $42,730 – 33,020 + 5,560
= $15,270

CFA = OCF – Change in NWC – Net capital spending
= $14,245 – 760 – 15,270
= –$1,785

The cash flow from assets can be positive or negative, since it represents whether the firm raised funds or distributed funds on a net basis. In this problem, even though net income and OCF are positive, the firm invested heavily in both fixed assets and net working capital; it had to raise a net $1,785 in funds from its stockholders and creditors to make these investments.

d. Cash flow to creditors = Interest – Net new LTD
= $1,260 – 0
= $1,260

Cash flow to stockholders = Cash flow from assets – Cash flow to creditors
= –$1,785 – 1,260
= –$3,045

We can also calculate the cash flow to stockholders as:

Cash flow to stockholders = Dividends – Net new equity

Solving for net new equity, we get:

Net new equity = $2,730 – (–3,045)
= $5,775

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The firm had positive earnings in an accounting sense (NI > 0) and had positive cash flow from operations. The firm invested $760 in new net working capital and $15,270 in new fixed assets. The firm had to raise $1,785 from its stakeholders to support this new investment. It accomplished this by raising $5,775 in the form of new equity. After paying out $2,730 of this in the form of dividends to shareholders and $1,260 in the form of interest to creditors, $1,785 was left to meet the firm's cash flow needs for investment.

22. *a.* Total assets 2019 = $1,173 + 5,702 = $6,875
Total liabilities 2019 = $523 + 3,168 = $3,691
Owners' equity 2019 = $6,875 – 3,691 = $3,184

Total assets 2020 = $1,260 + 6,019 = $7,279
Total liabilities 2020 = $570 + 3,399 = $3,969
Owners' equity 2020 = $7,279 – 3,969 = $3,310

b. NWC 2019 = $CA_{2019} - CL_{2019}$ = $1,173 – 523 = $650
NWC 2020 = $CA_{2020} - CL_{2020}$ = $1,260 – 570 = $690
Change in NWC = $NWC_{2020} - NWC_{2019}$ = $690 – 650 = $40

c. We can calculate net capital spending as:

Net capital spending = Net fixed assets 2020 – Net fixed assets 2019 + Depreciation
Net capital spending = $6,019 – 5,702 + 1,472
Net capital spending = $1,789

So, the company had a net capital spending cash flow of $1,789. We also know that net capital spending is:

Net capital spending = Fixed assets bought – Fixed assets sold
$1,789 = $3,050 – Fixed assets sold
Fixed assets sold = $3,050 – 1,789
Fixed assets sold = $1,261

To calculate the cash flow from assets, we must first calculate the operating cash flow. The operating cash flow is calculated as follows (you can also prepare a traditional income statement):

EBIT = Sales – Costs – Depreciation
EBIT = $17,259 – 5,113 – 1,472
EBIT = $10,674

EBT = EBIT – Interest
EBT = $10,674 – 618
EBT = $10,674

Taxes = EBT × .25
Taxes = $10,674 × .25
Taxes = $2,514

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OCF = EBIT + Depreciation – Taxes
OCF = $10,674 + 1,472 – 2,514
OCF = $9,632

Cash flow from assets = OCF – Change in NWC – Net capital spending
Cash flow from assets = $9,632 – 40 – 1,789
Cash flow from assets = $7,803

d. Net new borrowing = $LTD_{2020} - LTD_{2019}$
Net new borrowing = $3,399 – 3,168
Net new borrowing = $231

Net new borrowing = $231 = Debt issued – Debt retired
Debt retired = $618 – 231
Debt retired = $466

Cash flow to creditors = Interest – Net new LTD
Cash flow to creditors = $618 – 231
Cash flow to creditors = $387

23.

	Balance sheet as of Dec. 31, 2019		
Cash	$25,636	Accounts payable	$32,819
Accounts receivable	33,940		
Inventory	60,344	Long-term debt	85,860
Current assets	$119,920		
Net fixed assets	$215,940	Owners' equity	217,181
Total assets	$335,860	Total liab. & equity	$335,860

	Balance sheet as of Dec. 31, 2020		
Cash	$26,227	Accounts payable	$30,767
Accounts receivable	38,327		
Inventory	62,015	Long-term debt	100,171
Current assets	$126,479		
Net fixed assets	$220,130	Owners' equity	215,671
Total assets	$346,609	Total liab. & equity	$346,609

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2019 Income Statement	
Sales	$48,892
COGS	20,628
Other expenses	3,986
Depreciation	7,024
EBIT	$17,254
Interest	2,518
EBT	$14,736
Taxes	3,684
Net income	$11,052
Dividends	$5,900
Additions to RE	5,152

2020 Income Statement	
Sales	$51,932
COGS	23,277
Other expenses	3,331
Depreciation	7,030
EBIT	$18,294
Interest	3,770
EBT	$14,524
Taxes	3,631
Net income	$10,893
Dividends	$8,600
Additions to RE	2,293

24. OCF = EBIT + Depreciation – Taxes
OCF = $18,294 + 7,030 – 3,631
OCF = $21,693

Change in NWC = $NWC_{end} - NWC_{beg} = (CA - CL)_{end} - (CA - CL)_{beg}$
Change in NWC = ($126,479 – 30,767) – (119,920 – 32,819)
Change in NWC = $8,611

Net capital spending = $NFA_{end} - NFA_{beg}$ + Depreciation
Net capital spending = $220,130 – 215,940 + 7,030
Net capital spending = $11,220

Cash flow from assets = OCF – Change in NWC – Net capital spending
Cash flow from assets = $21,693 – 8,611 – 11,220
Cash flow from assets = $1,862

Cash flow to creditors = Interest – Net new LTD
Net new LTD = $LTD_{end} - LTD_{beg}$
Cash flow to creditors = $3,770 – ($100,171 – 85,860)
Cash flow to creditors = –$10,541

Net new equity = Common $stock_{end}$ – Common $stock_{beg}$
Common stock + Retained earnings = Total owners' equity
Net new equity = $(OE - RE)_{end} - (OE - RE)_{beg}$
Net new equity = $OE_{end} - OE_{beg} + RE_{beg} - RE_{end}$
$RE_{end} = RE_{beg}$ + Additions to RE
Net new equity = $OE_{end} - OE_{beg} + RE_{beg} - (RE_{beg}$ + Additions to $RE_{2020})$
Net new equity = $OE_{end} - OE_{beg}$ – Additions to RE_{2020}
Net new equity = $215,671 – 217,181 – 2,293
Net new equity = –$3,803

Cash flow to stockholders = Dividends – Net new equity
Cash flow to stockholders = $8,600 – (–$3,803)
Cash flow to stockholders = $12,403

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As a check, cash flow from assets is $1,862.

Cash flow from assets = Cash flow to creditors + Cash flow to stockholders
Cash flow from assets = –$10,541 + 12,403
Cash flow from assets = $1,862

Challenge

25. We will begin by calculating the operating cash flow. First, we need the EBIT, which can be calculated as:

EBIT = Net income + Current taxes + Deferred taxes + Interest
EBIT = $321 + 185 + 34 + 96
EBIT = $636

Now we can calculate the operating cash flow as:

Operating cash flow	
Earnings before interest and taxes	$636
Depreciation	177
– Current taxes	–185
Operating cash flow	$628

The net capital spending is found in the investing activities portion of the accounting statement of cash flows, so:

Net capital spending	
Acquisition of fixed assets	$332
– Sale of fixed assets	–42
Capital spending	$290

The net working capital cash flows are all found in the operations cash flow section of the accounting statement of cash flows. However, instead of calculating the net working capital cash flows as the change in net working capital, we must calculate each item individually. Doing so, we find:

Net working capital cash flow	
Cash	$27
Accounts receivable	52
Inventories	–41
Accounts payable	–33
Accrued expenses	17
Other	–4
NWC cash flow	$18

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Except for the interest expense and notes payable, the cash flow to creditors is found in the financing activities of the accounting statement of cash flows. The interest expense from the income statement is given, so:

Cash flow to creditors	
Interest	$96
Retirement of debt	195
Debt service	$291
– Proceeds from sale of long-term debt	–105
Total	$186

And we can find the cash flow to stockholders in the financing section of the accounting statement of cash flows. The cash flow to stockholders was:

Cash flow to stockholders	
Dividends	$158
Repurchase of stock	26
Cash to stockholders	$184
– Proceeds from new stock issue	–50
Total	$134

26. Net capital spending $= NFA_{end} - NFA_{beg} + \text{Depreciation}$

$= (NFA_{end} - NFA_{beg}) + (\text{Depreciation} + AD_{beg}) - AD_{beg}$

$= (NFA_{end} - NFA_{beg}) + AD_{end} - AD_{beg}$

$= (NFA_{end} + AD_{end}) - (NFA_{beg} + AD_{beg}) = FA_{end} - FA_{beg}$

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CHAPTER 3
FINANCIAL STATEMENTS ANALYSIS AND LONG-TERM PLANNING

Answers to Concept Questions

1. Time trend analysis gives a picture of changes in the company's financial situation over time. Comparing a firm to itself over time allows the financial manager to evaluate whether some aspects of the firm's operations, finances, or investment activities have changed. Peer group analysis involves comparing the financial ratios and operating performance of a particular firm to a set of peer group firms in the same industry or line of business. Comparing a firm to its peers allows the financial manager to evaluate whether some aspects of the firm's operations, finances, or investment activities are out of line with the norm, thereby providing some guidance on appropriate actions to take to adjust these ratios if necessary. Both allow an investigation into what is different about a company from a financial perspective, but neither method gives an indication of whether the difference is positive or negative. For example, suppose a company's current ratio is increasing over time. It could mean that the company had been facing liquidity problems in the past and is rectifying those problems, or it could mean the company has become less efficient in managing its current accounts. Similar arguments could be made for a peer group comparison. A company with a current ratio lower than its peers could be more efficient at managing its current accounts, or it could be facing liquidity problems. Neither analysis method tells us whether a ratio is good or bad, both show that something is different, and tell us where to look.

2. If a company is growing by opening new stores, then presumably total revenues would be rising. Comparing total sales at two different points in time might be misleading. Same-store sales control for this by only looking at revenues of stores open within a specific period.

3. The reason is that, ultimately, sales are the driving force behind a business. A firm's assets, employees, and, in fact, just about every aspect of its operations and financing exist to directly or indirectly support sales. Put differently, a firm's future need for things like capital assets, employees, inventory, and financing are determined by its future sales level.

4. Two assumptions of the sustainable growth formula are that the company does not want to sell new equity, and that financial policy is fixed. If the company raises outside equity, or increases its debt-equity ratio, it can grow at a higher rate than the sustainable growth rate. Of course, the company could also grow faster than its profit margin increases if it changes its dividend policy by increasing the retention ratio or if its total asset turnover increases.

5. The sustainable growth rate is greater than 20 percent, because at a 20 percent growth rate, the negative EFN indicates that there is excess financing still available. If the firm is 100 percent equity financed, then the sustainable and internal growth rates are equal and the internal growth rate would be greater than 20 percent. However, when the firm has some debt, the internal growth rate is always less than the sustainable growth rate, so it is ambiguous whether the internal growth rate would be greater than or less than 20 percent. If the retention ratio is increased, the firm will have more internal funding sources available, and it will have to take on more debt to keep the debt-equity ratio constant, so the EFN will decline. Conversely, if the retention ratio is decreased, the EFN will rise. If the retention rate

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is zero, both the internal and sustainable growth rates are zero, and the EFN will rise to the change in total assets.

6. Common-size financial statements provide the financial manager with a ratio analysis of the company. The common-size income statement can show, for example, that cost of goods sold as a percentage of sales is increasing. The common-size balance sheet can show a firm's increasing reliance on debt as a form of financing. Common-size statements of cash flows are not calculated for a simple reason: There is no possible denominator.

7. It would reduce the external funds needed. If the company is not operating at full capacity, it would be able to increase sales without a commensurate increase in fixed assets.

8. Presumably not, but, of course, if the product had been *much* less popular, then a similar fate would have awaited due to lack of sales.

9. Since customers did not pay until shipment, receivables rose. The firm's NWC, but not its cash, increased. At the same time, costs were rising faster than cash revenues, so operating cash flow declined. The firm's capital spending was also rising. Thus, all three components of cash flow from assets were negatively impacted.

10. Financing possibly could have been arranged if the company had taken quick enough action. Sometimes it becomes apparent that help is needed only when it is too late, again emphasizing the need for planning.

11. All three were important, but the lack of cash or, more generally, financial resources ultimately spelled doom. An inadequate cash resource is usually cited as the most common cause of small business failure.

12. Demanding cash up front, increasing prices, subcontracting production, and improving financial resources via new owners or new sources of credit, are some of the options. When orders exceed capacity, price increases may be especially beneficial.

13. ROE is a better measure of the company's performance. ROE shows the percentage return for the year earned on shareholder investment. Since the goal of a company is to maximize shareholder wealth, this ratio shows the company's performance in achieving this goal over the period.

14. The EBITDA/Assets ratio shows the company's operating performance before interest, depreciation, and taxes. This ratio would show how a company has controlled costs. While taxes are a cost, and interest and depreciation can be considered costs, they are not as easily controlled by company management. Conversely, depreciation and amortization can be altered by accounting choices. This ratio only uses revenue minus costs that are directly related to operations in the numerator. As such, it gives a better metric to measure management performance over a period than does ROA.

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Solutions to Questions and Problems

NOTE: All end-of-chapter problems were solved using a spreadsheet. Many problems require multiple steps. Due to space and readability constraints, when these intermediate steps are included in this solutions manual, rounding may appear to have occurred. However, the final answer for each problem is found without rounding during any step in the problem.

Basic

1. Using the DuPont identity, the ROE is:

ROE = (PM)(TAT)(EM)
ROE = (.0597)(2.10)(.85)
ROE = .1066, or 10.66%

2. The equity multiplier is:

EM = 1 + D/E
EM = 1 + .90
EM = 1.90

One formula to calculate return on equity is:

ROE = (ROA)(EM)
ROE = .077(1.90)
ROE = .1463, or 14.63%

ROE can also be calculated as:

ROE = NI/TE

So, net income is:

NI = ROE(TE)
NI = (.1463)($880,000)
NI = $128,744

3. This is a multi-step problem involving several ratios. The ratios given are all part of the DuPont identity. The only DuPont identity ratio not given is the profit margin. If we know the profit margin, we can find the net income since sales are given. So, we begin with the DuPont identity:

ROE = .14 = (PM)(TAT)(EM) = (PM)(S/TA)(1 + D/E)

Solving the DuPont identity for profit margin, we get:

PM = [(ROE)(TA)]/[(1 + D/E)(S)]
PM = [(.14)($3,020)]/[(1 + .55)($5,930)]
PM = .0460, or 4.60%

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Now that we have the profit margin, we can use this number and the given sales figure to solve for net income:

PM = .0460 = NI/S
NI = .0460($5,930)
NI = $272.77

4. An increase of sales to $53,100 is an increase of:

Sales increase = ($53,100 – 45,000)/$45,000
Sales increase = .18, or 18%

Assuming costs and assets increase proportionally, the pro forma financial statements will look like this:

Pro forma income statement

Sales	$53,100.00
Costs	42,598.00
EBIT	10,502.00
Taxes	2,520.48
Net income	$ 7,981.52

Pro forma balance sheet

Assets	$ 123,310	Debt	$ 28,200.00
		Equity	81,685.52
Total	$ 123,310	Total	$109,885.52

The payout ratio is constant, so the dividends paid this year is the payout ratio from last year times net income, or:

Dividends = ($2,200/$6,764)($7,981.52)
Dividends = $2,596.00

The addition to retained earnings is:

Addition to retained earnings = $7,981.52 – 2,596
Addition to retained earnings = $5,385.52

And the new equity balance is:

Equity = $76,300 + 5,385.52
Equity = $81,685.52

So the EFN is:

EFN = Total assets – Total liabilities and equity
EFN = $123,310 – 109,885.52
EFN = $13,424.48

5. The maximum percentage sales increase is the sustainable growth rate. To calculate the sustainable growth rate, we first need to calculate the ROE, which is:

ROE = Net income/Total equity
ROE = $13,035/$114,000
ROE = .1143, or 11.43%

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The plowback ratio, *b*, is one minus the payout ratio, so:

$b = 1 - .30$
$b = .70$

Now we can use the sustainable growth rate equation to get:

Sustainable growth rate = (ROE × *b*)/[1 – (ROE × *b*)]
Sustainable growth rate = [.1143(.70)]/[1 – .1143(.70)]
Sustainable growth rate = .0870, or 8.70%

So, the maximum dollar increase in sales is:

Maximum increase in sales = $74,300(.0870)
Maximum increase in sales = $6,464.33

6. We need to calculate the retention ratio to calculate the sustainable growth rate. The retention ratio is:

$b = 1 - .20$
$b = .80$

Now we can use the sustainable growth rate equation to get:

Sustainable growth rate = (ROE × *b*)/[1 – (ROE × *b*)]
Sustainable growth rate = [.138(.80)]/[1 – .138(.80)]
Sustainable growth rate = .1241, or 12.41%

7. We must first calculate the ROE using the DuPont ratio to calculate the sustainable growth rate. The ROE is:

ROE = (PM)(TAT)(EM)
ROE = (.076)(3.35)(1.25)
ROE = .3183, or 31.83%

The plowback ratio is one minus the dividend payout ratio, so:

$b = 1 - .70$
$b = .30$

Now, we can use the sustainable growth rate equation to get:

Sustainable growth rate = (ROE × *b*)/[1 – (ROE × *b*)]
Sustainable growth rate = [.3183(.30)]/[1 – .3183(.30)]
Sustainable growth rate = .1056, or 10.56%

8. An increase of sales to $16,472 is an increase of:

Sales increase = ($16,472 – 14,200)/$14,200
Sales increase = .16, or 16%

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Assuming costs and assets increase proportionally, the pro forma financial statements will look like this:

Pro forma income statement			Pro forma balance sheet		
Sales	$ 16,472.00	Assets	$33,756.00	Debt	$ 6,200.00
Costs	12,574.40			Equity	26,797.60
Net income	$3,897.60	Total	$33,756.00	Total	$32,997.60

If no dividends are paid, the equity account will increase by the net income, so:

Equity = $22,900 + 3,897.60
Equity = $26,797.60

So the EFN is:

EFN = Total assets – Total liabilities and equity
EFN = $33,756 – 32,997.60
EFN = $758.40

9. *a.* First, we need to calculate the current sales and change in sales. The current sales are next year's sales divided by one plus the growth rate, so:

Current sales = Next year's sales/(1 + *g*)
Current sales = $179,400,000/(1 + .15)
Current sales = $156,000,000

And the change in sales is:

Change in sales = $179,400,000 – 156,000,000
Change in sales = $23,400,000

We can now complete the current balance sheet. The current assets, fixed assets, and short-term debt are calculated as a percentage of current sales. The long-term debt and par value of stock are given. The plug variable is the accumulated retained earnings. So:

Assets		Liabilities and equity	
Current assets	$31,200,000	Short-term debt	$23,400,000
		Long-term debt	$27,200,000
Fixed assets	140,400,000	Common stock	$13,000,000
		Accumulated RE	108,000,000
		Total equity	$121,000,000
Total assets	$171,600,000	Total liabilities and equity	$171,600,000

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b. We can use the equation from the text to answer this question. The assets/sales and debt/sales are the percentages given in the problem, so:

$$\text{EFN} = \left(\frac{\text{Assets}}{\text{Sales}}\right) \times \Delta\text{Sales} - \left(\frac{\text{Spontaneous debt}}{\text{Sales}}\right) \times \Delta\text{Sales} - (PM \times \text{Projected sales}) \times (1 - d)$$

$$\text{EFN} = (.20 + .90) \times \$23{,}400{,}000 - (.15 \times \$23{,}400{,}000) - (.10 \times \$179{,}400{,}000) \times (1 - .40)$$

$$\text{EFN} = \$11{,}466{,}000$$

c. The current assets, fixed assets, and short-term debt will all increase at the same percentage as sales. The long-term debt and common stock will remain constant. The accumulated retained earnings will increase by the addition to retained earnings for the year. We can calculate the net income for the year as:

Net income = Profit margin × Sales
Net income = .10($179,400,000)
Net income = $17,940,000

The addition to retained earnings for the year will be the net income times one minus the dividend payout ratio, which is:

Addition to retained earnings = Net income(1 – *d*)
Addition to retained earnings = $17,940,000(1 – .40)
Addition to retained earnings = $10,764,000

So, the new accumulated retained earnings will be:

Accumulated retained earnings = $108,000,000 + 10,764,000
Accumulated retained earnings = $118,764,000

The pro forma balance sheet will be:

Assets		Liabilities and equity	
Current assets	$35,880,000	Short-term debt	$26,910,000
		Long-term debt	$27,200,000
Fixed assets	161,460,000	Common stock	$13,000,000
		Accumulated RE	118,764,000
		Total equity	$131,764,000
Total assets	$197,340,000	Total liabilities and equity	$185,874,000

The EFN is:

EFN = Total assets – Total liabilities and equity
EFN = $197,340,000 – 185,874,000
EFN = $11,466,000

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10. *a.* The sustainable growth rate is:

Sustainable growth rate = (ROE × *b*)/[1 – (ROE × *b*)]

where:

b = Retention ratio = 1 – Payout ratio = .70

So:

Sustainable growth rate = [.1215(.70)]/[1 – .1215(.70)]
Sustainable growth rate = .0930, or 9.30%

b. It is possible for the sustainable growth rate and the actual growth rate to differ. If any of the actual parameters in the sustainable growth rate equation differs from those used to compute the sustainable growth rate, the actual growth rate will differ from the sustainable growth rate. Since the sustainable growth rate includes ROE in the calculation, this also implies that changes in the profit margin, total asset turnover, or equity multiplier will affect the sustainable growth rate.

c. The company can increase its growth rate by doing any of the following:

Increase the debt-equity ratio by selling more debt or repurchasing stock.
Increase the profit margin, most likely by better controlling costs.
Decrease its total assets/sales ratio; in other words, utilize its assets more efficiently.
Reduce the dividend payout ratio.

Intermediate

11. The solution requires substituting two ratios into a third ratio. Rearranging D/TA:

Firm A	Firm B
D/TA = .45	D/TA = .40
(TA – E)/TA = .45	(TA – E)/TA = .40
(TA/TA) – (E/TA) = .45	(TA/TA) – (E/TA) = .40
1 – (E/TA) = .45	1 – (E/TA) = .40
E/TA = .55	E/TA = .60
E = .55(TA)	E = .60(TA)

Rearranging ROA, we find:

NI/TA = .07	NI/TA = .08
NI = .07(TA)	NI = .08(TA)

Since ROE = NI/E, we can substitute the above equations into the ROE formula, which yields:

ROE = .07(TA)/.55(TA) = .1273, or 12.73%	ROE = .08(TA)/.60(TA) = .1333, or 13.33%

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12. Profit margin = Net income/Sales
Profit margin = –£21,435/£168,327
Profit margin = –.1273, or –12.73%

As long as both net income and sales are measured in the same currency, there is no problem; in fact, except for some market value ratios like EPS and BVPS, none of the financial ratios discussed in the text are measured in terms of currency. This is one reason why financial ratio analysis is widely used in international finance to compare the business operations of firms and/or divisions across national economic borders. The net income in dollars is:

Net income = Profit margin × Sales
Net income = –.1273($214,496)
Net income = –$27,314.23

13. *a.* The equation for external funds needed is:

$$\text{EFN} = \left(\frac{\text{Assets}}{\text{Sales}}\right) \times \Delta\text{Sales} - \left(\frac{\text{Spontaneous debt}}{\text{Sales}}\right) \times \Delta\text{Sales} - (\text{PM} \times \text{Projected sales}) \times (1 - d)$$

where:

Assets/Sales = $44,980,000/$34,700,000 = 1.2963
ΔSales = Current sales × Sales growth rate = $34,700,000(.18) = $6,246,000
Spontaneous debt/Sales = $5,410,000/$34,700,000 = .1559
Profit margin = Net income/Sales = $5,852,000/$34,700,000 = .1686
Projected sales = Current sales × (1 + Sales growth rate)
= $34,700,000(1 + .18)
= $40,946,000
d = Dividends/Net income = $1,650,000/$5,852,000 = .2820

so:

EFN = (1.2963 × $6,246,000) – (.1559 × $6,246,000) – (.1686 × $40,946,000) × (1 – .2820)
EFN = $2,164,240

b. The current assets, fixed assets, and short-term debt will all increase at the same percentage as sales. The long-term debt and common stock will remain constant. The accumulated retained earnings will increase by the addition to retained earnings for the year. We can calculate the addition to retained earnings for the year as:

Net income = Profit margin × Sales
Net income = .1686($40,946,000)
Net income = $6,905,360

The addition to retained earnings for the year will be the net income times one minus the dividend payout ratio, which is:

Addition to retained earnings = Net income(1 – *d*)
Addition to retained earnings = $6,905,360(1 – .2820)
Addition to retained earnings = $4,958,360

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So, the new accumulated retained earnings will be:

Accumulated retained earnings = $28,390,000 + 4,958,360
Accumulated retained earnings = $33,348,360

The pro forma balance sheet will be:

Assets		Liabilities and equity	
Current assets	$13,310,400	Short-term debt	$6,383,800
		Long-term debt	$8,080,000
Fixed assets	39,766,000	Common stock	$3,100,000
		Accumulated RE	33,348,360
		Total equity	$36,448,360
Total assets	$53,076,400	Total liabilities and equity	$50,912,160

The EFN is:

EFN = Total assets – Total liabilities and equity
EFN = $53,076,400 – 50,912,160
EFN = $2,164,240

c. The sustainable growth rate is:

Sustainable growth rate = (ROE × *b*)/[1 – (ROE × *b*)]

where:

ROE = Net income/Total equity = $5,852,000/$31,490,000 = .1858
b = Retention ratio = Retained earnings/Net income = $4,202,000/$5,852,000 = .7180

So:

Sustainable growth rate = [.1858(.7180)]/[1 – .1858(.7180)]
Sustainable growth rate = .1540, or 15.40%

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d. With a lower dividend, the company can meet its goals. With a zero dividend, EFN is:

Assets		Liabilities and equity	
Current assets	$13,310,400	Short-term debt	$6,383,800
		Long-term debt	$8,080,000
Fixed assets	39,766,000	Common stock	$3,100,000
		Accumulated retained earnings	35,295,360
		Total equity	$38,395,360
Total assets	$53,076,400	Total liabilities and equity	$52,859,160

The EFN is:

EFN = Total assets – Total liabilities and equity
EFN = $53,076,400 – 52,859,160
EFN = $217,240

If the dividend decrease is insufficient, the company does have several other alternatives. It can increase its asset utilization and/or its profit margin. The company could also increase the debt in its capital structure. This will decrease the equity account, thereby increasing ROE.

14. This is a multi-step problem involving several ratios. It is often easier to look backward to determine where to start. We need receivables turnover to find days' sales in receivables. To calculate receivables turnover, we need credit sales, and to find credit sales, we need total sales. Since we are given the profit margin and net income, we can use these to calculate total sales as:

PM = .081 = NI/Sales
.081 = $284,000/Sales
Sales = $3,506,173

Credit sales are 80 percent of total sales, so:

Credit sales = $3,506,173(.80)
Credit sales = $2,804,938

Now we can find receivables turnover by:

Receivables turnover = Credit sales/Accounts receivable
Receivables turnover = $2,804,938/$189,600
Receivables turnover = 14.79 times

Days' sales in receivables = 365 days/Receivables turnover
Days' sales in receivables = 365/14.79
Days' sales in receivables = 24.67 days

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15. The solution to this problem requires a number of steps. First, remember that current assets plus fixed assets equal total assets. So, if we find the current assets and the total assets, we can solve for net fixed assets. Using the numbers given for the current ratio and the current liabilities, we solve for current assets:

Current ratio = Current assets/Current liabilities
1.35 = Current assets/$1,380
Current assets = $1,863

To find the total assets, we must first find the total debt and equity from the information given. So, we find the sales using the profit margin:

Profit margin = Net income/Sales
.0750 = Net income/$10,530
Net income = $789.75

We now use the sales figure as an input into ROE to find the total equity:

ROE = Net income/Total equity
.1345 = $789.75/Total equity
Total equity = $5,871.75

Next, we need to find the long-term debt. The long-term debt ratio is:

Long-term debt ratio = .45 = LTD/(LTD + TE)

Inverting both sides gives:

1/.45 = (LTD + TE)/LTD = 1 + (TE/LTD)

Substituting the total equity into the equation and solving for long-term debt gives the following:

1 + $5,871.75/LTD = 2.222
LTD = $5,871.75/1.222
LTD = $4,804.16

Now, we can find the total debt of the company:

Total debt = Current liabilities + Long-term debt
Total debt = $1,380 + 4,804.16
Total debt = $6,184.16

And, with the total debt, we can find the total debt and equity, which is equal to total assets:

Total assets = Total debt + Total equity
Total assets = $6,184.16 + 5,871.75
Total assets = $12,055.90

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And finally, we are ready to solve the balance sheet identity as:

Net fixed assets = Total assets – Current assets
Net fixed assets = $12,055.90 – 1,863
Net fixed assets = $10,192.90

16. This problem requires you to work backward through the income statement. First, recognize that:

Net income = $(1 - T_C)$EBT

Plugging in the numbers given and solving for EBT, we get:

Net income = $(1 - T_C)$EBT
$32,145 = (1 – .21)EBT
EBT = $40,689.87

Now, we can add interest to EBT to get EBIT as follows:

EBIT = EBT + Interest paid
EBIT = $40,689.87 + 8,640
EBIT = $49,329.87

To get EBITD (earnings before interest, taxes, and depreciation), the numerator in the cash coverage ratio, add depreciation to EBIT:

EBITD = EBIT + Depreciation
EBITD = $49,329.87 + 9,730
EBITD = $59,059.87

Now, we can plug the numbers into the cash coverage ratio and calculate:

Cash coverage ratio = EBITD/Interest
Cash coverage ratio = $59,059.87/$8,640
Cash coverage ratio = 6.84 times

17. The only ratio given which includes cost of goods sold is the inventory turnover ratio, so it is the last ratio used. Since current liabilities are given, we start with the current ratio:

Current ratio = Current assets/Current liabilities
1.45 = Current assets/$305,000
Current assets = $442,250

Using the quick ratio, we can solve for inventory:

Quick ratio = (Current assets – Inventory)/Current liabilities
.85 = ($442,250 – Inventory)/$305,000
$259,250 = $442,250 – Inventory
Inventory = $183,000

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Now, we can solve for the cost of goods sold using the inventory turnover, which gives us:

Inventory turnover = COGS/Inventory
14.85 = COGS/$183,000
COGS = $2,717,550

18. The common-size balance sheet answers are found by dividing each category by total assets. For example, the cash percentage for 2019 is:

$17,928/$517,952 = .0346, or 3.46%

This means that cash is 3.46% of total assets.

The common-base year answers are found by dividing each category value for 2020 by the same category value for 2019. For example, the cash common-base year number is found by:

$22,608/$17,928 = 1.12610

The common-size and common-base year balance sheets for the company are:

	2019	Common size	**2020**	Common size	Common base year
		Assets			
Current assets					
Cash	$21,514	3.40%	$25,878	3.74%	1.2028
Accounts receivable	34,278	5.41%	36,993	5.35%	1.0792
Inventory	28,328	4.47%	65,749	9.50%	2.3210
Total	$84,120	13.29%	$128,620	18.59%	1.5290
Fixed assets					
Net plant and equipment	548,909	86.71%	$563,412	81.41%	1.0264
Total assets	$633,029	100%	$692,032	100.00%	1.0932
		Liabilities and Owners' Equity			
Current liabilities					
Accounts payable	$29,711	4.69%	$37,027	5.35%	1.2462
Notes payable	37,514	5.93%	45,397	6.56%	1.2101
Total	$67,225	10.62%	$82,424	11.91%	1.2261
Long-term debt	$51,200	8.09%	$80,500	11.63%	1.5723
Owners' equity					
Common stock	$63,000	9.95%	$63,000	9.10%	1.0000
Accumulated RE	451,604	71.34%	466,108	67.35%	1.0321
Total	$514,604	81.29%	$529,108	76.46%	1.0282
Total L&E	$633,029	100%	$692,032	100.00%	1.0932

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19. To determine full capacity sales, we divide the current sales by the capacity the company is currently using, so:

Full capacity sales = $850,000/.94
Full capacity sales = $904,255

The maximum sales growth is the full capacity sales divided by the current sales, so:

Maximum sales growth = ($904,255/$850,000) – 1
Maximum sales growth = .0638, or 6.38%

20. To find the new level of fixed assets, we need to find the full capacity ratio. Doing so, we find:

Full capacity ratio = Fixed assets/Full capacity sales
Full capacity ratio = $935,000/$904,255
Full capacity ratio = 1.0340

Next, we calculate the total dollar amount of fixed assets needed at the new sales figure.

Total fixed assets = 1.0340($925,000)
Total fixed assets = $956,450

The new fixed assets necessary is the total fixed assets at the new sales figure minus the current level of fixed assets.

New fixed assets = $956,450 – 935,000
New fixed assets = $21,450

21. Assuming costs vary with sales and a 20 percent increase in sales, the pro forma income statement will look like this:

Pro Forma Income Statement

Sales	$ 820,224
Costs	680,688
Other expenses	20,784
EBIT	$ 118,752
Interest	15,780
Taxable income	$ 102,972
Taxes	21,624
Net income	$ 81,348

The payout ratio is constant, so the dividends paid this year is the payout ratio from last year times net income, or:

Dividends = ($22,719/$65,712)($81,348)
Dividends = $28,125

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And the addition to retained earnings will be:

Addition to retained earnings = $81,348 – 28,125
Addition to retained earnings = $53,223

The new retained earnings on the pro forma balance sheet will be:

New retained earnings = $157,802 + 53,223
New retained earnings = $211,025

The pro forma balance sheet will look like this:

Pro Forma Balance Sheet

Assets		Liabilities and Owners' Equity	
Current assets		Current liabilities	
Cash	$ 24,785	Accounts payable	$ 66,096
Accounts receivable	35,662	Notes payable	13,776
Inventory	85,159	Total	$ 79,872
Total	$ 145,606	Long-term debt	127,000
Fixed assets			
Net plant and equipment	404,784	Owners' equity	
		Common stock and paid-in surplus	$ 105,000
		Retained earnings	211,025
		Total	$ 316,025
Total assets	$ 550,390	Total liabilities and owners' equity	$ 522,897

So the EFN is:

EFN = Total assets – Total liabilities and equity
EFN = $550,390 – 522,897
EFN = $27,493

22. First, we need to calculate full capacity sales, which is:

Full capacity sales = $683,520/.85
Full capacity sales = $804,141

The full capacity ratio at full capacity sales is:

Full capacity ratio = Fixed assets/Full capacity sales
Full capacity ratio = $337,320/$804,141
Full capacity ratio = .41948

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The fixed assets required at full capacity sales is the full capacity ratio times the projected sales level:

Total fixed assets = .41948($820,224) = $344,066

So, EFN is:

EFN = ($145,606 + 344,066) – $522,897 = –$33,225

23. The D/E ratio of the company is:

D/E = ($68,856 + 127,000)/$262,802
D/E = .7453

So the new total debt amount will be:

New total debt = .7453($316,025)
New total debt = $235,521

This is the new total debt for the company. Given that our calculation for EFN is the amount that must be raised externally and does not increase spontaneously with sales, we need to subtract the spontaneous increase in accounts payable. The new level of accounts payable, which is the current accounts payable times the sales growth, will increase by:

Spontaneous increase in accounts payable = $55,080(.20)
Spontaneous increase in accounts payable = $11,016

This means that $11,016 of the new total debt is not raised externally. So, the debt raised externally, which will be the EFN is:

EFN = New total debt – (Beginning LTD + Beginning current liabilities + Spontaneous increase in AP)
EFN = $235,521 – ($127,000 + 68,856 + 11,016)
EFN = $28,649

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The pro forma balance sheet with the new long-term debt will be:

Pro Forma Balance Sheet

Assets		Liabilities and Owners' Equity	
Current assets		Current liabilities	
Cash	$ 24,785	Accounts payable	$ 66,096
Accounts receivable	35,662	Notes payable	13,776
Inventory	85,159	Total	$ 79,872
Total	$ 145,606	Long-term debt	155,649
Fixed assets			
Net plant and equipment	404,784	Owners' equity	
		Common stock and paid-in surplus	$ 105,000
		Retained earnings	211,025
		Total	$ 316,025
		Total liabilities and owners'	
Total assets	$ 550,390	equity	$ 551,546

The funds raised by the debt issue can be put into an excess cash account to make the balance sheet balance. The excess debt will be:

Excess debt = $551,546 – 550,390 = $1,157

To make the balance sheet balance, the company will have to increase its assets. We will put this amount in an account called excess cash, which will give us the following balance sheet:

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Pro Forma Balance Sheet

Assets		Liabilities and Owners' Equity	
Current assets		Current liabilities	
Cash	$ 24,785	Accounts payable	$ 66,096
Excess cash	1,157		
Accounts receivable	35,662	Notes payable	13,776
Inventory	85,159	Total	$ 79,872
Total	$ 146,762	Long-term debt	$ 155,649
Fixed assets			
Net plant and equipment	407,784	Owners' equity	
		Common stock and paid-in surplus	$ 105,000
		Retained earnings	211,025
		Total	$ 316,025
Total assets	$ 551,546	Total liabilities and owners' equity	$ 551,546

The excess cash has an opportunity cost that we discussed earlier. Increasing fixed assets would also not be a good idea since the company already has enough fixed assets. A likely scenario would be the repurchase of debt and equity in its current capital structure weights. The company's debt/assets and equity/assets are:

Debt/assets = .7453/(1 + .7453) = .43
Equity/assets = 1/(1 + .7453) = .57

So, the amount of debt and equity needed will be:

Total debt needed = .43($550,390) = $235,027
Equity needed = .57($550,390) = $315,362

So, the repurchases of debt and equity will be:

Debt repurchase = ($79,872 + 155,649) – 235,027 = $494
Equity repurchase = $316,025 – 315,362 = $663

Assuming all of the debt repurchase is from long-term debt, and the equity repurchase is entirely from the retained earnings, the final pro forma balance sheet will be:

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RETRO MACHINE, INC.
Pro Forma Balance Sheet

Assets		Liabilities and Owners' Equity	
Current assets		Current liabilities	
Cash	$ 24,785	Accounts payable	$ 66,096
Accounts receivable	35,662	Notes payable	13,776
Inventory	85,159	Total	$ 79,872
Total	$ 145,606	Long-term debt	155,155
Fixed assets			
Net plant and equipment	404,784	Owners' equity	
		Common stock and paid-in surplus	$ 105,000
		Retained earnings	210,362
		Total	$ 315,362
Total assets	$ 550,390	Total liabilities and owners' equity	$ 550,390

Challenge

24. The pro forma income statements for all three growth rates will be:

Pro Forma Income Statement

	15 % Sales Growth	*20% Sales Growth*	*25% Sales Growth*
Sales	$786,048	$820,224	$854,400
Costs	652,326	680,688	709,050
Other expenses	19,918	20,784	21,650
EBIT	$113,804	$118,752	$123,700
Interest	15,780	15,780	15,780
Taxable income	$98,024	$102,972	$107,920
Taxes	20,585	21,624	22,663
Net income	$77,439	$81,348	$85,257
Dividends	$26,773	$28,125	$29,476
Add to RE	50,666	53,223	55,781

We will calculate the EFN for the 15 percent growth rate first. Assuming the payout ratio is constant, the dividends paid will be:

Dividends = ($22,719/$65,712)($77,439)
Dividends = $26,773

And the addition to retained earnings will be:

Addition to retained earnings = $77,439 – 26,773
Addition to retained earnings = $50,666

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The new retained earnings on the pro forma balance sheet will be:

New retained earnings = $157,802 + 50,666
New retained earnings = $208,468

The pro forma balance sheet will look like this:

15% Sales Growth:

Pro Forma Balance Sheet

Assets		Liabilities and Owners' Equity	
Current assets		Current liabilities	
Cash	$ 23,752	Accounts payable	$ 63,342
Accounts receivable	34,176	Notes payable	13,776
Inventory	81,611	Total	$ 77,118
Total	$ 139,539	Long-term debt	$ 127,000
Fixed assets			
Net plant and equipment	387,918	Owners' equity	
		Common stock and paid-in surplus	$ 105,000
		Retained earnings	208,468
		Total	$ 313,468
Total assets	$ 527,457	Total liabilities and owners' equity	$ 517,586

So the EFN is:

EFN = Total assets – Total liabilities and equity
EFN = $527,457 – 517,586
EFN = $9,871

At a 20 percent growth rate, and assuming the payout ratio is constant, the dividends paid will be:

The payout ratio is constant, so the dividends paid this year is the payout ratio from last year times net income, or:

Dividends = ($22,719/$65,712)($81,348)
Dividends = $28,125

And the addition to retained earnings will be:

Addition to retained earnings = $81,348 – 28,125
Addition to retained earnings = $53,223

The new retained earnings on the pro forma balance sheet will be:

New retained earnings = $157,802 + 53,223
New retained earnings = $211,025

The pro forma balance sheet will look like this:

20% sales growth:

RETRO MACHINE, INC.
Pro Forma Balance Sheet

Assets		Liabilities and Owners' Equity	
Current assets		Current liabilities	
Cash	$ 24,785	Accounts payable	$ 66,096
Accounts receivable	35,662	Notes payable	13,776
Inventory	85,159	Total	$ 79,872
Total	$ 145,606	Long-term debt	127,000
Fixed assets			
Net plant and equipment	404,784	Owners' equity	
		Common stock and paid-in surplus	$ 105,000
		Retained earnings	211,025
		Total	$ 316,025
Total assets	$ 550,390	Total liabilities and owners' equity	$ 522,897

So the EFN is:

EFN = Total assets – Total liabilities and equity
EFN = $550,390 – 522,897
EFN = $27,493

At a 25 percent growth rate, and assuming the payout ratio is constant, the dividends paid will be:

Dividends = ($22,719/$65,712)($85,257)
Dividends = $29,476

And the addition to retained earnings will be:

Addition to retained earnings = $85,257 – 29,746
Addition to retained earnings = $55,781

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The new retained earnings on the pro forma balance sheet will be:

New retained earnings = $157,802 + 55,781
New retained earnings = $213,583

The pro forma balance sheet will look like this:

25% Sales Growth:

Pro Forma Balance Sheet

Assets		Liabilities and Owners' Equity	
Current assets		Current liabilities	
Cash	$ 25,818	Accounts payable	$ 68,850
Accounts receivable	37,148	Notes payable	13,776
Inventory	88,708	Total	$ 82,626
Total	$ 151,673	Long-term debt	$ 127,000
Fixed assets			
Net plant and equipment	421,650	Owners' equity	
		Common stock and paid-in surplus	$ 105,000
		Retained earnings	213,583
		Total	$ 318,583
Total assets	$ 573,323	Total liabilities and owners' equity	$ 528,209

So the EFN is:

EFN = Total assets – Total liabilities and equity
EFN = $573,323 – 528,209
EFN = $45,114

25. The pro forma income statements for all three growth rates will be:

	Pro Forma Income Statement		
	20% Sales Growth	*30% Sales Growth*	*35% Sales Growth*
Sales	$820,224	$888,576	$922,752
Costs	680,688	737,412	765,774
Other expenses	20,784	22,516	23,382
EBIT	$118,752	$128,648	$133,596
Interest	15,780	15,780	15,780
Taxable income	$102,972	$112,868	$117,816
Taxes	21,624	23,702	24,741
Net income	$81,348	$89,166	$93,075
Dividends	$28,125	$30,828	$32,179
Add to RE	53,223	58,338	60,895

At a 30 percent growth rate, and assuming the payout ratio is constant, the dividends paid will be:

Dividends = ($22,719/$65,712)($89,166)
Dividends = $30,828

And the addition to retained earnings will be:

Addition to retained earnings = $89,166 – 30,828
Addition to retained earnings = $58,338

The new addition to retained earnings on the pro forma balance sheet will be:

New addition to retained earnings = $157,802 + 58,338
New addition to retained earnings = $216,140

The new total debt will be:

New total debt = .7453($321,140)
New total debt = $239,333

So, the new long-term debt will be the new total debt minus the new short-term debt, or:

New long-term debt = $239,333 – 85,380
New long-term debt = $153,953

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The pro forma balance sheet will look like this:

Sales growth rate = 30% and debt/equity ratio = .7453:

Pro Forma Balance Sheet

Assets		Liabilities and Owners' Equity	
Current assets		Current liabilities	
Cash	$ 26,850	Accounts payable	$ 71,604
Accounts receivable	38,633	Notes payable	13,776
Inventory	92,256	Total	$ 85,380
Total	$ 157,739	Long-term debt	153,953
Fixed assets			
Net plant and equipment	438,516	Owners' equity	
		Common stock and paid-in surplus	$ 105,000
		Retained earnings	216,140
		Total	$ 321,140
Total assets	$ 596,255	Total liabilities and owners' equity	$ 560,473

So the excess debt raised is:

Excess debt = $560,473 – 596,255
Excess debt = –$35,782

At a 30 percent growth rate, the firm will need funds in the amount of $35,782 in addition to the external debt already raised. So, the EFN will be:

EFN = $26,953 + 35,782
EFN = $62,735

At a 35 percent growth rate, and assuming the payout ratio is constant, the dividends paid will be:

Dividends = ($22,719/$65,712)($93,075)
Dividends = $32,179

And the addition to retained earnings will be:

Addition to retained earnings = $93,075 – 32,179
Addition to retained earnings = $60,895

The new retained earnings on the pro forma balance sheet will be:

New retained earnings = $157,802 + 60,895
New retained earnings = $218,697

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The new total debt will be:

New total debt = .7453($323,697)
New total debt = $241,239

So, the new long-term debt will be the new total debt minus the new short-term debt, or:

New long-term debt = $241,239 – 88,134
New long-term debt = $153,105

Sales growth rate = 35% and debt/equity ratio = .7453:

Pro Forma Balance Sheet

Assets		Liabilities and Owners' Equity	
Current assets		Current liabilities	
Cash	$ 27,883	Accounts payable	$ 74,358
Accounts receivable	40,119	Notes payable	13,776
Inventory	95,804	Total	$ 88,134
Total	$ 163,806	Long-term debt	$ 153,105
Fixed assets			
Net plant and equipment	455,382	Owners' equity	
		Common stock and paid-in surplus	$ 105,000
		Retained earnings	218,697
		Total	$ 323,697
		Total liabilities and owners'	
Total assets	$ 619,188	equity	$ 564,937

So the excess debt raised is:

Excess debt = $564,937 – 619,188
Excess debt = –$54,252

At a 35 percent growth rate, the firm will need funds in the amount of $54,252 in addition to the external debt already raised. So, the EFN will be:

EFN = $26,105 + 54,252
EFN = $80,357

26. We need the ROE to calculate the sustainable growth rate. The ROE is:

ROE = (PM)(TAT)(EM)
ROE = (.065)(1/2.10)(1 + .35)
ROE = .0418, or 4.18%

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Now, we can use the sustainable growth rate equation to find the retention ratio as:

Sustainable growth rate = (ROE × b)/[1 – (ROE × b)]
Sustainable growth rate = .10 = .0418b/(1 – .0418b)
b = 2.18

This implies the payout ratio is:

Payout ratio = 1 – b
Payout ratio = 1 – 2.18
Payout ratio = –1.18

This is a negative dividend payout ratio of 118 percent, which is impossible. The growth rate is not consistent with the other constraints. The lowest possible payout rate is 0, which corresponds to a retention ratio of 1, or total earnings retention.

The maximum sustainable growth rate for this company is:

Maximum sustainable growth rate = (ROE × b)/[1 – (ROE × b)]
Maximum sustainable growth rate = [.0418(1)]/[1 – .0418(1)]
Maximum sustainable growth rate = .0436, or 4.36%

27. Assuming that all debt is constant, we know that EFN is:

EFN = Increase in assets – Addition to retained earnings

The increase in assets is the beginning assets times the growth rate, so:

Increase in assets = A × g

The addition to retained earnings next year is the current net income times the retention ratio, times one plus the growth rate, so:

Addition to retained earnings = (NI × b)(1 + g)

And rearranging the profit margin to solve for net income, we get:

NI = PM(S)

Substituting the last three equations into the EFN equation we started with and rearranging, we get:

EFN = A(g) – PM(S)b(1 + g)
EFN = A(g) – PM(S)b – [PM(S)b]g
EFN = –PM(S)b + [A – PM(S)b]g

28. We start with the EFN equation we derived in Problem 27 and set it equal to zero:

EFN = 0 = –PM(S)b + [A – PM(S)b]g

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Substituting the rearranged profit margin equation into the internal growth rate equation, we have:

Internal growth rate = [PM(S)*b*]/[A – PM(S)*b*]

Since:

ROA = NI/A
ROA = PM(S)/A

We can substitute this into the internal growth rate equation and divide both the numerator and denominator by A. This gives:

Internal growth rate = {[PM(S)*b*]/A}/{[A – PM(S)*b*]/A}
Internal growth rate = *b*(ROA)/[1 – *b*(ROA)]

To derive the sustainable growth rate, we must realize that to maintain a constant D/E ratio with no external equity financing, EFN must equal the addition to retained earnings times the D/E ratio:

EFN = (D/E)[PM(S)*b*(1 + *g*)]
EFN = A(*g*) – PM(S)*b*(1 + *g*)

Solving for g and then dividing numerator and denominator by A:

Sustainable growth rate = PM(S)*b*(1 + D/E)/[A – PM(S)*b*(1 + D/E)]
Sustainable growth rate = [ROA(1 + D/E)*b*]/[1 – ROA(1 + D/E)*b*]
Sustainable growth rate = *b*(ROE)/[1 – *b*(ROE)]

29. In the following derivations, the subscript "E" refers to end of period numbers, and the subscript "B" refers to beginning of period numbers. TE is total equity and TA is total assets.

For the sustainable growth rate*:*

Sustainable growth rate = ($ROE_E \times b$)/(1 – $ROE_E \times b$)
Sustainable growth rate = ($NI/TE_E \times b$)/(1 – $NI/TE_E \times b$)

We multiply this equation by:

(TE_E/TE_E)

Sustainable growth rate = ($NI/TE_E \times b$)/(1 – $NI/TE_E \times b$) × (TE_E/TE_E)
Sustainable growth rate = ($NI \times b$)/(TE_E – $NI \times b$)

Recognize that the denominator is equal to beginning of period equity, that is:

(TE_E – $NI \times b$) = TE_B

Substituting this into the previous equation, we get:

Sustainable rate = ($NI \times b$)/TE_B

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Which is equivalent to:

Sustainable rate = $(NI/TE_B) \times b$

Since $ROE_B = NI/TE_B$

The sustainable growth rate equation is:

Sustainable growth rate = $ROE_B \times b$

For the internal growth rate:

Internal growth rate = $(ROA_E \times b)/(1 - ROA_E \times b)$
Internal growth rate = $(NI/TA_E \times b)/(1 - NI/TA_E \times b)$

We multiply this equation by:

(TA_E/TA_E)

Internal growth rate = $(NI/TA_E \times b)/(1 - NI/TA_E \times b) \times (TA_E/TA_E)$
Internal growth rate = $(NI \times b)/(TA_E - NI \times b)$

Recognize that the denominator is equal to beginning of period assets, that is:

$(TA_E - NI \times b) = TA_B$

Substituting this into the previous equation, we get:

Internal growth rate = $(NI \times b)/TA_B$

Which is equivalent to:

Internal growth rate = $(NI/TA_B) \times b$

Since $ROA_B = NI/TA_B$

The internal growth rate equation is:

Internal growth rate = $ROA_B \times b$

30. Since the company issued no new equity, shareholders' equity increased by retained earnings. Retained earnings for the year were:

Retained earnings = NI – Dividends
Retained earnings = $75,000 – 32,000
Retained earnings = $43,000

So, the equity at the end of the year was:

Ending equity = $265,000 + 43,000
Ending equity = $308,000

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The ROE based on the end of period equity is:

ROE = $75,000/$308,000
ROE = .2435, or 24.35%

The plowback ratio is:

Plowback ratio = Addition to retained earnings/NI
Plowback ratio = $43,000/$75,000
Plowback ratio = .5733, or 57.33%

Using the equation presented in the text for the sustainable growth rate, we get:

Sustainable growth rate = (ROE × *b*)/[1 – (ROE × *b*)]
Sustainable growth rate = [.2435(.5733)]/[1 – .2435(.5733)]
Sustainable growth rate = .1623, or 16.23%

The ROE based on the beginning of period equity is:

ROE = $75,000/$265,000
ROE = .2830, or 28.30%

Using the shortened equation for the sustainable growth rate and the beginning of period ROE, we get:

Sustainable growth rate = ROE × *b*
Sustainable growth rate = .2830 × .5733
Sustainable growth rate = .1623, or 16.23%

Using the shortened equation for the sustainable growth rate and the end of period ROE, we get:

Sustainable growth rate = ROE × *b*
Sustainable growth rate = .2435 × .5733
Sustainable growth rate = .1396, or 13.96%

Using the end of period ROE in the shortened sustainable growth rate results in a growth rate that is too low. This will always occur whenever the equity increases. If equity increases, the ROE based on end of period equity is lower than the ROE based on beginning of period equity. The ROE (and sustainable growth rate) in the abbreviated equation is based on equity that did not exist when the net income was earned.

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CHAPTER 4
DISCOUNTED CASH FLOW VALUATION

Answers to Concept Questions

1. Assuming positive cash flows and interest rates, the future value increases and the present value decreases.

2. Assuming positive cash flows and interest rates, the present value will fall and the future value will rise.

3. The better deal is the one with equal installments.

4. Yes, they should. APRs generally don't provide the relevant rate. The only advantage is that they are easier to compute, but, with modern computing equipment, that advantage is not very important.

5. A freshman does. The reason is that the freshman gets to use the money for much longer before interest starts to accrue.

6. It's a reflection of the time value of money. TMCC gets to use the $24,099 immediately. If TMCC uses it wisely, it will be worth more than $100,000 in thirty years.

7. Oddly enough, it actually makes it more desirable since TMCC only has the right to pay the full $100,000 before it is due. This is an example of a "call" feature. Such features are discussed at length in a later chapter.

8. The key considerations would be: (1) Is the rate of return implicit in the offer attractive relative to other, similar risk investments? and (2) How risky is the investment; i.e., how certain are we that we will actually get the $100,000? Thus, our answer does depend on who is making the promise to repay.

9. The Treasury security would have a somewhat higher price because the Treasury is the strongest of all borrowers.

10. The price would be higher because, as time passes, the price of the security will tend to rise toward $100,000. This rise is just a reflection of the time value of money. As time passes, the time until receipt of the $100,000 grows shorter, and the present value rises. In 2025, the price will probably be higher for the same reason. We cannot be sure, however, because interest rates could be much higher, or TMCC's financial position could deteriorate. Either event would tend to depress the security's price.

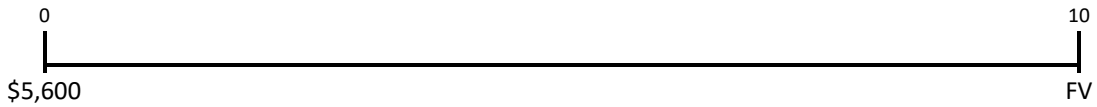
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Solutions to Questions and Problems

NOTE: All-end-of chapter problems were solved using a spreadsheet. Many problems require multiple steps. Due to space and readability constraints, when these intermediate steps are included in this solutions manual, rounding may appear to have occurred. However, the final answer for each problem is found without rounding during any step in the problem.

Basic

1. The time line for the cash flows is:



The simple interest per year is:

$5,600 × .07 = $392

So, after 10 years, you will have:

$392 × 10 = $3,920 in interest

The total balance will be $5,600 + 3,920 = $9,520

With compound interest, we use the future value formula:

$FV = PV(1 + r)^t$
$FV = \$5,600(1.07)^{10}$
FV = $11,016.05

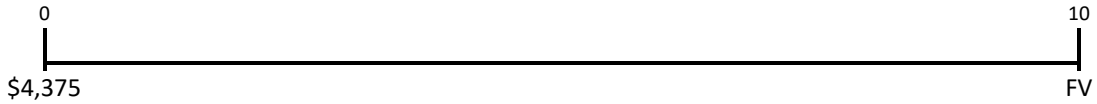
The difference is:

$11,016.05 – 9,520 = $1,496.05

2. To find the FV of a lump sum, we use:

$FV = PV(1 + r)^t$

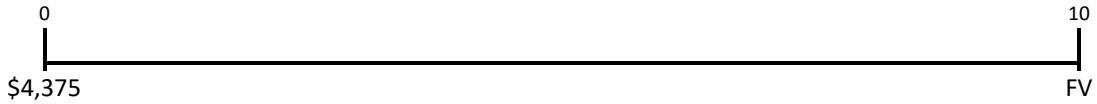
The time line for the cash flows is:



$FV = \$4,375(1.06)^{10}$ = $7,834.96

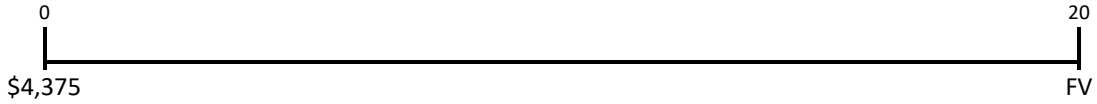
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b. The time line for the cash flows is:



$FV = \$4{,}375(1.08)^{10} = \$9{,}445.30$

c. The time line for the cash flows is:

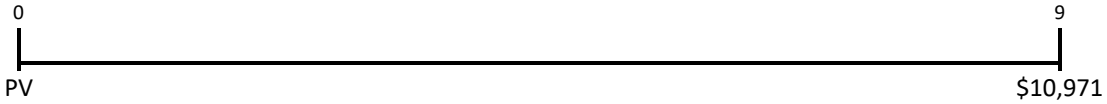


$FV = \$4{,}375(1.06)^{20} = \$14{,}031.22$

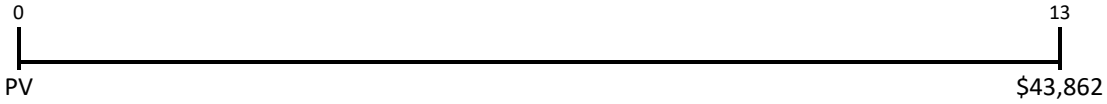
d. Because interest compounds on the interest already earned, the interest earned in part (c) is more than twice the interest earned in part (a). With compound interest, future values grow exponentially.

3. To find the PV of a lump sum, we use:

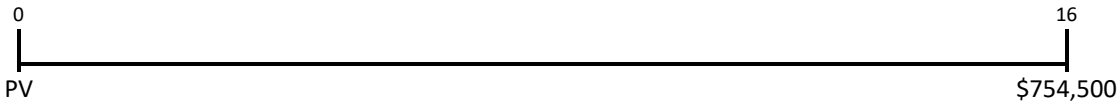
$PV = FV/(1 + r)^t$



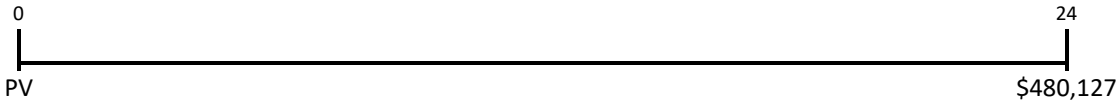
$PV = \$10{,}971/1.07^9 = \$5{,}967.50$



$PV = \$43{,}862/1.09^{13} = \$14{,}306.85$



$PV = \$754{,}500/1.14^{16} = \$92{,}721.75$



$PV = \$480{,}127/1.11^{24} = \$39{,}228.77$

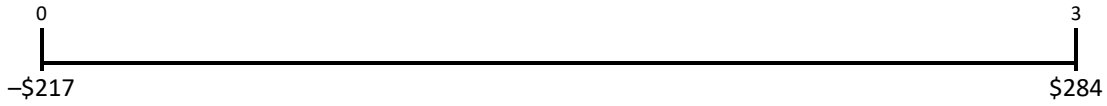
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4. To answer this question, we can use either the FV or the PV formula. Both will give the same answer since they are the inverse of each other. We will use the FV formula, that is:

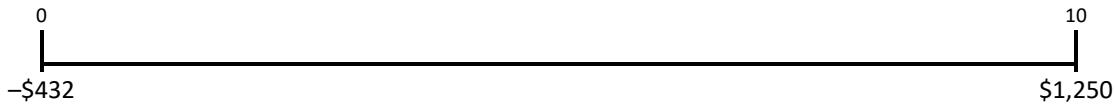
$FV = PV(1 + r)^t$

Solving for r, we get:

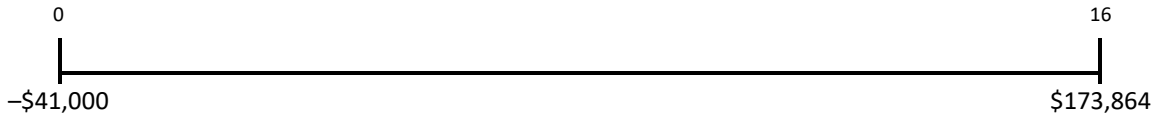
$r = (FV/PV)^{1/t} - 1$



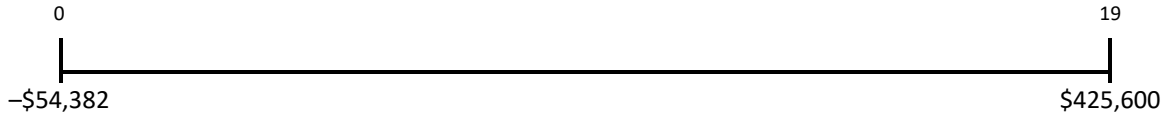
$FV = \$284 = \$217(1 + r)^3$; $r = (\$284/\$217)^{1/3} - 1$ = .0938, or 9.38%



$FV = \$1,250 = \$432(1 + r)^{10}$; $r = (\$1,250/\$432)^{1/10} - 1$ = .1121, or 11.21%



$FV = \$173,864 = \$41,000(1 + r)^{16}$; $r = (\$173,864/\$41,000)^{1/16} - 1$ = .0945, or 9.45%



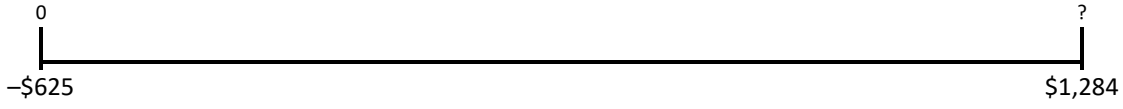
$FV = \$425,600 = \$54,382(1 + r)^{19}$; $r = (\$425,600/\$54,382)^{1/19} - 1$ = .1144, or 11.44%

5. To answer this question, we can use either the FV or the PV formula. Both will give the same answer since they are the inverse of each other. We will use the FV formula, that is:

$FV = PV(1 + r)^t$

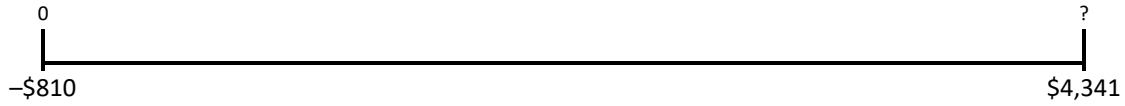
Solving for t, we get:

$t = \ln(FV/PV)/\ln(1 + r)$

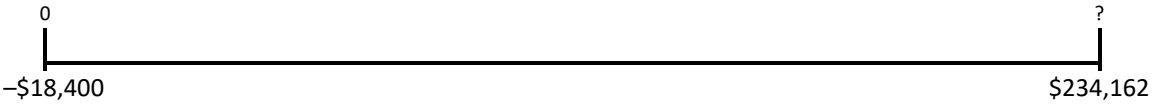


$FV = \$1,284 = \$625(1.07)^t$; $t = \ln(\$1,284/\$625)/\ln 1.07$ = 10.64 years

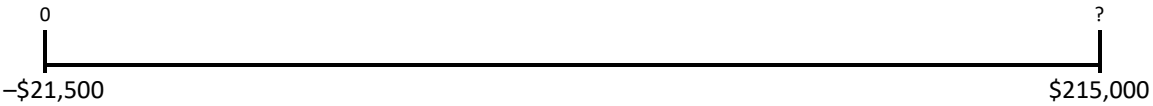
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FV = $4,341 = $810(1.10)^t; t = ln($4,341/$810)/ln 1.10 = 17.61 years



FV = $234,162 = $18,400(1.08)^t; t = ln($234,162/$18,400)/ln 1.08 = 33.05 years



FV = $215,000 = $21,500(1.13)^t; t = ln($215,000/$21,500)/ln 1.13 = 18.84 years

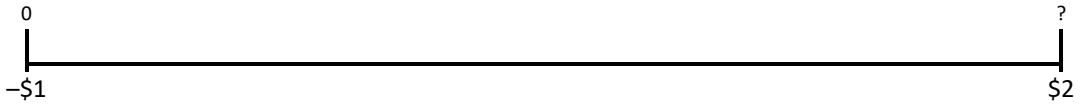
6. To find the length of time for money to double, triple, etc., the present value and future value are irrelevant as long as the future value is twice the present value for doubling, three times as large for tripling, etc. To answer this question, we can use either the FV or the PV formula. Both will give the same answer since they are the inverse of each other. We will use the FV formula, that is:

FV = PV(1 + r)^t

Solving for t, we get:

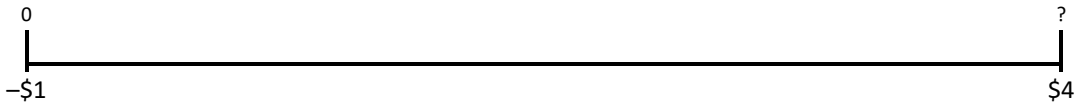
t = ln(FV/PV)/ln(1 + r)

The length of time to double your money is:



FV = $2 = $1(1.0483)^t
t = ln 2/ln 1.0483 = 14.69 years

The length of time to quadruple your money is:

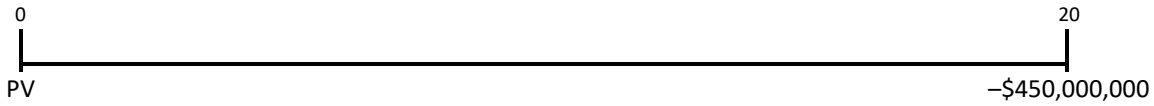


FV = $4 = $1(1.0483)^t
t = ln 4/ln 1.0483 = 29.39 years

Notice that the length of time to quadruple your money is twice as long as the time needed to double your money (the difference is due to rounding). This is an important concept of time value of money.

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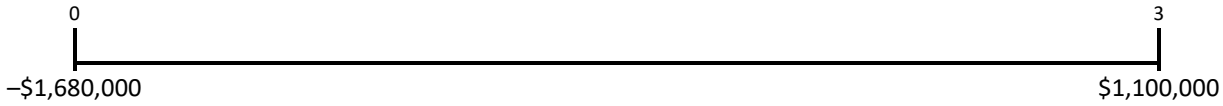
7. The time line is:



To find the PV of a lump sum, we use:

$PV = FV/(1 + r)^t$
$PV = \$450,000,000/(1.048)^{20}$
$PV = \$176,192,274.03$

8. The time line is:



To answer this question, we can use either the FV or the PV formula. Both will give the same answer since they are the inverse of each other. We will use the FV formula, that is:

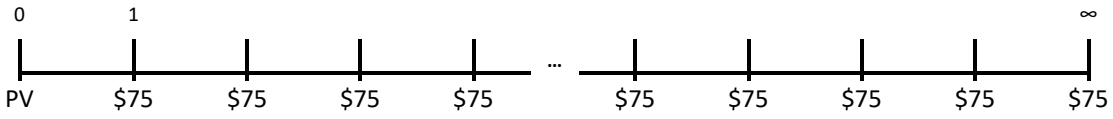
$FV = PV(1 + r)^t$

Solving for r, we get:

$r = (FV/PV)^{1/t} - 1$
$r = (\$1,100,000/\$1,680,000)^{1/3} - 1$
$r = -.1317$, or -13.17%

Notice that the interest rate is negative. This occurs when the FV is less than the PV.

9. The time line is:



A consol is a perpetuity. To find the PV of a perpetuity, we use the equation:

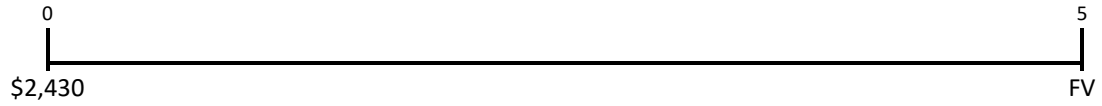
$PV = C/r$
$PV = \$75/.031$
$PV = \$2,419.35$

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10. To find the future value with continuous compounding, we use the equation:

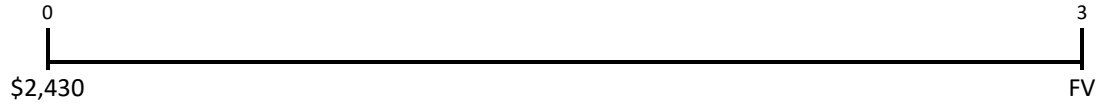
$FV = PVe^{Rt}$

a.



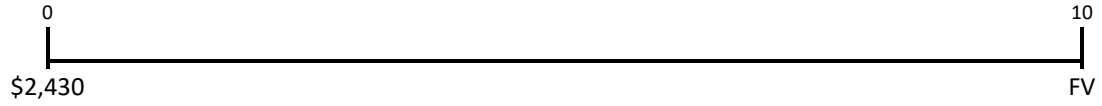
$FV = \$2{,}430e^{.14(5)} = \$4{,}893.42$

b.



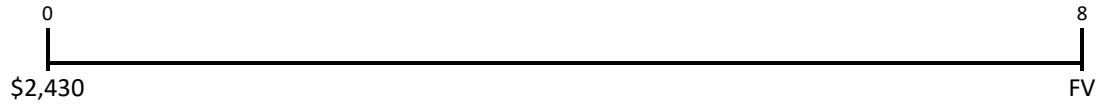
$FV = \$2{,}430e^{.06(3)} = \$2{,}909.24$

c.



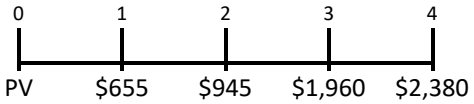
$FV = \$2{,}430e^{.08(10)} = \$5{,}408.06$

d.



$FV = \$2{,}430e^{.09(8)} = \$4{,}992.27$

11. The time line is:



To solve this problem, we must find the PV of each cash flow and add them. To find the PV of a lump sum, we use:

$PV = FV/(1 + r)^t$

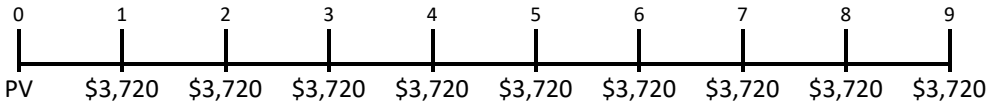
$PV@5\% = \$655/1.05 + \$945/1.05^2 + \$1{,}960/1.05^3 + \$2{,}380/1.05^4 = \$5{,}132.11$

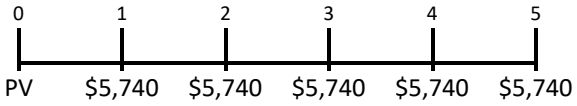
$PV@13\% = \$655/1.13 + \$945/1.13^2 + \$1{,}960/1.13^3 + \$2{,}380/1.13^4 = \$4{,}137.80$

$PV@18\% = \$655/1.18 + \$945/1.18^2 + \$1{,}960/1.18^3 + \$2{,}380/1.18^4 = \$3{,}654.26$

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12. The times lines are:





To find the PVA, we use the equation:

$PVA = C(\{1 - [1/(1 + r)^t]\}/r)$

At an interest rate of 5 percent:

X@5%: $PVA = \$3{,}720\{[1 - (1/1.05)^9]/.05\} = \$26{,}441.10$

Y@5%: $PVA = \$5{,}740\{[1 - (1/1.05)^5]/.05\} = \$24{,}851.20$

And at an interest rate of 21 percent:

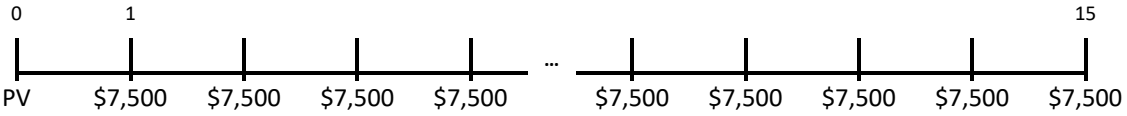
X@21%: $PVA = \$3{,}720\{[1 - (1/1.21)^9]/.21\} = \$14{,}528.22$

Y@21%: $PVA = \$5{,}740\{[1 - (1/1.21)^5]/.21\} = \$16{,}795.15$

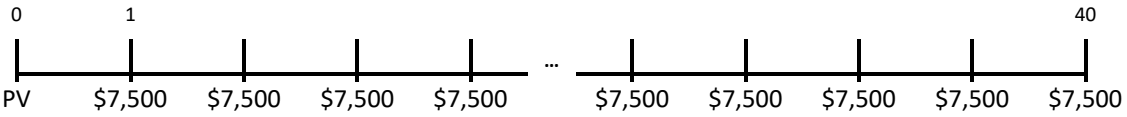
Notice that the PV of Cash Flow X has a greater PV at an interest rate of 5 percent, but a lower PV at an interest rate of 21 percent. The reason is that X has greater total cash flows. At a lower interest rate, the total cash flow is more important since the cost of waiting (the interest rate) is not as great. At a higher interest rate, Y is more valuable since it has larger cash flows. At a higher interest rate, these bigger cash flows early are more important since the cost of waiting (the interest rate) is so much greater.

13. To find the PVA, we use the equation:

$PVA = C(\{1 - [1/(1 + r)^t]\}/r)$

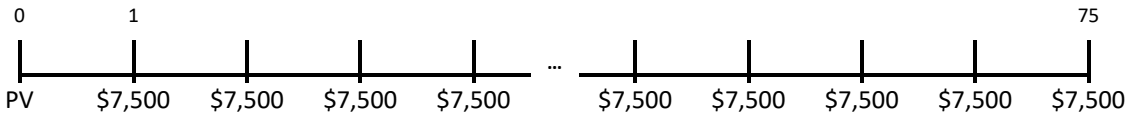


PVA@15 yrs: $PVA = \$7{,}500\{[1 - (1/1.068)^{15}]/.068\} = \$69{,}180.70$



PVA@40 yrs: $PVA = \$7{,}500\{[1 - (1/1.068)^{40}]/.068\} = \$102{,}356.28$

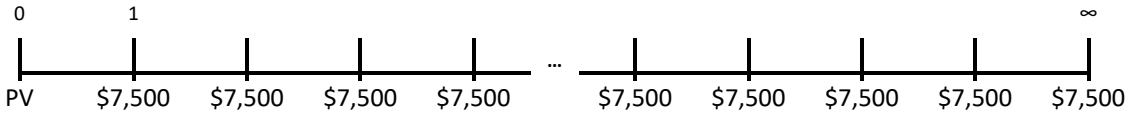
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PVA@75 yrs: PVA = $7,500{[1 – (1/1.068)^{75}]/.068} = $109,500.32

To find the PV of a perpetuity, we use the equation:

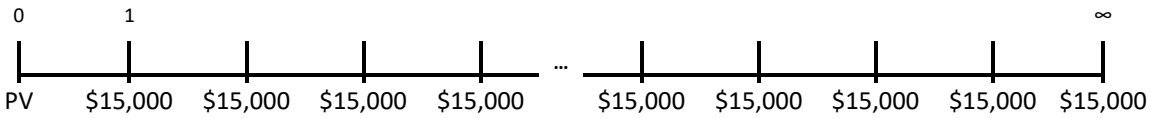
PV = *C*/*r*



PV = $7,500/.068
PV = $110,294.12

Notice that as the length of the annuity payments increases, the present value of the annuity approaches the present value of the perpetuity. The present value of the 75-year annuity and the present value of the perpetuity imply that the value today of all perpetuity payments beyond 75 years is only $793.80.

14. The time line is:

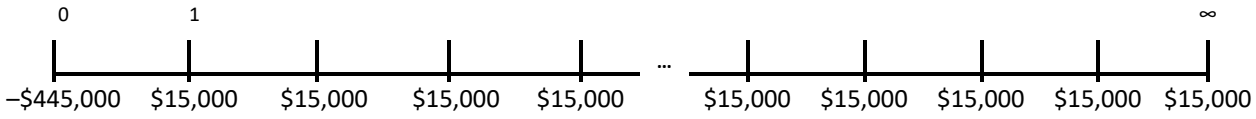


This cash flow is a perpetuity. To find the PV of a perpetuity, we use the equation:

PV = *C*/*r*
PV = $15,000/.043
PV = $348,837.21

To find the interest rate that equates the perpetuity cash flows with the PV of the cash flows, we can use the PV of a perpetuity equation:

PV = *C*/*r*



$445,000 = $15,000/*r*

We can now solve for the interest rate as follows:

r = $15,000/$445,000
r = .0337, or 3.37%

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15. For discrete compounding, to find the EAR, we use the equation:

$EAR = [1 + (APR/m)]^m - 1$

$EAR = [1 + (.084/4)]^4 - 1 = .0867$, or 8.67%

$EAR = [1 + (.186/12)]^{12} - 1 = .2027$, or 20.27%

$EAR = [1 + (.094/365)]^{365} - 1 = .0985$, or 9.85%

To find the EAR with continuous compounding, we use the equation:

$EAR = e^{APR} - 1$
$EAR = e^{.078} - 1$
EAR = .0811, or 8.11%

16. Here, we are given the EAR and need to find the APR. Using the equation for discrete compounding:

$EAR = [1 + (APR/m)]^m - 1$

We can now solve for the APR. Doing so, we get:

$APR = m[(1 + EAR)^{1/m} - 1]$

$EAR = .099 = [1 + (APR/2)]^2 - 1$ $APR = 2[(1.099)^{1/2} - 1] = .0967$, or 9.67%

$EAR = .114 = [1 + (APR/12)]^{12} - 1$ $APR = 12[(1.114)^{1/12} - 1] = .1084$, or 10.84%

$EAR = .155 = [1 + (APR/52)]^{52} - 1$ $APR = 52[(1.155)^{1/52} - 1] = .1443$, or 14.43%

Solving the continuous compounding EAR equation:

$EAR = e^{APR} - 1$

We get:

$APR = \ln(1 + EAR)$
$APR = \ln(1 + .163)$
APR = .1510, or 15.10%

17. For discrete compounding, to find the EAR, we use the equation:

$EAR = [1 + (APR/m)]^m - 1$

So, for each bank, the EAR is:

First National: $EAR = [1 + (.148/12)]^{12} - 1 = .1585$, or 15.85%

First United: $EAR = [1 + (.151/2)]^2 - 1 = .1567$, or 15.67%

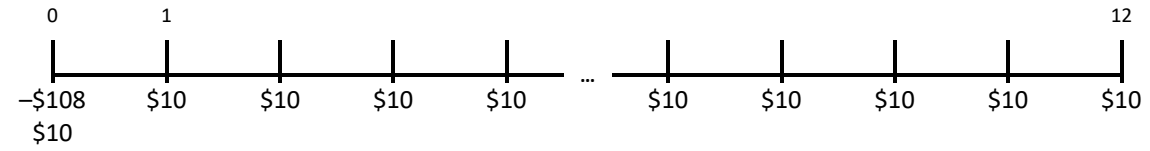
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Notice that the higher APR does not necessarily mean the higher EAR. The number of compounding periods within a year will also affect the EAR.

18. The cost of a case of wine is 10 percent less than the cost of 12 individual bottles, so the cost of a case will be:

Cost of case = (12)($10)(1 – .10)
Cost of case = $108

Now, we need to find the interest rate. The cash flows are an annuity due, so:



PVA = $(1 + r)C(\{1 - [1/(1 + r)^t]\}/r)$
$\$108 = (1 + r)\$10(\{1 - [1/(1 + r)^{12}]/r)$

Solving for the interest rate, we get:

r = .0198, or 1.98% per week

So, the APR of this investment is:

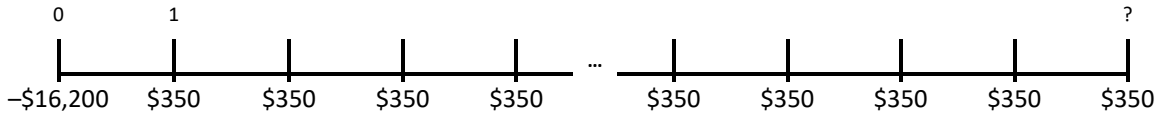
APR = .0198(52)
APR = 1.0277, or 102.77%

And the EAR is:

EAR = $(1 + .0198)^{52} - 1$
EAR = 1.7668, or 176.68%

The analysis appears to be correct. He really can earn about 177 percent buying wine by the case. The only question left is this: Can you really find a fine bottle of Bordeaux for $10?

19. The time line is:



Here, we need to find the length of an annuity. We know the interest rate, the PV, and the payments. Using the PVA equation:

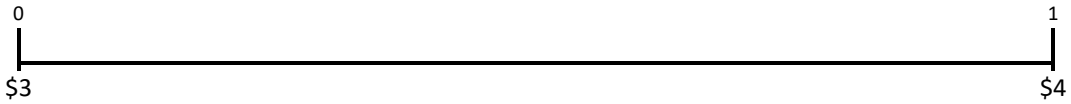
PVA = $C(\{1 - [1/(1 + r)^t]\}/r)$
$\$16{,}200 = \$350\{[1 - (1/1.013)^t]/.013\}$

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Now, we solve for *t*:

$1/1.013^t = 1 – [(\$16{,}200)(.013)/(\$350)]$
$1.013^t = 1/.3983 = 2.511$
$t = \ln 2.511/\ln 1.013$
$t = 71.27$ months

20. The time line is:



Here, we are trying to find the interest rate when we know the PV and FV. Using the FV equation:

$FV = PV(1 + r)$
$\$4 = \$3(1 + r)$
$r = 4/3 – 1 = .3333$, or 33.33% per week

The interest rate is 33.33% per week. To find the APR, we multiply this rate by the number of weeks in a year, so:

APR = (52)33.33% = 17.3333, or 1,733.33%

And using the equation to find the EAR:

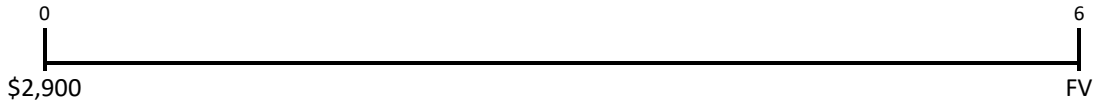
$EAR = [1 + (APR/m)]^m – 1$
$EAR = [1 + .3333]^{52} – 1 = 3{,}139{,}165.1569$, or 313,916,515.69%

Intermediate

21. To find the FV of a lump sum with discrete compounding, we use:

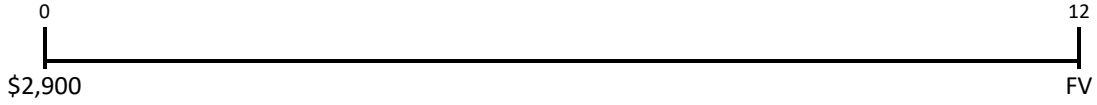
$FV = PV(1 + r)^t$

a.



$FV = \$2{,}900(1.063)^6 = \$4{,}184.06$

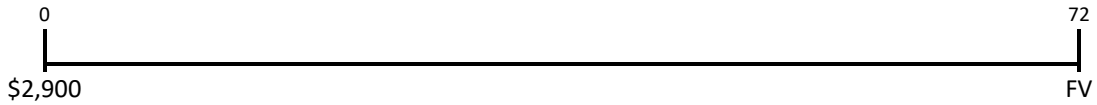
b.



$FV = \$2{,}900(1 + .063/2)^{12} = \$4{,}207.55$

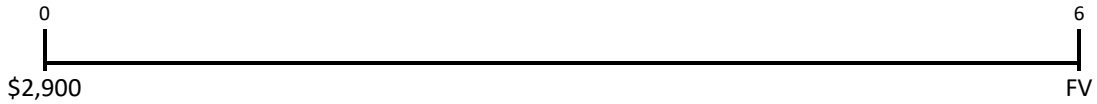
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c.



$FV = \$2{,}900(1 + .063/12)^{72} = \$4{,}227.97$

d.



To find the future value with continuous compounding, we use the equation:

$FV = PVe^{rt}$
$FV = \$2{,}900e^{.063(6)} = \$4{,}232.15$

e. The future value increases when the compounding period is shorter because interest is earned on previously accrued interest. The shorter the compounding period, the more frequently interest is earned, and the greater the future value, assuming the same stated interest rate.

22. The total interest paid by First Simple Bank is the interest rate per period times the number of periods. In other words, the interest by First Simple Bank paid over 10 years will be:

$.068(10) = .68$

First Complex Bank pays compound interest, so the interest paid by this bank will be the FV factor of $1, or:

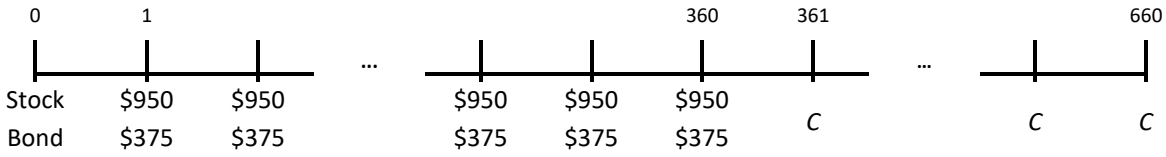
$(1 + r)^{10}$

Setting the two equal, we get:

$(.068)(10) = (1 + r)^{10} - 1$

$r = 1.68^{1/10} - 1$
$r = .0532$, or 5.32%

23. Although the stock and bond accounts have different interest rates, we can draw one time line, but we need to remember to apply different interest rates. The time line is:



We need to find the annuity payment in retirement. Our retirement savings ends at the same time the retirement withdrawals begin, so the PV of the retirement withdrawals will be the FV of the retirement savings. So, we find the FV of the stock account and the FV of the bond account and add the two FVs.

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Stock account: FVA = $950[{[1 + (.105/12)]^{360} – 1}/(.105/12)] = $2,390,580.94

Bond account: FVA = $375[{[1 + (.061/12)]^{360} – 1}/(.061/12)] = $383,979.55

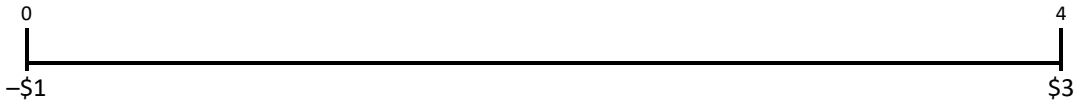
So, the total amount saved at retirement is:

$2,390,580.94 + 383,979.55 = $2,774,560.49

Solving for the withdrawal amount in retirement using the PVA equation gives us:

PVA = $2,774,560.49 = C[1 – {1/[1 + (.069/12)]^{300}}/(.069/12)]
C = $2,774,560.49/142.773
C = $19,433.38 withdrawal per month

24. The time line is:

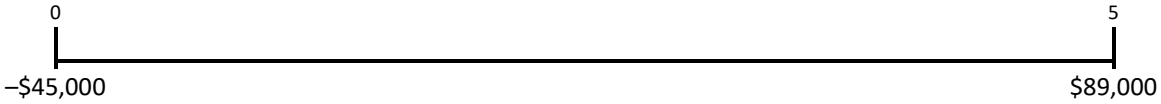


Since we are looking to triple our money, the PV and FV are irrelevant as long as the FV is three times as large as the PV. The number of periods is four, the number of quarters per year. So:

FV = $3 = $1(1 + r)$^{(12/3)}$
r = .3161, or 31.61%

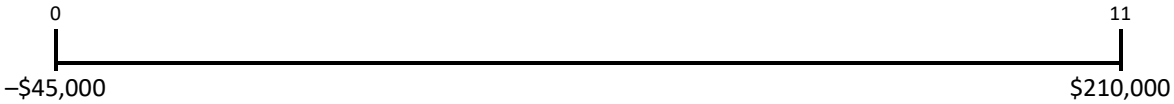
25. Here, we need to find the interest rate for two possible investments. Each investment is a lump sum, so:

G:



PV = $45,000 = $89,000/(1 + r)^5
(1 + r)^5 = $89,000/$45,000
r = 1.9778$^{1/5}$ – 1 = .1461, or 14.61%

H:



PV = $45,000 = $210,000/(1 + r)^{11}
(1 + r)^{11} = $210,000/$45,000
r = 4.6667$^{1/11}$ – 1 = .1503, or 15.03%

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26. This is a growing perpetuity. The present value of a growing perpetuity is:

PV = $C/(r - g)$
PV = $185,000/(.12 – .025)
PV = $1,947,368.42

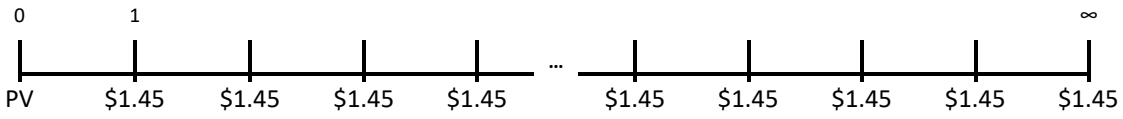
It is important to recognize that when dealing with annuities or perpetuities, the present value equation calculates the present value one period before the first payment. In this case, since the first payment is in three years, we have calculated the present value two years from now. To find the value today, we can discount this value as a lump sum. Doing so, we find the value of the cash flow stream today is:

PV = FV/$(1 + r)^t$
PV = $1,947,368.42/$(1 + .12)^2$
PV = $1,552,430.18

27. The dividend payments are made quarterly, so we must use the quarterly interest rate. The quarterly interest rate is:

Quarterly rate = Stated rate/4
Quarterly rate = .049/4
Quarterly rate = .0123

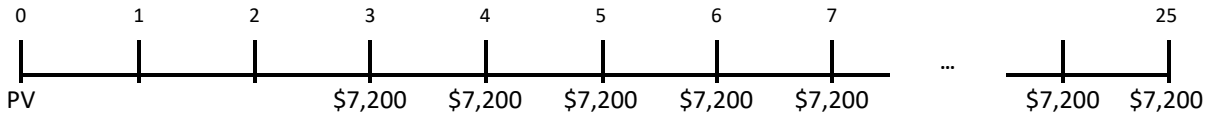
The time line is:



Using the present value equation for a perpetuity, we find the value today of the dividends paid must be:

PV = C/r
PV = $1.45/.0123
PV = $118.37

28. The time line is:



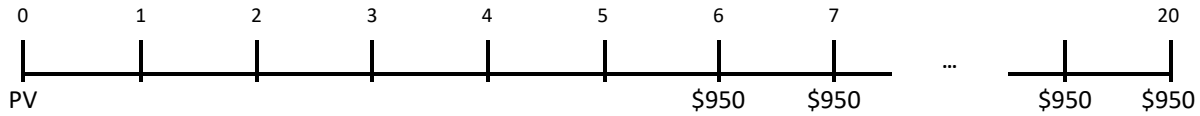
We can use the PVA annuity equation to answer this question. The annuity has 23 payments, not 22 payments. Since there is a payment made in Year 3, the annuity actually begins in Year 2. So, the value of the annuity in Year 2 is:

PVA = $C(\{1 - [1/(1 + r)^t]\}/r)$
PVA = $7,200($\{1 - [1/(1 + .074)^{23}]\}$/.074)
PVA = $78,460.71

This is the value of the annuity one period before the first payment, or Year 2. So, the value of the cash flows today is:

$PV = FV/(1 + r)^t$
$PV = \$78,460.71/(1 + .074)^2$
$PV = \$68,021.10$

29. The time line is:



We need to find the present value of an annuity. Using the PVA equation, and the 12 percent interest rate, we get:

$PVA = C(\{1 – [1/(1 + r)^t]\}/r)$
$PVA = \$950(\{1 – [1/(1 + .12)^{15}]\}/.12)$
$PVA = \$6,470.32$

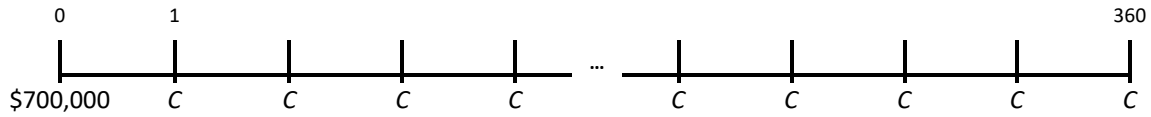
This is the value of the annuity in Year 5, one period before the first payment. Finding the value of this amount today, we find:

$PV = FV/(1 + r)^t$
$PV = \$6,470.32/(1 + .09)^5$
$PV = \$4,205.26$

30. The amount borrowed is the value of the home times one minus the down payment, or:

Amount borrowed = $\$875,000(1 – .20)$
Amount borrowed = $\$700,000$

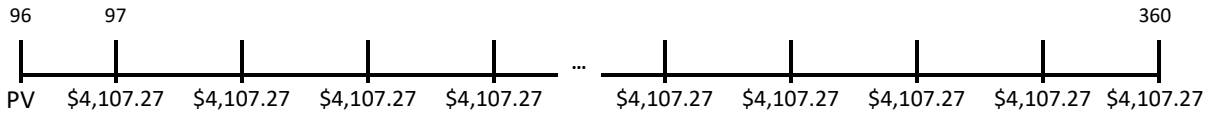
The time line is:



The monthly payments with a balloon payment loan are calculated assuming a longer amortization schedule, in this case, 30 years. The payments based on a 30-year repayment schedule would be:

$PVA = \$700,000 = C(\{1 – [1/(1 + .058/12)^{360}]\}/(.058/12))$
$C = \$4,107.27$

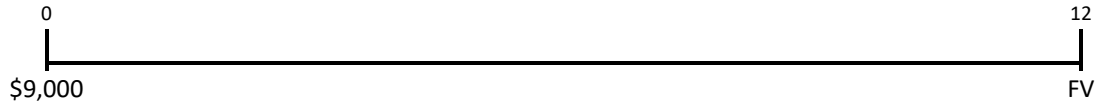
Now, at Year 8 (Month 96), we need to find the PV of the payments which have not been made. The time line is:



The balloon payment will be:

PVA = $4,107.27({1 – [1/(1 + .058/12)$^{22(12)}$]}/(.058/12))
PVA = $611,832.40

31. The time line is:



Here, we need to find the FV of a lump sum, with a changing interest rate. We must do this problem in two parts. After the first six months, the balance will be:

FV = $9,000[1 + (.018/12)]^6 = $9,081.30

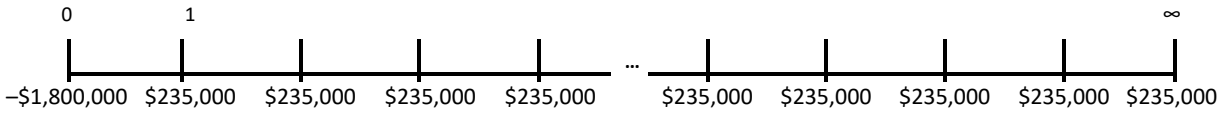
This is the balance in six months. The FV in another six months will be:

FV = $9,081.30[1 + (.15/12)]^6 = $9,784.04

The problem asks for the interest accrued, so, to find the interest, we subtract the beginning balance from the FV. The interest accrued is:

Interest = $9,784.04 – 9,000 = $784.04

32. The time line is:



The company would be indifferent at the interest rate that makes the present value of the cash flows equal to the cost today. Since the cash flows are a perpetuity, we can use the PV of a perpetuity equation. Doing so, we find:

PV = *C*/*r*
$1,800,000 = $235,000/*r*
r = $235,000/$1,800,000
r = .1306, or 13.06%

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33. The company will accept the project if the present value of the increased cash flows is greater than the cost. The cash flows are a growing perpetuity, so the present value is:

$PV = C\{[1/(r - g)] - [1/(r - g)] \times [(1 + g)/(1 + r)]^t\}$
$PV = \$43{,}000\{[1/(.11 - .055)] - [1/(.11 - .055)] \times [(1 + .055)/(1 + .11)]^5\}$
$PV = \$175{,}426.59$

The company should accept the project since the cost is less than the increased cash flows.

34. Since your salary grows at 3.3 percent per year, your salary next year will be:

Next year's salary = $\$85{,}000(1 + .033)$
Next year's salary = $\$87{,}805$

This means your deposit next year will be:

Next year's deposit = $\$87{,}805(.10)$
Next year's deposit = $\$8{,}780.50$

Since your salary grows at 3.3 percent, you deposit will also grow at 3.3 percent. We can use the present value of a growing annuity equation to find the value of your deposits today. Doing so, we find:

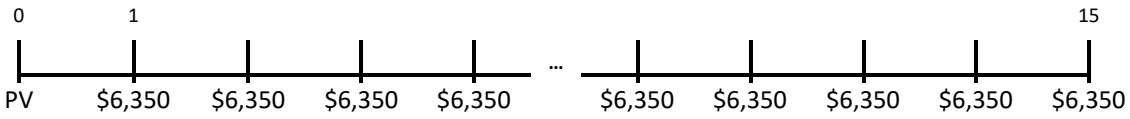
$PV = C\{[1/(r - g)] - [1/(r - g)] \times [(1 + g)/(1 + r)]^t\}$
$PV = \$8{,}780.50\{[1/(.095 - .033)] - [1/(.095 - .033)] \times [(1 + .033)/(1 + .095)]^{35}\}$
$PV = \$123{,}207.12$

Now, we can find the future value of this lump sum in 35 years. We find:

$FV = PV(1 + r)^t$
$FV = \$123{,}207.12(1 + .095)^{35}$
$FV = \$2{,}952{,}092.51$

This is the value of your savings in 35 years.

35. The time line is:



The relationship between the PVA and the interest rate is:

PVA falls as *r* increases, and PVA rises as *r* decreases
FVA rises as *r* increases, and FVA falls as *r* decreases

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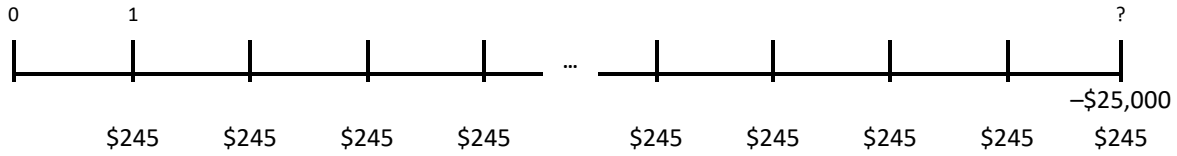
The present values of $6,350 per year for 15 years at the various interest rates given are:

PVA@10% = $6,350{[1 – (1/1.10)^{15}]/.10} = $48,298.60

PVA@5% = $6,350{[1 – (1/1.05)^{15}]/.05} = $65,910.83

PVA@15% = $6,350{[1 – (1/1.15)^{15}]/.15} = $37,130.80

36. The time line is:



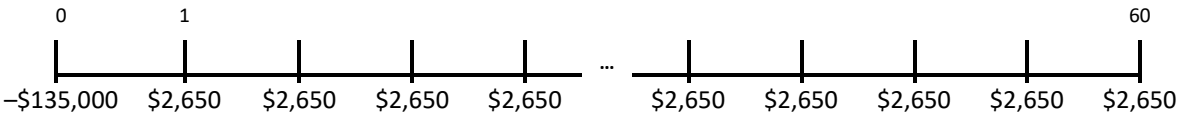
Here, we are given the FVA, the interest rate, and the amount of the annuity. We need to solve for the number of payments. Using the FVA equation:

FVA = $25,000 = $245[{[1 + (.0875/12)]^{t} – 1}/(.0875/12)]

Solving for *t*, we get:

1.00729^{t} = 1 + [($25,000)(.0875/12)/$245]
t = ln 1.74405/ln 1.00729
t = 76.56 payments

37. The time line is:



Here, we are given the PVA, number of periods, and the amount of the annuity. We need to solve for the interest rate. Using the PVA equation:

PVA = $135,000 = $2,650[{1 – [1/(1 + *r*)^{60}]}/*r*]

To find the interest rate, we need to solve this equation on a financial calculator, using a spreadsheet, or by trial and error. If you use trial and error, remember that increasing the interest rate lowers the PVA, and decreasing the interest rate increases the PVA. Using a spreadsheet, we find:

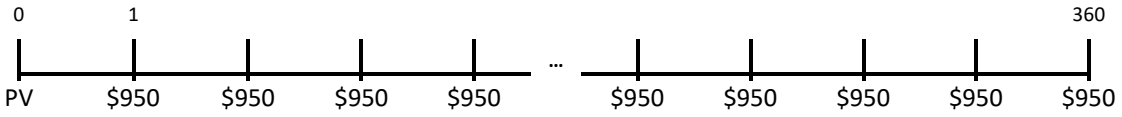
r = .553%

The APR is the periodic interest rate times the number of periods in the year, so:

APR = 12(.553%) = 6.64%

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38. The time line is:

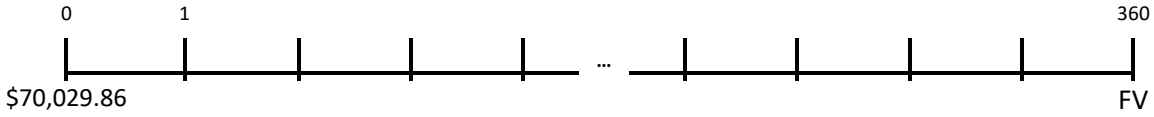


The amount of principal paid on the loan is the PV of the monthly payments you make. So, the present value of the $950 monthly payments is:

PVA = $950[(1 – {1/[1 + (.051/12)]^{360}})/(.051/12)]
PVA = $174,970.14

The monthly payments of $950 will amount to a principal payment of $174,970.14. The amount of principal you will still owe is:

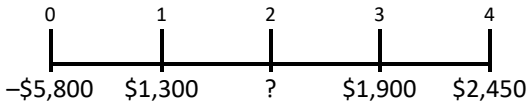
$245,000 – 174,970.14 = $70,029.86



This remaining principal amount will increase at the interest rate on the loan until the end of the loan period. So the balloon payment in 30 years, which is the FV of the remaining principal will be:

Balloon payment = $70,029.86[1 + (.051/12)]^{360}
Balloon payment = $322,363.44

39. The time line is:



We are given the total PV of all four cash flows. If we find the PV of the three cash flows we know, and subtract them from the total PV, the amount left over must be the PV of the missing cash flow. So, the PV of the cash flows we know are:

PV of Year 1 CF: $1,300/1.07 = $1,214.95

PV of Year 3 CF: $1,900/1.07^3 = $1,550.97

PV of Year 4 CF: $2,450/1.07^4 = $1,869.09

So, the PV of the missing CF is:

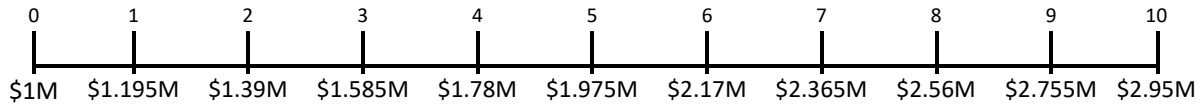
$5,800 – 1,214.95 – 1,550.97 – 1,869.09 = $1,164.99

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The question asks for the value of the cash flow in Year 2, so we must find the future value of this amount. The value of the missing CF is:

$\$1{,}164.99(1.07)^2 = \$1{,}333.79$

40. The time line is:



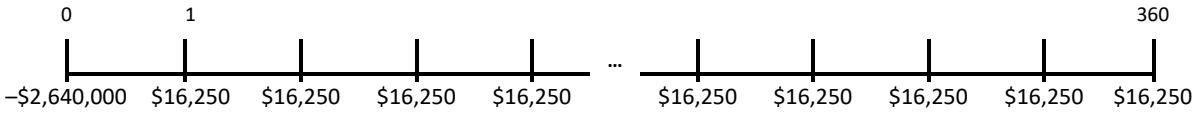
To solve this problem, we need to find the PV of each lump sum and add them together. It is important to note that the first cash flow of $1 million occurs today, so we do not need to discount that cash flow. The PV of the lottery winnings is:

$\$1{,}000{,}000 + \$1{,}195{,}000/1.073 + \$1{,}390{,}000/1.073^2 + \$1{,}585{,}000/1.073^3 + \$1{,}780{,}000/1.073^4 + \$1{,}975{,}000/1.073^5 + \$2{,}170{,}000/1.073^6 + \$2{,}365{,}000/1.073^7 + \$2{,}560{,}000/1.073^8 + \$2{,}755{,}000/1.073^9 + \$2{,}950{,}000/1.073^{10} = \$14{,}577{,}923.31$

41. Here, we are finding interest rate for an annuity cash flow. We are given the PVA, number of periods, and the amount of the annuity. We need to solve for the interest rate. We should also note that the PV of the annuity is not the amount borrowed since we are making a down payment on the warehouse. The amount borrowed is:

Amount borrowed = .80($3,300,000) = $2,640,000

The time line is:



Using the PVA equation:

$\text{PVA} = \$2{,}640{,}000 = \$16{,}250[\{1 - [1/(1 + r)^{360}]\}/r]$

Unfortunately, this equation cannot be solved to find the interest rate using algebra. To find the interest rate, we need to solve this equation on a financial calculator, using a spreadsheet, or by trial and error. If you use trial and error, remember that increasing the interest rate decreases the PVA, and decreasing the interest rate increases the PVA. Using a spreadsheet, we find:

$r = .521\%$

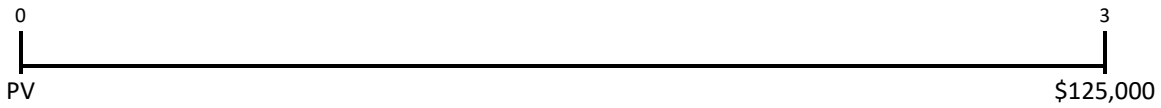
The APR is the monthly interest rate times the number of months in the year, so:

APR = 12(.521%)
APR = 6.25%

And the EAR is:

$EAR = (1 + .00521)^{12} - 1$
$EAR = .0643$, or 6.43%

42. The time line is:



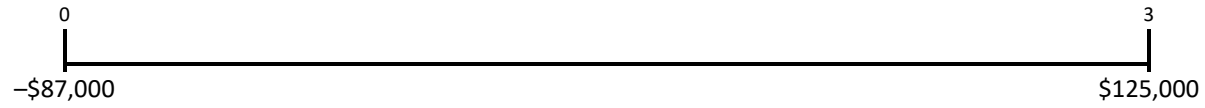
The profit the firm earns is just the PV of the sales price minus the cost to produce the asset. We find the PV of the sales price as the PV of a lump sum:

$PV = \$125,000/1.11^3$
$PV = \$91,398.92$

And the firm's profit is:

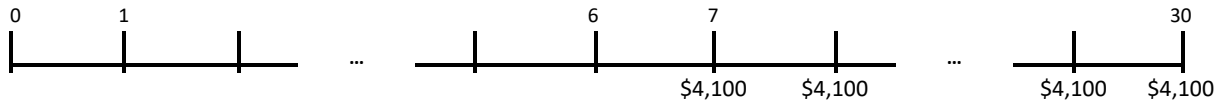
Profit = $91,398.92 – 87,000
Profit = $4,398.92

To find the interest rate at which the firm will break even, we need to find the interest rate using the PV (or FV) of a lump sum. Using the PV equation for a lump sum, we get:



$\$87,000 = \$125,000/(1 + r)^3$
$r = (\$125,000/\$87,000)^{1/3} - 1$
$r = .1284$, or 12.84%

43. The time line is:



We want to find the value of the cash flows today, so we will find the PV of the annuity, and then bring the lump sum PV back to today. The annuity has 24 payments, so the PV of the annuity is:

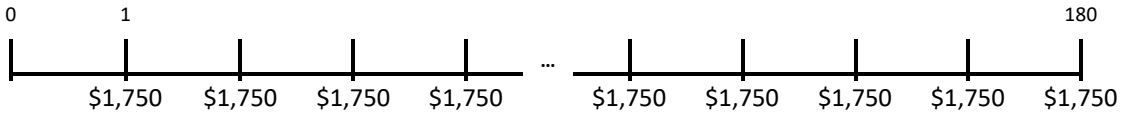
$PVA = \$4,100\{[1 - (1/1.069)^{24}]/.069\}$
$PVA = \$47,439.93$

Since this is an ordinary annuity equation, this is the PV one period before the first payment, so it is the PV at $t = 6$. To find the value today, we find the PV of this lump sum. The value today is:

$PV = \$47,439.93/1.069^6$
$PV = \$31,789.07$

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44. The time line for the annuity is:



This question is asking for the present value of an annuity, but the interest rate changes during the life of the annuity. We need to find the present value of the cash flows for the last eight years first. The PV of these cash flows is:

$PVA_2 = \$1{,}750[\{1 - 1/[1 + (.086/12)]^{96}\}/(.086/12)]$
$PVA_2 = \$121{,}161.48$

Note that this is the PV of this annuity exactly seven years from today. Now, we can discount this lump sum to today. The value of this cash flow today is:

$PV = \$121{,}161.48/[1 + (.114/12)]^{84}$
$PV = \$54{,}756.22$

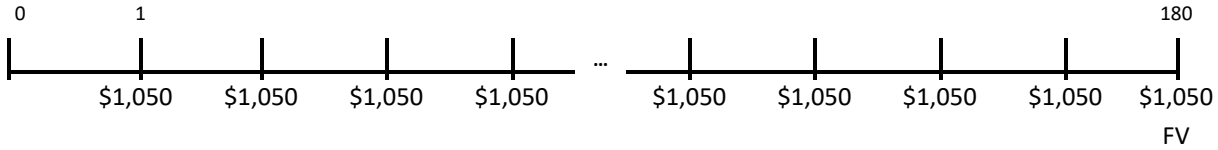
Now, we need to find the PV of the annuity for the first seven years. The value of these cash flows today is:

$PVA_1 = \$1{,}750[\{1 - 1/[1 + (.114/12)]^{84}\}/(.114/12)]$
$PVA_1 = \$100{,}960.71$

The value of the cash flows today is the sum of these two cash flows, so:

$PV = \$54{,}756.22 + 100{,}960.71$
$PV = \$155{,}716.92$

45. The time line for the annuity is:



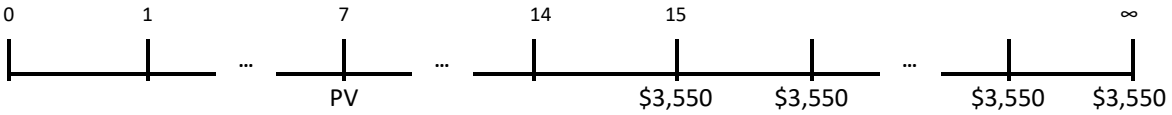
Here, we are trying to find the dollar amount invested today that will equal the FVA with a known interest rate and payments. First, we need to determine how much we would have in the annuity account. Finding the FV of the annuity, we get:

$FVA = \$1{,}050[\{[1 + (.0605/12)]^{180} - 1\}/(.0605/12)]$
$FVA = \$306{,}664.39$

Now, we need to find the PV of a lump sum that will give us the same FV. So, using the FV of a lump sum with continuous compounding, we get:

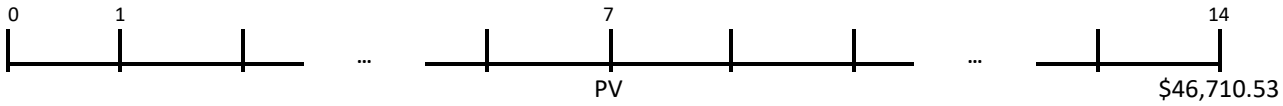
$FV = \$306{,}664.39 = PVe^{-.07(15)}$
$PV = \$306{,}664.39/e^{-1.05}$
$PV = \$107{,}313.44$

46. The time line is:



To find the value of the perpetuity at $t = 7$, we first need to use the PV of a perpetuity equation. Using this equation, we find:

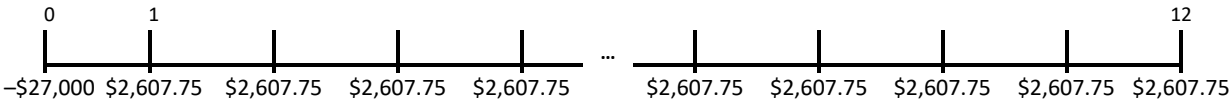
PV = $3,550/.076
PV = $46,710.53



Remember that the PV of a perpetuity (and annuity) equations give the PV one period before the first payment, so, this is the value of the perpetuity at $t = 14$. To find the value at $t = 7$, we find the PV of this lump sum as:

PV = $46,710.53/1.076^7
PV = $27,972.34

47. The time line is:



To find the APR and EAR, we need to use the actual cash flows of the loan. In other words, the interest rate quoted in the problem is only relevant to determine the total interest under the terms given. The interest rate for the cash flows of the loan is:

PVA = $27,000 = $2,607.75{(1 – [1/(1 + r)]^{12})/r}

Again, we cannot solve this equation for r, so we need to solve this equation on a financial calculator, using a spreadsheet, or by trial and error. Using a spreadsheet, we find:

r = 2.347% per month

So, the APR is:

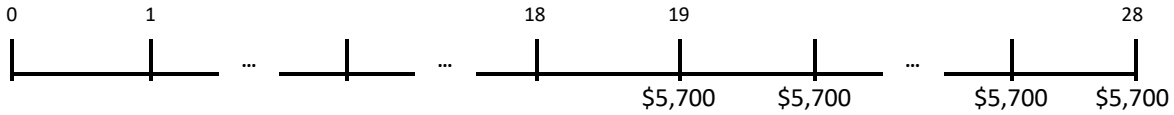
APR = 12(2.347%)
APR = 28.16%

And the EAR is:

EAR = 1.02347^{12} – 1
EAR = .3209, or 32.09%

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48. The time line is:



The cash flows in this problem are semiannual, so we need the effective semiannual rate. The interest rate given is the APR, so the monthly interest rate is:

Monthly rate = .09/12 = .075

To get the semiannual interest rate, we can use the EAR equation, but instead of using 12 months as the exponent, we will use 6 months. The effective semiannual rate is:

Semiannual rate = $1.075^6 - 1 = .0459$, or 4.59%

We can now use this rate to find the PV of the annuity. The PV of the annuity is:

PVA @ $t = 9$: $\$5{,}700[(1 - 1/1.0459^{10})/.0459] = \$44{,}914.10$

Note, that this is the value one period (six months) before the first payment, so it is the value at $t = 9$. So, the value at the various times the questions asked for uses this value 9 years from now.

PV @ $t = 5$: $\$44{,}914.10/1.0459^8 = \$31{,}377.62$

Note, that you can also calculate this present value (as well as the remaining present values) using the number of years. To do this, you need the EAR. The EAR is:

EAR = $1 + .075^{12} - 1 = .0938$, or 9.38%

So, we can find the PV at $t = 5$ using the following method as well:

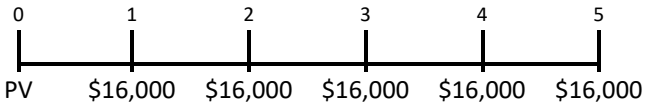
PV @ $t = 5$: $\$44{,}914.10/1.0938^4 = \$31{,}377.62$

The value of the annuity at the other times in the problem is:

PV @ $t = 3$: $\$44{,}914.10/1.0459^{12} = \$26{,}226.40$
PV @ $t = 3$: $\$44{,}914.10/1.0938^6 = \$26{,}226.40$

PV @ $t = 0$: $\$44{,}914.10/1.0459^{18} = \$20{,}040.88$
PV @ $t = 0$: $\$44{,}914.10/1.0938^9 = \$20{,}040.88$

49. *a.* The time line for the ordinary annuity is:

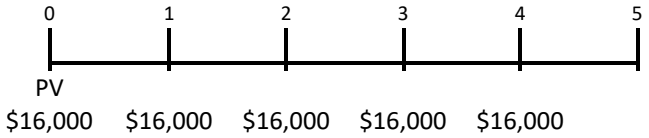


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If the payments are in the form of an ordinary annuity, the present value will be:

$PVA = C(\{1 - [1/(1 + r)^t]\}/r)$
$PVA = \$16{,}000[\{1 - [1/(1 + .072)^5]\}/.072]$
$PVA = \$65{,}253.34$

The time line for the annuity due is:

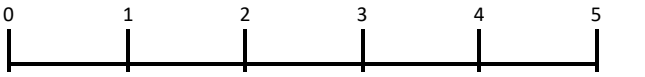


PV
$16,000 $16,000 $16,000 $16,000 $16,000

If the payments are an annuity due, the present value will be:

$PVA_{due} = (1 + r)PVA$
$PVA_{due} = (1 + .072)\$65{,}253.34$
$PVA_{due} = \$69{,}951.58$

b. The time line for the ordinary annuity is:



FV
$16,000 $16,000 $16,000 $16,000 $16,000

We can find the future value of the ordinary annuity as:

$FVA = C\{[(1 + r)^t - 1]/r\}$
$FVA = \$16{,}000\{[(1 + .072)^5 - 1]/.072\}$
$FVA = \$92{,}379.73$

The time line for the annuity due is:



$16,000 $16,000 $16,000 $16,000 $16,000 FV

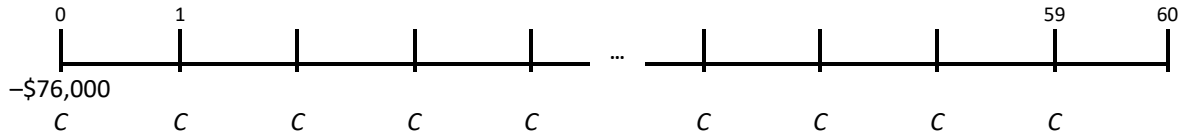
If the payments are an annuity due, the future value will be:

$FVA_{due} = (1 + r)FVA$
$FVA_{due} = (1 + .072)\$92{,}379.73$
$FVA_{due} = \$99{,}031.07$

c. Assuming a positive interest rate, the present value of an annuity due will always be larger than the present value of an ordinary annuity. Each cash flow in an annuity due is received one period earlier, which means there is one period less to discount each cash flow. Assuming a positive interest rate, the future value of an annuity due will always be higher than the future value of an ordinary annuity. Since each cash flow is made one period sooner, each cash flow receives one extra period of compounding.

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50. The time line is:



We need to use the PVA due equation, that is:

$PVA_{due} = (1 + r)PVA$

Using this equation:

$PVA_{due} = \$76,000 = [1 + (.0498/12)] \times C[\{1 - 1/[1 + (.0498/12)]^{60}\}/(.0498/12)$
$C = \$1,427.59$

Notice, to find the payment for the PVA due we compound the payment for an ordinary annuity forward one period.

51. The payment for a loan repaid with equal payments is the annuity payment with the loan value as the PV of the annuity. So, the loan payment will be:

$PVA = C(\{1 - [1/(1 + r)]^t\}/r)$
$\$57,000 = C\{[1 - 1/(1 + .09)^3]/.09\}$
$C = \$22,518.12$

The interest payment is the beginning balance times the interest rate for the period, and the principal payment is the total payment minus the interest payment. The ending balance is the beginning balance minus the principal payment. The ending balance for a period is the beginning balance for the next period. The amortization table for an equal payment is:

Year	Beginning Balance	Total Payment	Interest Payment	Principal Payment	Ending Balance
1	$57,000.00	$22,518.12	$5,130.00	$17,388.12	$39,611.88
2	39,611.88	22,518.12	3,565.07	18,953.05	20,658.83
3	20,658.83	22,518.12	1,859.29	20,658.83	0

In the third year, $1,859.29 of interest is paid.

Total interest over life of the loan = $5,130 + 3,565.07 + 1,859.29
Total interest over life of the loan = $10,554.36

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52. This amortization table calls for equal principal payments of $19,000 per year. The interest payment is the beginning balance times the interest rate for the period, and the total payment is the principal payment plus the interest payment. The ending balance for a period is the beginning balance for the next period. The amortization table for an equal principal reduction is:

Year	Beginning Balance	Total Payment	Interest Payment	Principal Payment	Ending Balance
1	$57,000.00	$24,130.00	$5,130.00	$19,000.00	$38,000.00
2	38,000.00	22,420.00	3,420.00	19,000.00	19,000.00
3	19,000.00	20,710.00	1,710.00	19,000.00	0

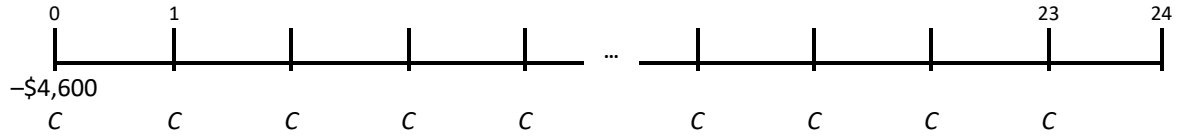
In the third year, $1,710 of interest is paid.

Total interest over life of the loan = $5,130 + 3,420 + 1,710
Total interest over life of the loan = $10,260

Notice that the total payments for the equal principal reduction loan are lower. This is because more principal is repaid early in the loan, which reduces the total interest expense over the life of the loan.

Challenge

53. The time line is:



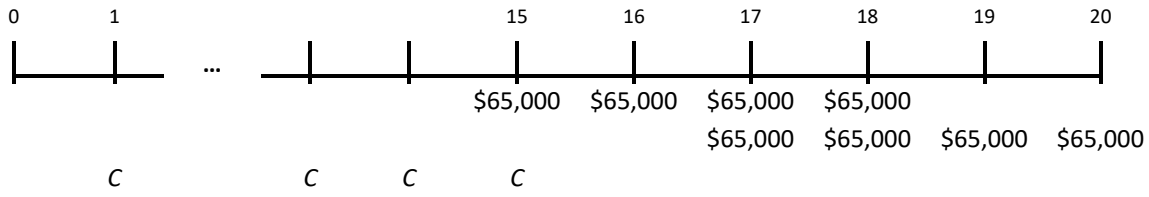
The monthly interest rate is the annual interest rate divided by 12, or:

Monthly interest rate = .086/12
Monthly interest rate = .00717

Now we can set the present value of the lease payments equal to the cost of the equipment, or $4,600. The lease payments are in the form of an annuity due, so:

$PVA_{due} = (1 + r)C(\{1 - [1/(1 + r)^t]\}/r)$
$\$4{,}600 = (1 + .00717)C(\{1 - [1/(1 + .00717)]^{24}\}/.00717)$
$C = \$207.82$

54. The time line is:



First, we will calculate the present value of the college expenses for each child. The expenses are an annuity, so the present value of the college expenses is:

PVA = $C(\{1 - [1/(1 + r)]^t\}/r)$
PVA = $\$65{,}000(\{1 - [1/(1 + .092)^4]\}/.092)$
PVA = $209,660.66

This is the cost of each child's college expenses one year before they enter college. So, the cost of the oldest child's college expenses today will be:

PV = $FV/(1 + r)^t$
PV = $\$209{,}660.66/(1 + .092)^{14}$
PV = $61,150.50

And the cost of the youngest child's college expenses today will be:

PV = $FV/(1 + r)^t$
PV = $\$209{,}660.66/(1 + .092)^{16}$
PV = $51,280.79

Therefore, the total cost today of your children's college expenses is:

Cost today = $61,150.50 + 51,280.79
Cost today = $112,431.29

This is the present value of your annual savings, which are an annuity. So, the amount you must save each year will be:

PVA = $C(\{1 - [1/(1 + r)]^t\}/r)$
$\$112{,}431.29 = C(\{1 - [1/(1 + .092)^{15}]\}/.092)$
C = $14,113.20

55. The salary is a growing annuity, so we use the equation for the present value of a growing annuity. The salary growth rate is 3.2 percent and the discount rate is 9 percent, so the value of the salary offer today is:

PV = $C\{[1/(r - g)] - [1/(r - g)] \times [(1 + g)/(1 + r)]^t\}$
PV = $\$75{,}000\{[1/(.09 - .032)] - [1/(.09 - .032)] \times [(1 + .032)/(1 + .09)]^{35}\}$
PV = $1,102,339.96

The yearly bonuses are 10 percent of the annual salary. This means that next year's bonus will be:

Next year's bonus = .10($75,000)
Next year's bonus = $7,500

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Since the salary grows at 3.2 percent, the bonus will grow at 3.2 percent as well. Using the growing annuity equation, with a 3.2 percent growth rate and a 9 percent discount rate, the present value of the annual bonuses is:

$PV = C\{[1/(r - g)] - [1/(r - g)] \times [(1 + g)/(1 + r)]^t\}$
$PV = \$7{,}500\{[1/(.09 - .032)] - [1/(.09 - .032)] \times [(1 + .032)/(1 + .09)]^{35}\}$
$PV = \$110{,}234.00$

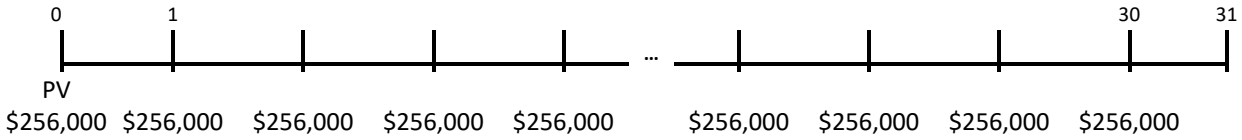
Notice the present value of the bonus is 10 percent of the present value of the salary. The present value of the bonus will always be the same percentage of the present value of the salary as the bonus percentage. So, the total value of the offer is:

PV = PV(Salary) + PV(Bonus) + Bonus paid today
PV = $1,102,339.96 + 110,234 + 15,000
PV = $1,227,573.96

56. Here, we need to compare two options. In order to do so, we must get the value of the two cash flow streams to the same time, so we will find the value of each today. We must also make sure to use the aftertax cash flows, since it is more relevant. For Option A, the aftertax cash flows are:

Aftertax cash flows = Pretax cash flows(1 – tax rate)
Aftertax cash flows = $400,000(1 – .36)
Aftertax cash flows = $256,000

So, the cash flows are:



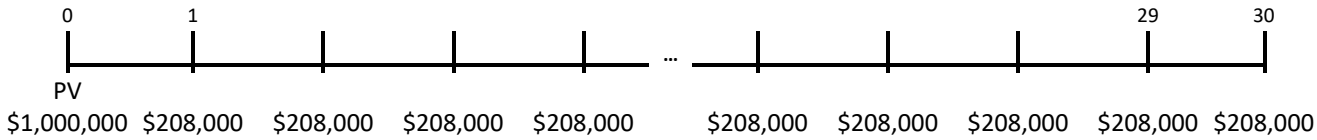
The aftertax cash flows from Option A are in the form of an annuity due, so the present value of the cash flow today is:

$PVA_{due} = (1 + r)C(\{1 - [1/(1 + r)^t]\}/r)$
$PVA_{due} = (1 + .041)\$256{,}000(\{1 - [1/(1 + .041)]^{31}\}/.041)$
$PVA_{due} = \$4{,}629{,}503.60$

For Option B, the aftertax cash flows are:

Aftertax cash flows = Pretax cash flows(1 – tax rate)
Aftertax cash flows = $325,000(1 – .36)
Aftertax cash flows = $208,000

The cash flows are:



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The aftertax cash flows from Option B are an ordinary annuity, plus the cash flow today, so the present value is:

$PV = C(\{1 - [1/(1 + r)^t]\}/r) + C_0$
$PV = \$208{,}000\{1 - [1/(1 + .041)^{30}]\}/.041) + \$1{,}000{,}000$
$PV = \$4{,}553{,}471.68$

You should choose Option A because it has a higher present value on an aftertax basis.

57. We need to find the first payment into the retirement account. The present value of the desired amount at retirement is:

$PV = FV/(1 + r)^t$
$PV = \$2{,}500{,}000/(1 + .097)^{30}$
$PV = \$155{,}503.86$

This is the value today. Since the savings are in the form of a growing annuity, we can use the growing annuity equation and solve for the payment. Doing so, we get:

$PV = C\{[1/(r - g)] - [1/(r - g)] \times [(1 + g)/(1 + r)]^t\}$
$\$155{,}503.86 = C\{[1/(.097 - .03)] - [1/(.097 - .03)] \times [(1 + .03)/(1 + .097)]^{30}\}$
$C = \$12{,}271.50$

This is the amount you need to save next year. So, the percentage of your salary is:

Percentage of salary = \$12,271.50/\$85,000
Percentage of salary = .1444, or 14.44%

Note that this is the percentage of your salary you must save each year. Since your salary is increasing at 3 percent, and the savings are increasing at 3 percent, the percentage of salary will remain constant.

58. Since she put \$2,000 down, the amount borrowed will be:

Amount borrowed = \$43,000 – 2,000
Amount borrowed = \$41,000

So, the monthly payments will be:

$PVA = C(\{1 - [1/(1 + r)^t]\}/r)$
$\$41{,}000 = C(\{1 - [1/(1 + (.058/12)^{60}]\}/(.058/12))$
$C = \$788.84$

The amount remaining on the loan is the present value of the remaining payments. Since the first payment was made on October 1, 2017, and she made a payment on October 1, 2019, there are 35 payments remaining, with the first payment due immediately. So, we can find the present value of the remaining 34 payments after November 1, 2019, and add the payment made on this date. So the remaining principal owed on the loan is:

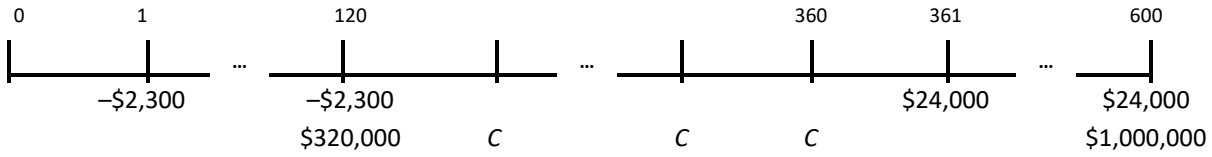
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PV = $C(\{1 - [1/(1 + r)^t]\}/r) + C_0$
PV = $788.84(\{1 - [1/(1 + .058/12)^{34}]\}/(.058/12))$
C = $24,677.82

She must also pay a one percent prepayment penalty and the payment due on November 1, 2019, so the total amount of the payment is:

Total payment = Balloon payment(1 + Prepayment penalty) + Current payment
Total payment = $24,677.82(1 + .01) + $788.84
Total payment = $25,713.43

59. The time line is:



The cash flows for this problem occur monthly, and the interest rate given is the EAR. Since the cash flows occur monthly, we must get the effective monthly rate. One way to do this is to find the APR based on monthly compounding, and then divide by 12. So, the pre-retirement APR is:

EAR = .11 = $[1 + (APR/12)]^{12} - 1$; APR = $12[(1.11)^{1/12} - 1] = .1048$, or 10.48%

And the post-retirement APR is:

EAR = .07 = $[1 + (APR/12)]^{12} - 1$; APR = $12[(1.07)^{1/12} - 1] = .0678$, or 6.78%

First, we will calculate how much he needs at retirement. The amount needed at retirement is the PV of the monthly spending plus the PV of the inheritance. The PV of these two cash flows is:

PVA = $\$24,000\{1 - [1/(1 + .0678/12)^{12(20)}]\}/(.0678/12) = \$3,147,769.06$

PV = $\$1,000,000/(1 + .07)^{20} = \$258,419.00$

So, at retirement, he needs:

$3,147,769.06 + 258,419.00 = $3,406,188.07

He will be saving $2,300 per month for the next 10 years until he purchases the cabin. The value of his savings after 10 years will be:

FVA = $\$2,300[\{[1 + (.1048/12)]^{12(10)} - 1\}/(.1048/12)] = \$484,357.76$

After he purchases the cabin, the amount he will have left is:

$484,357.76 – 375,000 = $109,357.76

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He still has 20 years until retirement. When he is ready to retire, this amount will have grown to:

FV = $109,357.76[1 + (.1048/12)]$^{12(20)}$ = $881,676.30

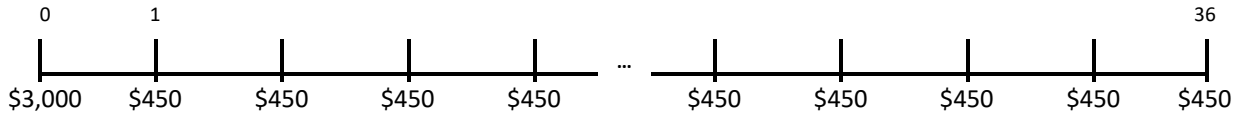
So, when he is ready to retire, based on his current savings, he will be short:

$3,406,188.07 – 881,676.30 = $2,524,511.77

This amount is the FV of the monthly savings he must make between Years 10 and 30. So, finding the annuity payment using the FVA equation, we find his monthly savings will need to be:

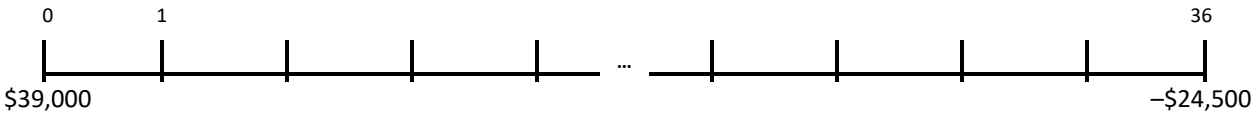
FVA = $2,524,511.77 = C[{[1 + (.1048/12)]$^{12(20)}$ – 1}/(.1048/12)]
C = $3,122.29

60. To answer this question, we should find the PV of both options, and compare them. Since we are purchasing the car, the lowest PV is the best option. The PV of the leasing option is the PV of the lease payments, plus the $3,000. The interest rate we would use for the leasing option is the same as the interest rate of the loan. The PV of leasing is:



PV = $3,000 + $450{1 – [1/(1 + .041/12)$^{12(3)}$]}/(.041/12) = $18,218.90

The PV of purchasing the car is the current price of the car minus the PV of the resale price. The PV of the resale price is:



PV = $24,500/[1 + (.041/12)]$^{12(3)}$ = $21,669.00

The PV of the decision to purchase is:

$39,000 – 21,669 = $17,331

In this case, it is cheaper to buy the car than lease it since the PV of the leasing cash flows is lower. To find the breakeven resale price, we need to find the resale price that makes the PV of the two options the same. In other words, the PV of the decision to buy should be:

$39,000 – PV of resale price = $18,218.90
PV of resale price = $20,781.10

The resale price that would make the PV of the lease versus buy decision equal is the FV of this price, so:

Break-even resale price = $20,781.10[1 + (.041/12)]$^{12(3)}$
Break-even resale price = $23,496.09

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61. To find the quarterly salary for the player, we first need to find the PV of the current contract. The cash flows for the contract are annual, and we are given a daily interest rate. We need to find the EAR so the interest compounding is the same as the timing of the cash flows. The EAR is:

EAR = $[1 + (.05/365)]^{365} - 1 = .0513$, or 5.13%

The PV of the current contract offer is the sum of the PV of the cash flows. So, the PV is:

PV = \$10,000,000 + \$7,400,000/1.0513 + \$7,400,000/1.0513^2 + \$7,700,000/1.0513^3
+ \$8,500,000/1.0513^4 + \$10,400,000/1.0513^5 + \$11,900,000/1.0513^6
PV = \$54,237,375.60

The player wants the contract increased in value by \$3,500,000, so the PV of the new contract will be:

PV = \$54,237,375.60 + 3,500,000 = \$57,737,375.60

The player has also requested a signing bonus payable today in the amount of \$13 million. We can subtract this amount from the PV of the new contract. The remaining amount will be the PV of the future quarterly paychecks.

\$57,737,375.60 – 13,000,000 = \$44,737,375.60

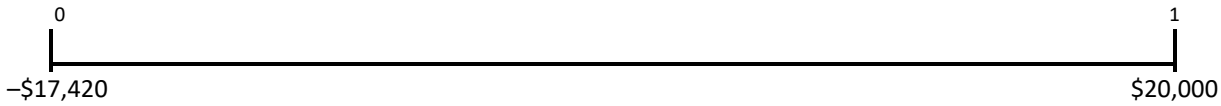
To find the quarterly payments, first realize that the interest rate we need is the effective quarterly rate. Using the daily interest rate, we can find the quarterly interest rate using the EAR equation, with the number of days being 91.25, the number of days in a quarter (365/4). The effective quarterly rate is:

Effective quarterly rate = $[1 + (.05/365)]^{91.25} - 1 = .01258$ or 1.258%

Now, we have the interest rate, the length of the annuity, and the PV. Using the PVA equation and solving for the payment, we get:

PVA = \$44,737,375.60 = $C\{[1 - (1/1.01258)^{24}]/.01258\}$
C = \$2,171,144.82

62. The time line for the cash flows is:



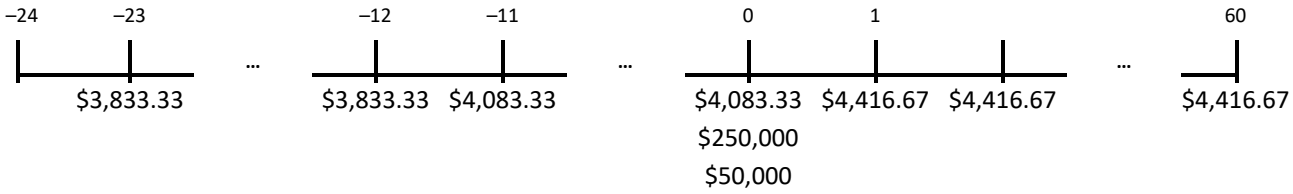
To find the APR and EAR, we need to use the actual cash flows of the loan. In other words, the interest rate quoted in the problem is only relevant to determine the total interest under the terms given. The cash flows of the loan are the \$20,000 you must repay in one year, and the \$17,420 you borrow today. The interest rate of the loan is:

\$20,000 = \$17,420(1 + r)
r = \$20,000/\$17,420 – 1
r = .1481, or 14.81%

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Because of the discount, you only get the use of $17,420, and the interest you pay on that amount is 14.81%, not 12.9%.

63. The time line is:



Here, we have cash flows that would have occurred in the past and cash flows that would occur in the future. We need to bring both cash flows to today. Before we calculate the value of the cash flows today, we must adjust the interest rate, so we have the effective monthly interest rate. Finding the APR with monthly compounding and dividing by 12 will give us the effective monthly rate. The APR with monthly compounding is:

APR = $12[(1.09)^{1/12} – 1] = .0865$, or 8.65%

To find the value today of the back pay from two years ago, we will find the FV of the annuity (salary), and then find the FV of the lump sum value of the salary. Doing so gives us:

FV = ($46,000/12)[{[1 + (.0865/12)]^{12} – 1}/(.0865/12)](1 + .09) = $52,176.10

Notice we found the FV of the annuity with the effective monthly rate, and then found the FV of the lump sum with the EAR. Alternatively, we could have found the FV of the lump sum with the effective monthly rate as long as we used 12 periods. The answer would be the same either way.

Now, we need to find the value today of last year's back pay:

FVA = ($49,000/12)[{[1 + (.0865/12)]^{12} – 1}/(.0865/12)] = $50,989.80

Next, we find the value today of the five years' future salary:

PVA = ($53,000/12){[{1 – {1/[1 + (.0865/12)]$^{12(5)}$}]/(.0865/12)} = $214,522.97

The value today of the jury award is the sum of salaries, plus the compensation for pain and suffering, and court costs. The award should be for:

Award = $52,176.10 + 50,989.80 + 214,522.97 + 250,000 + 50,000
Award = $617,688.87

As the plaintiff, you would prefer a lower interest rate. In this problem, we are calculating both the PV and FV of annuities. A lower interest rate will decrease the FVA, but increase the PVA. So, by a lower interest rate, we are lowering the value of the back pay. But, we are also increasing the PV of the future salary. Since the future salary is larger and has a longer time, this is the more important cash flow to the plaintiff.

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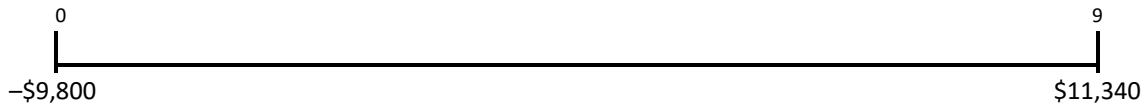
64. To find the interest rate of a loan, we need to look at the cash flows of the loan. Since this loan is in the form of a lump sum, the amount you will repay is the FV of the principal amount, which will be:

Loan repayment amount = $10,000(1.134) = $11,340

The amount you will receive today is the principal amount of the loan times one minus the points.

Amount received = $10,000(1 – .02) = $9,800

So, the time line is:

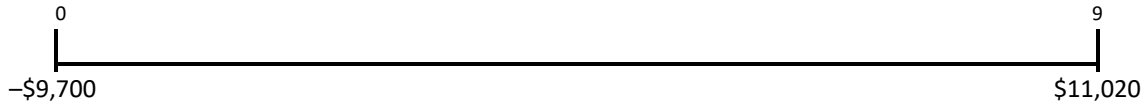


Now, we find the interest rate for this PV and FV.

$11,340 = $9,800(1 + *r*)
r = $11,340/$9,800 – 1
r = .1571, or 15.71%

The effective rate is not affected by the loan amount, since it drops out when solving for *r*.

65. This is the same question as before, with different values. Assuming a $10,000 face value loan, the time line is:



Loan repayment amount = $10,000(1.102) = $11,020

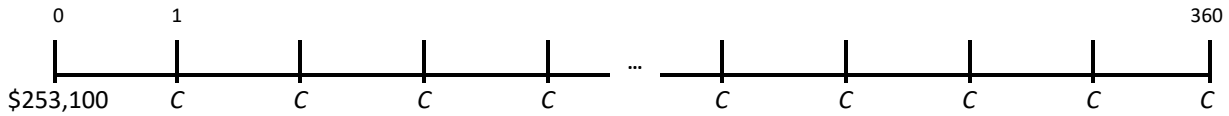
Amount received = $10,000(1 – .03) = $9,700

$11,020 = $9,700(1 + *r*)
r = $11,020/$9,700 – 1
r = .1361, or 13.61%

The effective rate is not affected by the loan amount, since it drops out when solving for *r*.

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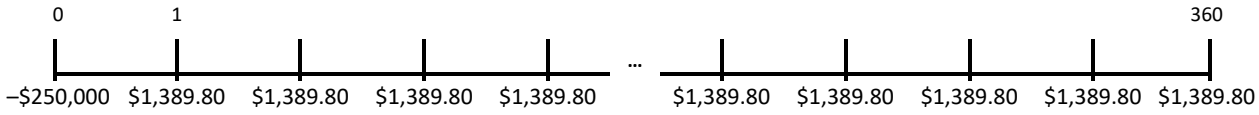
66. First, we will find the APR and EAR for the loan with the refundable fee. Remember, we need to use the actual cash flows of the loan to find the interest rate. With the $3,100 application fee, you will need to borrow $253,100 to have $250,000 after deducting the fee. The time line is:



Solving for the payment under these circumstances, we get:

PVA = $253,100 = $C[(1 – 1/1.0043^{360})/.0043]$ where .0043 = .052/12
C = $1,389.80

We can now use this amount in the PVA equation with the original amount we wished to borrow, $250,000.



Solving for r, we find:

PVA = $250,000 = $1,389.80({1 – [1/(1 + r)^{360}]}/r)

Solving for r with a spreadsheet, on a financial calculator, or by trial and error, gives:

r = .4425% per month

APR = 12(.4425%) = 5.31%

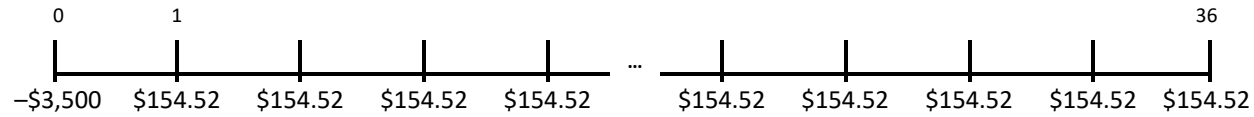
EAR = (1 + .004425)^{12} – 1 = .0544, or 5.44%

With the nonrefundable fee, the APR of the loan is the quoted APR since the fee is not considered part of the loan. So:

APR = 5.20%

EAR = [1 + (.052/12)]^{12} – 1 = .0533, or 5.33%

67. The time line is:



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Be careful of interest rate quotations. The actual interest rate of a loan is determined by the cash flows. Here, we are told that the PV of the loan is $3,500, and the payments are $154.52 per month for three years, so the interest rate on the loan is:

PVA = $3,500 = $154.52[{1 – [1/(1 + r)^{36}]}/r]

Solving for r with a spreadsheet, on a financial calculator, or by trial and error, gives:

r = 2.76% per month

APR = 12(2.76%) = 33.07%

EAR = (1 + .0276)^{12} – 1 = .3857, or 38.57%

It's called add-on interest because the interest amount of the loan is added to the principal amount of the loan before the loan payments are calculated.

68. The payments are a growing annuity, so we use the equation for the present value of a growing annuity. The payment growth rate is 2.5 percent and the EAR 11 percent. Since the payments are quarterly, we need the APR, which is:

EAR = (1 + APR/m)^m – 1
.11 = (1 + APR/4)^4 – 1
APR = .1057, or 10.57%

And the quarterly interest rate is:

Quarterly rate = .1057/4
Quarterly rate = .0264, or 2.64%

So, the present value of the payments is:

PV = C\{[1/(r – g)] – [1/(r – g)] × [(1 + g)/(1 + r)]^t\}
PV = $225,000{[1/(.0264 – .025)] – [1/(.0264 – .025)] × [(1 + .025)/(1 + .0264)]^{25}}
PV = $5,389,286.60

When we add the payment made today, we get:

Value of offer = $5,389,286.60 + 750,000
Value of offer = $6,139,286.60

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69. We will calculate the number of periods necessary to repay the balance with no fee first. We need to use the PVA equation and solve for the number of payments.

Without fee and annual rate = 18.20%:

PVA = \$10,000 = \$175[(1 – 1/1.0152^t)/.0152] where .0152 = .182/12

Solving for t, we get:

t = ln{1/[1 – (\$10,000/\$175)(.0152)]}/ln 1.0152
t = ln 7.5/ln 1.0152
t = 133.86 months

Without fee and annual rate = 7.90%:

PVA = \$10,000 = \$175[(1 – 1/1.00658^t)/.00658] where .00658 = .079/12

Solving for t, we get:

t = ln{1/[1 – (\$10,000/\$175)(.00658)]}/ln 1.00658
t = ln 1.60305/ln 1.00658
t = 71.92 months

So, you will pay the card off:

133.86 – 71.92 = 61.94 months sooner

We have already calculated the time to pay off the current card with no fee as 133.86 months. The time to repay the new card with a transfer fee is:

With fee and annual rate = 7.90%:

PVA = \$10,300 = \$175[[1 – 1/1.00658^t)/.00658] where .00658 = .079/12

Solving for t, we get:

t = ln{1/[1 – (\$10,300/\$175)(.00658)]}/ln 1.00658
t = ln 1.63259/ln 1.00658
t = 74.70 months

So, you will pay the card off:

133.86 – 74.70 = 59.16 months sooner

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70. We need to find the FV of the premiums to compare with the cash payment promised at age 65. We have to find the value of the premiums at Year 6 first since the interest rate changes at that time. So:

$FV_1 = \$700(1.10)^5 = \$1,127.36$

$FV_2 = \$700(1.10)^4 = \$1,024.87$

$FV_3 = \$800(1.10)^3 = \$1,064.80$

$FV_4 = \$800(1.10)^2 = \$968$

$FV_5 = \$900(1.10)^1 = \$990$

Value at year six = \$1,127.36 + 1,024.87 + 1,064.80 + 968 + 990 + 900
Value at year six = \$6,075.03

Finding the FV of this lump sum at the child's 65th birthday:

$FV = \$6,075.03(1.08)^{59}$
FV = \$569,573.51

The policy is not worth buying; the future value of the policy is \$569,573.51, but the policy contract will pay off \$500,000. The premiums are worth \$69,573.51 more than the policy payoff.

Note, we could also compare the PV of the two cash flows. The PV of the premiums is:

$PV = \$700/1.10 + \$700/1.10^2 + \$800/1.10^3 + \$800/1.10^4 + \$900/1.10^5 + \$900/1.10^6$
PV = \$3,429.19

And the value today of the \$500,000 at age 65 is:

$PV = (\$500,000/1.08^{59})/1.10^6$
PV = \$3,010.32

The premiums still have the higher cash flow. At time zero, the difference is \$418.88. Whenever you are comparing two or more cash flow streams, the cash flow with the highest value at one time will have the highest value at any other time.

Here is a question for you: Suppose you invest \$418.88, the difference in the cash flows at time zero, for six years at a 10 percent interest rate, and then for 59 years at an 8 percent interest rate. How much will it be worth? Without doing calculations, you know it will be worth \$69,573.51, the difference in the cash flows at Time 65!

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71. Since the payments occur at six-month intervals, we need to get the effective six-month interest rate. We are assuming 365 days per year, in other words, we are ignoring leap year. We can calculate the daily interest rate since we have an APR compounded daily, so the effective six-month interest rate is:

Effective six-month rate = $(1 + \text{Daily rate})^{182.5} - 1$
Effective six-month rate = $(1 + .08/365)^{182.5} - 1$
Effective six-month rate = .0408 or 4.08%

Now, we can use the PVA equation to find the present value of the semi-annual payments. Doing so, we find:

$PVA = C(\{1 - [1/(1 + r)^t]\}/r)$
$PVA = \$1{,}950{,}000\{[1 - 1/(1 + .0408)^{40}]/.0408\}$
PVA = $38,137,152.90

This is the value six months from today, which is one period (six months) prior to the first payment. So, the value today is:

PV = $38,137,152.90/(1 + .0408)
PV = $36,641,934.34

This means the total value of the lottery winnings today is:

Value of winnings today = $36,641,934.34 + 5,000,000
Value of winnings today = $41,641,934.34

You should not take the offer since the value of the offer is less than the present value of the payments.

72. Here, we need to find the interest rate that makes the PVA, the college costs, equal to the FVA, the savings. The PV of the college costs are:

$PVA = \$45{,}000[\{1 - [1/(1 + r)^4]\}/r]$

And the FV of the savings is:

$FVA = \$20{,}000\{[(1 + r)^6 - 1]/r\}$

Setting these two equations equal to each other, we get:

$\$45{,}000[\{1 - [1/(1 + r)^4]\}/r] = \$20{,}000\{[(1 + r)^6 - 1]/r\}$

Reducing the equation gives us:

$(1 + r)^{10} - 2.25(1 + r)^4 + 22.50 = 0$

Now, we need to find the roots of this equation. We can solve using trial and error, a root-solving calculator routine, or a spreadsheet. Using a spreadsheet, we find:

$r = 8.33\%$

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73. Here, we need to find the interest rate that makes us indifferent between an annuity and a perpetuity. To solve this problem, we need to find the PV of the two options and set them equal to each other. The PV of the perpetuity is:

$PV = \$15{,}000/r$

And the PV of the annuity is:

$PVA = \$31{,}000[\{1 - [1/(1 + r)^{10}]\}/r]$

Setting them equal and solving for r, we get:

$\$15{,}000/r = \$31{,}000[\{1 - [1/(1 + r)^{10}]\}/r]$
$\$15{,}000/\$31{,}000 = 1 - [1/(1 + r)^{10}]$
$(1 - .4839)^{1/10} = 1/(1 + r)$
$r = 1/(1 - .4839)^{1/10} - 1$
$r = .0684$, or 6.84%

74. The cash flows in this problem occur every two years, so we need to find the effective two-year rate. One way to find the effective two-year rate is to use an equation similar to the EAR, except use the number of days in two years as the exponent. (We use the number of days in two years since it is daily compounding; if monthly compounding was assumed, we would use the number of months in two years.) So, the effective two-year interest rate is:

Effective 2-year rate $= [1 + (.11/365)]^{365(2)} - 1$
Effective 2-year rate = .2460, or 24.60%

We can use this interest rate to find the PV of the perpetuity. Doing so, we find:

$PV = \$45{,}000/.2460$
$PV = \$182{,}900.49$

This is an important point: Remember that the PV equation for a perpetuity (and an ordinary annuity) tells you the PV one period before the first cash flow. In this problem, since the cash flows are two years apart, we have found the value of the perpetuity one period (two years) before the first payment, which is one year ago. We need to compound this value for one year to find the value today. The value of the cash flows today is:

$PV = \$182{,}900.49(1 + .11/365)^{365}$
$PV = \$204{,}164.42$

The second part of the question assumes the perpetuity cash flows begin in four years. In this case, when we use the PV of a perpetuity equation, we find the value of the perpetuity two years from today. So, the value of these cash flows today is:

$PV = \$182{,}900.49/(1 + .11/365)^{2(365)}$
$PV = \$146{,}785.94$

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75. To solve for the PVA due:

$$\text{PVA} = \frac{C}{(1+r)} + \frac{C}{(1+r)^2} + ... + \frac{C}{(1+r)^t}$$

$$\text{PVA}_{\text{due}} = C + \frac{C}{(1+r)} + ... + \frac{C}{(1+r)^{t-1}}$$

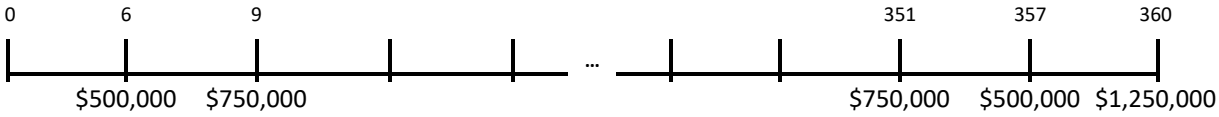
$$\text{PVA}_{\text{due}} = (1+r)\left(\frac{C}{(1+r)} + \frac{C}{(1+r)^2} + ... + \frac{C}{(1+r)^t} \right)$$

$$\text{PVA}_{\text{due}} = (1 + r)\ \text{PVA}$$

And the FVA due is:

$$\text{FVA} = C + C(1 + r) + C(1 + r)^2 + ... + C(1 + r)^{t-1}$$
$$\text{FVA}_{\text{due}} = C(1 + r) + C(1 + r)^2 + ... + C(1 + r)^t$$
$$\text{FVA}_{\text{due}} = (1 + r)[C + C(1 + r) + ... + C(1 + r)^{t-1}]$$
$$\text{FVA}_{\text{due}} = (1 + r)\text{FVA}$$

76. The time line is:



Since the cash flows are every six months and every nine months, we need the six- and nine-month interest rates, which are:

Six-month rate = $[1 + (.081/12)]^6 - 1$
Six-month rate = .0412, or 4.12%

Nine-month rate = $[1 + (.081/12)]^9 - 1$
Nine-month rate = .0624, or 6.24%

Now we can find the present value of the cash flows. Even though there is a cash flow every 18 months that is the combined value of the two cash flows, we can still treat each cash flow as an individual annuity. Finding the present value of each annuity, we get:

$\text{PVA}_1 = \$500{,}000\{[1 - 1/(1 + .0412)^{60}]/.0412\}$
$\text{PVA}_1 = \$11{,}061{,}542.37$

$\text{PVA}_2 = \$750{,}000\{[1 - 1/(1 + .0624)^{40}]/.0624\}$
$\text{PVA}_2 = \$10{,}949{,}552.71$

So, the present value of the lottery payments is:

Present value = $11,061,542.37 + 10,949,552.71
Present value = $22,011,095.07

77. *a.* The APR is the interest rate per week times 52 weeks in a year, so:

APR = 52(4.9%)
APR = 254.80%

EAR = $(1 + .049)^{52} - 1$
EAR = 11.0317, or 1,103.17%

b. In a discount loan, the amount you receive is lowered by the discount, and you repay the full principal. With a discount of 4.9 percent, you would receive $9.51 for every $10 in principal, so the weekly interest rate would be:

$\$10 = \$9.51(1 + r)$
$r = \$10/\$9.51 - 1$
$r = .0515$, or 5.15%

Note the dollar amount we use is irrelevant. In other words, we could use $.951 and $1, $95.10 and $100, or any other combination and we would get the same interest rate. Now we can find the APR and the EAR:

APR = 52(5.15%)
APR = 267.93%

EAR = $(1 + .0515)^{52} - 1$
EAR = 12.6337, or 1,263.37%

c. Using the cash flows from the loan, we have the PVA and the annuity payments and need to find the interest rate, so:

PVA = $\$78.91 = \$25[\{1 - [1/(1 + r)^4]\}/r]$

Using a spreadsheet, trial and error, or a financial calculator, we find:

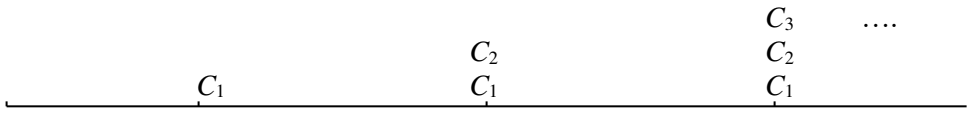
$r = 10.20\%$ per week

APR = 52(10.20%)
APR = 530.24%

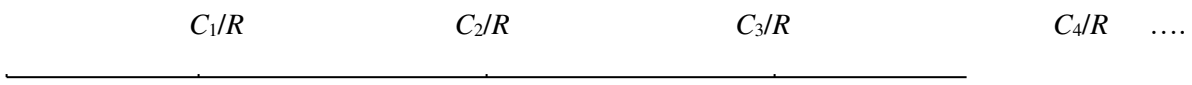
EAR = $1.1020^{52} - 1$
EAR = 154.8879, or 15,488.79%

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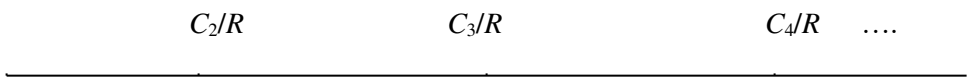
78. To answer this, we can diagram the perpetuity cash flows, which are: (Note, the subscripts are only to differentiate when the cash flows begin. The cash flows are all the same amount.)



Thus, each of the increased cash flows is a perpetuity in itself. So, we can write the cash flows stream as:



So, we can write the cash flows as the present value of a perpetuity with a perpetuity payment of:



The present value of this perpetuity is:

PV = $(C/R)/R = C/R^2$

So, the present value equation of a perpetuity that increases by C each period is:

PV = $C/R + C/R^2$

79. Since it is only an approximation, we know the Rule of 72 is exact for only one interest rate. Using the basic future value equation for an amount that doubles in value and solving for t, we find:

FV = $PV(1 + R)^t$
$\$2 = \$1(1 + R)^t$
$\ln(2) = t \ln(1 + R)$
$t = \ln(2)/\ln(1 + R)$

We also know the Rule of 72 approximation is:

$t = 72/R$

We can set these two equations equal to each other and solve for R. We also need to remember that the exact future value equation uses decimals, so the equation becomes:

$.72/R = \ln(2)/\ln(1 + R)$
$0 = (.72/R)/[\ln(2)/\ln(1 + R)]$

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It is not possible to solve this equation directly for R, but using Solver, we find the interest rate for which the Rule of 72 is exact is 7.846894 percent.

80. We are only concerned with the time it takes money to double, so the dollar amounts are irrelevant. We can write the future value of a lump sum with continuously compounded interest as:

$\$2 = \$1e^{Rt}$
$2 = e^{Rt}$
$Rt = \ln(2)$
$Rt = .693147$
$t = .693147/R$

Since we are using percentage interest rates while the equation uses decimal form, to make the equation correct with percentages, we can multiply by 100:

$t = 69.3147/R$

Calculator Solutions

1.

	N	I/Y	PV	PMT	FV
Enter	10	7%	±$5,600		
Solve for					$11,016.05

$\$11,016.05 - 9,520 = \$1,496.05$

2.

	N	I/Y	PV	PMT	FV
Enter	10	6%	±$4,375		
Solve for					$7,834.96
Enter	10	8%	±$4,375		
Solve for					$9,445.30
Enter	20	6%	±$4,375		
Solve for					$14,031.22

3.

	N	I/Y	PV	PMT	FV
Enter	9	7%			±$10,971
Solve for			$5,967.50		
Enter	13	9%			±$43,862
Solve for			$14,306.85		

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	N	I/Y	PV	PMT	FV
Enter	16	14%			±$754,500
Solve for			$92,721.75		
Enter	24	11%			±$480,127
Solve for			$39,228.77		

4.

	N	I/Y	PV	PMT	FV
Enter	3		$217		±$284
Solve for		9.38%			
Enter	10		$432		±$1,250
Solve for		11.21%			
Enter	16		$41,000		±$173,864
Solve for		9.45%			
Enter	19		$54,382		±$425,600
Solve for		11.44%			

5.

	N	I/Y	PV	PMT	FV
Enter		7%	$625		±$1,284
Solve for	10.64				
Enter		10%	$810		±$4,341
Solve for	17.61				
Enter		8%	$18,400		±$234,162
Solve for	33.05				
Enter		13%	$21,500		±$215,000
Solve for	18.84				

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6.

	N	I/Y	PV	PMT	FV
Enter		4.83%	$1		±$2
Solve for	14.69				

	N	I/Y	PV	PMT	FV
Enter		4.83%	$1		±$4
Solve for	29.39				

7.

	N	I/Y	PV	PMT	FV
Enter	20	4.8%			±$450,000,000
Solve for			$176,192,274.03		

8.

	N	I/Y	PV	PMT	FV
Enter	3		±$1,680,000		$1,100,000
Solve for		–13.17%			

11.

CFo	$0	**CFo**	$0	**CFo**	$0
C01	$655	**C01**	$655	**C01**	$655
F01	1	**F01**	1	**F01**	1
C02	$945	**C02**	$945	**C02**	$945
F02	1	**F02**	1	**F02**	1
C03	$1,960	**C03**	$1,960	**C03**	$1,960
F03	1	**F03**	1	**F03**	1
C04	$2,380	**C04**	$2,380	**C04**	$2,380
F04	1	**F04**	1	**F04**	1
I = 5		I = 13		I = 18	
NPV CPT		NPV CPT		NPV CPT	
$5,132.11		$4,137.80		$3,654.26	

12.

	N	I/Y	PV	PMT	FV
Enter	9	5%		±$3,720	
Solve for			$26,441.10		

	N	I/Y	PV	PMT	FV
Enter	5	5%		±$5,740	
Solve for			$24,851.20		

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Enter	9	21%		±$3,720	
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			$14,528.22		

Enter	5	21%		±$5,740	
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			$16,795.15		

13.

Enter	15	6.8%		±$7,500	
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			$69,180.70		

Enter	40	6.8%		±$7,500	
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			$102,356.28		

Enter	75	6.8%		±$7,500	
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			$109,500.32		

15.

Enter	8.4%		4
	NOM	**EFF**	**C/Y**
Solve for		8.67%	

Enter	18.6%		12
	NOM	**EFF**	**C/Y**
Solve for		20.27%	

Enter	9.4%		365
	NOM	**EFF**	**C/Y**
Solve for		9.85%	

16.

Enter		9.9%	2
	NOM	**EFF**	**C/Y**
Solve for	9.67%		

Enter		11.4%	12
	NOM	**EFF**	**C/Y**
Solve for	10.84%		

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Enter		15.5%	52		
	NOM	**EFF**	**C/Y**		
Solve for	14.43%				

17.

Enter	14.8%		12		
	NOM	**EFF**	**C/Y**		
Solve for		15.85%			

Enter	15.1%		2		
	NOM	**EFF**	**C/Y**		
Solve for		15.67%			

18. 2nd BGN 2nd SET

Enter	12		$108	±$10	
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for		1.98%			

APR = 1.98% × 52 = 102.77%

Enter	102.77%		52		
	NOM	**EFF**	**C/Y**		
Solve for		176.68%			

19.

Enter		1.3%	$16,200	±$350	
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for	71.27				

20.

Enter	1,733.33%		52
	NOM	**EFF**	**C/Y**
Solve for		313,916,515.69%	

21.

Enter	6	6.3%	±$2,900		
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for					$4,184.06

Enter	6 × 2	6.3%/2	±$2,900		
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for					$4,207.55

Enter	6 × 12	6.3%/12	±$2,900		
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for					$4,227.97

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23. Stock account:

	N	I/Y	PV	PMT	FV
Enter	360	10.5%/12		±$950	
Solve for					$2,390,580.94

Bond account:

	N	I/Y	PV	PMT	FV
Enter	360	6.1%/12		±$375	
Solve for					$383,979.55

Savings at retirement = $2,390,580.94 + 383,979.55 = $2,774,560.49

	N	I/Y	PV	PMT	FV
Enter	300	6.9%/12	±$2,774,560.49		
Solve for				$19,433.38	

24.

	N	I/Y	PV	PMT	FV
Enter	12/3		±$1		$3
Solve for		31.61%			

25.

	N	I/Y	PV	PMT	FV
Enter	5		±$45,000		$89,000
Solve for		14.61%			

	N	I/Y	PV	PMT	FV
Enter	11		±45,000		$210,000
Solve for		15.03%			

28.

	N	I/Y	PV	PMT	FV
Enter	23	7.4%		±$7,200	
Solve for			$78,460.71		

	N	I/Y	PV	PMT	FV
Enter	2	7.4%			±$78,460.71
Solve for			$68,021.10		

29.

	N	I/Y	PV	PMT	FV
Enter	15	12%		±$950	
Solve for			$6,470.32		

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	N	I/Y	PV	PMT	FV
Enter	5	9%			±$6,470.32
Solve for			$4,205.26		

30.

	N	I/Y	PV	PMT	FV
Enter	30 × 12	5.8%/12	±.80($875,000)		
Solve for				$4,107.27	

	N	I/Y	PV	PMT	FV
Enter	22 × 12	5.8%/12		±$4,107.27	
Solve for			$611,832.40		

31.

	N	I/Y	PV	PMT	FV
Enter	6	1.8%/12	±$9,000		
Solve for					$9,081.30

	N	I/Y	PV	PMT	FV
Enter	6	15%/12	±$9,081.30		
Solve for					$9,784.04

$9,784.04 – 9,000 = $784.04

35.

	N	I/Y	PV	PMT	FV
Enter	15	10%		±$6,350	
Solve for			$48,298.60		

	N	I/Y	PV	PMT	FV
Enter	15	5%		±$6,350	
Solve for			$65,910.83		

	N	I/Y	PV	PMT	FV
Enter	15	15%		±$6,350	
Solve for			$37,130.80		

36.

	N	I/Y	PV	PMT	FV
Enter		8.75%/12		±$245	$25,000
Solve for	76.56				

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37.

Enter	60		$135,000	±$2,650	
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for		.553%			

.553% × 12 = 6.64%

38.

Enter	360	5.1%/12		±$950	
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			$174,970.14		

$245,000 – 174,970.14 = $70,029.86

Enter	360	5.1%/12	±$70,029.86		
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for					$322,363.44

39.

CFo	$0
C01	$1,300
F01	1
C02	$0
F02	1
C03	$1,900
F03	1
C04	$2,450
F04	1

I = 7%
NPV CPT
$4,635.01

PV of missing CF = $5,800 – 4,635.01 = $1,164.99

Value of missing CF:

Enter	2	7%	±$1,164.99		
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for					$1,333.79

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40.

CF$_0$	$1,000,000
C01	$1,195,000
F01	1
C02	$1,390,000
F02	1
C03	$1,585,000
F03	1
C04	$1,780,000
F04	1
C05	$1,975,000
F05	1
C06	$2,170,000
F06	1
C07	$2,365,000
F07	1
C08	$2,560,000
F08	1
C09	$2,755,000
F09	1
C010	$2,950,000

I = 7.3%
NPV CPT
$14,577,923.31

41.

	N	I/Y	PV	PMT	FV
Enter	360		.80($3,300,000)	±$16,250	
Solve for		.521%			

APR = .521% × 12 = 6.25%

	NOM	EFF	C/Y
Enter	6.25%		12
Solve for		6.43%	

42.

	N	I/Y	PV	PMT	FV
Enter	3	11%			$125,000
Solve for			$91,398.92		

Profit = $91,398.92 – 87,000 = $4,398.92

	N	I/Y	PV	PMT	FV
Enter	3		±$87,000		$125,000
Solve for		12.84%			

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43.

Enter	24	6.9%		±$4,100	
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			$47,439.93		

Enter	6	6.9%			±$47,439.93
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			$31,789.07		

44.

Enter	96	8.6%/12		±$1,750	
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			$121,161.48		

Enter	84	11.4%/12		±$1,750	±$121,161.48
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			$155,716.92		

45.

Enter	15 × 12	6.05%/12		±$1,050	
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for					$306,664.39

FV = $306,664.39 = PV$e^{-.07(15)}$; PV = $306,664.39$e^{-1.05}$ = $107,313.44

46. PV@ t = 14: $3,550/.076 = $46,710.53

Enter	7	7.6%			±$46,710.53
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			$27,972.34		

47.

Enter	12		$27,000	±$2,607.75	
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for		2.347%			

APR = 2.347 × 12 = 28.16%

Enter	28.16%		12
	NOM	**EFF**	**C/Y**
Solve for		32.09%	

48. Monthly rate = .09/12 = .0075; semiannual rate = $1.0075^6 - 1$ = .0459, or 4.59%

Enter	10	4.59%		±$5,700	
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			$44,914.10		

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Enter	8	4.59%			±$44,914.10
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			$31,377.62		

Enter	12	4.59%			±$44,914.10
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			$26,226.40		

Enter	18	4.59%			±$44,914.10
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			$20,040.88		

49.

Enter	5	7.2%		±$16,000	
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			$65,253.34		

2nd BGN 2nd SET

Enter	5	7.2%		±$16,000	
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			$69,951.58		

Enter	5	7.2%		±$16,000	
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for					$92,379.73

2nd BGN 2nd SET

Enter	5	7.2%		±$16,000	
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for					$99,031.07

50. 2nd BGN 2nd SET

Enter	60	4.98%/12	±$76,000		
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for				$1,427.59	

53. 2nd BGN 2nd SET

Enter	24	8.6%/12	±$4,600		
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for				$207.82	

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54. PV of college expenses:

	N	I/Y	PV	PMT	FV
Enter	4	9.2%		±$65,000	
Solve for			$209,660.66		

Cost today of oldest child's expenses:

	N	I/Y	PV	PMT	FV
Enter	14	9.2%			$209,660.66
Solve for			$61,150.50		

Cost today of youngest child's expenses:

	N	I/Y	PV	PMT	FV
Enter	16	9.2%			±$209,660.66
Solve for			$51,280.79		

Total cost today = $61,150.50 + 51,280.79 = $112,431.29

	N	I/Y	PV	PMT	FV
Enter	15	9.2%	±$112,431.29		
Solve for				$14,113.20	

56. Option A:
Aftertax cash flows = Pretax cash flows(1 – tax rate)
Aftertax cash flows = $400,000(1 – .36)
Aftertax cash flows = $256,000

2ND BGN 2nd SET

	N	I/Y	PV	PMT	FV
Enter	31	4.1%		±$256,000	
Solve for			$4,629,503.60		

Option B:
Aftertax cash flows = Pretax cash flows(1 – tax rate)
Aftertax cash flows = $325,000(1 – .36)
Aftertax cash flows = $208,000

	N	I/Y	PV	PMT	FV
Enter	30	4.1%		±$208,000	
Solve for			$3,553,471.68		

Total value = $3,553,471.68 + 1,000,000 = $4,553,471.68

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58.

	N	I/Y	PV	PMT	FV
Enter	5 × 12	5.8%/12	±$43,000		
Solve for				$788.84	

	N	I/Y	PV	PMT	FV
Enter	34	5.8%/12		$788.84	
Solve for			$24,677.82		

Total payment = Amount due(1 + Prepayment penalty) + Current payment
Total payment = $24,677.82(1 + .01) + $788.84
Total payment = $25,713.43

59. Pre-retirement APR:

	NOM	EFF	C/Y
Enter		11%	12
Solve for	10.48%		

Post-retirement APR:

	NOM	EFF	C/Y
Enter		7%	12
Solve for	6.785%		

At retirement, he needs:

	N	I/Y	PV	PMT	FV
Enter	240	6.785%/12		±$24,000	
Solve for			$3,147,769.06		

In 10 years, his savings will be worth:

	N	I/Y	PV	PMT	FV
Enter	120	10.48%/12		±$2,300	
Solve for					$484,357.76

After purchasing the cabin, he will have: $484,357.76 – 340,000 = $109,357.76

Each month between Years 10 and 30, he needs to save:

	N	I/Y	PV	PMT	FV
Enter	240	10.48%/12	$109,357.76		±$3,406,188.07
Solve for				$3,122.29	

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60. PV of resale:

Enter	36	4.1%/12			±$24,500
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			$21,669.00		

$39,000 – 21,669.00 = $17,331.00

PV of lease:

Enter	36	4.1%/12		±$450	
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			$15,218.90		

$15,218.90 + 3,000 = $18,218.90

Buy the car.

You would be indifferent when the PVs of the two cash flows are equal. The present value of the purchase decision must be $17,331.00. Since the difference in the two cash flows is $39,000 – 18,218.90 = $20,781.10, this must be the present value of the future resale price of the car. The break-even resale price of the car is:

Enter	36	4.1%/12	±$20,781.10		
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for					$23,496.09

61.

Enter	5%		365
	NOM	**EFF**	**C/Y**
Solve for		5.13%	

CF$_0$	$10,000,000
C01	$7,400,000
F01	1
C02	$7,400,000
F02	1
C03	$7,700,000
F03	1
C04	$8,500,000
F04	1
C05	$10,400,000
F05	1
C06	$11,900,000
F06	1

I = 5.13%
NPV CPT
$54,237,375.60

New contract value = $54,237,375.60 + 3,500,000 = $57,737,375.60

PV of payments = $57,737,375.60 – 13,000,000 = $44,737,375.60
Effective quarterly rate = $[1 + (.05/365)]^{91.25} - 1 = .01258$, or 1.258%

Enter	24	1.258%	±$44,737,375.60		
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for				$2,171,144.82	

62.

Enter	1		$17,420		±$20,000
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for		14.81%			

63.

Enter		9%	12		
	NOM	**EFF**	**C/Y**		
Solve for	8.65%				

Enter	12	8.65%/12		±$46,000/12	
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for					$47,867.98

Enter	12	8.65%/12	$47,867.98	±$49,000/12	
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for					$103,165.90

Enter	60	8.65%/12		±$53,000/12	
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			$214,522.97		

Award = $103,165.90 + 214,522.97 + 250,000 + 50,000 = $617,688.87

64.

Enter	1		$9,800		±$11,340
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for		15.71%			

65.

Enter	1		$9,700		±$11,020
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for		13.61%			

66. Refundable fee: With the $3,100 application fee, you will need to borrow $253,100 to have $250,000 after deducting the fee. Solve for the payment under these circumstances.

Enter	30 × 12	5.2%/12	±$253,100		
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for				$1,389.80	

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Enter	30 × 12		$250,000	±$1,389.80	
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for		.4425%			

APR = .4425% × 12 = 5.31%

Enter	5.31%		12
	NOM	**EFF**	**C/Y**
Solve for		5.44%	

Without refundable fee: APR = 5.20%

Enter	5.20%		12
	NOM	**EFF**	**C/Y**
Solve for		5.33%	

67.

Enter	36		$3,500	±$154.52	
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for		2.76%			

APR = 2.76% × 12 = 33.07%

Enter	33.07%		12
	NOM	**EFF**	**C/Y**
Solve for		38.57%	

69. Without fee:

Enter		18.2%/12	$10,000	±$175	
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for	133.86				

Enter		7.9%/12	$10,000	±$175	
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for	71.92				

With fee:

Enter		7.9%/12	$10,300	±$175	
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for	74.70				

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70. Value at Year 6:

Enter	5	10%	±$700		
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for					$1,127.36

Enter	4	10%	±$700		
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for					$1,024.87

Enter	3	10%	±$800		
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for					$1,064.80

Enter	2	10%	±$800		
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for					$968

Enter	1	10%	±$900		
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for					$990

So, at Year 5, the value is: $1,127.36 + 1,024.87 + 1,064.80 + 968 + 990 + 900 = $6,075.03

At Year 65, the value is:

Enter	59	8%	±$6,075.03		
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for					$569,573.51

The policy is not worth buying; the future value of the policy is $569,573.51 but the policy contract will pay off $500,000.

71. Effective six-month rate = $(1 + \text{Daily rate})^{182.5} - 1$
Effective six-month rate = $(1 + .08/365)^{182.5} - 1$
Effective six-month rate = .0408, or 4.08%

Enter	40	4.08%		±$1,950,000	
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			$38,137,152.90		

	N	I/Y	PV	PMT	FV
Enter	1	4.08%			±$38,137,152.90
Solve for			$36,641,934.34		

Value of winnings today = $36,641,934.34 + 5,000,000
Value of winnings today = $41,641,934.34

72.

CFo	±$20,000
C01	±$20,000
F01	5
C02	$45,000
F02	4

IRR CPT
8.33%

76. Six-month rate = $[1 + (.081/12)]^6 - 1$
Six-month rate = .0412, or 4.12%

Nine-month rate = $[1 + (.081/12)]^9 - 1$
Nine-month rate = .0624, or 6.24%

	N	I/Y	PV	PMT	FV
Enter	60	4.12%		±$500,000	
Solve for			$11,061,542.37		

	N	I/Y	PV	PMT	FV
Enter	40	6.24%		±$750,000	
Solve for			$10,949,552.71		

Value today = $11,061,542.37 + 10,949,552.71 = $22,011,095.07

77.

a. APR = 4.90% × 52 = 254.80%

	NOM	EFF	C/Y
Enter	254.80%		52
Solve for		1,158.52%	

b.

	N	I/Y	PV	PMT	FV
Enter	1		$95.10		±$100.00
Solve for		5.15%			

APR = 5.15% × 52 = 267.93%

Enter	267.93%		52		
	NOM	**EFF**	**C/Y**		
Solve for		1,263.37%			

c.

Enter	4		$78.91	±$25	
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for		10.20%			

APR = 10.20% × 52 = 530.24%

Enter	530.24%		52
	NOM	**EFF**	**C/Y**
Solve for		15,488.79%	

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CHAPTER 5
INTEREST RATES AND BOND VALUATION

Answers to Concept Questions

1. No. As interest rates fluctuate, the value of a Treasury security will fluctuate. Long-term Treasury securities have substantial interest rate risk.

2. All else the same, the Treasury security will have lower coupons because of its lower default risk, so it will have greater interest rate risk.

3. No. If the bid were higher than the ask, the implication would be that a dealer was willing to sell a bond and immediately buy it back at a higher price. How many such transactions would you like to do?

4. Prices and yields move in opposite directions. Since the bid price must be lower, the bid yield must be higher.

5. There are two benefits. First, the company can take advantage of interest rate declines by calling in an issue and replacing it with a lower coupon issue. Second, a company might wish to eliminate a covenant for some reason. Calling the issue does this. The cost to the company is a higher coupon. A put provision is desirable from an investor's standpoint, so it helps the company by reducing the coupon rate on the bond. The cost to the company is that it may have to buy back the bond at an unattractive price.

6. Bond issuers look at outstanding bonds of similar maturity and risk. The yields on such bonds are used to establish the coupon rate necessary for a particular issue to initially sell for par value. Bond issuers also ask potential purchasers what coupon rate would be necessary to attract them. The coupon rate is fixed and determines what the bond's coupon payments will be. The required return is what investors actually demand on the issue, and it will fluctuate through time. The coupon rate and required return are equal only if the bond sells exactly at par.

7. Yes. Some investors have obligations that are denominated in dollars; i.e., they are nominal. Their primary concern is that an investment provides the needed nominal dollar amounts. Pension funds, for example, often must plan for pension payments many years in the future. If those payments are fixed in dollar terms, then it is the nominal return on an investment that is important.

8. Companies pay to have their bonds rated because unrated bonds can be difficult to sell; many large investors are prohibited from investing in unrated issues.

9. Junk bonds often are not rated because there would be no point in an issuer paying a rating agency to assign its bonds a low rating (it's like paying someone to kick you!).

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10. The term structure is based on pure discount bonds. The yield curve is based on coupon-bearing issues.

11. Bond ratings have a subjective factor to them. Split ratings reflect a difference of opinion among credit agencies.

12. As a general constitutional principle, the federal government cannot tax the states without their consent if doing so would interfere with state government functions. At one time, this principle was thought to provide for the tax-exempt status of municipal interest payments. However, modern court rulings make it clear that Congress can revoke the municipal exemption, so the only basis now appears to be historical precedent. The fact that the states and the federal government do not tax each other's securities is referred to as "reciprocal immunity."

13. Lack of transparency means that a buyer or seller can't see recent transactions, so it is much harder to determine what the best bid and ask prices are at any point in time.

14. When the bonds are initially issued, the coupon rate is set at auction so that the bonds sell at par value. The wide range of coupon rates shows the interest rate when the bond was issued. Notice that interest rates have evidently declined. Why?

15. Companies charge that bond rating agencies are pressuring them to pay for bond ratings. When a company pays for a rating, it has the opportunity to make its case for a particular rating. With an unsolicited rating, the company has no input.

16. A 100-year bond looks like a share of preferred stock. In particular, it is a loan with a life that almost certainly exceeds the life of the lender, assuming that the lender is an individual. With a junk bond, the credit risk can be so high that the borrower is almost certain to default, meaning that the creditors are very likely to end up as part owners of the business. In both cases, the "equity in disguise" has a significant tax advantage.

17. *a*. The bond price is the present value of the cash flows from a bond. The YTM is the interest rate used in valuing the cash flows from a bond.

b. If the coupon rate is higher than the required return on a bond, the bond will sell at a premium, since it provides periodic income in the form of coupon payments in excess of that required by investors on other similar bonds. If the coupon rate is lower than the required return on a bond, the bond will sell at a discount since it provides insufficient coupon payments compared to that required by investors on other similar bonds. For premium bonds, the coupon rate exceeds the YTM; for discount bonds, the YTM exceeds the coupon rate, and for bonds selling at par, the YTM is equal to the coupon rate.

c. Current yield is defined as the annual coupon payment divided by the current bond price. For premium bonds, the current yield exceeds the YTM, for discount bonds the current yield is less than the YTM, and for bonds selling at par value, the current yield is equal to the YTM. In all cases, the current yield plus the expected one-period capital gains yield of the bond must be equal to the required return.

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18. A long-term bond has more interest rate risk compared to a short-term bond, all else the same. A low coupon bond has more interest rate risk than a high coupon bond, all else the same. When comparing a high coupon, long-term bond to a low coupon, short-term bond, we are unsure which has more interest rate risk. Generally, the maturity of a bond is a more important determinant of the interest rate risk, so the long-term, high coupon bond probably has more interest rate risk. The exception would be if the maturities are close, and the coupon rates are vastly different.

Solutions to Questions and Problems

NOTE: All end-of-chapter problems were solved using a spreadsheet. Many problems require multiple steps. Due to space and readability constraints, when these intermediate steps are included in this solutions manual, rounding may appear to have occurred. However, the final answer for each problem is found without rounding during any step in the problem.

Basic

1. The price of a pure discount (zero coupon) bond is the present value of the par. Remember, even though there are no coupon payments, the periods are semiannual to stay consistent with coupon bond payments. So, the price of the bond for each YTM is:

a. $P = \$1{,}000/(1 + .04/2)^{42} = \$435.30$

b. $P = \$1{,}000/(1 + .10/2)^{42} = \$128.84$

c. $P = \$1{,}000/(1 + .14/2)^{42} = \$58.33$

2. The price of any bond is the PV of the interest payments, plus the PV of the par value. Notice this problem assumes a semiannual coupon. The price of the bond at each YTM will be:

a. $P = \$35(\{1 - [1/(1 + .035)]^{36}\}/.035) + \$1{,}000[1/(1 + .035)^{36}]$
$P = \$1{,}000.00$
When the YTM and the coupon rate are equal, the bond will sell at par.

b. $P = \$35(\{1 - [1/(1 + .045)]^{36}\}/.045) + \$1{,}000[1/(1 + .045)^{36}]$
$P = \$823.34$
When the YTM is greater than the coupon rate, the bond will sell at a discount.

c. $P = \$35(\{1 - [1/(1 + .025)]^{36}\}/.025) + \$1{,}000[1/(1 + .025)^{36}]$
$P = \$1{,}235.56$
When the YTM is less than the coupon rate, the bond will sell at a premium.

We would like to introduce shorthand notation here. Rather than write (or type, as the case may be) the entire equation for the PV of a lump sum, or the PVA equation, it is common to abbreviate the equations as:

$PVIF_{R,t} = 1/(1 + R)^t$

which stands for Present Value Interest Factor, and

$PVIFA_{R,t} = (\{1 - [1/(1 + R)]^t\}/R)$

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which stands for Present Value Interest Factor of an Annuity

These abbreviations are shorthand notation for the equations in which the interest rate and the number of periods are substituted into the equations and solved. We will use this shorthand notation in the remainder of the solutions key.

3. Here we are finding the YTM of a semiannual coupon bond. The bond price equation is:

$P = \$960 = \$25.50(\text{PVIFA}_{R\%,26}) + \$1{,}000(\text{PVIF}_{R\%,26})$

Since we cannot solve the equation directly for R, using a spreadsheet, a financial calculator, or trial and error, we find:

$R = 2.768\%$

Since the coupon payments are semiannual, this is the semiannual interest rate. The YTM is the APR of the bond, so:

$\text{YTM} = 2 \times 2.768\% = 5.54\%$

4. Here we need to find the coupon rate of the bond. We need to set up the bond pricing equation and solve for the coupon payment as follows:

$P = \$1{,}030 = C(\text{PVIFA}_{3.6\%,25}) + \$1{,}000(\text{PVIF}_{3.6\%,25})$

Solving for the coupon payment, we get:

$C = \$37.84$

Since this is the semiannual payment, the annual coupon payment is:

$2 \times \$37.84 = \$75.68$

And the coupon rate is the annual coupon payment divided by par value, so:

Coupon rate = \$75.68/\$1,000
Coupon rate = .0757, or 7.57%

5. The price of any bond is the PV of the interest payment, plus the PV of the par value. The fact that the bond is denominated in euros is irrelevant. Notice this problem assumes an annual coupon. The price of the bond will be:

$P = €38(\text{PVIFA}_{3.1\%,16}) + €1{,}000(\text{PVIF}_{3.1\%,16})$
$P = €1{,}087.26$

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6. Here we are finding the YTM of an annual coupon bond. The fact that the bond is denominated in yen is irrelevant. The bond price equation is:

P = ¥95,400 = ¥4,900(PVIFA$_{R\%,18}$) + ¥100,000(PVIF$_{R\%,18}$)

Since we cannot solve the equation directly for R, using a spreadsheet, a financial calculator, or trial and error, we find:

R = 5.30%

Since the coupon payments are annual, this is the yield to maturity.

7. The approximate relationship between nominal interest rates (R), real interest rates (r), and inflation (h) is:

$R = r + h$

Approximate r = .051 – .029
Approximate r = .022, or 2.20%

The Fisher equation, which shows the exact relationship between nominal interest rates, real interest rates, and inflation is:

$(1 + R) = (1 + r)(1 + h)$
$(1 + .051) = (1 + r)(1 + .029)$
Exact r = [(1 + .051)/(1 + .029)] – 1
Exact r = .0214, or 2.14%

8. The Fisher equation, which shows the exact relationship between nominal interest rates, real interest rates, and inflation, is:

$(1 + R) = (1 + r)(1 + h)$
$R = (1 + .023)(1 + .035) – 1$
R = .0588, or 5.88%

9. The Fisher equation, which shows the exact relationship between nominal interest rates, real interest rates, and inflation, is:

$(1 + R) = (1 + r)(1 + h)$
h = [(1 + .135)/(1 + .086)] – 1
h = .0451, or 4.51%

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10. The Fisher equation, which shows the exact relationship between nominal interest rates, real interest rates, and inflation, is:

$(1 + R) = (1 + r)(1 + h)$
$r = [(1 + .109)/(1 + .038)] – 1$
$r = .0684$, or 6.84%

11. To find the price of a zero coupon bond, we need to find the value of the future cash flows. With a zero coupon bond, the only cash flow is the par value at maturity. We find the present value assuming semiannual compounding to keep the YTM of a zero coupon bond equivalent to the YTM of a coupon bond, so:

$P = \$10{,}000(\text{PVIF}_{2.45\%,26})$
$P = \$5{,}329.53$

12. To find the price of this bond, we need to find the present value of the bond's cash flows. So, the price of the bond is:

$P = \$46(\text{PVIFA}_{1.90\%,26}) + \$2{,}000(\text{PVIF}_{1.90\%,26})$
$P = \$2{,}162.94$

13. To find the price of this bond, we need to find the present value of the bond's cash flows. So, the price of the bond is:

$P = \$97.50(\text{PVIFA}_{2.10\%,32}) + \$5{,}000(\text{PVIF}_{2.10\%,32})$
$P = \$4{,}826.52$

14. The coupon rate, located in the second column of the quote, is 2.875%. The bid price is:

Bid price = (102.6563/100) × $1,000
Bid price = $1,026.563

The previous day's ask price is found by:

Previous day's asked price = Today's asked price – Change
Previous day's asked price = 102.6719 – .8359
Previous day's asked price = 101.8360

The previous day's price in dollars was:

Previous day's dollar price = (101.8360/100) × $1,000
Previous day's dollar price = $1,018.36

15. This is a premium bond because it sells for more than 100 percent of face value. The current yield is based on the asked price, so the current yield is:

Current yield = Annual coupon payment/Price
Current yield = $35/$1,116.797
Current yield = .0313, or 3.13%

The YTM is located under the "Asked yield" column, so the YTM is 2.741%.

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The bid-ask spread is the difference between the bid price and the ask price, so:

Bid-Ask spread = 111.6797 – 111.6172
Bid-Ask spread = (.0625/100) × $1,000
Bid-Ask spread = $.625

Intermediate

16. Here we are finding the YTM of semiannual coupon bonds for various maturity lengths. The bond price equation is:

$P = C(\text{PVIFA}_{R\%,t}) + \$1{,}000(\text{PVIF}_{R\%,t})$

Miller Corporation bond:

$P_0 = \$37(\text{PVIFA}_{2.7\%,26}) + \$1{,}000(\text{PVIF}_{2.7\%,26}) = \$1{,}185.10$
$P_1 = \$37(\text{PVIFA}_{2.7\%,24}) + \$1{,}000(\text{PVIF}_{2.7\%,24}) = \$1{,}174.96$
$P_3 = \$37(\text{PVIFA}_{2.7\%,20}) + \$1{,}000(\text{PVIF}_{2.7\%,20}) = \$1{,}152.99$
$P_8 = \$37(\text{PVIFA}_{2.7\%,10}) + \$1{,}000(\text{PVIF}_{2.7\%,10}) = \$1{,}086.62$
$P_{12} = \$37(\text{PVIFA}_{2.7\%,2}) + \$1{,}000(\text{PVIF}_{2.7\%,2}) = \$1{,}019.22$
$P_{13} = \$1{,}000$

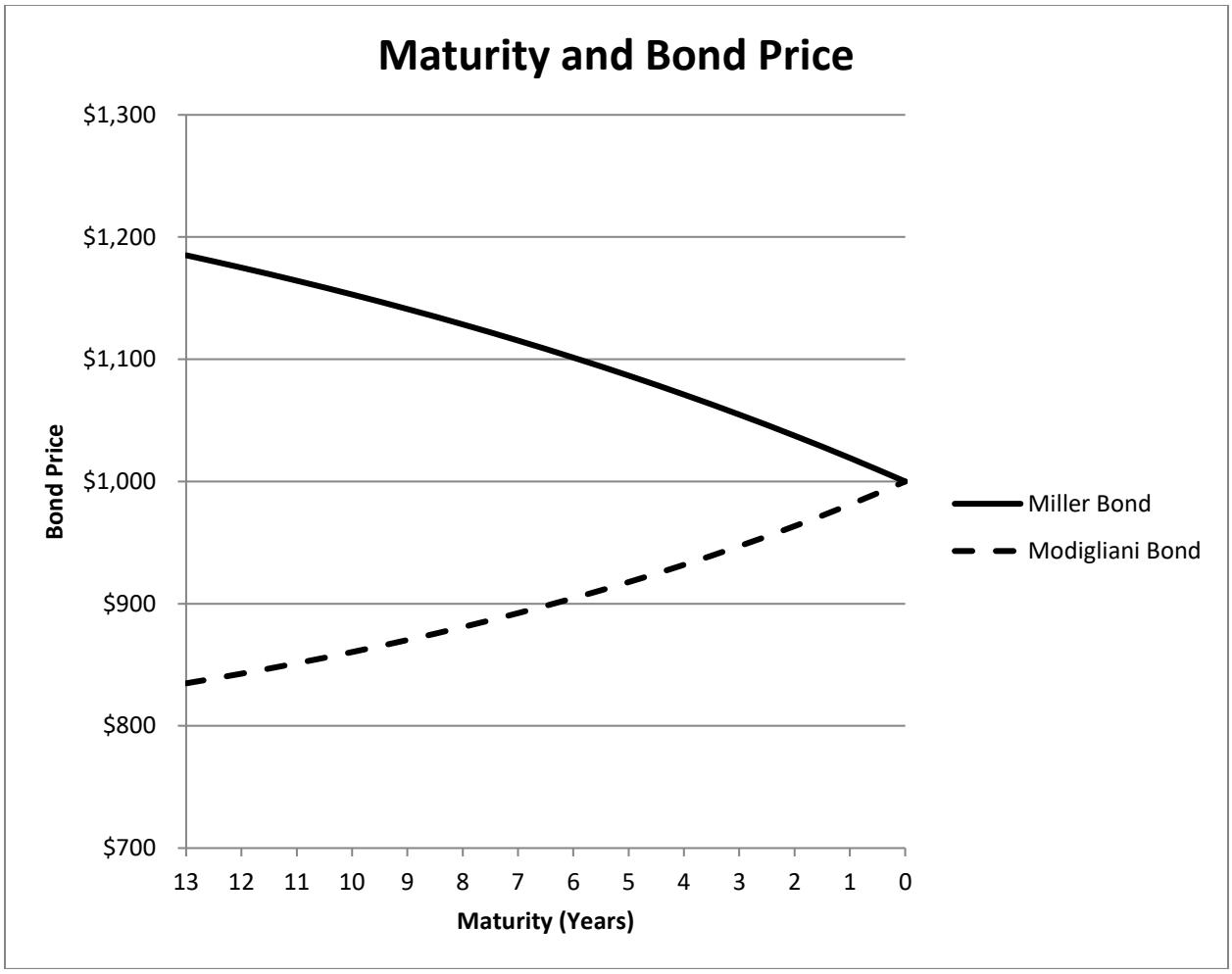
Modigliani Company bond:

$P_0 = \$27(\text{PVIFA}_{3.7\%,26}) + \$1{,}000(\text{PVIF}_{3.7\%,26}) = \$834.82$
$P_1 = \$27(\text{PVIFA}_{3.7\%,24}) + \$1{,}000(\text{PVIF}_{3.7\%,24}) = \$842.74$
$P_3 = \$27(\text{PVIFA}_{3.7\%,20}) + \$1{,}000(\text{PVIF}_{3.7\%,20}) = \$860.41$
$P_8 = \$27(\text{PVIFA}_{3.7\%,10}) + \$1{,}000(\text{PVIF}_{3.7\%,10}) = \$917.67$
$P_{12} = \$27(\text{PVIFA}_{3.7\%,2}) + \$1{,}000(\text{PVIF}_{3.7\%,2}) = \$981.06$
$P_{13} = \$1{,}000$

All else held constant, the premium over par value for a premium bond declines as maturity approaches, and the discount from par value for a discount bond declines as maturity approaches. This is called "pull to par." In both cases, the largest percentage price changes occur at the shortest maturity lengths.

Also, notice that the price of each bond when no time is left to maturity is the par value, even though the purchaser would receive the par value plus the coupon payment immediately. This is because we calculate the clean price of the bond.

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17. Any bond that sells at par has a YTM equal to the coupon rate. Both bonds sell at par, so the initial YTM on both bonds is the coupon rate, 7.3 percent. If the YTM suddenly rises to 9.3 percent:

P_{Laurel} = \$36.50(PVIFA$_{4.65\%,8}$) + \$1,000(PVIF$_{4.65\%,8}$) = \$934.44

P_{Hardy} = \$36.50(PVIFA$_{4.65\%,46}$) + \$1,000(PVIF$_{4.65\%,46}$) = \$811.53

The percentage change in price is calculated as:

Percentage change in price = (New price – Original price)/Original price

$\Delta P_{\text{Laurel}}\%$ = (\$934.44 – 1,000)/\$1,000 = –.0656, or –6.56%

$\Delta P_{\text{Hardy}}\%$ = (\$811.53 – 1,000)/\$1,000 = –.1885, or –18.85%

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If the YTM suddenly falls to 5.3 percent:

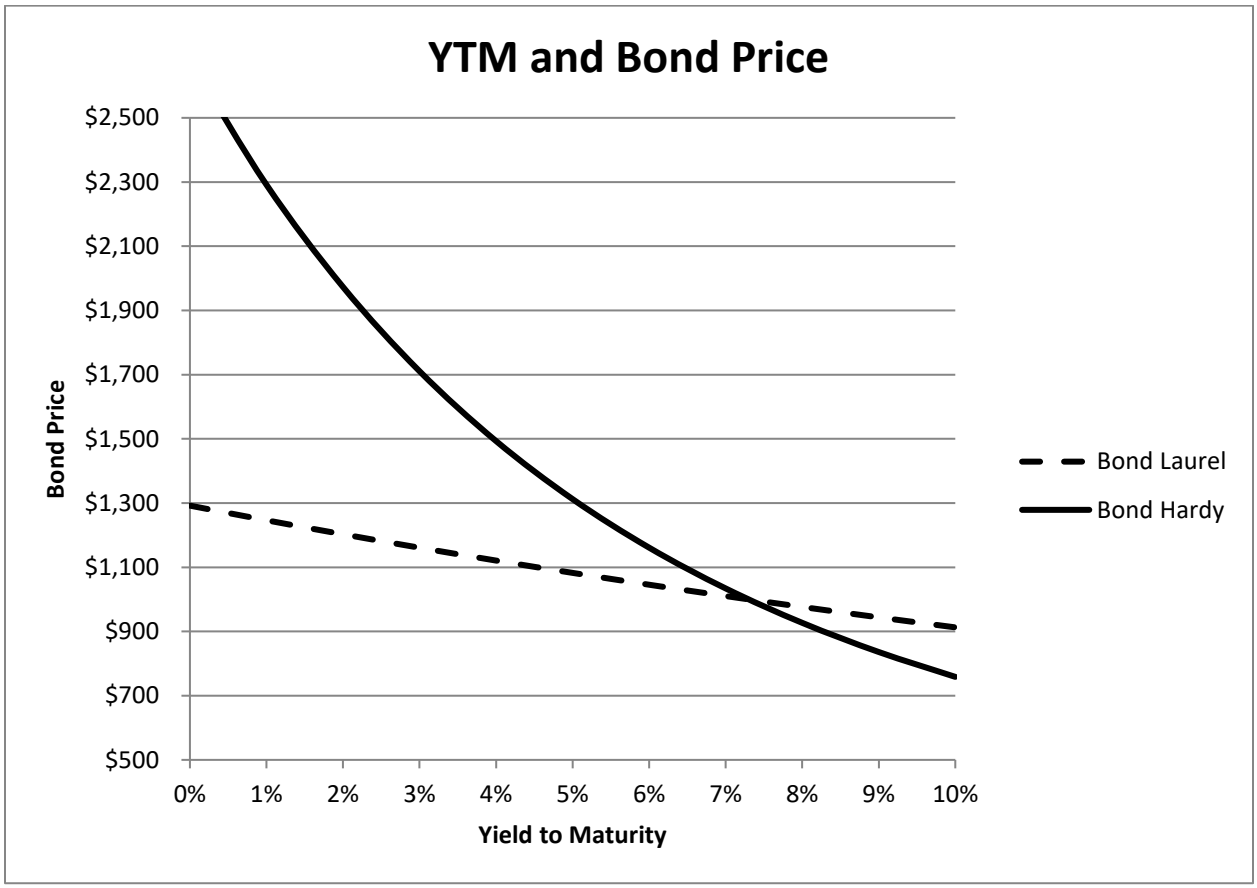
P_{Laurel} = \$36.50(PVIFA$_{2.65\%,8}$) + \$1,000(PVIF$_{2.65\%,8}$) = \$1,074.24

P_{Hardy} = \$36.50(PVIFA$_{2.65\%,46}$) + \$1,000(PVIF$_{2.65\%,46}$) = \$1,264.06

$\Delta P_{Laurel}\%$ = (\$1,074.24 – 1,000)/\$1,000 = +.0712, or 7.12%

$\Delta P_{Hardy}\%$ = (\$1,264.06 – 1,000)/\$1,000 = +.2641, or 26.41%

All else the same, the longer the maturity of a bond, the greater is its price sensitivity to changes in interest rates. Notice also that for the same interest rate change, the gain from a decline in interest rates is larger than the loss from the same magnitude change. For a plain vanilla bond, this is always true.



18. Initially, at a YTM of 9.5 percent, the prices of the two bonds are:

P_{Faulk} = \$32(PVIFA$_{4.75\%,36}$) + \$1,000(PVIF$_{4.75\%,36}$) = \$735.07

P_{Gonas} = \$63(PVIFA$_{4.75\%,36}$) + \$1,000(PVIF$_{4.75\%,36}$) = \$1,264.93

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If the YTM rises from 9.5 percent to 11.5 percent:

P_{Faulk} = \$32(PVIFA$_{5.75\%,36}$) + \$1,000(PVIF$_{5.75\%,36}$) = \$615.78

P_{Gonas} = \$63(PVIFA$_{5.75\%,36}$) + \$1,000(PVIF$_{5.75\%,36}$) = \$1,082.87

The percentage change in price is calculated as:

Percentage change in price = (New price – Original price)/Original price

$\Delta P_{Faulk}\%$ = (\$615.78 – 735.07)/\$735.07 = –.1623, or –16.23%
$\Delta P_{Gonas}\%$ = (\$1,082.87 – 1,264.93)/\$1,264.93 = –.1439, or –14.39%

If the YTM declines from 9.5 percent to 7.5 percent:

P_{Faulk} = \$32(PVIFA$_{3.75\%,36}$) + \$1,000(PVIF$_{3.75\%,36}$) = \$892.31

P_{Gonas} = \$63(PVIFA$_{3.75\%,36}$) + \$1,000(PVIF$_{3.75\%,36}$) = \$1,499.31

$\Delta P_{Faulk}\%$ = (\$892.31 – 735.07)/\$735.07 = +.2139, or 21.39%

$\Delta P_{Gonas}\%$ = (\$1,499.31 – 1,264.93)/\$1,264.93 = +.1853, or 18.53%

All else the same, the lower the coupon rate on a bond, the greater is its price sensitivity to changes in interest rates.

19. The current yield is:

Current yield = Annual coupon payment/Price
Current yield = \$57/\$930
Current yield = .0613, or 6.13%

The bond price equation for this bond is:

P_0 = \$930 = \$28.50PVIFA$_{R\%,22}$) + \$1,000(PVIF$_{R\%,22}$)

Using a spreadsheet, financial calculator, or trial and error we find:

R = 3.303%

This is the semiannual interest rate, so the YTM is:

YTM = 2 × 3.303%
YTM = 6.61%

The effective annual yield is the same as the EAR, so using the EAR equation from the previous chapter:

Effective annual yield = $(1 + .03303)^2 - 1$
Effective annual yield = .0671, or 6.71%

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20. The company should set the coupon rate on its new bonds equal to the required return. The required return can be observed in the market by finding the YTM on outstanding bonds of the company. So, the YTM on the bonds currently sold in the market is:

$P = \$1{,}094.30 = \$28(\text{PVIFA}_{R\%,40}) + \$1{,}000(\text{PVIF}_{R\%,40})$

Using a spreadsheet, financial calculator, or trial and error we find:

$R = 2.429\%$

This is the semiannual interest rate, so the YTM is:

YTM = 2 × 2.429%
YTM = 4.86%

21. Accrued interest is the coupon payment for the period times the fraction of the period that has passed since the last coupon payment. Since we have a semiannual coupon bond, the coupon payment per six months is one-half of the annual coupon payment. There are two months until the next coupon payment, so four months have passed since the last coupon payment. The accrued interest for the bond is:

Accrued interest = \$56/2 × 4/6
Accrued interest = \$18.67

And we calculate the clean price as:

Clean price = Dirty price – Accrued interest
Clean price = \$945 – 18.67
Clean price = \$926.33

22. Accrued interest is the coupon payment for the period times the fraction of the period that has passed since the last coupon payment. Since we have a semiannual coupon bond, the coupon payment per six months is one-half of the annual coupon payment. There are four months until the next coupon payment, so two months have passed since the last coupon payment. The accrued interest for the bond is:

Accrued interest = \$71/2 × 2/6
Accrued interest = \$11.83

And we calculate the dirty price as:

Dirty price = Clean price + Accrued interest
Dirty price = \$1,030 + 11.83
Dirty price = \$1,041.83

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23. To find the number of years to maturity for the bond, we need to find the price of the bond. Since we already have the coupon rate, we can use the bond price equation, and solve for the number of years to maturity. We are given the current yield of the bond, so we can calculate the price as:

Current yield = .0695 = \$63/P_0
P_0 = \$63/.0695
P_0 = \$906.47

Now that we have the price of the bond, the bond price equation is:

P = \$906.47 = \$63{[(1 – (1/1.0714)^t]/.0714} + \$1,000/1.0714^t

We can solve this equation for t as follows:

\$906.47(1.0714)^t = \$882.35(1.0714)^t – \$882.35 + \$1,000
117.65 = 24.12(1.0714)^t
4.877 = 1.0714^t
t = ln 4.877/ln 1.0714
t = 22.976 ≈ 23 years

The bond has about 23 years to maturity.

24. The bond has 19 years to maturity, so the bond price equation is:

P = \$964.25 = \$27(PVIFA$_{R\%,38}$) + \$1,000(PVIF$_{R\%,38}$)

Using a spreadsheet, financial calculator, or trial and error we find:

R = 2.855%

This is the semiannual interest rate, so the YTM is:

YTM = 2 × 2.855%
YTM = 5.71%

The current yield is the annual coupon payment divided by the bond price, so:

Current yield = \$54/\$964.25
Current yield = .0560, or 5.60%

25. We found the maturity of a bond in Problem 23. However, in this case, the maturity is indeterminate. A bond selling at par can have any length of maturity. In other words, when we solve the bond pricing equation as we did in Problem 23, the number of periods can be any positive number.

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Challenge

26. To find the capital gains yield and the current yield, we need to find the price of the bond. The current price of Bond P and the price of Bond P in one year is:

P: $P_0 = \$78(\text{PVIFA}_{6\%,8}) + \$1{,}000(\text{PVIF}_{6\%,8}) = \$1{,}111.78$

$P_1 = \$78(\text{PVIFA}_{6\%,7}) + \$1{,}000(\text{PVIF}_{6\%,7}) = \$1{,}100.48$

Current yield = \$78/\$1,111.78
Current yield = .0702, or 7.02%

The capital gains yield is:

Capital gains yield = (New price – Original price)/Original price
Capital gains yield = (\$1,100.48 – 1,111.78)/\$1,111.78
Capital gains yield = –.0102, or –1.02%

The current price of Bond D and the price of Bond D in one year is:

D: $P_0 = \$42(\text{PVIFA}_{6\%,8}) + \$1{,}000(\text{PVIF}_{6\%,8}) = \$888.22$

$P_1 = \$42(\text{PVIFA}_{6\%,7}) + \$1{,}000(\text{PVIF}_{6\%,7}) = \$899.52$

Current yield = \$42/\$888.22
Current yield = .0473, or 4.73%

Capital gains yield = (\$899.52 – 888.22)/\$888.22
Capital gains yield = .0127, or 1.27%

All else held constant, premium bonds pay a higher current income while having price depreciation as maturity nears; discount bonds pay a lower current income but have price appreciation as maturity nears. For either bond, the total return is still 6 percent, but this return is distributed differently between current income and capital gains.

27. *a.* The rate of return you expect to earn if you purchase a bond and hold it until maturity is the YTM. The bond price equation for this bond is:

$P_0 = \$945 = \$55(\text{PVIFA}_{R\%,21}) + \$1{,}000(\text{PVIF}_{R\%,21})$

Using a spreadsheet, financial calculator, or trial and error we find:

R = YTM = 5.86%

b. To find our HPY, we need to find the price of the bond in two years. The price of the bond in two years, at the new interest rate, will be:

$P_2 = \$54(\text{PVIFA}_{4.86\%,19}) + \$1{,}000(\text{PVIF}_{4.86\%,19})$
$P_2 = \$1{,}065.74$

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To calculate the HPY, we need to find the interest rate that equates the price we paid for the bond with the cash flows we received. The cash flows we received were $54 each year for two years, and the price of the bond when we sold it. The equation to find our HPY is:

$P_0 = \$945 = \$54(\text{PVIFA}_{R\%,2}) + \$1{,}065.74(\text{PVIF}_{R\%,2})$

Solving for R, we get:

$R = \text{HPY} = 11.75\%$

The realized HPY is greater than the expected YTM when the bond was bought because interest rates dropped by 1 percent; bond prices rise when yields fall.

28. The price of any bond (or financial instrument) is the PV of the future cash flows. Even though Bond M makes different coupon payments, to find the price of the bond, we just find the PV of the cash flows. The PV of the cash flows for Bond M is:

$P_M = \$800(\text{PVIFA}_{2.65\%,16})(\text{PVIF}_{2.65\%,12}) + \$1{,}000(\text{PVIFA}_{2.65\%,12})(\text{PVIF}_{2.65\%,28}) + \$20{,}000(\text{PVIF}_{2.65\%,40})$
$P_M = \$19{,}454.97$

Notice that for the coupon payments of $800, we found the PVA for the coupon payments, and then discounted the lump sum back to today.

Bond N is a zero coupon bond with a $20,000 par value; therefore, the price of the bond is the PV of the par, or:

$P_N = \$20{,}000(\text{PVIF}_{2.65\%,40})$
$P_N = \$7{,}025.41$

29. To calculate this, we need to set up an equation with the callable bond equal to a weighted average of the noncallable bonds. We will invest X percent of our money in the first noncallable bond, which means our investment in Bond 3 (the other noncallable bond) will be (1 – X). The equation is:

$C_2 = C_1 X + C_3(1 - X)$
$7.60 = 5.50X + 8.40(1 - X)$
$7.60 = 5.50X + 8.40 - 8.40X$
$X = .27586$

So, we invest about 28 percent of our money in Bond 1, and about 72 percent in Bond 3. This combination of bonds should have the same value as the callable bond, excluding the value of the call. So:

$P_2 = .27586P_1 + .72414P_3$
$P_2 = .27586(106.375) + .72414(108.21875)$
$P_2 = 107.71$

The call value is the difference between this implied bond value and the actual bond price. So, the call value is:

Call value = 107.71 – 103.50 = 4.210

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Assuming a $1,000 par value, the call value is $42.10.

30. In general, this is not likely to happen, although it can (and did). The reason that this bond has a negative YTM is that it is a callable U.S. Treasury bond. Market participants know this. Given the high coupon rate of the bond, it is extremely likely to be called, which means the bondholder will not receive all the cash flows promised. A better measure of the return on a callable bond is the yield to call (YTC). The YTC calculation is basically the same as the YTM calculation, but the number of periods is the number of periods until the call date. If the YTC were calculated on this bond, it would be positive. As we mentioned in the chapter, several European government bonds have also had negative YTMs.

31. To find the real annual increase in salary, we need to find the nominal growth rate and the annual inflation rate. So, the nominal growth rate in salary was:

$\$105,350 = \$26,300(1 + R)^{30}$
$R = (\$105,350/\$26,300)^{1/30} - 1$
$R = .0473$, or 4.73%

And the annual inflation rate was:

$1,046.27 = 455.18(1 + h)^{30}$
$h = (1,046.27/455.18)^{1/30} - 1$
$h = .0281$, or 2.81%

Using the Fisher effect, we find the real annual increase in salary was:

$(1 + .0473) = (1 + r)(1 + .0281)$
$r = 1.0473/1.0281 - 1$
$r = .0187$, or 1.87%

To find the real current salary, we can find the future value of the original salary increased at the real interest rate, which is:

$FV = \$26,300(1 + .0187)^{30}$
$FV = \$45,832.54$

Of course, we could also deflate the ending salary by the inflation rate to get the same answer:

$PV = \$105,350/(1 + .0281)^{30}$
$PV = \$45,832.54$

32. To find the present value, we need to find the real weekly interest rate. To find the real return, we need to use the effective annual rates in the Fisher equation. So, we find the real EAR is:

$(1 + R) = (1 + r)(1 + h)$
$1 + .059 = (1 + r)(1 + .031)$
$r = .0272$, or 2.72%

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Now, to find the weekly interest rate, we need to find the APR. Using the equation for discrete compounding:

$EAR = [1 + (APR/m)]^m - 1$

We can solve for the APR. Doing so, we get:

$APR = m[(1 + EAR)^{1/m} - 1]$
$APR = 52[(1 + .0272)^{1/52} - 1]$
$APR = .0268$, or 2.68%

So, the weekly interest rate is:

Weekly rate = APR/52
Weekly rate = .0268/52
Weekly rate = .0005, or .05%

Now we can find the present value of the cost of the roses. The real cash flows are an ordinary annuity, discounted at the real interest rate. So, the present value of the cost of the roses is:

$PVA = C(\{1 - [1/(1 + r)]^t\}/r)$
$PVA = \$5(\{1 - [1/(1 + .0005)]^{30(52)}\}/.0005)$
PVA = $5,358.64

33. To answer this question, we need to find the monthly interest rate, which is the APR divided by 12. We also must be careful to use the real interest rate. The Fisher equation uses the effective annual rate, so, the real effective annual interest rates, and the monthly interest rates for each account are:

Stock account:
$(1 + R) = (1 + r)(1 + h)$
$1 + .12 = (1 + r)(1 + .04)$
$r = .0769$, or 7.69%

$APR = m[(1 + EAR)^{1/m} - 1]$
$APR = 12[(1 + .0769)^{1/12} - 1]$
$APR = .0743$, or 7.43%

Monthly rate = APR/12
Monthly rate = .0743/12
Monthly rate = .0062, or .62%

Bond account:
$(1 + R) = (1 + r)(1 + h)$
$1 + .07 = (1 + r)(1 + .04)$
$r = .0288$, or 2.88%

$APR = m[(1 + EAR)^{1/m} - 1]$
$APR = 12[(1 + .0288)^{1/12} - 1]$
$APR = .0285$, or 2.85%

Monthly rate = APR/12

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Monthly rate = .0285/12
Monthly rate = .0024, or .24%

Now we can find the future value of the retirement account in real terms. The future value of each account will be:

Stock account:
FVA = $C\{(1 + r)^t - 1]/r\}$
FVA = $\$600\{[(1 + .0062)^{360} - 1]/.0062]\}$
FVA = $797,821.31

Bond account:
FVA = $C\{(1 + r)^t - 1]/r\}$
FVA = $\$275\{[(1 + .0024)^{360} - 1]/.0024]\}$
FVA = $156,123.72

The total future value of the retirement account will be the sum of the two accounts, or:

Account value = $797,821.31 + 156,123.72
Account value = $953,945.02

Now we need to find the monthly interest rate in retirement. We can use the same procedure that we used to find the monthly interest rates for the stock and bond accounts, so:

$(1 + R) = (1 + r)(1 + h)$
$1 + .08 = (1 + r)(1 + .04)$
$r = .0385$, or 3.85%

$APR = m[(1 + EAR)^{1/m} - 1]$
$APR = 12[(1 + .0385)^{1/12} - 1]$
APR = .0378, or 3.78%

Monthly rate = APR/12
Monthly rate = .0378/12
Monthly rate = .0031, or .31%

Now we can find the real monthly withdrawal in retirement. Using the present value of an annuity equation and solving for the payment, we find:

$PVA = C(\{1 - [1/(1 + r)]^t\}/r)$
$\$953,945.02 = C(\{1 - [1/(1 + .0031)]^{300}\}/.0031)$
$C = \$4,920.11$

This is the real dollar amount of the monthly withdrawals. The nominal monthly withdrawals will increase by the inflation rate each month. To find the nominal dollar amount of the last withdrawal, we can increase the real dollar withdrawal by the inflation rate. We can increase the real withdrawal by the effective annual inflation rate since we are only interested in the nominal amount of the last withdrawal. So, the last withdrawal in nominal terms will be:

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$FV = PV(1 + r)^t$
$FV = \$4{,}920.11(1 + .04)^{(30 + 25)}$
$FV = \$42{,}541.04$

34. In this problem, we need to calculate the future value of the annual savings after the five years of operations. The savings are the revenues minus the costs, or:

Savings = Revenues – Costs

Since the annual fee and the number of members are increasing, we need to calculate the effective growth rate for revenues, which is:

Effective growth rate = (1 + .06)(1 + .03) – 1
Effective growth rate = .0918, or 9.18%

The revenue for the current year is the number of members times the annual fee, or:

Current revenue = 575($900)
Current revenue = $517,500

The revenue will grow at 9.18 percent, and the costs will grow at 2 percent, so the savings each year for the next five years will be:

Year	*Revenue*	*Costs*	*Savings*
1	$565,006.50	$ 96,900.00	$468,106.50
2	616,874.10	98,838.00	518,036.10
3	673,503.14	100,814.76	572,688.38
4	735,330.73	102,831.06	632,499.67
5	802,834.09	104,887.68	697,946.41

Now we can find the value of each year's savings using the future value of a lump sum equation, so:

$FV = PV(1 + r)^t$

Year		*Future Value*
1	$\$468{,}106.50(1 + .09)^4 =$	$660,770.53
2	$\$518{,}036.10(1 + .09)^3 =$	670,871.44
3	$\$572{,}688.38(1 + .09)^2 =$	680,441.06
4	$\$632{,}499.67(1 + .09)^1 =$	689,424.64
5		697,946.41
	Total future value of savings =	$3,399,424.41

He will spend $450,000 on a luxury boat, so the value of his account will be:

Value of account = $3,399,424.41 – 450,000
Value of account = $2,949,424.41

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Now we can use the present value of an annuity equation to find the payment. Doing so, we find:

PVA = $C(\{1 - [1/(1 + r)]^t\}/r)$
$\$2,949,424.41 = C(\{1 - [1/(1 + .09)]^{25}\}/.09)$
$C = \$300,269.84$

Calculator Solutions

1.

a.

	N	I/Y	PV	PMT	FV
Enter	42	2%			±$1,000
Solve for			$435.30		

b.

	N	I/Y	PV	PMT	FV
Enter	42	5%			±$1,000
Solve for			$128.84		

c.

	N	I/Y	PV	PMT	FV
Enter	42	7%			±$1,000
Solve for			$58.33		

2.

a.

	N	I/Y	PV	PMT	FV
Enter	36	3.5%		±$35	±$1,000
Solve for			$1,000.00		

b.

	N	I/Y	PV	PMT	FV
Enter	36	4.5%		±$35	±$1,000
Solve for			$823.34		

c.

	N	I/Y	PV	PMT	FV
Enter	36	2.5%		±$35	±$1,000
Solve for			$1,235.56		

3.

	N	I/Y	PV	PMT	FV
Enter	26		±$960	$25.50	$1,000
Solve for		2.768%			

2.768% × 2 = 5.54%

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4.

	N	I/Y	PV	PMT	FV
Enter	25	3.6%	±$1,030		$1,000
Solve for				$37.84	

$37.84 × 2 = $75.68
$75.68/$1,000 = .0757, or 7.57%

5.

	N	I/Y	PV	PMT	FV
Enter	16	3.1%		±€38	±€1,000
Solve for			€1,087.26		

6.

	N	I/Y	PV	PMT	FV
Enter	18		±¥95,400	¥4,900	¥100,000
Solve for		5.30%			

16.

Miller Corporation

P_0

	N	I/Y	PV	PMT	FV
Enter	26	2.7%		±$37	±$1,000
Solve for			$1,185.10		

P_1

	N	I/Y	PV	PMT	FV
Enter	24	2.7%		±$37	±$1,000
Solve for			$1,174.96		

P_3

	N	I/Y	PV	PMT	FV
Enter	20	2.7%		±$37	±$1,000
Solve for			$1,152.99		

P_8

	N	I/Y	PV	PMT	FV
Enter	10	2.7%		±$37	±$1,000
Solve for			$1,086.22		

P_{12}

	N	I/Y	PV	PMT	FV
Enter	2	2.7%		±$37	±$1,000
Solve for			$1,019.22		

Modigliani Company

P_0

	N	I/Y	PV	PMT	FV
Enter	26	3.7%		±$27	±$1,000
Solve for			$834.82		

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P_1

Enter	24	3.7%		±$27	±$1,000
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			$842.74		

P_3

Enter	20	3.7%		±$27	±$1,000
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			$860.41		

P_8

Enter	10	3.7%		±$27	±$1,000
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			$917.67		

P_{12}

Enter	2	3.7%		±$27	±$1,000
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			$981.06		

17. If both bonds sell at par, the initial YTM on both bonds is the coupon rate, 7.3 percent. If the YTM suddenly rises to 9.3 percent:

P_{Laurel}

Enter	8	4.65%		±$36.50	±$1,000
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			$934.44		

$\Delta P_{\text{Laurel}}\% = (\$934.44 - 1{,}000)/\$1{,}000 = -.0656$, or -6.56%

P_{Hardy}

Enter	46	4.65%		±$36.50	±$1,000
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			$811.53		

$\Delta P_{\text{Hardy}}\% = (\$811.53 - 1{,}000)/\$1{,}000 = -.1885$, or -18.85%

If the YTM suddenly falls to 5.3 percent:

P_{Laurel}

Enter	8	2.65%		±$36.50	±$1,000
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			$1,071.24		

$\Delta P_{\text{Laurel}}\% = (\$1{,}071.24 - 1{,}000)/\$1{,}000 = +.0712$, or $+7.12\%$

P_{Hardy}

Enter	46	2.65%		±$36.50	±$1,000
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			$1,264.06		

$\Delta P_{\text{Hardy}}\% = (\$1{,}264.06 - 1{,}000)/\$1{,}000 = = +.2641$, or $+26.41\%$

All else the same, the longer the maturity of a bond, the greater is its price sensitivity to changes in interest rates.

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18. Initially, at a YTM of 9.5 percent, the prices of the two bonds are:

P_{Faulk}

	N	I/Y	PV	PMT	FV
Enter	36	4.75%		±$32	±$1,000
Solve for			$735.07		

P_{Gonas}

	N	I/Y	PV	PMT	FV
Enter	36	4.75%		±$63	±$1,000
Solve for			$1,264.93		

If the YTM rises from 9.5 percent to 11.5 percent:

P_{Faulk}

	N	I/Y	PV	PMT	FV
Enter	36	5.75%		±$32	±$1,000
Solve for			$615.78		

$\Delta P_{Faulk}\% = (\$615.78 - 735.07)/\$735.07 = -.1623$, or -16.23%

P_{Gonas}

	N	I/Y	PV	PMT	FV
Enter	36	5.75%		±$63	±$1,000
Solve for			$1,082.87		

$\Delta P_{Gonas}\% = (\$1,082.87 - 1,264.93)/\$1,264.93 = -.1439$, or -14.39%

If the YTM declines from 9.5 percent to 7.5 percent:

P_{Faulk}

	N	I/Y	PV	PMT	FV
Enter	36	3.75%		±$32	±$1,000
Solve for			$892.31		

$\Delta P_{Faulk}\% = (\$892.31 - 735.07)/\$735.07 = +.2139$, or $+21.39\%$

P_{Gonas}

	N	I/Y	PV	PMT	FV
Enter	36	3.75%		±$63	±$1,000
Solve for			$1,499.31		

$\Delta P_{Gonas}\% = (\$1,499.31 - 1,264.93)/\$1,264.93 = +.1853$, or $+18.53\%$

All else the same, the lower the coupon rate on a bond, the greater is its price sensitivity to changes in interest rates.

19.

	N	I/Y	PV	PMT	FV
Enter	22		±$930	$28.50	$1,000
Solve for		3.303%			

YTM = 3.303% × 2 = 6.61%

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20. The company should set the coupon rate on its new bonds equal to the required return; the required return can be observed in the market by finding the YTM on outstanding bonds of the company.

	N	I/Y	PV	PMT	FV
Enter	40		±$1,094.30	$28	$1,000
Solve for		2.429%			

2.429% × 2 = 4.86%

23. Current yield = .0695 = $63/$P_0$; P_0 = $906.47

	N	I/Y	PV	PMT	FV
Enter		7.14%	±$906.47	$63	$1,000
Solve for	22.9760				

24.

	N	I/Y	PV	PMT	FV
Enter	38		±$964.25	$27	$1,000
Solve for		2.855%			

2.855% × 2 = 5.71%

26.

Bond P

P_0

	N	I/Y	PV	PMT	FV
Enter	8	6%		±$78	±$1,000
Solve for			$1,111.78		

P_1

	N	I/Y	PV	PMT	FV
Enter	7	6%		±$78	±$1,000
Solve for			$1,100.48		

Current yield = $78/$1,111.78 = .0702, or 7.02%

Capital gains yield = ($1,100.48 – 1,111.78)/$1,111.78 = –.0102, or –1.02%

Bond D

P_0

	N	I/Y	PV	PMT	FV
Enter	8	6%		±$42	±$1,000
Solve for			$888.22		

P_1

	N	I/Y	PV	PMT	FV
Enter	7	6%		±$42	±$1,000
Solve for			$899.52		

Current yield = $42/$888.22 = .0473, or 4.73%

Capital gains yield = ($899.52 – 888.22)/$888.22 = .0127, or 1.27%

All else held constant, premium bonds pay a higher current income while having price depreciation as maturity nears; discount bonds pay a lower current income but have price appreciation as maturity nears. For either bond, the total return is still 6 percent, but this return is distributed differently between current income and capital gains.

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27.

a.

Enter	21		±$945	$54	$1,000
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for		5.86%			

This is the rate of return you expect to earn on your investment when you purchase the bond.

b.

Enter	19	4.86%		±$54	±$1,000
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			$1,065.74		

The HPY is:

Enter	2		±$945	$54	$1,065.74
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for		11.75%			

The realized HPY is greater than the expected YTM when the bond was purchased because interest rates dropped by 1 percent; bond prices rise when yields fall.

28.

P_M

CF$_0$	$0
C01	$0
F01	12
C02	$800
F02	16
C03	$1,000
F03	11
C04	$21,000
F04	1

I = 2.65%
NPV CPT
$19,454.97

P_N

Enter	40	2.65%			±$20,000
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			$7,025.41		

31.

Enter	30	1.87%	±$26,300		
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for					$45,832.54

Enter	30	2.81%			±$105,350
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			$45,832.54		

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32.

Real return: $1 + .059 = (1 + r)(1 + .032)$; $r = 2.72\%$

Enter		2.72%	12		
	NOM	**EFF**	**C/Y**		
Solve for	2.68%				
Enter	52 × 30	2.68%/52		±$5	
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			$5,358.64		

33.

Real return for stock account: $1 + .12 = (1 + r)(1 + .04)$; $r = 7.6923\%$

Enter		7.6923%	12		
	NOM	**EFF**	**C/Y**		
Solve for	7.4337%				

Real return for bond account: $1 + .07 = (1 + r)(1 + .04)$; $r = 2.8846\%$

Enter		2.8846%	12		
	NOM	**EFF**	**C/Y**		
Solve for	2.8472%				

Real return post-retirement: $1 + .08 = (1 + r)(1 + .04)$; r = 3.8462%

Enter		3.8462%	12		
	NOM	**EFF**	**C/Y**		
Solve for	3.7800%				

Stock portfolio value:

Enter	12 × 30	7.4337%/12		±$600	
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for					$797,821.31

Bond portfolio value:

Enter	12 × 30	2.8472%/12		±$275	
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for					$156,123.72

Retirement value = $797,821.31 + 156,123.72 = $953,945.02

Retirement withdrawal:

Enter	25 × 12	3.7800%/12	±$953,945.02		
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for				$4,920.11	

The last withdrawal in real terms is:

Enter	30 + 25	4%	±$4,920.11		
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for					$42,541.04

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34.

Future value of savings:

Year 1:

	N	I/Y	PV	PMT	FV
Enter	4	9%	±$468,106.50		
Solve for					$660,770.53

Year 2:

	N	I/Y	PV	PMT	FV
Enter	3	9%	±$518,036.10		
Solve for					$670,871.77

Year 3:

	N	I/Y	PV	PMT	FV
Enter	2	9%	±$572,688.38		
Solve for					$680,411.06

Year 4:

	N	I/Y	PV	PMT	FV
Enter	1	9%	±$632,499.67		
Solve for					$689,424.64

Future value = $660,770.53 + 670,871.77 + 680,411.06 + 689,424.64 + 697,946.41
Future value = $3,399,424.41

He will spend $450,000 on a luxury boat, so the value of his account will be:

Value of account = $3,399,424.41 – 450,000
Value of account = $2,949,424.41

	N	I/Y	PV	PMT	FV
Enter	25	9%	±$2,949,424.41		
Solve for				$300,269.84	

CHAPTER 6
STOCK VALUATION

Answers to Concept Questions

1. The value of any investment depends on the present value of its cash flows; i.e., what investors will actually receive. The cash flows from a share of stock are the dividends.

2. Investors believe the company will eventually start paying dividends (or be sold to another company).

3. In general, companies that need the cash will often forgo dividends since dividends are a cash expense. Young, growing companies with profitable investment opportunities are one example; another example is a company in financial distress. This question is examined in depth in a later chapter.

4. The general method for valuing a share of stock is to find the present value of all expected future dividends. The dividend growth model presented in the text is only valid (i) if dividends are expected to occur forever; that is, the stock provides dividends in perpetuity, and (ii) if a constant growth rate of dividends occurs forever. A violation of the first assumption might be a company that is expected to cease operations and dissolve itself some finite number of years from now. The stock of such a company would be valued by applying the general method of valuation explained in this chapter. A violation of the second assumption might be a start-up firm that isn't currently paying any dividends but is expected to eventually start making dividend payments some number of years from now. This stock would also be valued by the general dividend valuation method explained in this chapter.

5. The common stock probably has a higher price because the dividend can grow, whereas it is fixed on the preferred. However, the preferred is less risky because of the dividend and liquidation preference, so it is possible the preferred could be worth more, depending on the circumstances.

6. The two components are the dividend yield and the capital gains yield. For most companies, the capital gains yield is larger. This is easy to see for companies that pay no dividends. For companies that do pay dividends, the dividend yields are rarely over 5 percent and are often much less.

7. Yes. If the dividend grows at a steady rate, so does the stock price. In other words, the dividend growth rate and the capital gains yield are the same.

8. The three factors are: 1) The company's future growth opportunities. 2) The company's level of risk, which determines the interest rate used to discount cash flows. 3) The accounting method used.

9. In a corporate election, you can buy votes (by buying shares), so money can be used to influence or even determine the outcome. Many would argue the same is true in political elections, but, in principle at least, no one has more than one vote.

10. It wouldn't seem to be. Investors who don't like the voting features of a particular class of stock are under no obligation to buy it.

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11. Investors buy such stock because they want it, recognizing that the shares have no voting power. Presumably, investors pay a little less for such shares than they would otherwise.

12. Presumably, the current stock value reflects the risk, timing and magnitude of all future cash flows, both short-term and long-term. If this is correct, then the statement is false.

Solutions to Questions and Problems

NOTE: All end-of-chapter problems were solved using a spreadsheet. Many problems require multiple steps. Due to space and readability constraints, when these intermediate steps are included in this solutions manual, rounding may appear to have occurred. However, the final answer for each problem is found without rounding during any step in the problem.

Basic

1. The constant dividend growth model is:

$P_t = D_t \times (1 + g)/(R - g)$

So, the price of the stock today is:

$P_0 = D_0(1 + g)/(R - g)$
$P_0 = \$3.14(1.04)/(.11 - .04)$
$P_0 = \$46.65$

The dividend at Year 4 is the dividend today times the FVIF for the growth rate in dividends and four years, so:

$P_3 = D_3(1 + g)/(R - g)$
$P_3 = D_0(1 + g)^4/(R - g)$
$P_3 = \$3.14(1.04)^4/(.11 - .04)$
$P_3 = \$52.48$

We can do the same thing to find the dividend in Year 16, which gives us the price in Year 15, so:

$P_{15} = D_{15}(1 + g)/(R - g)$
$P_{15} = D_0(1 + g)^{16}/(R - g)$
$P_{15} = \$3.14(1.04)^{16}/(.11 - .04)$
$P_{15} = \$84.02$

There is another feature of the constant dividend growth model: The stock price grows at the dividend growth rate. So, if we know the stock price today, we can find the future value for any time in the future we want to calculate the stock price. In this problem, we want to know the stock price in three years, and we have already calculated the stock price today. The stock price in three years will be:

$P_3 = P_0(1 + g)^3$
$P_3 = \$46.65(1 + .04)^3$
$P_3 = \$52.48$

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And the stock price in 15 years will be:

$P_{15} = P_0(1 + g)^{15}$
$P_{15} = \$46.65(1 + .04)^{15}$
$P_{15} = \$84.02$

2. We need to find the required return of the stock. Using the constant growth model, we can solve the equation for R. Doing so, we find:

$R = (D_1/P_0) + g$
$R = (\$1.84/\$34) + .044$
$R = .0981$, or 9.81%

3. The dividend yield is the dividend next year divided by the current price, so the dividend yield is:

Dividend yield = D_1/P_0
Dividend yield = \$1.84/\$34
Dividend yield = .0541, or 5.41%

The capital gains yield, or percentage increase in the stock price, is the same as the dividend growth rate, so:

Capital gains yield = 4.4%

4. Using the constant growth model, we find the price of the stock today is:

$P_0 = D_1/(R - g)$
$P_0 = \$3.64/(.11 - .043)$
$P_0 = \$54.33$

5. The required return of a stock is made up of two parts: The dividend yield and the capital gains yield. So, the required return of this stock is:

R = Dividend yield + Capital gains yield
$R = .039 + .056$
$R = .0950$, or 9.50%

6. We know the stock has a required return of 12 percent, and the dividend and capital gains yield are equal, so:

Dividend yield = 1/2(.108) = .054 = Capital gains yield

Now we know both the dividend yield and capital gains yield. The dividend is the stock price times the dividend yield, so:

$D_1 = .054(\$76)$
$D_1 = \$4.10$

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This is the dividend next year. The question asks for the dividend this year. Using the relationship between the dividend this year and the dividend next year:

$D_1 = D_0(1 + g)$

We can solve for the dividend that was just paid:

$\$4.10 = D_0(1 + .054)$
$D_0 = \$4.10/1.054$
$D_0 = \$3.89$

7. The price of any financial instrument is the PV of the future cash flows. The future dividends of this stock are an annuity for 8 years, so the price of the stock is the PVA, which will be:

$P_0 = \$8.75(\text{PVIFA}_{10.9\%,8})$
$P_0 = \$45.19$

8. The price of a share of preferred stock is the dividend divided by the required return. This is the same equation as the constant growth model, with a dividend growth rate of zero percent. Remember that most preferred stock pays a fixed dividend, so the growth rate is zero. Using this equation, we find the price per share of the preferred stock is:

$R = D/P_0$
$R = \$3.50/\$96$
$R = .0365$, or 3.65%

9. The growth rate of earnings is the return on equity times the retention ratio, so:

$g = \text{ROE} \times b$
$g = .13(.75)$
$g = .0975$, or 9.75%

To find next year's earnings, we multiply the current earnings times one plus the growth rate, so:

Next year's earnings = Current earnings$(1 + g)$
Next year's earnings = $\$31{,}500{,}000(1 + .0975)$
Next year's earnings = $\$34{,}571{,}250$

10. We can use the constant dividend growth model, which is:

$P_t = D_t(1 + g)/(R - g)$

So the price of each company's stock today is:

Red stock price = $\$3.08/(.08 - .05) = \$102.67$
Yellow stock price = $\$3.08/(.11 - .05) = \$51.33$
Blue stock price = $\$3.08/(.14 - .05) = \$34.22$

As the required return increases, the stock price decreases. This is a function of the time value of money: A higher discount rate decreases the present value of cash flows. It is also important to note that relatively small changes in the required return can have a dramatic impact on the stock price.

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11. If the company uses straight voting, you will need to own one-half of the shares, plus one share, in order to guarantee enough votes to win the election. So, the number of shares needed to guarantee election under straight voting will be:

Shares needed = (475,000 shares/2) + 1
Shares needed = 237,501

And the total cost to you will be the shares needed times the price per share, or:

Total cost = 237,501 × $46
Total cost = $10,925,046

12. If the company uses cumulative voting, you will need $1/(N + 1)$ percent of the stock (plus one share) to guarantee election, where N is the number of seats up for election. So, the percentage of the company's stock you need will be:

Percent of stock needed = $1/(N + 1)$
Percent of stock needed = $1/(4 + 1)$
Percent of stock needed = .20, or 20%

So, the number of shares you need to purchase is:

Number of shares to purchase = (475,000 × .20) + 1
Number of shares to purchase = 95,001

And the total cost to you will be the shares needed times the price per share, or:

Total cost = 95,001 × $46
Total cost = $4,370,046

13. Using the equation to calculate the price of a share of stock with the PE ratio:

P = Benchmark PE ratio × EPS

So, with a PE ratio of 18, we find:

P = 18($4.21)
P = $75.78

And with a PE ratio of 21, we find:

P = 21($4.21)
P = $88.41

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Intermediate

14. This stock has a constant growth rate of dividends, but the required return changes twice. To find the value of the stock today, we will begin by finding the price of the stock at Year 6, when both the dividend growth rate and the required return are stable forever. The price of the stock in Year 6 will be the dividend in Year 7, divided by the required return minus the growth rate in dividends. So:

$P_6 = D_6(1 + g)/(R - g)$
$P_6 = D_0(1 + g)^7/(R - g)$
$P_6 = \$3.29(1.04)^7/(.10 - .04)$
$P_6 = \$72.16$

Now we can find the price of the stock in Year 3. We need to find the price here since the required return changes at that time. The price of the stock in Year 3 is the PV of the dividends in Years 4, 5, and 6, plus the PV of the stock price in Year 6. The price of the stock in Year 3 is:

$P_3 = \$3.29(1.04)^4/1.13 + \$3.29(1.04)^5/1.13^2 + \$3.29(1.04)^6/1.13^3 + \$72.16/1.13^3$
$P_3 = \$59.43$

Finally, we can find the price of the stock today. The price today will be the PV of the dividends in Years 1, 2, and 3, plus the PV of the stock in Year 3. The price of the stock today is:

$P_0 = \$3.29(1.04)/1.15 + \$3.29(1.04)^2/(1.15)^2 + \$3.29(1.04)^3/(1.15)^3 + \$59.43/(1.15)^3$
$P_0 = \$47.18$

15. Here we have a stock that pays no dividends for 9 years. Once the stock begins paying dividends, it will have a constant growth rate of dividends. We can use the constant growth model at that point. It is important to remember that the general form of the constant dividend growth formula is:

$P_t = [D_t \times (1 + g)]/(R - g)$

This means that since we will use the dividend in Year 10, we will be finding the stock price in Year 10. The dividend growth model is similar to the PVA and the PV of a perpetuity: The equation gives you the PV one period before the first payment. So, the price of the stock in Year 11 will be:

$P_{10} = D_{12}/(R - g)$
$P_{10} = \$13/(.11 - .055)$
$P_{10} = \$236.36$

The price of the stock today is the PV of the stock price in the future. We discount the future stock price at the required return. The price of the stock today will be:

$P_0 = \$236.36/1.11^9$
$P_0 = \$92.40$

16. The price of a stock is the PV of the future dividends. This stock is paying five dividends, so the price of the stock is the PV of these dividends using the required return. The price of the stock is:

$P_0 = \$14.50/1.10 + \$18/1.10^2 + \$21.50/1.10^3 + \$25/1.10^4 + \$28.50/1.10^5$
$P_0 = \$78.98$

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17. With nonconstant dividends, we find the price of the stock when the dividends level off at a constant growth rate, and then find the PV of the future stock price, plus the PV of all dividends during the supernormal growth period. The stock begins constant growth in Year 5, so we can find the price of the stock in Year 4, one year before the constant dividend growth begins, as:

$P_4 = D_4(1 + g)/(R - g)$
$P_4 = \$2.65(1.05)/(.10 - .05)$
$P_4 = \$55.65$

The price of the stock today is the PV of the first four dividends, plus the PV of the Year 4 stock price. So, the price of the stock today will be:

$P_0 = \$15/1.10 + \$11/1.10^2 + \$9/1.10^3 + (\$2.65 + 55.65)/1.10^4$
$P_0 = \$69.31$

18. With differential dividends, we find the price of the stock when the dividends level off at a constant growth rate, and then find the PV of the future stock price, plus the PV of all dividends during the supernormal growth period. The stock begins constant growth in Year 4, so we can find the price of the stock in Year 3, one year before the constant dividend growth begins as:

$P_3 = D_3(1 + g)/(R - g)$
$P_3 = D_0(1 + g_1)^3(1 + g_2)/(R - g_2)$
$P_3 = \$2.45(1.26)^3(1.045)/(.104 - .045)$
$P_3 = \$86.80$

The price of the stock today is the PV of the first three dividends, plus the PV of the Year 3 stock price. The price of the stock today will be:

$P_0 = \$2.45(1.26)/1.104 + \$2.45(1.26)^2/1.104^2 + \$2.45(1.26)^3/1.104^3 + \$86.80/1.104^3$
$P_0 = \$74.14$

19. Here we need to find the dividend next year for a stock experiencing differential growth. We know the stock price, the dividend growth rates, and the required return, but not the dividend. First, we need to realize that the dividend in Year 3 is the current dividend times the FVIF. The dividend in Year 3 will be:

$D_3 = D_0(1.25)^3$

And the dividend in Year 4 will be the dividend in Year 3 times one plus the growth rate, or:

$D_4 = D_0(1.25)^3(1.17)$

The stock begins constant growth after the 4th dividend is paid, so we can find the price of the stock in Year 4 as the dividend in Year 5, divided by the required return minus the growth rate. The equation for the price of the stock in Year 4 is:

$P_4 = D_4(1 + g)/(R - g)$

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Now we can substitute the previous dividend in Year 4 into this equation as follows:

$P_4 = D_0(1 + g_1)^3(1 + g_2)(1 + g_3)/(R - g_3)$
$P_4 = D_0(1.25)^3(1.17)(1.04)/(.10 - .04)$
$P_4 = 39.61D_0$

When we solve this equation, we find that the stock price in Year 4 is 39.61 times as large as the dividend today. Now we need to find the equation for the stock price today. The stock price today is the PV of the dividends in Years 1, 2, 3, and 4, plus the PV of the Year 4 price. So:

$P_0 = D_0(1.25)/1.10 + D_0(1.25)^2/1.10^2 + D_0(1.25)^3/1.10^3 + D_0(1.25)^3(1.17)/1.10^4 + 36.91D_0/1.10^4$

We can factor out D_0 in the equation and combine the last two terms. Doing so, we get:

$P_0 = \$71 = D_0\{1.25/1.10 + 1.25^2/1.10^2 + 1.25^3/1.10^3 + [(1.25)^3(1.17) + 39.61]/1.10^4\}$

Reducing the equation even further by solving all the terms in the braces, we get:

$\$71 = 32.51D_0$

$D_0 = \$71/32.51$
$D_0 = \$2.18$

This is the dividend today, so the projected dividend for the next year will be:

$D_1 = \$2.18(1.25)$
$D_1 = \$2.73$

20. The constant growth model can be applied even if the dividends are declining by a constant percentage, just make sure to recognize the negative growth. So, the price of the stock today will be:

$P_0 = D_0(1 + g)/(R - g)$
$P_0 = \$14(1 - .03)/[.096 - (-.03)]$
$P_0 = \$107.78$

21. We are given the stock price, the dividend growth rate, and the required return, and are asked to find the dividend. Using the constant dividend growth model, we get:

$P_0 = \$57.13 = D_0(1 + g)/(R - g)$

Solving this equation for the dividend gives us:

$D_0 = \$57.13(.11 - .04)/(1.04)$
$D_0 = \$3.85$

22. The price of a share of preferred stock is the dividend payment divided by the required return. We know the dividend payment in Year 10, so we can find the price of the stock in Year 9, one year before the first dividend payment. Doing so, we get:

$P_9 = \$7/.041$
$P_9 = \$170.73$

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The price of the stock today is the PV of the stock price in the future, so the price today will be:

$P_0 = \$170.73/(1.041)^9$
$P_0 = \$118.92$

23. The dividend yield is the dividend divided by the stock price, so:

Dividend yield = Dividend/Stock price
.024 = Dividend/$43.23
Dividend = $1.04

The "Net Chg" of the stock shows the stock increased by $.19 on this day, so the closing stock price yesterday was:

Yesterday's closing price = $43.23 – .19
Yesterday's closing price = $43.04

To find the net income, we need to find the EPS. The stock quote tells us the PE ratio for the stock is 22. Since we know the stock price as well, we can use the PE ratio to solve for EPS as follows:

P/E = 22 = Stock price/EPS = $43.23/EPS
EPS = $43.23/22
EPS = $1.965

We know that EPS is just the total net income divided by the number of shares outstanding, so:

EPS = NI/Shares = $1.965 = NI/25,000,000
NI = $1.965(25,000,000)
NI = $49,125,000

24. To find the number of shares owned, we can divide the amount invested by the stock price. The share price of any financial asset is the present value of the cash flows, so, to find the price of the stock we need to find the cash flows. The cash flows are the two dividend payments plus the sale price. We also need to find the aftertax dividends since the assumption is all dividends are taxed at the same rate for all investors. The aftertax dividends are the dividends times one minus the tax rate, so:

Year 1 aftertax dividend = $3.15(1 – .20)
Year 1 aftertax dividend = $2.52

Year 2 aftertax dividend = $3.27(1 – .20)
Year 2 aftertax dividend = $2.62

We can now discount all cash flows from the stock at the required return. Doing so, we find the price of the stock is:

$P = \$2.52/1.09 + \$2.62/1.09^2 + \$106/1.09^3$
$P = \$86.37$

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The number of shares owned is the total investment divided by the stock price, which is:

Shares owned = $100,000/$86.37
Shares owned = 1,157.87

25. Here we have a stock paying a constant dividend for a fixed period, and an increasing dividend thereafter. We need to find the present value of the two different cash flows using the appropriate quarterly interest rate. The constant dividend is an annuity, so the present value of these dividends is:

$PVA = C(PVIFA_{R,t})$
$PVA = \$.61(PVIFA_{2.75\%,12})$
PVA = $6.16

Now we can find the present value of the dividends beyond the constant dividend phase. Using the present value of a growing annuity equation, we find:

$P_{12} = D_{13}/(R - g)$
$P_{12} = \$.61(1 + .011)/(.0275 - .011)$
$P_{12} = \$37.38$

This is the price of the stock immediately after it has paid the last constant dividend. So, the present value of the future price is:

$PV = \$37.38/(1 + .0275)^{12}$
PV = $26.99

The price today is the sum of the present value of the two cash flows, so:

$P_0 = \$6.16 + 26.99$
$P_0 = \$33.15$

26. Here we need to find the dividend next year for a stock with nonconstant growth. We know the stock price, the dividend growth rates, and the required return, but not the dividend. First, we need to realize that the dividend in Year 3 is the constant dividend times the FVIF. The dividend in Year 3 will be:

$D_3 = D(1.04)$

The equation for the stock price will be the present value of the constant dividends, plus the present value of the future stock price, or:

$P_0 = D/1.098 + D/1.098^2 + [D(1.04)/(.098 - .04)]/1.098^2$
$\$76 = D/1.098 + D/1.098^2 + [D(1.04)/(.098 - .04)]/1.098^2$

We can factor out D in the equation. Doing so, we get:

$\$76 = D\{1/1.098 + 1/1.098^2 + [(1.04)/(.098 - .04)]/1.098^2\}$

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Reducing the equation even further by solving all the terms in the braces, we get:

$\$76 = D(16.6133)$
$D = \$76/16.6133$
$D = \$4.57$

27. The required return of a stock consists of two components, the capital gains yield and the dividend yield. In the constant dividend growth model (growing perpetuity equation), the capital gains yield is the same as the dividend growth rate, or algebraically:

$R = D_1/P_0 + g$

We can find the dividend growth rate using the sustainable growth rate equation, or:

$g = \text{ROE} \times b$
$g = .12 \times .70$
$g = .0840$, or 8.40%

This is also the growth rate in dividends. To find the current dividend, we can use the information provided about the net income, shares outstanding, and payout ratio. The total dividends paid is the net income times the payout ratio. To find the dividend per share, we can divide the total dividends paid by the number of shares outstanding. So:

Dividend per share = (Net income × Payout ratio)/Shares outstanding
Dividend per share = ($36,300,000 × .30)/2,700,000
Dividend per share = $4.03

Now we can use the initial equation for the required return. We must remember that the equation uses the dividend in one year, so:

$R = D_1/P_0 + g$
$R = \$4.03(1 + .0840)/\$116 + .0840$
$R = .1217$, or 12.17%

28. First, we need to find the annual dividend growth rate over the past four years. To do this, we can use the future value of a lump sum equation and solve for the interest rate. Doing so, we find the dividend growth rate over the past four years was:

$\text{FV} = \text{PV}(1 + R)^t$
$\$1.87 = \$1.02(1 + R)^4$
$R = (\$1.87/\$1.02)^{1/4} - 1$
$R = .1636$, or 16.36%

We know the dividend will grow at this rate for five years before slowing to a constant rate indefinitely. So, the dividend amount in seven years will be:

$D_7 = D_0(1 + g_1)^5(1 + g_2)^2$
$D_7 = \$1.87(1 + .1636)^5(1 + .05)^2$
$D_7 = \$4.40$

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29. *a.* We can find the price of all the outstanding company stock by using the dividends the same way we would value an individual share. Since earnings are equal to dividends, and there is no growth, the value of the company's stock today is the present value of a perpetuity, so:

$P = D/R$
$P = \$1{,}400{,}000/.12$
$P = \$11{,}666{,}666.67$

The price-earnings ratio is the stock price divided by the current earnings, so the price-earnings ratio of each company with no growth is:

PE = Price/Earnings
PE = \$11,666,666.67/\$1,400,000
PE = 8.33 times

b. Since the earnings have increased, the price of the stock will increase. The new price of all the outstanding company stock is:

$P = D/R$
$P = (\$1{,}400{,}000 + 330{,}000)/.12$
$P = \$14{,}416{,}666.67$

The price-earnings ratio is the stock price divided by the current earnings, so the price-earnings ratio with the increased earnings is:

PE = Price/Earnings
PE = \$14,416,666.67/\$1,400,000
PE = 10.30 times

c. Since the earnings have increased, the price of the stock will increase. The new price of the all the outstanding company stock is:

$P = D/R$
$P = (\$1{,}400{,}000 + 660{,}000)/.12$
$P = \$17{,}166{,}666.67$

The price-earnings ratio is the stock price divided by the current earnings, so the price-earnings with the increased earnings is:

PE = Price/Earnings
PE = \$17,166,666.67/\$1,400,000
PE = 12.26 times

30. *a.* Using the equation to calculate the price of a share of stock with the PE ratio:

P = Benchmark PE ratio × EPS

So, with a PE ratio of 19, we find:

$P = 18(\$3.75)$
$P = \$67.50$

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b. First, we need to find the earnings per share next year, which will be:

$EPS_1 = EPS_0(1 + g)$
$EPS_1 = \$3.75(1 + .065)$
$EPS_1 = \$3.99$

Using the equation to calculate the price of a share of stock with the PE ratio:

P_1 = Benchmark PE ratio × EPS_1
$P_1 = 18(\$3.99)$
$P_1 = \$71.89$

c. To find the implied return over the next year, we calculate the return as:

$R = (P_1 - P_0)/P_0$
$R = (\$71.89 - 67.50)/\$67.50$
$R = .065$, or 6.5%

Notice that the return is the same as the growth rate in earnings. Assuming a stock pays no dividends and the PE ratio is constant, this will always be true when using price ratios to evaluate the price of a share of stock.

31. We need to find the enterprise value of the company. We can calculate EBITDA as sales minus costs, so:

EBITDA = Sales – Costs
EBITDA = \$42,800,000 – 24,600,000
EBITDA = \$18,200,000

Solving the EV/EBITDA multiple for enterprise value, we find:

Enterprise value = \$18,200,000(7.5)
Enterprise value = \$136,500,000

The total value of equity is the enterprise value minus any outstanding debt and cash, so:

Equity value = Enterprise value – Debt + Cash
Equity value = \$136,500,000 – 63,000,000 + 24,000,000
Equity value = \$97,500,000

So, the price per share is:

Stock price = \$97,500,000/960,000
Stock price = \$101.56

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32. *a.* To value the stock today, we first need to calculate the cash flows for the next 6 years. The sales, costs, and net investment all grow by same rate, namely 14 percent, 12 percent, 10 percent, and 8 percent, respectively, for the following 4 years, then 6 percent indefinitely. So, the cash flows for each year will be:

	Year 1	*Year 2*	*Year 3*	*Year 4*	*Year 5*	*Year 6*
Sales	$138,000,000	$157,320,000	$176,198,400	$193,818,240	$209,323,699	$221,883,121
Costs	77,000,000	87,780,000	98,313,600	108,144,960	116,796,557	123,804,350
EBT	$61,000,000	$69,540,000	$77,884,800	$85,673,280	$92,527,142	$98,078,771
Taxes	12,810,000	14,603,400	16,355,808	17,991,389	19,430,700	20,596,542
Net income	$48,190,000	$54,936,600	$61,528,992	$67,681,891	$73,096,442	$77,482,229
Investment	11,000,000	12,540,000	14,044,800	15,449,280	16,685,222	17,686,336
Cash flow	$37,190,000	$42,396,600	$47,484,192	$52,232,611	$56,411,220	$59,795,893

To find the terminal value of the company in Year 6, we can discount the Year 7 cash flows as a growing perpetuity, which will be:

Terminal value = $59,795,893(1 + .06)/(.12 – .06)
Terminal value = $1,056,394,115

So, the value of the company today is:

Company value = $37,190,000/1.12 + $42,396,600/$1.12^2$ + $47,484,192/$1.12^3$
+ $52,232,611/$1.12^4$ + 56,411,220/1.12^5 + ($59,795,893 + 1,056,394,115)/1.12^6
Company value = $731,502,582

Dividing the company value by the shares outstanding to get the share price, we get:

Share price = $731,502,582/6,200,000
Share price = $117.98

b. In this case, we are going to use the PE multiple to find the terminal value. All the cash flows from part (a) will remain the same. So, the terminal value in Year 6 is:

Terminal value = 12($77,482,229)
Terminal value = $929,786,749

Under this assumption for the terminal value, the value of the company today is:

Company value today = $37,190,000/1.12 + $42,396,600/$1.12^2$ + $47,484,192/$1.12^3$
+ $52,232,611/$1.12^4$ + 56,411,220/1.12^5 + ($59,795,893 + 929,786,749)/1.12^6
Company value today = $667,359,350

Dividing the company value by the shares outstanding to get the share price we get:

Share price = $667,359,350/6,200,000
Share price = $107.64

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Challenge

33. We are asked to find the dividend yield and capital gains yield for each of the stocks. All the stocks have a 16 percent required return, which is the sum of the dividend yield and the capital gains yield. To find the components of the total return, we need to find the stock price for each stock. Using this stock price and the dividend, we can calculate the dividend yield. The capital gains yield for the stock will be the total return (required return) minus the dividend yield.

W: $P_0 = D_0(1 + g)/(R - g) = \$4.15(1.10)/(.16 - .10) = \$76.08$

Dividend yield = $D_1/P_0 = \$4.15(1.10)/\$76.08 = .06$, or 6%

Capital gains yield = .16 – .06 = .10, or 10%

X: $P_0 = D_0(1 + g)/(R - g) = \$4.15/(.16 - 0) = \$25.94$

Dividend yield = $D_1/P_0 = \$4.15/\$25.94 = .16$, or 16%

Capital gains yield = .16 – .16 = 0%

Y: $P_0 = D_0(1 + g)/(R - g) = \$4.15(1 - .05)/(.16 + .05) = \$18.77$

Dividend yield = $D_1/P_0 = \$4.15(.95)/\$18.77 = .21$, or 21%

Capital gains yield = .16 – .21 = –.05, or –5%

Z: $P_2 = D_2(1 + g)/(R - g) = D_0(1 + g_1)^2(1 + g_2)/(R - g_2) = \$4.15(1.30)^2(1.08)/(.16 - .08)$
$P_2 = \$94.68$

$P_0 = \$4.15(1.30)/(1.16) + \$4.15(1.30)^2/(1.16)^2 + \$94.68/(1.16)^2$
$P_0 = \$80.23$

Dividend yield = $D_1/P_0 = \$4.15(1.30)/\$80.23 = .0672$, or 6.72%

Capital gains yield = .16 – .0672 = .0928, or 9.28%

In all cases, the required return is 16 percent, but the return is distributed differently between current income and capital gains. High-growth stocks have an appreciable capital gains component but a relatively small current income yield; conversely, mature, negative-growth stocks provide a high current income but also price depreciation over time.

34. *a.* Using the constant growth model, the price of the stock paying annual dividends will be:

$P_0 = D_0(1 + g)/(R - g)$
$P_0 = \$3.24(1.04)/(.11 - .04)$
$P_0 = \$48.14$

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b. If the company pays quarterly dividends instead of annual dividends, the quarterly dividend will be one-fourth of the annual dividend, or:

Quarterly dividend = \$3.24(1.04)/4
Quarterly dividend = \$.8424

To find the equivalent annual dividend, we must assume that the quarterly dividends are reinvested at the required return. We can then use this interest rate to find the equivalent annual dividend. In other words, when we receive the quarterly dividend, we reinvest it at the required return on the stock. So, the effective quarterly rate is:

Effective quarterly rate = $1.11^{.25} - 1$
Effective quarterly rate = .0264, or 2.64%

The effective annual dividend will be the FVA of the quarterly dividend payments at the effective quarterly required return. In this case, the effective annual dividend will be:

Effective D_1 = \$.8424($FVIFA_{2.64\%,4}$)
Effective D_1 = \$3.51

Now, we can use the constant growth model to find the current stock price as:

P_0 = \$3.51/(.11 – .04)
P_0 = \$50.08

Note that we cannot find the quarterly effective required return and growth rate to find the value of the stock. This would assume the dividends increased each quarter, not each year.

35. Here we have a stock with nonconstant growth, but the dividend growth changes every year for the first four years. We can find the price of the stock in Year 3 since the dividend growth rate is constant after the third dividend. The price of the stock in Year 3 will be the dividend in Year 4, divided by the required return minus the constant dividend growth rate. So, the price in Year 3 will be:

P_3 = \$3.65(1.16)(1.12)(1.08)(1.04)/(.105 – .04)
P_3 = \$81.94

The price of the stock today will be the PV of the first three dividends, plus the PV of the stock price in Year 3, so:

P_0 = \$3.65(1.16)/(1.105) + \$3.65(1.16)(1.12)/1.105^2 + \$3.65(1.16)(1.12)(1.08)/1.105^3
+ \$81.94/1.105^3
P_0 = \$72.24

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36. Here we want to find the required return that makes the PV of the dividends equal to the current stock price. The equation for the stock price is:

$$P = \$3.65(1.16)/(1 + R) + \$3.65(1.16)(1.12)/(1 + R)^2 + \$3.65(1.16)(1.12)(1.08)/(1 + R)^3 + [\$3.65(1.16)(1.12)(1.08)(1.04)/(R - .04)]/(1 + R)^3$$

We need to find the roots of this equation. Using spreadsheet, trial and error, or a calculator with a root solving function, we find that:

$R = .0979$, or 9.79%

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CHAPTER 7
NET PRESENT VALUE AND OTHER INVESTMENT CRITERIA

Answers to Concept Questions

1. Assuming conventional cash flows, a payback period less than the project's life means that the NPV is positive for a zero discount rate, but nothing more definitive can be said. For discount rates greater than zero, the payback period will still be less than the project's life, but the NPV may be positive, zero, or negative, depending on whether the discount rate is less than, equal to, or greater than the IRR. The discounted payback includes the effect of the relevant discount rate. If a project's discounted payback period is less than the project's life, it must be the case that NPV is positive.

2. Assuming conventional cash flows, if a project has a positive NPV for a certain discount rate, then it will also have a positive NPV for a zero discount rate; thus, the payback period must be less than the project life. Since discounted payback is calculated at the same discount rate as is NPV, if NPV is positive, the discounted payback period must be less than the project's life. If NPV is positive, then the present value of future cash inflows is greater than the initial investment cost; thus, PI must be greater than 1. If NPV is positive for a certain discount rate R, then it will be zero for some larger discount rate R^*; thus, the IRR must be greater than the required return.

3. *a.* Payback period is the accounting break-even point of a series of cash flows. To actually compute the payback period, it is assumed that any cash flow occurring during a given period is realized continuously throughout the period, and not at a single point in time. The payback is then the point in time for the series of cash flows when the initial cash outlays are fully recovered. Given some predetermined cutoff for the payback period, the decision rule is to accept projects that pay back before this cutoff and reject projects that take longer to pay back. The worst problem associated with the payback period is that it ignores the time value of money. In addition, the selection of a hurdle point for the payback period is an arbitrary exercise that lacks any steadfast rule or method. The payback period is biased towards short-term projects; it fully ignores any cash flows that occur after the cutoff point.

b. The average accounting return is interpreted as an average measure of the accounting performance of a project over time, computed as some average profit measure attributable to the project divided by some average balance sheet value for the project. This text computes AAR as average net income with respect to average (total) book value. Given some predetermined cutoff for AAR, the decision rule is to accept projects with an AAR in excess of the target measure and reject all other projects. AAR is not a measure of cash flows or market value but is rather a measure of financial statement accounts that often bear little resemblance to the relevant value of a project. In addition, the selection of a cutoff is arbitrary, and the time value of money is ignored. For a financial manager, both the reliance on accounting numbers rather than relevant market data and the exclusion of time value of money considerations are troubling. Despite these problems, AAR continues to be used in practice because (1) the accounting information is usually available, (2) analysts often use accounting ratios to analyze firm performance, and (3) managerial compensation is often tied to the attainment of target accounting ratio goals.

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c. The IRR is the discount rate that causes the NPV of a series of cash flows to be identically zero. IRR can thus be interpreted as a financial break-even rate of return; at the IRR discount rate, the net value of the project is zero. The acceptance and rejection criteria are:

If $C_0 < 0$ and all future cash flows are positive, accept the project if the internal rate of return is greater than or equal to the discount rate.
If $C_0 < 0$ and all future cash flows are positive, reject the project if the internal rate of return is less than the discount rate.
If $C_0 > 0$ and all future cash flows are negative, accept the project if the internal rate of return is less than or equal to the discount rate.
If $C_0 > 0$ and all future cash flows are negative, reject the project if the internal rate of return is greater than the discount rate.

IRR is the discount rate that causes NPV for a series of cash flows to be zero. NPV is preferred in all situations to IRR; IRR can lead to ambiguous results if there are non-conventional cash flows, and it also may ambiguously rank some mutually exclusive projects. However, for stand-alone projects with conventional cash flows, IRR and NPV are interchangeable techniques.

d. The profitability index is the present value of cash inflows relative to the project cost. As such, it is a benefit/cost ratio, providing a measure of the relative profitability of a project. The profitability index decision rule is to accept projects with a PI greater than one, and to reject projects with a PI less than one. The profitability index can be expressed as: PI = (NPV + cost)/cost = 1 + (NPV/cost). If a firm has a basket of positive NPV projects and is subject to capital rationing, PI may provide a good ranking measure of the projects, indicating the "bang for the buck" of each particular project.

e. NPV is the present value of a project's cash flows, including the initial outlay. NPV specifically measures (after considering the time value of money) the net increase or decrease in firm wealth due to the project. The decision rule is to accept projects that have a positive NPV and reject projects with a negative NPV. NPV is superior to the other methods of analysis presented in the text because it has no serious flaws. The method unambiguously ranks mutually exclusive projects, and it can differentiate between projects of different scale and time horizon. The only drawback to NPV is that it relies on cash flow and discount rate values that are often estimates and thus not certain, but this is a problem shared by the other performance criteria as well. A project with NPV = $2,500 implies that the total shareholder wealth of the firm will increase by $2,500 if the project is accepted.

4. For a project with future cash flows that are an annuity:

Payback = I/*C*

And the IRR is:

$0 = -I + C/IRR$

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Solving this equation for IRR, we get:

IRR = *C*/I

Notice this is just the reciprocal of the payback. So:

IRR = 1/PB

For long-lived projects with relatively constant cash flows, the sooner the project pays back, the greater is the IRR, and the IRR is approximately equal to the reciprocal of the payback period.

5. There are a number of reasons. Two of the most important have to do with transportation costs and exchange rates. Manufacturing in the U.S. places the finished product much closer to the point of sale, resulting in significant savings in transportation costs. It also reduces inventories because goods spend less time in transit. Higher labor costs tend to offset these savings to some degree, at least compared to other possible manufacturing locations. Of great importance is the fact that manufacturing in the U.S. means that a much higher proportion of the costs are paid in dollars. Since sales are in dollars, the net effect is to immunize profits to a large extent against fluctuations in exchange rates. This issue is discussed in greater detail in the chapter on international finance.

6. The single biggest difficulty, by far, is coming up with reliable cash flow estimates. Determining an appropriate discount rate is also not a simple task. These issues are discussed in greater depth in the next several chapters. The payback approach is probably the simplest, followed by the AAR, but even these require revenue and cost projections. The discounted cash flow measures (discounted payback, NPV, IRR, and profitability index) are really only slightly more difficult in practice.

7. Yes, they are. Such entities generally need to allocate available capital efficiently, just as for-profits do. However, it is frequently the case that the "revenues" from not-for-profit ventures are not tangible. For example, charitable giving has real opportunity costs, but the benefits are generally hard to measure. To the extent that benefits are measurable, the question of an appropriate required return remains. Payback rules are commonly used in such cases. Finally, realistic cost/benefit analysis along the lines indicated should definitely be used by the U.S. government and would go a long way toward balancing the budget!

8. The statement is false. If the cash flows of Project B occur early and the cash flows of Project A occur late, then for a low discount rate the NPV of A can exceed the NPV of B. Observe the following example.

	C_0	C_1	C_2	IRR	NPV @ 0%
Project A	–$1,000,000	$0	$1,440,000	20%	$440,000
Project B	–$2,000,000	$2,400,000	$0	20%	400,000

However, in one particular case, the statement is true for equally risky projects. If the lives of the two projects are equal and the cash flows of Project B are twice the cash flows of Project A in every time period, the NPV of Project B will be twice the NPV of Project A.

9. Although the profitability index (PI) is higher for Project B than for Project A, Project A should be chosen because it has the greater NPV. Confusion arises because Project B requires a smaller investment than Project A. Since the denominator of the PI ratio is lower for Project B than for Project A, B can have a higher PI yet have a lower NPV. Only in the case of capital rationing could the company's decision have been incorrect.

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10. *a.* Project A would have a higher IRR since the initial investment for Project A is less than that of Project B, if the cash flows for the two projects are identical.

b. Yes, since both the cash flows as well as the initial investment are twice that of Project B.

11. Project B's NPV would be more sensitive to changes in the discount rate. The reason is the time value of money. Cash flows that occur further out in the future are always more sensitive to changes in the interest rate. This sensitivity is similar to the interest rate risk of a bond.

12. The MIRR is calculated by finding the present value of all cash outflows, finding the future value of all cash inflows to the end of the project, and then calculating the IRR of the two cash flows. As a result, the cash flows have been discounted or compounded by one interest rate (the required return), and then the interest rate between the two remaining cash flows is calculated. As such, the MIRR is not a true interest rate. In contrast, consider the IRR. If you take the initial investment, and calculate the future value at the IRR, you can replicate the future cash flows of the project exactly.

13. The statement is incorrect. It is true that if you calculate the future value of all intermediate cash flows to the end of the project at the required return, then calculate the NPV of this future value and the initial investment, you will get the same NPV. However, NPV says nothing about reinvestment of intermediate cash flows. The NPV is the present value of the project cash flows. What is actually done with those cash flows once they are generated is not relevant. Put differently, the value of a project depends on the cash flows generated by the project, not on the future value of those cash flows. The fact that the reinvestment "works" only if you use the required return as the reinvestment rate is also irrelevant because reinvestment is not relevant to the value of the project in the first place.

One caveat: Our discussion here assumes that the cash flows are truly available once they are generated, meaning that it is up to firm management to decide what to do with the cash flows. In certain cases, there may be a requirement that the cash flows be reinvested. For example, in international investing, a company may be required to reinvest the cash flows in the country in which they are generated and not "repatriate" the money. Such funds are said to be "blocked" and reinvestment becomes relevant because the cash flows are not truly available.

14. The statement is incorrect. It is true that if you calculate the future value of all intermediate cash flows to the end of the project at the IRR, then calculate the IRR of this future value and the initial investment, you will get the same IRR. However, as in the previous question, what is done with the cash flows once they are generated does not affect the IRR. Consider the following example:

	C_0	C_1	C_2	IRR
Project A	–$100	$10	$110	10%

Suppose this $100 is a deposit into a bank account. The IRR of the cash flows is 10 percent. Does the IRR change if the Year 1 cash flow is reinvested in the account, or if it is withdrawn and spent on pizza? No. Finally, consider the yield to maturity calculation on a bond. If you think about it, the YTM is the IRR on the bond, but no mention of a reinvestment assumption for the bond coupons is suggested. The reason is that reinvestment is irrelevant to the YTM calculation; in the same way, reinvestment is irrelevant in the IRR calculation. Our caveat about blocked funds applies here as well.

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Solutions to Questions and Problems

NOTE: All end-of-chapter problems were solved using a spreadsheet. Many problems require multiple steps. Due to space and readability constraints, when these intermediate steps are included in this solutions manual, rounding may appear to have occurred. However, the final answer for each problem is found without rounding during any step in the problem.

Basic

1. *a.* The payback period is the time that it takes for the cumulative undiscounted cash inflows to equal the initial investment.

Project A:

Cumulative cash flows Year 1 = \$15,400 = \$15,400
Cumulative cash flows Year 2 = \$15,400 + 15,600 = \$31,000

So, the payback period is less than two years. Companies can calculate a more precise value using fractional years. To calculate the fractional payback period, find the fraction of Year 2's cash flows that is needed for the company to have cumulative undiscounted cash flows of \$30,600. Divide the difference between the initial investment and the cumulative undiscounted cash flows as of Year 1 by the undiscounted cash flow of Year 2.

Payback period = 1 + (\$30,600 – 15,400)/\$15,600
Payback period = 1.97 years

Project B:

Cumulative cash flows Year 1 = \$10,600 = \$10,600
Cumulative cash flows Year 2 = \$10,600 + 8,600 = \$19,200
Cumulative cash flows Year 3 = \$10,600 + 8,600 + 9,600 = \$28,800

Payback period = 2 + (\$21,400 – 19,200)/\$9,600
Payback period = 2.23 years

Since Project A has a payback period less than two years and Project B has a payback period longer than two years, the company should choose Project A.

b. Discount each project's cash flows at 15 percent. Choose the project with the highest NPV.

Project A:
$NPV = –\$30,600 + \$15,400/1.15 + \$15,600/1.15^2 + \$6,200/1.15^3$
NPV = –\$1,336.25

Project B:
$NPV = –\$21,400 + \$10,600/1.15 + \$8,600/1.15^2 + \$9,600/1.15^3$
NPV = \$632.38

The firm should choose Project B since it has a higher NPV than Project A.

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2. To calculate the payback period, we need to find the time that the project has recovered its initial investment. If the initial cost is $4,900, the payback period is:

Payback = 3 + ($310/$1,530) = 3.20 years

There is a shortcut to calculate the payback period if the future cash flows are an annuity. Just divide the initial cost by the annual cash flow. For the $4,900 cost, the payback period is:

Payback = $4,900/$1,530 = 3.20 years

For an initial cost of $7,900, the payback period is:

Payback = $7,900/$1,530 = 5.16 years

The payback period for an initial cost of $13,400 is a little trickier. Notice that the total cash inflows after eight years will be:

Total cash inflows = 8($1,530) = $12,240

If the initial cost is $13,400, the project never pays back. Notice that if you use the shortcut for annuity cash flows, you get:

Payback = $13,400/$1,530 = 8.76 years

This answer does not make sense since the cash flows stop after eight years, so there is no payback period.

3. When we use discounted payback, we need to find the value of all cash flows today. The value today of the project cash flows for the first four years is:

Value today of Year 1 cash flow = $5,100/1.12 = $4,553.57
Value today of Year 2 cash flow = $5,700/$1.12^2$ = $4,544.01
Value today of Year 3 cash flow = $6,200/$1.12^3$ = $4,413.04
Value today of Year 4 cash flow = $6,400/$1.12^4$ = $4,067.32

To find the discounted payback, we use these values to find the payback period. The discounted first year cash flow is $4,553.57, so the discounted payback for an initial cost of $6,000 is:

Discounted payback = 1 + ($6,000 – 4,553.57)/$4,544.01 = 1.32 years

For an initial cost of $9,500, the discounted payback is:

Discounted payback = 2 + ($9,500 – 4,553.57 – 4,544.01)/$4,413.04 = 2.09 years

Notice the calculation of discounted payback. We know the payback period is between two and three years, so we subtract the discounted values of the Year 1 and Year 2 cash flows from the initial cost. This is the numerator, which is the discounted amount we still need to make to recover our initial investment. We divide this amount by the discounted amount we will earn in Year 3 to get the fractional portion of the discounted payback.

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If the initial cost is $15,400, the discounted payback is:

Discounted payback = 3 + ($15,400 – 4,553.57 – 4,544.01 – 4,413.04)/$4,067.32
Discounted payback = 3.46 years

4. To calculate the discounted payback, discount all future cash flows back to the present, and use these discounted cash flows to calculate the payback period. To find the fractional year, we divide the amount we need to make in the last year to pay back the project by the amount we will make. Doing so, we find:

R = 0%: 3 + ($2,300/$4,400) = 3.52 years
Discounted payback = Regular payback = 3.52 years

R = 7%: $4,400/1.07 + $4,400/$1.07^2$ + $4,400/$1.07^3$ + $4,400/$1.07^4$ = $14,903.73
$4,400/$1.07^5$ = $3,137.14
Discounted payback = 4 + ($15,500 – 14,903.73)/$3,137.14 = 4.19 years

R = 21%: $4,400/1.21 + $4,400/$1.21^2$ + $4,400/$1.21^3$ + $4,400/$1.21^4$ + $4,400/$1.21^5$
+ $4,400/$1.21^6$ = $14,276.31; The project never pays back.

5. *a.* The average accounting return is the average project earnings after taxes, divided by the average book value, or average net investment, of the machine during its life. The book value of the machine is the gross investment minus the accumulated depreciation.

Average book value = (Book $value_0$ + Book $value_1$ + Book $value_2$ + Book $value_3$ +
Book $value_4$ + Book $value_5$)/(Economic life)
Average book value = ($63,000 + 47,250 + 31,500 + 17,750 + 0)/5
Average book value = $31,500

To find the average accounting return, we divide the average project earnings by the average book value of the machine to calculate the average accounting return. Doing so, we find:

Average accounting return = Average project earnings/Average book value
Average accounting return = $6,100/$31,500
Average accounting return = .1937, or 19.37%

b. The three flaws of the AAR are: 1) The AAR does not work with the right raw materials. It uses net income and book value of the investment, both of which come from the accounting books. Accounting numbers are somewhat arbitrary. 2) AAR takes no account of timing. The AAR would be the same if the net income in the first year occurs in the last year. 3) The AAR uses an arbitrary interest rate as the cutoff rate and offers no guidance on what the right targeted rate of return should be.

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6. First, we need to determine the average book value of the project. The book value is the gross investment minus accumulated depreciation.

	Purchase Date	Year 1	Year 2	Year 3
Gross investment	$34,000	$34,000	$34,000	$34,000
Less: Accumulated depreciation	0	9,600	25,500	34,000
Net Investment	$34,000	$24,400	$8,500	$0

Now, we can calculate the average book value as:

Average book value = ($34,000 + 24,400 + 8,500 + 0)/4
Average book value = $16,725

To calculate the average accounting return, we must remember to use the aftertax average net income when calculating the average accounting return. So, the average aftertax net income is:

Average aftertax net income = $(1 - T_C)$Annual pretax net income
Average aftertax net income = (1 – .25)$3,560
Average aftertax net income = $2,670

The average accounting return is the average after-tax net income divided by the average book value, which is:

Average accounting return = $2,670/$16,725
Average accounting return = .1596, or 15.96%

7. The IRR is the interest rate that makes the NPV of the project equal to zero. So, the equation that defines the IRR for this project is:

$0 = C_0 + C_1/(1 + \text{IRR}) + C_2/(1 + \text{IRR})^2 + C_3/(1 + \text{IRR})^3$
$0 = -\$20{,}300 + \$9{,}600/(1 + \text{IRR}) + \$13{,}700/(1 + \text{IRR})^2 + \$5{,}800/(1 + \text{IRR})^3$

Using a spreadsheet, financial calculator, or trial and error to find the root of the equation, we find that:

IRR = 21.89%

Since the IRR is greater than the required return, we would accept the project.

8. The IRR is the interest rate that makes the NPV of the project equal to zero. So, the equation that defines the IRR for Project A is:

$0 = C_0 + C_1/(1 + \text{IRR}) + C_2/(1 + \text{IRR})^2 + C_3/(1 + \text{IRR})^3$
$0 = -\$8{,}100 + \$2{,}900/(1 + \text{IRR}) + \$4{,}600/(1 + \text{IRR})^2 + \$3{,}100/(1 + \text{IRR})^3$

Using a spreadsheet, financial calculator, or trial and error to find the root of the equation, we find that:

IRR = 14.55%

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And the IRR for Project B is:

$0 = C_0 + C_1/(1 + \text{IRR}) + C_2/(1 + \text{IRR})^2 + C_3/(1 + \text{IRR})^3$
$0 = -\$5,400 + \$2,200/(1 + \text{IRR}) + \$2,700/(1 + \text{IRR})^2 + \$2,300/(1 + \text{IRR})^3$

Using a spreadsheet, financial calculator, or trial and error to find the root of the equation, we find that:

IRR = 15.74%

9. The profitability index is defined as the PV of the cash inflows divided by the PV of the cash outflows. The cash flows from this project are an annuity, so the equation for the profitability index is:

$\text{PI} = C(\text{PVIFA}_{R,t})/C_0$
$\text{PI} = \$62,000(\text{PVIFA}_{15\%,7})/\$187,000$
PI = $257,946.02/$187,000
PI = 1.379

Therefore, the project should be accepted.

10. *a.* The profitability index is the present value of the future cash flows divided by the initial cost. So, for Project Alpha, the profitability index is:

$\text{PI}_{\text{Alpha}} = [\$990/1.10 + \$1,500/1.10^2 + \$1,300/1.10^3]/\$2,600 = 1.199$

And for Project Beta the profitability index is:

$\text{PI}_{\text{Beta}} = [\$2,100/1.10 + \$3,400/1.10^2 + \$1,400/1.10^3]/\$3,900 = 1.480$

b. Since the projects are independent and both have a profitability index greater than 1, the company should accept both projects. If the projects were mutually exclusive, you could not rank them by the profitability index.

Intermediate

11. *a.* To have a payback equal to the project's life, given C is a constant cash flow for N years:

$C = \text{I/N}$

b. To have a positive NPV, $\text{I} < C\ (\text{PVIFA}_{R\%,N})$. Thus, $C > \text{I}/(\text{PVIFA}_{R\%,N})$.

c. Benefits $= C(\text{PVIFA}_{R\%,N}) = 2 \times \text{costs} = 2\text{I}$
$C = 2\text{I}/(\text{PVIFA}_{R\%,N})$

12. *a.* The IRR is the interest rate that makes the NPV of the project equal to zero. So, the equation that defines the IRR for this project is:

$0 = C_0 + C_1/(1 + \text{IRR}) + C_2/(1 + \text{IRR})^2 + C_3/(1 + \text{IRR})^3 + C_4/(1 + \text{IRR})^4$
$0 = \$15,900 - \$5,900/(1 + \text{IRR}) - \$5,700/(1 + \text{IRR})^2 - \$4,900/(1 + \text{IRR})^3$
$\quad - \$4,100/(1 + \text{IRR})^4$

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Using a spreadsheet, financial calculator, or trial and error to find the root of the equation, we find that:

IRR = 12.02%

b. This problem differs from previous ones because the initial cash flow is positive and all future cash flows are negative. In other words, this is a financing-type project, while previous projects were investing-type projects. For financing situations, accept the project when the IRR is less than the discount rate. Reject the project when the IRR is greater than the discount rate.

IRR = 12.02%
Discount Rate = 10%

IRR > Discount Rate

Reject the offer when the discount rate is less than the IRR.

c. Using the same reason as part (b), we would accept the project if the discount rate is 20 percent.

IRR = 12.02%
Discount Rate = 20%

IRR < Discount Rate

Accept the offer when the discount rate is greater than the IRR.

d. The NPV is the sum of the present value of all cash flows, so the NPV of the project if the discount rate is 10 percent will be:

$NPV = \$15{,}900 - \$5{,}900/1.1 - \$5{,}700/1.1^2 - \$4{,}900/1.1^3 - \$4{,}100/1.1^4$
NPV = –$656.18

When the discount rate is 10 percent, the NPV of the offer is negative, so reject the offer.

And the NPV of the project if the discount rate is 20 percent will be:

$NPV = \$15{,}900 - \$5{,}900/1.2 - \$5{,}700/1.2^2 - \$4{,}900/1.2^3 - \$4{,}100/1.2^4$
NPV = $2,212.11

When the discount rate is 20 percent, the NPV of the offer is positive, so accept the offer.

e. Yes, the decisions under the NPV rule are consistent with the choices made under the IRR rule since the signs of the cash flows change only once.

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13. *a.* The IRR is the interest rate that makes the NPV of the project equal to zero. So, the IRR for each project is:

Deepwater Fishing IRR:

$0 = C_0 + C_1/(1 + \text{IRR}) + C_2/(1 + \text{IRR})^2 + C_3/(1 + \text{IRR})^3$
$0 = -\$918{,}000 + \$495{,}000/(1 + \text{IRR}) + \$450{,}000/(1 + \text{IRR})^2 + \$370{,}000/(1 + \text{IRR})^3$

Using a spreadsheet, financial calculator, or trial and error to find the root of the equation, we find that:

IRR = 21.54%

Submarine Ride IRR:

$0 = C_0 + C_1/(1 + \text{IRR}) + C_2/(1 + \text{IRR})^2 + C_3/(1 + \text{IRR})^3$
$0 = -\$1{,}815{,}000 + \$1{,}150{,}000/(1 + \text{IRR}) + \$742{,}000/(1 + \text{IRR})^2 + \$575{,}000/(1 + \text{IRR})^3$

Using a spreadsheet, financial calculator, or trial and error to find the root of the equation, we find that:

IRR = 19.65%

Based on the IRR, the deepwater fishing project should be chosen because it has the higher IRR. This decision is not necessarily correct as we shall see.

b. To calculate the incremental IRR, we subtract the smaller project's cash flows from the larger project's cash flows. In this case, we subtract the deepwater fishing cash flows from the submarine ride cash flows. The incremental IRR is the IRR of these incremental cash flows. So, the incremental cash flows of the submarine ride are:

	Year 0	Year 1	Year 2	Year 3
Submarine Ride	–$1,815,000	$1,150,000	$742,000	$575,000
Deepwater Fishing	–918,000	495,000	450,000	370,000
Submarine – Fishing	–$897,000	$655,000	$292,000	$205,000

Setting the present value of these incremental cash flows equal to zero, we find the incremental IRR is:

$0 = C_0 + C_1/(1 + \text{IRR}) + C_2/(1 + \text{IRR})^2 + C_3/(1 + \text{IRR})^3$
$0 = -\$897{,}000 + \$655{,}000/(1 + \text{IRR}) + \$292{,}000/(1 + \text{IRR})^2 + \$205{,}000/(1 + \text{IRR})^3$

Using a spreadsheet, financial calculator, or trial and error to find the root of the equation, we find that:

Incremental IRR = 17.35%

For investing-type projects, accept the larger project when the incremental IRR is greater than the discount rate. Since the incremental IRR, 17.35 percent, is greater than the required rate of return of 15 percent, choose the submarine ride project. Note that this is not the choice when evaluating the IRR of each project separately. The IRR decision rule is flawed because there is a

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scale problem. That is, the submarine ride has a greater initial investment than does the deepwater fishing project. This problem is corrected by calculating the IRR of the incremental cash flows, or by evaluating the NPV of each project.

c. The NPV is the sum of the present value of the cash flows from the project, so the NPV of each project will be:

Deepwater fishing:

$NPV = -\$918,000 + \$495,000/1.15 + \$450,000/1.15^2 + \$370,000/1.15^3$
$NPV = \$95,980.44$

Submarine ride:

$NPV = -\$1,815,000 + \$1,150,000/1.15 + \$742,000/1.15^2 + \$575,000/1.15^3$
$NPV = \$124,130.43$

Since the NPV of the submarine ride project is greater than the NPV of the deepwater fishing project, choose the submarine ride project. The incremental IRR rule is always consistent with the NPV rule.

14. *a.* The profitability index is the PV of the future cash flows divided by the initial investment. The cash flows for both projects are an annuity, so:

$PI_I = \$39,000(PVIFA_{10\%,3})/\$75,000 = 1.293$

$PI_{II} = \$24,000(PVIFA_{10\%,3})/\$42,000 = 1.421$

The profitability index decision rule implies that we accept Project II, since PI_{II} is greater than the PI_I.

b. The NPV of each project is:

$NPV_I = -\$75,000 + \$39,000(PVIFA_{10\%,3}) = \$21,987.23$

$NPV_{II} = -\$42,000 + \$24,000(PVIFA_{10\%,3}) = \$17,684.45$

The NPV decision rule implies accepting Project I, since the NPV_I is greater than the NPV_{II}.

c. Using the profitability index to compare mutually exclusive projects can be ambiguous when the magnitudes of the cash flows for the two projects are of different scale. In this problem, Project I is roughly twice as large as Project II and produces a larger NPV, yet the profitability index criterion implies that Project II is more acceptable.

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15. *a.* The equation for the NPV of the project is:

$NPV = –\$63,000,000 + \$89,000,000/1.1 – \$11,000,000/1.1^2 = \$8,818,181.82$

The NPV is greater than 0, so we would accept the project.

b. The equation for the IRR of the project is:

$0 = –\$63,000,000 + \$89,000,000/(1 + IRR) – \$11,000,000/(1 + IRR)^2$

From Descartes rule of signs, we know there are two possible IRRs since the cash flows change signs twice. From trial and error, the two IRRs are:

IRR = 27.58%, –86.31%

When there are multiple IRRs, the IRR decision rule is ambiguous. Both IRRs are correct; that is, both interest rates make the NPV of the project equal to zero. If we are evaluating whether to accept this project, we would not want to use the IRR to make our decision.

16. *a.* The payback period is the time that it takes for the cumulative undiscounted cash inflows to equal the initial investment.

Board game:

Cumulative cash flows Year 1 = \$292,000 = \$292,000
Cumulative cash flows Year 2 = \$292,000 + 165,000 = \$457,000

Payback period = 1 + (\$380,000 – 292,000)/\$165,000 = 1.53 years

PC game:

Cumulative cash flows Year 1 = \$396,000 = \$396,000
Cumulative cash flows Year 2 = \$396,000 + 319,000 = \$715,000

Payback period = 1 + (\$625,000 – 396,000)/\$319,000
Payback period = 1.72 years

Since the board game has a shorter payback period than the PC game project, the company should choose the board game.

b. The NPV is the sum of the present value of the cash flows from the project, so the NPV of each project will be:

Board game:

$NPV = –\$380,000 + \$292,000/1.10 + \$165,000/1.10^2 + \$107,000/1.10^3$
NPV = \$102,208.87

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PC game:

$NPV = –\$625{,}000 + \$396{,}000/1.10 + \$319{,}000/1.10^2 + \$204{,}000/1.10^3$
$NPV = \$151{,}904.58$

Since the NPV of the PC game is greater than the NPV of the board game, choose the PC game.

c. The IRR is the interest rate that makes the NPV of a project equal to zero. So, the IRR of each project is:

Board game:

$0 = –\$380{,}000 + \$292{,}000/(1 + IRR) + \$165{,}000/(1 + IRR)^2 + \$107{,}000/(1 + IRR)^3$

Using a spreadsheet, financial calculator, or trial and error to find the root of the equation, we find that:

$IRR = 27.97\%$

PC game:

$0 = –\$625{,}000 + \$396{,}000/(1 + IRR) + \$319{,}000/(1 + IRR)^2 + \$204{,}000/(1 + IRR)^3$

Using a spreadsheet, financial calculator, or trial and error to find the root of the equation, we find that:

$IRR = 25.05\%$

Since the IRR of the board game is greater than the IRR of the PC game, IRR implies we choose the board game.

d. To calculate the incremental IRR, we subtract the smaller project's cash flows from the larger project's cash flows. In this case, we subtract the board game cash flows from the PC game cash flows. The incremental IRR is the IRR of these incremental cash flows. So, the incremental cash flows of the PC game are:

	Year 0	Year 1	Year 2	Year 3
PC game	–\$625,000	\$396,000	\$319,000	\$204,000
Board game	–380,000	292,000	165,000	107,000
PC game – Board game	–\$245,000	\$104,000	\$154,000	\$97,000

Setting the present value of these incremental cash flows equal to zero, we find the incremental IRR is:

$0 = C_0 + C_1/(1 + IRR) + C_2/(1 + IRR)^2 + C_3/(1 + IRR)^3$
$0 = –\$245{,}000 + \$104{,}000/(1 + IRR) + \$154{,}000/(1 + IRR)^2 + \$97{,}000/(1 + IRR)^3$

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Using a spreadsheet, financial calculator, or trial and error to find the root of the equation, we find that:

Incremental IRR = 21.23%

For investing-type projects, accept the larger project when the incremental IRR is greater than the discount rate. Since the incremental IRR, 21.23%, is greater than the required rate of return of 10 percent, choose the PC game project. Note that this is not the choice when evaluating only the IRR of each project. The IRR decision rule is flawed because there is a scale problem. That is, the PC game has a greater initial investment than does the board game. This problem is corrected by calculating the IRR of the incremental cash flows, or by evaluating the NPV of each project.

17. *a.* The profitability index is the PV of the future cash flows divided by the initial investment. The profitability index for each project is:

$PI_{L6} = [\$15{,}000{,}000/1.10 + \$13{,}000{,}000/1.10^2 + \$9{,}000{,}000/1.10^3]/\$20{,}000{,}000 = 1.56$

$PI_{G5} = [\$23{,}000{,}000/1.10 + \$29{,}000{,}000/1.10^2 + \$21{,}000{,}000/1.10^3]/\$35{,}000{,}000 = 1.73$

$PI_{Wi\text{-}Fi} = [\$23{,}000{,}000/1.10 + \$42{,}000{,}000/1.10^2 + \$39{,}000{,}000/1.10^3]/\$55{,}000{,}000 = 1.54$

The profitability index implies we accept the G5 project. Remember this is not necessarily correct because the profitability index does not necessarily rank projects with different initial investments correctly.

b. The NPV of each project is:

$NPV_{L6} = -\$20{,}000{,}000 + \$15{,}000{,}000/1.10 + \$13{,}000{,}000/1.10^2 + \$9{,}000{,}000/1.10^3$
$NPV_{L6} = \$11{,}141{,}998.50$

$NPV_{G5} = -\$35{,}000{,}000 + \$23{,}000{,}000/1.10 + \$29{,}000{,}000/1.10^2 + \$21{,}000{,}000/1.10^3$
$NPV_{G5} = \$25{,}653{,}643.88$

$NPV_{Wi\text{-}Fi} = -\$55{,}000{,}000 + \$23{,}000{,}000/1.10 + \$42{,}000{,}000/1.10^2 + \$39{,}000{,}000/1.10^3$
$NPV_{Wi\text{-}Fi} = \$29{,}921{,}111.95$

NPV implies we accept the Wi-Fi project since it has the highest NPV. This is the correct decision if the projects are mutually exclusive.

c. We would like to invest in all three projects since each has a positive NPV. If the budget is limited to $55 million, we can only accept the L6 project and the G5 project, or the Wi-Fi project. NPV is additive across projects and the company. The total NPV of the L6 project and the G5 project is:

$NPV_{L6 \text{ and } G5} = \$11{,}141{,}998.50 + 25{,}653{,}643.88$
$NPV_{L6 \text{ and } G5} = \$36{,}795{,}642.37$

This is greater than the Wi-Fi project, so we should accept the L6 project and the G5 project.

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18. *a.* The payback period is the time that it takes for the cumulative undiscounted cash inflows to equal the initial investment.

AZM Mini-SUV:

Cumulative cash flows Year 1 = \$290,000 = \$290,000
Cumulative cash flows Year 2 = \$290,000 + 245,000 = \$535,000

Payback period = 1 + (\$525,000 – 290,000)/\$245,000 = 1.96 years

AZF Full-SUV:

Cumulative cash flows Year 1 = \$410,000 = \$410,000
Cumulative cash flows Year 2 = \$410,000 + 390,000 = \$800,000

Payback period = 2 + (\$810,000 – 800,000)/\$350,000 = 2.03 years

Since the AZM has a shorter payback period than the AZF, the company should choose the AZM. Remember the payback period does not necessarily rank projects correctly.

b. The NPV of each project is:

$NPV_{AZM} = -\$525,000 + \$290,000/1.10 + \$245,000/1.10^2 + \$185,000/1.10^3$
$NPV_{AZM} = \$80,108.94$

$NPV_{AZF} = -\$810,000 + \$410,000/1.10 + \$390,000/1.10^2 + \$350,000/1.10^3$
$NPV_{AZF} = \$148,001.50$

The NPV criterion implies we accept the AZF because it has the highest NPV.

c. The IRR is the interest rate that makes the NPV of the project equal to zero. So, the IRR of the AZM is:

$0 = -\$525,000 + \$290,000/(1 + IRR) + \$245,000/(1 + IRR)^2 + \$185,000/(1 + IRR)^3$

Using a spreadsheet, financial calculator, or trial and error to find the root of the equation, we find that:

$IRR_{AZM} = 19.19\%$

And the IRR of the AZF is:

$0 = -\$810,000 + \$410,000/(1 + IRR) + \$390,000/(1 + IRR)^2 + \$350,000/(1 + IRR)^3$

Using a spreadsheet, financial calculator, or trial and error to find the root of the equation, we find that:

$IRR_{AZF} = 20.41\%$

The IRR criterion implies we accept the AZM because it has the highest IRR. Remember the IRR does not necessarily rank projects correctly.

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d. To calculate the incremental IRR, we subtract the smaller project's cash flows from the larger project's cash flows. So, the incremental cash flows are:

	Year 0	Year 1	Year 2	Year 3
AZF	–$810,000	$410,000	$390,000	$350,000
AZM	–525,000	290,000	245,000	185,000
AZF – AZM	–$285,000	$120,000	$145,000	$165,000

Setting the present value of these incremental cash flows equal to zero, we find the incremental IRR is:

$0 = C_0 + C_1/(1 + \text{IRR}) + C_2/(1 + \text{IRR})^2 + C_3/(1 + \text{IRR})^3$
$0 = -\$285{,}000 + \$120{,}000/(1 + \text{IRR}) + \$145{,}000/(1 + \text{IRR})^2 + \$165{,}000/(1 + \text{IRR})^3$

Using a spreadsheet, financial calculator, or trial and error to find the root of the equation, we find that:

Incremental IRR = 22.36%

19. *a.* The profitability index is the PV of the future cash flows divided by the initial investment. The profitability index for each project is:

$PI_A = [\$203{,}000/1.12 + \$203{,}000/1.12^2]/\$300{,}000 = 1.144$

$PI_B = [\$360{,}000/1.12 + \$360{,}000/1.12^2]/\$525{,}000 = 1.159$

$PI_C = [\$210{,}000/1.12 + \$185{,}000/1.12^2]/\$300{,}000 = 1.117$

b. The NPV of each project is:

$NPV_A = -\$300{,}000 + \$203{,}000/1.12 + \$203{,}000/1.12^2$
$NPV_A = \$43{,}080.36$

$NPV_B = -\$525{,}000 + \$360{,}000/1.12 + \$360{,}000/1.12^2$
$NPV_B = \$83{,}418.37$

$NPV_C = -\$300{,}000 + \$210{,}000/1.12 + \$185{,}000/1.12^2$
$NPV_C = \$34{,}980.87$

c. Accept Projects A, B, and C. Since the projects are independent, accept all three projects because the respective profitability index of each is greater than one.

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d. Accept Project B. Since the Projects are mutually exclusive, choose the Project with the highest PI, while taking into account the scale of the project. Because Projects A and C have the same initial investment, the problem of scale does not arise when comparing the profitability indices. Based on the profitability index rule, Project C can be eliminated because its PI is less than the PI of Project A. Because of the problem of scale, we cannot compare the PIs of Projects A and B. However, we can calculate the PI of the incremental cash flows of the two projects, which are:

Project	C_0	C_1	C_2
B – A	–$225,000	$157,000	$157,000

When calculating incremental cash flows, remember to subtract the cash flows of the project with the smaller initial cash outflow from those of the project with the larger initial cash outflow. This procedure insures that the incremental initial cash outflow will be negative. The incremental PI calculation is:

PI(B – A) = [$157,000/1.12 + $157,000/$1.12^2$]/$225,000
PI(B – A) = 1.179

The company should accept Project B since the PI of the incremental cash flows is greater than one.

e. Remember that the NPV is additive across projects. Since we can spend $825,000, we could take two of the projects. In this case, we should take the two projects with the highest NPVs, which are Project B and Project A.

20. *a.* The payback period is the time that it takes for the cumulative undiscounted cash inflows to equal the initial investment.

Dry Prepeg:

Cumulative cash flows Year 1 = $828,000 = $828,000
Cumulative cash flows Year 2 = $828,000 + 546,000 = $1,374,000
Cumulative cash flows Year 3 = $828,000 + 546,000 + 1,680,000 = $3,054,000

Payback period = 2 + ($2,160,000 – 828,000 – 546,000)/$1,680,000 = 2.47 years

Solvent Prepeg:

Cumulative cash flows Year 1 = $678,000 = $678,000
Cumulative cash flows Year 2 = $678,000 + 492,000 = $1,170,000

Payback period = 1 + ($1,100,000 – 678,000)/$492,000 = 1.86 years

Since the solvent prepeg has a shorter payback period than the dry prepeg, the company should choose the solvent prepeg. Remember the payback period does not necessarily rank projects correctly.

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b. The NPV of each project is:

$NPV_{Dry\ prepeg} = -\$2,160,000 + \$828,000/1.10 + \$546,000/1.10^2 + \$1,680,000/1.10^3$
$NPV_{Dry\ prepeg} = \$306,175.81$

$NPV_{Solvent\ prepeg} = -\$1,100,000 + \$678,000/1.10 + \$492,000/1.10^2 + \$408,000/1.10^3$
$NPV_{Solvent\ prepeg} = \$229,511.65$

The NPV criterion implies accepting the dry prepeg because it has the highest NPV.

c. The IRR is the interest rate that makes the NPV of the project equal to zero. So, the IRR of each dry prepeg is:

$0 = -\$2,160,000 + \$828,000/(1 + IRR) + \$546,000/(1 + IRR)^2 + \$1,680,000/(1 + IRR)^3$

Using a spreadsheet, financial calculator, or trial and error to find the root of the equation, we find that:

$IRR_{Dry\ prepeg} = 16.89\%$

And the IRR of the solvent prepeg is:

$0 = -\$1,100,000 + \$678,000/(1 + IRR) + \$492,000/(1 + IRR)^2 + \$408,000/(1 + IRR)^3$

Using a spreadsheet, financial calculator, or trial and error to find the root of the equation, we find that:

$IRR_{Solvent\ prepeg} = 22.71\%$

The IRR criterion implies accepting the solvent prepeg because it has the highest IRR. Remember the IRR does not necessarily rank projects correctly.

d. Incremental IRR analysis is necessary. The solvent prepeg has a higher IRR but is relatively smaller in terms of investment and NPV. In calculating the incremental cash flows, we subtract the cash flows from the project with the smaller initial investment from the cash flows of the project with the large initial investment, so the incremental cash flows are:

	Year 0	Year 1	Year 2	Year 3
Dry prepeg	–$2,160,000	$828,000	$546,000	$1,680,000
Solvent prepeg	–1,100,000	678,000	492,000	408,000
Dry prepeg – Solvent prepeg	–$1,060,000	$150,000	$54,000	$1,272,000

Setting the present value of these incremental cash flows equal to zero, we find the incremental IRR is:

$0 = -\$1,060,000 + \$150,000/(1 + IRR) + \$54,000/(1 + IRR)^2 + \$1,272,000/(1 + IRR)^3$

Using a spreadsheet, financial calculator, or trial and error to find the root of the equation, we find that:

Incremental IRR = 12.87%

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For investing-type projects, we accept the larger project when the incremental IRR is greater than the discount rate. Since the incremental IRR is greater than the required rate of return of 10 percent, we choose the dry prepeg. Note that this is not the choice when evaluating only the IRR of each project. The IRR decision rule is flawed because there is a scale problem. That is, the dry prepeg has a greater initial investment than does the solvent prepeg. This problem is corrected by calculating the IRR of the incremental cash flows, or by evaluating the NPV of each project.

21. *a.* The NPV of each project is:

$$NPV_{NP\text{-}30} = -\$1{,}320{,}000 + \$480{,}000/1.12 + \$470{,}000/1.12^2 + \$435{,}000/1.12^3 + \$415{,}000/1.12^4 + \$285{,}000/1.12^5$$
$$NPV_{NP\text{-}30} = \$218{,}333.62$$

$$NPV_{NX\text{-}20} = -\$910{,}000 + \$350{,}000/1.12 + \$350{,}000/1.12^2 + \$340{,}000/1.12^3 + \$325{,}000/1.12^4 + \$245{,}000/1.12^5$$
$$NPV_{NX\text{-}20} = \$269{,}086.10$$

The NPV criterion implies accepting the NX-20.

b. The IRR is the interest rate that makes the NPV of the project equal to zero, so the IRR of each project is:

NP-30:

$$0 = -\$1{,}320{,}000 + \$480{,}000/(1 + IRR) + \$470{,}000/(1 + IRR)^2 + \$435{,}000/(1 + IRR)^3 + \$415{,}000/(1 + IRR)^4 + \$285{,}000/(1 + IRR)^5$$

Using a spreadsheet, financial calculator, or trial and error to find the root of the equation, we find that:

$$IRR_{NP\text{-}30} = 18.99\%$$

And the IRR of the NX-20 is:

$$0 = -\$910{,}000 + \$350{,}000/(1 + IRR) + \$350{,}000/(1 + IRR)^2 + \$340{,}000/(1 + IRR)^3 + \$325{,}000/(1 + IRR)^4 + \$245{,}000/(1 + IRR)^5$$

Using a spreadsheet, financial calculator, or trial and error to find the root of the equation, we find that:

$$IRR_{NX\text{-}20} = 23.96\%$$

The IRR criterion implies accepting the NX-20.

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c. Incremental IRR analysis is not necessary. The NX-20 has a higher IRR and is relatively smaller in terms of investment, with a larger NPV. Nonetheless, we will calculate the incremental IRR. In calculating the incremental cash flows, we subtract the cash flows from the project with the smaller initial investment from the cash flows of the project with the larger initial investment, so the incremental cash flows are:

Year	Incremental cash flow
0	–$410,000
1	130,000
2	120,000
3	95,000
4	90,000
5	40,000

Setting the present value of these incremental cash flows equal to zero, we find the incremental IRR is:

$$0 = -\$410{,}000 + \$130{,}000/(1 + IRR) + \$120{,}000/(1 + IRR)^2 + \$95{,}000/(1 + IRR)^3 + \$90{,}000/(1 + IRR)^4 + \$40{,}000/(1 + IRR)^5$$

Using a spreadsheet, financial calculator, or trial and error to find the root of the equation, we find that:

Incremental IRR = 6.04%

For investing-type projects, accept the larger project when the incremental IRR is greater than the discount rate. Since the incremental IRR is less than the required rate of return of 12 percent, we reject the larger project and choose the NX-20.

d. The profitability index is the present value of all subsequent cash flows, divided by the initial investment, so the profitability index of each project is:

$$PI_{NP\text{-}30} = [\$480{,}000/1.12 + \$470{,}000/1.12^2 + \$435{,}000/1.12^3 + \$415{,}000/1.12^4 + \$285{,}000/1.12^5]/\$1{,}320{,}000$$
$$PI_{NP\text{-}30} = 1.165$$

$$PI_{NX\text{-}20} = [\$350{,}000/1.12 + \$350{,}000/1.12^2 + \$340{,}000/1.12^3 + \$325{,}000/1.12^4 + \$245{,}000/1.12^5]/\$910{,}000$$
$$PI_{NX\text{-}20} = 1.296$$

The PI criterion implies accepting the NX-20.

22. *a.* The NPV of each project is:

$$NPV_A = -\$1{,}030{,}000 + \$495{,}000/1.15 + \$495{,}000/1.15^2 + \$390{,}000/1.15^3 + \$295{,}000/1.15^4 + \$203{,}000/1.15^5$$
$$NPV_A = \$300{,}751.31$$

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$NPV_B = -\$1,725,000 + \$518,000/1.15 + \$565,000/1.15^2 + \$578,000/1.15^3 + \$783,000/1.15^4 + \$762,000/1.15^5$

$NPV_B = \$359,231.80$

The NPV criterion implies accepting Project B.

b. The IRR is the interest rate that makes the NPV of the project equal to zero, so the IRR of each project is:

Project A:

$0 = -\$1,030,000 + \$495,000/(1 + IRR) + \$495,000/(1 + IRR)^2 + \$390,000/(1 + IRR)^3 + \$295,000/(1 + IRR)^4 + \$203,000/(1 + IRR)^5$

Using a spreadsheet, financial calculator, or trial and error to find the root of the equation, we find that:

$IRR_A = 28.78\%$

And the IRR of Project B is:

$0 = -\$1,725,000 + \$518,000/(1 + IRR) + \$565,000/(1 + IRR)^2 + \$578,000/(1 + IRR)^3 + \$783,000/(1 + IRR)^4 + \$762,000/(1 + IRR)^5$

Using a spreadsheet, financial calculator, or trial and error to find the root of the equation, we find that:

$IRR_B = 22.82\%$

The IRR criterion implies accepting Project A.

c. In calculating the incremental cash flows, we subtract the cash flows from the project with the smaller initial investment from the cash flows of the project with the large initial investment, so the incremental cash flows are:

Year	Incremental cash flow
0	–$695,000
1	23,000
2	70,000
3	188,000
4	488,000
5	559,000

Setting the present value of these incremental cash flows equal to zero, we find the incremental IRR is:

$0 = -\$695,000 + \$23,000/(1 + IRR) + \$70,000/(1 + IRR)^2 + \$188,000/(1 + IRR)^3 + \$488,000/(1 + IRR)^4 + \$559,000/(1 + IRR)^5$

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Using a spreadsheet, financial calculator, or trial and error to find the root of the equation, we find that:

Incremental IRR = 17.36%

For investing-type projects, accept the larger project when the incremental IRR is greater than the discount rate. Since the incremental IRR is greater than the required rate of, choose Project B.

d. The profitability index is the present value of all subsequent cash flows, divided by the initial investment, so the profitability index of each project is:

$PI_A = [\$495,000/1.15 + \$495,000/1.15^2 + \$390,000/1.15^3 + \$295,000/1.15^4 + \$203,000/1.15^5]/\$1,030,000$
$PI_A = 1.292$

$PI_B = [\$518,000/1.15 + \$565,000/1.15^2 + \$578,000/1.15^3 + \$783,000/1.15^4 + \$762,000/1.15^5]/\$1,725,000$
$PI_B = 1.208$

The PI criterion implies accepting Project A.

Challenge

23. First, we need to find the future value of the cash flows for the one year in which they are blocked by the government. So, reinvesting each cash inflow for one year, we find:

Year 2 cash flow = \$560,000(1.04) = \$582,400
Year 3 cash flow = \$640,000(1.04) = \$665,600
Year 4 cash flow = \$535,000(1.04) = \$556,400
Year 5 cash flow = \$475,000(1.04) = \$494,000

So, the NPV of the project is:

$NPV = -\$1,750,000 + \$582,400/1.11^2 + \$665,600/1.11^3 + \$556,400/1.11^4 + \$494,000/1.11^5$
NPV = –\$130,947.24

And the IRR of the project is:

$0 = -\$1,750,000 + \$582,400/(1 + IRR)^2 + \$665,600/(1 + IRR)^3 + \$556,400/(1 + IRR)^4 + \$494,000/(1 + IRR)^5$

Using a spreadsheet, financial calculator, or trial and error to find the root of the equation, we find that:

IRR = 8.42%

While this may look like an MIRR calculation, it is not an MIRR, rather it is a standard IRR calculation. Since the cash inflows are blocked by the government, they are not available to the company for a period of one year. Thus, all we are doing is calculating the IRR based on when the cash flows actually occur for the company.

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24. Given the six-year payback, the worst case is that the payback occurs at the end of the sixth year. Thus, the worst case:

NPV = –$745,000 + $745,000/1.12^6
NPV = –$367,559.81

The best case has infinite cash flows beyond the payback point. Thus, the best-case NPV is infinite.

25. The equation for the IRR of the project is:

$0 = –\$2,016 + \$11,448/(1 + IRR) – \$24,280/(1 + IRR)^2 + \$22,800/(1 + IRR)^3 – \$8,000/(1 + IRR)^4$

Using Descartes rule of signs, from looking at the cash flows we know there are as many as four IRRs for this project. Even with most computer spreadsheets, we have to do some trial and error. From trial and error, IRRs of 25%, 33.33%, 42.86%, and 66.67% are found.

We would accept the project when the NPV is greater than zero. See for yourself if that the NPV is greater than zero for required returns between 25% and 33.33% or between 42.86% and 66.67%.

26. *a.* Here the cash inflows of the project grow at a constant rate forever, which is a growing perpetuity. So, the PV of the future cash flows from the project is:

PV of cash inflows = $C_1/(R – g)$
PV of cash inflows = $103,800/(.10 – .035)
PV of cash inflows = $1,596,923.08

NPV is the PV of the outflows minus by the PV of the inflows, so the NPV is:

NPV = –$1,550,000 + 1,596,923.08
NPV = $46,923.08

The NPV is positive, so we would accept the project.

b. Here we want to know the minimum growth rate in cash flows necessary to accept the project. The minimum growth rate is the growth rate at which we would have a zero NPV. The equation for a zero NPV, using the equation for the PV of a growing perpetuity is:

$0 = –\$1,550,000 + \$103,800/(.10 – g)$

Solving for g, we get:

g = .0330, or 3.30%

27. *a.* The project involves three cash flows: the initial investment, the annual cash inflows, and the abandonment costs. The mine will generate cash inflows over its 11-year economic life. To express the PV of the annual cash inflows, apply the growing annuity formula, discounted at the IRR and growing at 6 percent.

PV(Cash Inflows) = $C\{[1/(R – g)] – [1/(R – g)] \times [(1 + g)/(1 + R)]^t\}$
PV(Cash Inflows) = $605,000{[1/(IRR – .06)] – [1/(IRR – .06)] × [(1 + .06)/(1 + IRR)]^{11}}

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At the end of 11 years, the company will abandon the mine, incurring a $575,000 charge. Discounting the abandonment costs back 11 years at the IRR to express its present value, we get:

$$PV(\text{Abandonment}) = C_{11}/(1 + IRR)^{11}$$
$$PV(\text{Abandonment}) = -\$575{,}000/(1+ IRR)^{11}$$

So, the IRR equation for this project is:

$$0 = -\$3{,}500{,}000 + \$605{,}000\{[1/(IRR - .06)] - [1/(IRR - .06)] \times [(1 + .06)/(1 + IRR)]^{11}\} - \$575{,}000/(1 + IRR)^{11}$$

Using a spreadsheet or trial and error to find the root of the equation, we find that:

$$IRR = 17.28\%$$

b. Yes. Since the mine's IRR exceeds the required return of 13 percent, the mine should be opened. The correct decision rule for an investment-type project is to accept the project if the IRR is greater than the discount rate. Although it appears there is a sign change at the end of the project because of the abandonment costs, the last cash flow is actually positive because of the operating cash in the last year.

28. *a.* We can apply the growing perpetuity formula to find the PV of Project A. The perpetuity formula values the stream as of one year before the first payment. Therefore, the growing perpetuity formula values the stream of cash flows as of Year 2. Next, discount the PV as of the end of Year 2 back two years to find the PV as of today, Year 0. Doing so, we find:

$$PV(A) = [C_3/(R - g)]/(1 + R)^2$$
$$PV(A) = [\$7{,}000/(.12 - .03)]/(1.12)^2$$
$$PV(A) = \$62{,}003.97$$

We can apply the perpetuity formula to find the PV of Project B. The perpetuity formula discounts the stream back to Year 1, one period prior to the first cash flow. Discount the PV as of the end of Year 1 back one year to find the PV as of today, Year 0. Doing so, we find:

$$PV(B) = [C_2/R]/(1 + R)$$
$$PV(B) = [-\$8{,}000/.12]/(1.12)$$
$$PV(B) = -\$59{,}523.81$$

b. If we combine the cash flow streams to form Project C, we get:

$$\text{Project A} = [C_3/(R - g)]/(1 + R)^2$$

$$\text{Project B} = [C_2/R]/(1 + R)$$

$$\text{Project C} = \text{Project A} + \text{Project B}$$
$$\text{Project C} = [C_3/(R - g)]/(1 + R)^2 + [C_2/R]/(1 + R)$$
$$0 = [\$7{,}000/(IRR - .03)]/(1 + IRR)^2 + [-\$8{,}000/IRR]/(1 + IRR)$$

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Using a spreadsheet, financial calculator, or trial and error to find the root of the equation, we find that:

IRR = 13.21%

c. The correct decision rule for an investing-type project is to accept the project if the discount rate is below the IRR. Since there is one IRR, a decision can be made. At a point in the future, the cash flows from Project A will be greater than those from Project B. Therefore, although there are many cash flows, there will be only one change in sign. When the sign of the cash flows changes more than once over the life of the project, there may be multiple internal rates of return. In such cases, there is no correct decision rule for accepting and rejecting projects using the internal rate of return.

29. To answer this question, we need to examine the incremental cash flows. To make the projects equally attractive, Project Billion must have a larger initial investment. We know this because the subsequent cash flows from Project Billion are larger than the subsequent cash flows from Project Million. So, subtracting the Project Million cash flows from the Project Billion cash flows, we find the incremental cash flows are:

Year	Incremental cash flows
0	–I + $1,500
1	300
2	300
3	500

Now we can find the present value of the subsequent incremental cash flows at the discount rate, 12 percent. The present value of the incremental cash flows is:

PV = $1,500 + $300/1.12 + $300/$1.12^2$ + $500/$1.12^3$
PV = $2,362.91

So, if I_0 is greater than $2,362.91, the incremental cash flows will be negative. Since we are subtracting Project Million from Project Billion, this implies that for any value over $2,362.91 the NPV of Project Billion will be less than that of Project Million, so I_0 must be less than $2,362.91.

30. The IRR is the interest rate that makes the NPV of the project equal to zero. So, the IRR of the project is:

0 = $50,000 – $61,000/(1 + IRR) + $41,000/$(1 + IRR)^2$

Even though it appears there are two IRRs, a spreadsheet, financial calculator, or trial and error will not give an answer. The reason is that there is no real IRR for this set of cash flows. If you examine the IRR equation, what we are really doing is solving for the roots of the equation. Going back to high school algebra, in this problem we are solving a quadratic equation. In case you don't remember, the quadratic equation is:

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

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In this case, the equation is:

$$x = \frac{-(-61{,}000) \pm \sqrt{(-61{,}000)^2 - 4(50{,}000)(41{,}000)}}{2(50{,}000)}$$

The square root term works out to be:

3,721,000,000 – 8,200,000,000 = –4,479,000,000

The square root of a negative number is a complex number, so there is no real number solution, meaning the project has no real IRR.

Calculator Solutions

1. *b.*

Project A

CFo	–$30,600
C01	$15,400
F01	1
C02	$15,600
F02	1
C03	$6,200
F03	1

I = 15%
NPV CPT
–$1,336.25

Project B

CFo	–$21,400
C01	$10,600
F01	1
C02	$8,600
F02	1
C03	$9,600
F03	1

I = 15%
NPV CPT
$632.38

7.

CFo	–$20,300
C01	$9,600
F01	1
C02	$13,700
F02	1
C03	$5,800
F03	1

IRR CPT
21.89%

8.

Project A

CFo	–$8,100
C01	$2,900
F01	1
C02	$4,600
F02	1
C03	$3,100
F03	1

IRR CPT
14.55%

Project B

CFo	–$5,400
C01	$2,200
F01	1
C02	$2,700
F02	1
C03	$2,300
F03	1

IRR CPT
15.74%

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9.

CFo	0
C01	$62,000
F01	7

I = 15%
NPV CPT
$257,946.02

PI = $257,946.02/$187,000 = 1.379

12.

CFo	$15,900
C01	–$5,900
F01	1
C02	–$5,700
F02	1
C03	–$4,900
F03	1
C04	–$4,100
F04	1

IRR CPT
12.02%

CFo	$15,900
C01	–$5,900
F01	1
C02	–$5,700
F02	1
C03	–$4,900
F03	1
C04	–$4,100
F04	1

I = 10%
NPV CPT
–$656.18

CFo	$15,900
C01	–$5,900
F01	1
C02	–$5,700
F02	1
C03	–$4,900
F03	1
C04	–$4,100
F04	1

I = 20%
NPV CPT
$2,212.11

13. *a.* *Deepwater fishing*

CFo	–$918,000
C01	$495,000
F01	1
C02	$450,000
F02	1
C03	$370,000
F03	1

IRR CPT
21.54%

Submarine ride

CFo	–$1,815,000
C01	$1,150,000
F01	1
C02	$742,000
F02	1
C03	$575,000
F03	1

IRR CPT
19.65%

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b.

CF0	–$897,000
C01	$655,000
F01	1
C02	$292,000
F02	1
C03	$205,000
F03	1

IRR CPT
17.35%

c.

Deepwater fishing

CF0	–$918,000
C01	$495,000
F01	1
C02	$450,000
F02	1
C03	$370,000
F03	1

I = 15%
NPV CPT
$95,980.44

Submarine ride

CF0	–$1,815,000
C01	$1,150,000
F01	1
C02	$742,000
F02	1
C03	$575,000
F03	1

I = 15%
NPV CPT
$124,130.43

14. *Project I*

CF0	$0
C01	$39,000
F01	3

I = 10%
NPV CPT
$96,987.23

CF0	–$75,000
C01	$39,000
F01	3

I = 10%
NPV CPT
$21,987.23

PI = $96,987.23/$75,000 = 1.293

Project II

CF0	$0
C01	$24,000
F01	3

I = 10%
NPV CPT
$59,684.45

CF0	–$42,000
C01	$24,000
F01	3

I = 10%
NPV CPT
$17,684.45

PI = $59,684.45/$42,000 = 1.421

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15.

CFo	–$63,000,000
C01	$89,000,000
F01	1
C02	–$11,000,000
F02	1

I = 10%
NPV CPT
$8,818,181.82

CFo	–$63,000,000
C01	$89,000,000
F01	1
C02	–$11,000,000
F02	1

IRR CPT
27.58%

Financial calculators will only give you one IRR, even if there are multiple IRRs. Using trial and error, or a root-solving calculator, the other IRR is –86.31%.

16. *b.*

Board game

CFo	–$380,000
C01	$292,000
F01	1
C02	$165,000
F02	1
C03	$107,000
F03	1

I = 10%
NPV CPT
$102,208.87

PC game

CFo	–$625,000
C01	$396,000
F01	1
C02	$319,000
F02	1
C03	$204,000
F03	1

I = 10%
NPV CPT
$151,904.58

c.

Board game

CFo	–$380,000
C01	$292,000
F01	1
C02	$165,000
F02	1
C03	$107,000
F03	1

IRR CPT
27.97%

PC game

CFo	–$625,000
C01	$396,000
F01	1
C02	$319,000
F02	1
C03	$204,000
F03	1

IRR CPT
25.05%

d.

CFo	–$245,000
C01	$104,000
F01	1
C02	$154,000
F02	1
C03	$97,000
F03	1

IRR CPT
21.23%

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17. *a.*

L6		*G5*		*Wi-Fi*	
CFo	0	**CFo**	0	**CFo**	0
C01	$15,000,000	**C01**	$23,000,000	**C01**	$23,000,000
F01	1	**F01**	1	**F01**	1
C02	$13,000,000	**C02**	$29,000,000	**C02**	$42,000,000
F02	1	**F02**	1	**F02**	1
C03	$9,000,000	**C03**	$21,000,000	**C03**	$39,000,000
F03	1	**F03**	1	**F03**	1
I = 10%		I = 10%		I = 10%	
NPV CPT		NPV CPT		NPV CPT	
$31,141,998.50		$60,653,643.88		$84,921,111.95	

PI_{L6} = $31,141,998.50/$20,000,000 = 1.56
PI_{G5} = $60,653,643.88/$35,000,000 = 1.73
$PI_{Wi\text{-}Fi}$ = $84,921,111.95/$55,000,000 = 1.54

b.

L6		*G5*		*Wi-Fi*	
CFo	–$20,000,000	**CFo**	–$35,000,000	**CFo**	–$55,000,000
C01	$15,000,000	**C01**	$23,000,000	**C01**	$23,000,000
F01	1	**F01**	1	**F01**	1
C02	$13,000,000	**C02**	$29,000,000	**C02**	$42,000,000
F02	1	**F02**	1	**F02**	1
C03	$9,000,000	**C03**	$21,000,000	**C03**	$39,000,000
F03	1	**F03**	1	**F03**	1
I = 10%		I = 10%		I = 10%	
NPV CPT		NPV CPT		NPV CPT	
$11,141,998.50		$25,653,643.88		$29,921,111.95	

18. *b.*

AZM		*AZF*	
CFo	–$525,000	**CFo**	–$810,000
C01	$290,000	**C01**	$410,000
F01	1	**F01**	1
C02	$245,000	**C02**	$390,000
F02	1	**F02**	1
C03	$185,000	**C03**	$350,0000
F03	1	**F03**	1
I = 10%		I = 10%	
NPV CPT		NPV CPT	
$80,108.94		$148,001.50	

c.

AZM		*AZF*	
CFo	–$525,000	**CFo**	–$810,000
C01	$290,000	**C01**	$410,000
F01	1	**F01**	1
C02	$245,000	**C02**	$390,000
F02	1	**F02**	1
C03	$185,000	**C03**	$350,0000
F03	1	**F03**	1
IRR CPT		IRR CPT	
19.19%		20.41%	

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19. *a.*

Project A		*Project B*		*Project C*	
CFo	0	**CFo**	0	**CFo**	0
C01	$203,000	**C01**	$360,000	**C01**	$210,000
F01	2	**F01**	2	**F01**	1
C02		**C02**		**C02**	$185,000
F02		**F02**		**F02**	1
I = 12%		I = 12%		I = 12%	
NPV CPT		NPV CPT		NPV CPT	
$343,080.36		$608,418.37		$334,980.87	

PI_A = $343,080.36/$300,000 = 1.144
PI_B = $608,418.37/$525,000 = 1.159
PI_C = $334,980.87/$300,000 = 1.117

b.

Project A		*Project B*		*Project C*	
CFo	–$300,000	**CFo**	–$525,000	**CFo**	–$300,000
C01	$203,000	**C01**	$360,000	**C01**	$210,000
F01	2	**F01**	2	**F01**	1
C02		**C02**		**C02**	$185,000
F02		**F02**		**F02**	1
I = 12%		I = 12%		I = 12%	
NPV CPT		NPV CPT		NPV CPT	
$43,080.36		$83,418.37		$34,980.87	

d.

Project B – A	
CFo	0
C01	$157,000
F01	2
C02	
F02	
I = 12%	
NPV CPT	
$265,338.01	

PI(B – A) = $265,338.01/$225,000 = 1.179

20. *b.*

Dry prepeg		*Solvent prepeg*	
CFo	–$2,160,000	**CFo**	–$1,100,000
C01	$828,000	**C01**	$678,000
F01	1	**F01**	1
C02	$546,000	**C02**	$492,000
F02	1	**F02**	1
C03	$1,680,000	**C03**	$408,0000
F03	1	**F03**	1
I = 10%		I = 10%	
NPV CPT		NPV CPT	
$306,175.81		$229,511.65	

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c.

Dry prepeg

CFo	–$2,160,000
C01	$828,000
F01	1
C02	$546,000
F02	1
C03	$1,680,000
F03	1

IRR CPT
16.89%

Solvent prepeg

CFo	–$1,100,000
C01	$678,000
F01	1
C02	$492,000
F02	1
C03	$408,000
F03	1

IRR CPT
22.71%

d.

CFo	–$1,060,000
C01	$150,000
F01	1
C02	$54,000
F02	1
C03	$1,272,000
F03	1

IRR CPT
12.87%

21. *a.*

NP-30

CFo	–$1,320,000
C01	$480,000
F01	1
C02	$470,000
F02	1
C03	$435,000
F03	1
C04	$415,000
F04	1
C05	$285,000
F05	1

I = 12%
NPV CPT
$218,333.62

NX-20

CFo	–$910,000
C01	$350,000
F01	2
C02	$350,000
F02	1
C03	$340,000
F03	1
C04	$325,000
F04	1
C05	$245,000
F05	1

I = 12%
NPV CPT
$269,086.10

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b.

NP-30		*NX-20*	
CF0	–$1,320,000	**CF0**	–$910,000
C01	$480,000	**C01**	$350,000
F01	1	**F01**	2
C02	$470,000	**C02**	$350,000
F02	1	**F02**	1
C03	$435,000	**C03**	$340,000
F03	1	**F03**	1
C04	$415,000	**C04**	$325,000
F04	1	**F04**	1
C05	$285,000	**C05**	$245,000
F05	1	**F05**	1
IRR CPT		IRR CPT	
18.99%		23.96%	

c.

CF0	–$410,000
C01	$130,000
F01	1
C02	$120,000
F02	1
C03	$95,000
F03	1
C04	$90,000
F04	1
C05	$40,000
F05	1
IRR CPT	
6.04%	

d.

NP-30		*NX-20*	
CF0	0	**CF0**	0
C01	$480,000	**C01**	$350,000
F01	1	**F01**	2
C02	$470,000	**C02**	$350,000
F02	1	**F02**	1
C03	$435,000	**C03**	$340,000
F03	1	**F03**	1
C04	$415,000	**C04**	$325,000
F04	1	**F04**	1
C05	$285,000	**C05**	$245,000
F05	1	**F05**	1
I = 12%		I = 12%	
NPV CPT		NPV CPT	
$1,538,333.62		$1,179,086.10	

$PI_{NP\text{-}30}$ = $1,538,333.62/$1,320,000 = 1.165
$PI_{NX\text{-}20}$ = $1,179,086.10/$910,000 = 1.296

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22. *a.*

Project A		*Project B*	
CFo	–$1,030,000	**CFo**	–$1,725,000
C01	$495,000	**C01**	$518,000
F01	2	**F01**	1
C02	$390,000	**C02**	$565,000
F02	1	**F02**	1
C03	$295,000	**C03**	$578,000
F03	1	**F03**	1
C04	$203,000	**C04**	$783,000
F04	1	**F04**	1
C05		**C05**	$762,000
F05		**F05**	1
I = 15%		I = 15%	
NPV CPT		NPV CPT	
$300,751.31		$359,231.80	

b.

Project A		*Project B*	
CFo	–$1,030,000	**CFo**	–$1,725,000
C01	$495,000	**C01**	$518,000
F01	2	**F01**	1
C02	$390,000	**C02**	$565,000
F02	1	**F02**	1
C03	$295,000	**C03**	$578,000
F03	1	**F03**	1
C04	$203,000	**C04**	$783,000
F04	1	**F04**	1
C05		**C05**	$762,000
F05		**F05**	1
IRR CPT		I = 15%	
28.78%		22.82%	

c.

CFo	–$695,000
C01	$23,000
F01	1
C02	$70,000
F02	1
C03	$188,000
F03	1
C04	$488,000
F04	1
C05	$559,000
F05	1
IRR CPT	
17.36%	

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d.

Project A		*Project B*	
CFo	0	**CFo**	0
C01	$495,000	**C01**	$518,000
F01	2	**F01**	1
C02	$390,000	**C02**	$565,000
F02	1	**F02**	1
C03	$295,000	**C03**	$578,000
F03	1	**F03**	1
C04	$203,000	**C04**	$783,000
F04	1	**F04**	1
C05		**C05**	$762,000
F05		**F05**	1
I = 15%		I = 15%	
NPV CPT		NPV CPT	
$1,330,751.31		$2,084,231.80	

PI_A = $1,330,751.31/$1,030,000 = 1.292
PI_B = $2,084,231.80/$1,725,000 = 1.208

30.

CFo	$50,000
C01	–$61,000
F01	1
C02	$41,000
F02	1
IRR CPT	
ERROR 7	

CHAPTER 8
MAKING CAPITAL INVESTMENT DECISIONS

Answers to Concept Questions

1. In this context, an opportunity cost refers to the value of an asset or other input that will be used in a project. The relevant cost is what the asset or input is actually worth today, not, for example, what it cost to acquire it.

2. *a.* Yes, the reduction in the sales of the company's other products, referred to as erosion, should be treated as an incremental cash flow. These lost sales are included because they are a cost (a revenue reduction) that the firm must bear if it chooses to produce the new product.

b. Yes, expenditures on plant and equipment should be treated as incremental cash flows. These are costs of the new product line. However, if these expenditures have already occurred (and cannot be recaptured through a sale of the plant and equipment), they are sunk costs and are not included as incremental cash flows.

c. No, the research and development costs should not be treated as incremental cash flows. The costs of research and development undertaken on the product during the past three years are sunk costs and should not be included in the evaluation of the project. Decisions made and costs incurred in the past cannot be changed. They should not affect the decision to accept or reject the project.

d. Yes, the annual depreciation expense must be taken into account when calculating the cash flows related to a given project. While depreciation is not a cash expense that directly affects cash flow, it decreases a firm's net income and hence, lowers its tax bill for the year. Because of this depreciation tax shield, the firm has more cash on hand at the end of the year than it would have had without expensing depreciation.

e. No, dividend payments should not be treated as incremental cash flows. A firm's decision to pay or not pay dividends is independent of the decision to accept or reject any given investment project. For this reason, dividends are not an incremental cash flow to a given project. Dividend policy is discussed in more detail in later chapters.

f. Yes, the resale value of plant and equipment at the end of a project's life should be treated as an incremental cash flow. The price at which the firm sells the equipment is a cash inflow, and any difference between the book value of the equipment and its sale price will create accounting gains or losses that result in either a tax credit or liability.

g. Yes, salary and medical costs for production employees hired for a project should be treated as incremental cash flows. The salaries of all personnel connected to the project must be included as costs of that project.

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3. Item *a* is a relevant cost because the opportunity to sell the land is lost if the new golf club is produced. Item *b* is also relevant because the firm must take into account the erosion of sales of existing products when a new product is introduced. If the firm produces the new club, the earnings from the existing clubs will decrease, effectively creating a cost that must be included in the decision. Item *c* is not relevant because the costs of research and development are sunk costs. Decisions made in the past cannot be changed. They are not relevant to the production of the new clubs.

4. For tax purposes, a firm would choose MACRS because it provides for larger depreciation deductions earlier. These larger deductions reduce taxes but have no other cash consequences. Notice that the choice between MACRS and straight-line is purely a time value issue; the total depreciation is the same; only the timing differs.

5. It's probably only a mild over-simplification. Current liabilities will all be paid, presumably. The cash portion of current assets will be retrieved. Some receivables won't be collected, and some inventory will not be sold, of course. Counterbalancing these losses is the fact that inventory sold above cost (and not replaced at the end of the project's life) acts to increase working capital. These effects tend to offset one another.

6. Management's discretion to set the firm's capital structure is applicable at the firm level. Since any one particular project could be financed entirely with equity, another project could be financed with debt, and the firm's overall capital structure would remain unchanged, financing costs are not relevant in the analysis of a project's incremental cash flows according to the stand-alone principle.

7. The EAC approach is appropriate when comparing mutually exclusive projects with different lives that will be replaced when they wear out. This type of analysis is necessary so that the projects have a common life span over which they can be compared. For example, if one project has a three-year life and the other has a five-year life, then a 15-year horizon is the minimum necessary to place the two projects on an equal footing, implying that one project will be repeated five times and the other will be repeated three times. Note the shortest common life may be quite long when there are more than two alternatives and/or the individual project lives are relatively long. Assuming this type of analysis is valid implies that the project cash flows remain the same over the common life, thus ignoring the possible effects of, among other things: (1) inflation, (2) changing economic conditions, (3) the increasing unreliability of cash flow estimates that occur far into the future, and (4) the possible effects of future technology improvement that could alter the project cash flows.

8. Depreciation is a non-cash expense, but it is tax-deductible on the income statement. Thus, depreciation causes taxes paid, an actual cash outflow, to be reduced by an amount equal to the depreciation tax shield, $T_C D$. A reduction in taxes that would otherwise be paid is the same thing as a cash inflow, so the effects of the depreciation tax shield must be added in to get the total incremental aftertax cash flows.

9. There are two particularly important considerations. The first is erosion. Will the "essentialized" book displace copies of the existing book that would have otherwise been sold? This is of special concern given the lower price. The second consideration is competition. Will other publishers step in and produce such a product? If so, then any erosion is much less relevant. A particular concern to book publishers (and producers of a variety of other product types) is that the publisher only makes money from the sale of new books. Thus, it is important to examine whether the new book would displace sales of used books (good from the publisher's perspective) or new books (not good). This concern arises any time there is an active market for used product.

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10. Definitely. The damage to Porsche's reputation is a factor the company needed to consider. If the reputation was damaged, the company would have lost sales of its existing car lines.

11. One company may be able to produce at lower incremental cost or market better. Also, of course, one of the two may have made a mistake!

12. Porsche would recognize that the outsized profits would dwindle as more products come to market and competition becomes more intense.

Solutions to Questions and Problems

NOTE: All end-of-chapter problems were solved using a spreadsheet. Many problems require multiple steps. Due to space and readability constraints, when these intermediate steps are included in this solutions manual, rounding may appear to have occurred. However, the final answer for each problem is found without rounding during any step in the problem.

Basic

1. Using the tax shield approach to calculating OCF, we get:

$$\text{OCF} = (\text{Sales} - \text{Costs})(1 - T_C) + T_C\text{Depreciation}$$
$$\text{OCF} = [2{,}300(\$7 - 2)](1 - .21) + .21(\$37{,}000/6)$$
$$\text{OCF} = \$10{,}380$$

So, the NPV of the project is:

$$\text{NPV} = -\$37{,}000 + \$10{,}380(\text{PVIFA}_{14\%,6})$$
$$\text{NPV} = \$3{,}364.37$$

Since the NPV is positive, the company should accept the project.

2. We will use the bottom-up approach to calculate the operating cash flow for each year. We also must be sure to include the net working capital cash flows each year. So, the total cash flow each year will be:

		Year 1	Year 2	Year 3	Year 4
Sales		$14,200	$15,900	$15,700	$12,900
Costs		2,100	2,100	2,100	2,100
Depreciation		8,200	8,200	8,200	8,200
EBT		$3,900	$5,600	$5,400	$2,600
Tax		858	1,232	1,188	572
Net income		$3,042	$4,368	$4,212	$2,028
OCF	-	$11,242	$12,568	$12,412	$10,228
Capital spending	–$32,800				
NWC	–450	–175	–250	–275	1,150
Incremental cash flow	–$33,250	$11,067	$12,318	$12,137	$11,378

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The NPV for the project is:

$NPV = –\$33,250 + \$11,067/1.12 + \$12,318/1.12^2 + \$12,137/1.12^3 + \$11,378/1.12^4$
$NPV = \$2,320.89$

3. Using the tax shield approach to calculating OCF, we get:

$OCF = (Sales – Costs)(1 – T_C) + T_C Depreciation$
$OCF = (\$3,070,000 – 1,510,000)(1 – .21) + .21(\$3,750,000/3)$
$OCF = \$1,494,900$

So, the NPV of the project is:

$NPV = –\$3,750,000 + \$1,494,900(PVIFA_{10\%,3})$
$NPV = –\$32,404.96$

4. The cash outflow at the beginning of the project will increase because of the spending on NWC. At the end of the project, the company will recover the NWC, so it will be a cash inflow. The sale of the equipment will result in a cash inflow, but we also must account for the taxes which will be paid on this sale. So, the cash flows for each year of the project will be:

Year	Cash Flow	
0	–\$4,200,000	= –\$3,750,000 – 450,000
1	1,494,900	
2	1,494,900	
3	2,399,150	= \$1,494,900 + 450,000 + 575,000 + (\$0 – 575,000)(.21)

And the NPV of the project is:

$NPV = –\$4,200,000 + \$1,494,900(PVIFA_{10\%,2}) + (\$2,399,150/1.10^3)$
$NPV = \$196,971.45$

5. First, we will calculate the annual depreciation for the equipment necessary for the project. The depreciation amount each year will be:

Year 1 depreciation = \$3,750,000(.3333) = \$1,249,875
Year 2 depreciation = \$3,750,000(.4445) = \$1,666,875
Year 3 depreciation = \$3,750,000(.1481) = \$555,375

So, the book value of the equipment at the end of three years, which will be the initial investment minus the accumulated depreciation, is:

Book value in 3 years = \$3,750,000 – (\$1,249,875 + 1,666,875 + 555,375)
Book value in 3 years = \$277,875

The asset is sold at a gain to book value, so this gain is taxable.

Aftertax salvage value = \$575,000 + (\$277,875 – 575,000)(.21)
Aftertax salvage value = \$512,604

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To calculate the OCF, we will use the tax shield approach, so the cash flow each year is:

OCF = (Sales – Costs)(1 – T_C) + T_CDepreciation

Year	Cash Flow	
0	–$4,200,000	= –$3,750,000 – 450,000
1	1,494,873.75	= $1,560,000(.79) + .21($1,249,875)
2	1,582,443.75	= $1,560,000(.79) + .21($1,666,875)
3	2,311,632.50	= $1,560,000(.79) + .21($555,375) + $450,000 + 512,604

Remember to include the NWC cost in Year 0, and the recovery of the NWC at the end of the project. The NPV of the project with these assumptions is:

NPV = –$4,200,000 + ($1,494,873.75/1.10) + ($1,582,443.75/$1.10^2$) + ($2,311,632.50/1.10^3)
NPV = $203,544.60

6. The book value of the equipment at the end of three years is zero, so the aftertax salvage value is:

Aftertax salvage value = $575,000 + ($0 – 575,000)(.21)
Aftertax salvage value = $454,250

To calculate the OCF, we will use the tax shield approach, so the cash flow each year is:

OCF = (Sales – Costs)(1 – T_C) + T_C(Depreciation)

Year	Cash Flow	
0	–$4,200,000	= –$3,750,000 – 450,000
1	2,019,900	= $1,560,000(.79) + .21($3,750,000)
2	1,232,400	= $1,560,000(.79)
3	2,136,650	= $1,560,000(.79) + $450,000 + 454,250

Remember to include the NWC cost in Year 0, and the recovery of the NWC at the end of the project. The NPV of the project with these assumptions is:

NPV = –$4,200,000 + ($2,019,900/1.12) + ($1,232,400/$1.12^2$) + ($2,136,650/1.12^3)
NPV = $260,081.89

7. First, we will calculate the annual depreciation of the new equipment. It will be:

Annual depreciation charge = $655,000/5
Annual depreciation charge = $131,000

The aftertax salvage value of the equipment is:

Aftertax salvage value = $60,000(1 – .22)
Aftertax salvage value = $46,800

Using the tax shield approach, the OCF is:

OCF = $215,000(1 – .22) + .22($131,000)
OCF = $196,520

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Now we can find the project IRR. There is an unusual feature that is a part of this project. Accepting this project means that we will reduce NWC. This reduction in NWC is a cash inflow at Year 0. This reduction in NWC implies that when the project ends, we will have to increase NWC. So, at the end of the project, we will have a cash outflow to restore the NWC to its level before the project. We also must include the aftertax salvage value at the end of the project. The IRR of the project is:

$NPV = 0 = -\$655{,}000 + 45{,}000 + \$196{,}520(PVIFA_{IRR\%,5}) + [(\$46{,}800 - 45{,}000)/(1 + IRR)^5]$

IRR = 18.39%

8. First, we will calculate the annual depreciation of the new equipment. It will be:

Annual depreciation = \$304,000/5
Annual depreciation = \$60,800

Now, we calculate the aftertax salvage value. The aftertax salvage value is the market price minus (or plus) the taxes on the sale of the equipment, so:

Aftertax salvage value = $MV + (BV - MV)T_C$

Very often, the book value of the equipment is zero as it is in this case. If the book value is zero, the equation for the aftertax salvage value becomes:

Aftertax salvage value = $MV + (0 - MV)T_C$
Aftertax salvage value = $MV(1 - T_C)$

We will use this equation to find the aftertax salvage value since we know the book value is zero. So, the aftertax salvage value is:

Aftertax salvage value = \$30,000(1 – .23)
Aftertax salvage value = \$23,100

Using the tax shield approach, we find the OCF for the project is:

OCF = \$116,000(1 – .23) + .23(\$60,800)
OCF = \$103,304

Now we can find the project NPV. Notice that we include the NWC in the initial cash outlay. The recovery of the NWC occurs in Year 5, along with the aftertax salvage value.

$NPV = -\$304{,}000 - 15{,}000 + \$103{,}304(PVIFA_{10\%,5}) + [(\$23{,}100 + 15{,}000)/1.10^5]$
NPV = \$96,260.54

9. Very often the book value of the equipment is zero and it is always zero with 100 percent bonus depreciation. If the book value is zero, the equation for the aftertax salvage value becomes:

Aftertax salvage value = $MV + (0 - MV)T_C$
Aftertax salvage value = $MV(1 - T_C)$

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We will use this equation to find the aftertax salvage value since we know the book value is zero. So, the aftertax salvage value is:

Aftertax salvage value = $30,000(1 – .23)
Aftertax salvage value = $23,100

Using the tax shield approach, we find the OCF for Year 1 is:

OCF = $116,000(1 – .23) + .23($304,000)
OCF = $159,240

And the OCF for Years 2 through 5 is:

OCF = $116,000(1 – .23)
OCF = $89,320

Now we can find the project NPV. Notice we include the NWC in the initial cash outlay. The recovery of the NWC occurs in Year 5, along with the aftertax salvage value.

$$NPV = -\$304,000 - 15,000 + \$159,240/1.10 + \$89,320/1.10^2 + \$89,320/1.10^3 + \$89,320/1.10^4 + (\$89,320 + 23,100 + 15,000)/1.10^5$$
NPV = $106,813.81

10. To find the BV at the end of four years, we need to find the accumulated depreciation for the first four years. We could calculate a table with the depreciation each year, but an easier way is to add the MACRS depreciation amounts for each of the first four years and multiply this percentage times the cost of the asset. We can then subtract this from the asset cost. Doing so, we get:

BV_4 = $8,950,000 – 8,950,000(.2000 + .3200 + .1920 + .1152)
BV_4 = $1,546,560

The asset is sold at a gain to book value, so this gain is taxable.

Aftertax salvage value = $1,960,000 + ($1,546,560 – 1,960,000)(.24)
Aftertax salvage value = $1,860,774

11. We will begin by calculating the initial cash outlay, that is, the cash flow at Year 0. To undertake the project, we will have to purchase the equipment and increase net working capital. So, the cash outlay today for the project will be:

Equipment	–$3,570,000
NWC	–575,000
Total	–$4,145,000

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Using the bottom-up approach to calculating the operating cash flow, we find the operating cash flow each year will be:

Sales	$1,950,000
Costs	585,000
Depreciation	892,500
EBT	$472,500
Tax	99,225
Net income	$373,275

The operating cash flow is:

OCF = Net income + Depreciation
OCF = $373,275 + 892,500
OCF = $1,265,775

To find the NPV of the project, we add the present value of the project cash flows. We must be sure to add back the net working capital at the end of the project life, since we are assuming the net working capital will be recovered. So, the project NPV is:

NPV = –$4,145,000 + $1,265,775(PVIFA$_{14\%,4}$) + $575,000/1.14^4
NPV = –$116,449.65

12. We will need the aftertax salvage value of the equipment to compute the EAC. Even though the equipment for each product has different initial costs, both have the same salvage value. The aftertax salvage value for both is:

Aftertax salvage value = $76,000(1 – .21) = $60,040

To calculate the EAC, we first need the OCF and PV of costs of each option. The OCF and PV of costs for Techron I are:

OCF = –$90,000(1 – .21) + .21($490,000/3) = –$36,800

PV of costs = –$490,000 – $36,800(PVIFA$_{14\%,3}$) + ($60,040/1.14^3) = –$534,910.77

EAC = –$534,910.77/(PVIFA$_{14\%,3}$) = –$230,402.91

And the OCF and PV of costs for Techron II are:

OCF = –$97,000(1 – .21) + .21($620,000/5) = –$50,590

PV of costs = –$620,000 – $50,590(PVIFA$_{14\%,5}$) + ($60,040/1.14^5) = –$762,496.67

EAC = –$762,496.67/(PVIFA$_{14\%,5}$) = –$222,102.73

The two milling machines have unequal lives, so they can only be compared by expressing both on an equivalent annual basis, which is what the EAC method does. Thus, you prefer the Techron II because it has the lower (less negative) annual cost.

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Intermediate

13. First, we will calculate the depreciation each year, which will be:

$\text{Depreciation}_1 = \$530{,}000(.2000) = \$106{,}000$
$\text{Depreciation}_2 = \$530{,}000(.3200) = \$169{,}600$
$\text{Depreciation}_3 = \$530{,}000(.1920) = \$101{,}760$
$\text{Depreciation}_4 = \$530{,}000(.1152) = \$61{,}056$

The book value of the equipment at the end of the project is:

$BV_4 = \$530{,}000 - (\$106{,}000 + 169{,}600 + 101{,}760 + 61{,}056) = \$91{,}584$

The asset is sold at a loss to book value, so this creates a tax refund.

Aftertax salvage value = $\$45{,}000 + (\$91{,}584 - 45{,}000)(.21) = \$54{,}783$

So, the OCF for each year will be:

$OCF_1 = \$192{,}000(1 - .21) + .21(\$106{,}000) = \$173{,}940$
$OCF_2 = \$192{,}000(1 - .21) + .21(\$192{,}000) = \$187{,}296$
$OCF_3 = \$192{,}000(1 - .21) + .21(\$101{,}760) = \$173{,}050$
$OCF_4 = \$192{,}000(1 - .21) + .21(\$61{,}056) = \$164{,}502$

Now we have all the necessary information to calculate the project NPV. We need to be careful with the NWC in this project. Notice the project requires $15,000 of NWC at the beginning, and $4,000 more in NWC each successive year. We will subtract the $15,000 from the initial cash flow and subtract $4,000 each year from the OCF to account for this spending. In Year 4, we will add back the total spent on NWC, which is $27,000. The $4,000 spent on NWC capital during Year 4 is irrelevant. Why? Well, during this year the project required an additional $4,000, but we would get the money back immediately. So, the net cash flow for additional NWC would be zero. With all this, the equation for the NPV of the project is:

$$NPV = -\$530{,}000 - 15{,}000 + (\$173{,}940 - 4{,}000)/1.09 + (\$187{,}296 - 4{,}000)/1.09^2 + (\$173{,}050 - 4{,}000)/1.09^3 + (\$164{,}502 + 27{,}000 + 54{,}783)/1.09^4$$
$$NPV = \$70{,}196.22$$

14. The book value of the equipment at the end of the project is zero, so the aftertax salvage value will be:

Aftertax salvage value = $\$45{,}000 + (\$0 - 45{,}000)(.21)$
Aftertax salvage value = $\$35{,}550$

So, the OCF for each year will be:

$OCF_1 = \$192{,}000(1 - .21) + .21(\$530{,}000) = \$262{,}980$
$OCF_2 = \$192{,}000(1 - .21) = \$151{,}680$
$OCF_3 = \$192{,}000(1 - .21) = \$151{,}680$
$OCF_4 = \$192{,}000(1 - .21) = \$151{,}680$

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Now we have all the necessary information to calculate the project NPV. We need to be careful with the NWC in this project. Notice the project requires $15,000 of NWC at the beginning, and $4,000 more in NWC each successive year. We will subtract the $15,000 from the initial cash flow and subtract $4,000 each year from the OCF to account for this spending. In Year 4, we will add back the total spent on NWC, which is $27,000. The $4,000 spent on NWC capital during Year 4 is irrelevant. Why? Well, during this year the project required an additional $4,000, but we would get the money back immediately. So, the net cash flow for additional NWC would be zero. With all this, the equation for the NPV of the project is:

$$NPV = -\$530,000 - 15,000 + (\$262,980 - 4,000)/1.09 + (\$151,680 - 4,000)/1.09^2 + (\$151,680 - 4,000)/1.09^3 + (\$151,680 + 27,000 + 35,550)/1.09^4$$
$$NPV = \$82,697.62$$

15. If we are trying to decide between two projects that will not be replaced when they wear out, the proper capital budgeting method to use is NPV. Both projects only have costs associated with them, not sales, so we will use these to calculate the NPV of each project. Using the tax shield approach to calculate the OCF, the NPV of System A is:

$$OCF_A = -\$145,000(1 - .25) + .25(\$520,000/4)$$
$$OCF_A = -\$76,250$$

$$NPV_A = -\$520,000 - \$76,250(PVIFA_{11\%,4})$$
$$NPV_A = -\$756,561.48$$

And the NPV of System B is:

$$OCF_B = -\$123,000(1 - .25) + .25(\$695,000/6)$$
$$OCF_B = -\$63,292$$

$$NPV_B = -\$695,000 - \$63,292(PVIFA_{11\%,6})$$
$$NPV_B = -\$962,757.79$$

If the system will not be replaced when it wears out, then System A should be chosen, because it has the less negative NPV.

16. If the equipment will be replaced at the end of its useful life, the correct capital budgeting technique is EAC. Using the NPVs (which are the same as the PV of costs) we calculated in the previous problem, the EAC for each system is:

$$EAC_A = -\$756,561.48/(PVIFA_{11\%,4})$$
$$EAC_A = -\$243,859.70$$

$$EAC_B = -\$962,757.79/(PVIFA_{11\%,6})$$
$$EAC_B = -\$227,573.38$$

If the conveyor belt system will be continually replaced, we should choose System B since it has the less negative EAC.

17. The aftertax salvage value is:

$$\text{Aftertax salvage value} = \$45,000(1 - .22)$$

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Aftertax salvage value = $35,100

And the OCF each year will be:

	Year 1	Years 2-5
Sales	$275,000	$275,000
Variable costs	96,250	96,250
Fixed costs	47,000	47,000
Depreciation	425,000	0
EBIT	–$293,250	$131,750
Tax	–64,515	28,985
Net income	–$228,735	$102,765
+ Depreciation	425,000	0
OCF	$196,265	$102,765

Now we have all the necessary information to calculate the project NPV. The project NPV is:

$$NPV = –\$425,000 – 25,000 + \$196,265/1.09 + \$102,765/1.09^2 + \$102,765/1.09^3 + \$102,765/1.09^4 + (\$102,765 + 35,100 + 25,000)/1.09^5$$
$$NPV = \$74,560.70$$

18. Since we need to calculate the EAC for each machine, revenue is irrelevant. The sales figure is only used to calculate the variable costs since EAC only uses the costs of operating the equipment, not the sales. Using the bottom up approach, or net income plus depreciation, method to calculate OCF, we get:

	Machine A	Machine B
Variable costs	–$3,325,000	–$2,850,000
Fixed costs	–1,550,000	–1,800,000
Depreciation	–516,667	–544,444
EBT	–$5,391,667	–$5,194,444
Tax	1,132,250	1,090,833
Net income	–$4,259,417	–$4,103,611
+ Depreciation	516,667	544,444
OCF	–$3,742,750	–$3,559,167

The PV of costs and EAC for Machine A is:

$$\text{PV of costs}_A = –\$3,100,000 – \$3,742,750(\text{PVIFA}_{10\%,6})$$
$$\text{PV of costs}_A = –\$19,400,651.98$$

$$EAC_A = –\$19,400,651.98/(\text{PVIFA}_{10\%,6})$$
$$EAC_A = –\$4,454,532.88$$

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And the PV of costs and EAC for Machine B is:

PV of $\text{costs}_B = -\$4{,}900{,}000 - 3{,}559{,}167(\text{PVIFA}_{10\%,9})$
PV of $\text{costs}_B = -\$25{,}397{,}325.60$

$\text{EAC}_B = -\$25{,}397{,}325.60/(\text{PVIFA}_{10\%,9})$
$\text{EAC}_B = -\$4{,}410{,}005.31$

You should choose Machine B since it has a less negative EAC.

19. When we are dealing with nominal cash flows, we must be careful to discount cash flows at the nominal interest rate, and we must discount real cash flows using the real interest rate. Project A's cash flows are in real terms, so we need to find the real interest rate. Using the Fisher equation, the real interest rate is:

$1 + R = (1 + r)(1 + h)$
$1.11 = (1 + r)(1 + .04)$
$r = .0673$, or 6.73%

So, the NPV of Project A's real cash flows, discounted at the real interest rate, is:

$\text{NPV} = -\$73{,}000 + \$35{,}500/1.0673 + \$38{,}900/1.0673^2 + \$26{,}000/1.0673^3$
NPV = \$15,794.42

Project B's cash flow are in nominal terms, so the NPV discounted at the nominal interest rate, is:

$\text{NPV} = -\$82{,}000 + \$37{,}600/1.11 + \$49{,}300/1.11^2 + \$35{,}500/1.11^3$
NPV = \$17,844.15

We should accept Project B if the projects are mutually exclusive since it has the highest NPV.

20. To determine the value of a firm, we can find the present value of the firm's future cash flows. No depreciation is given, so we can assume depreciation is zero. Using the tax shield approach, we can find the present value of the aftertax revenues, and the present value of the aftertax costs. The required return, growth rates, price, and costs are all given in real terms. Subtracting the costs from the revenues will give us the value of the firm's cash flows. We must calculate the present value of each separately since each is growing at a different rate. First, we will find the present value of the revenues. The revenues in Year 1 will be the number of bottles sold, times the price per bottle, or:

Aftertax revenue in Year 1 in real terms = $(7{,}300{,}000 \times \$1.24)(1 - .21)$
Aftertax revenue in Year 1 in real terms = \$7,151,080

Revenues will grow at 2 percent per year in real terms forever. Applying the growing perpetuity formula, we find the present value of the revenues is:

PV of revenues = $C_1/(R - g)$
PV of revenues = $\$7{,}151{,}080/(.06 - .02)$
PV of revenues = \$178,777,000

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The real aftertax costs in Year 1 will be:

Aftertax costs in year 1 in real terms = (7,300,000 × $.83)(1 – .21)
Aftertax costs in year 1 in real terms = $4,786,610

Costs will grow at 1.5 percent per year in real terms forever. Applying the growing perpetuity formula, we find the present value of the costs is:

PV of costs = $C_1/(R - g)$
PV of costs = $4,786,610/(.06 – .015)
PV of costs = $106,369,111

Now we can find the value of the firm, which is:

Value of the firm = PV of revenues – PV of costs
Value of the firm = $178,777,000 – 106,369,111
Value of the firm = $72,407,889

21. To calculate the nominal cash flows, we increase each item in the income statement by the inflation rate, except for depreciation. Depreciation is a nominal cash flow, so it does not need to be adjusted for inflation in nominal cash flow analysis. Since the resale value is given in nominal terms as of the end of Year 5, it does not need to be adjusted for inflation. Also, no inflation adjustment is needed for either the depreciation charge or the recovery of net working capital since these items are already expressed in nominal terms. Note that an increase in required net working capital is a negative cash flow whereas a decrease in required net working capital is a positive cash flow. Remember, to calculate the taxes paid (or tax credit) on the salvage value, we take the book value minus the market value, times the tax rate, which, in this case, would be:

Taxes on salvage value = $(BV - MV)T_C$
Taxes on salvage value = ($0 – 80,000)(.22)
Taxes on salvage value = –$17,600

So, the nominal aftertax salvage value is:

Market price	$80,000
Tax on sale	–17,600
Aftertax salvage value	$62,400

Now we can find the nominal cash flows each year using the income statement. Doing so, we find:

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Sales			$296,400	$308,256	$320,586	$333,410
Expenses		86,000	89,440	93,018	96,738	100,608
Depreciation		146,000	146,000	146,000	146,000	146,000
EBT		$53,000	$60,960	$69,238	$77,848	$86,802
Tax		11,660	13,411	15,232	17,127	19,096
Net income		$41,340	$47,549	$54,006	$60,721	$67,705
OCF			$193,549	$200,006	$206,721	$213,705
Capital spending	–$730,000					$62,400
NWC	–30,000					30,000
Total cash flow	–$760,000		$193,549	$200,006	$206,721	$306,105

22. The present value of the company is the present value of the future cash flows generated by the company. Here we have real cash flows, a real interest rate, and a real growth rate. The cash flows are a growing perpetuity, with a negative growth rate. Using the growing perpetuity equation, the present value of the cash flows is:

$PV = C_1/(R - g)$
$PV = \$376{,}000/[.029 - (-.026)]$
$PV = \$6{,}836{,}363.64$

23. To find the EAC, we first need to calculate the NPV of the incremental cash flows. We will begin with the aftertax salvage value, which is:

Taxes on salvage value = $(BV - MV)T_C$
Taxes on salvage value = ($0 – 10,500)(.23)
Taxes on salvage value = –$2,415

Market price	$10,500
Tax on sale	–2,415
Aftertax salvage value	$8,085

Now we can find the operating cash flows. Using the tax shield approach, the operating cash flow each year will be:

$OCF = -\$13{,}900(1 - .23) + .23(\$104{,}300/7)$
$OCF = -\$7{,}276$

So, the PV of the cost of the decision to buy is:

$PV \text{ of costs} = -\$104{,}300 + \$7{,}276(PVIFA_{12\%,7}) + (\$8{,}085/1.12^7)$
PV of costs = –$133,848.65

In order to calculate the equivalent annual cost, set the NPV of the equipment equal to an annuity with the same economic life. Since the project has an economic life of seven years and is discounted at 12 percent, set the NPV equal to a seven-year annuity, discounted at 12 percent.

EAC = –$133,848.65/(PVIFA$_{12\%,7}$)
EAC = –$29,328.61

24. We will find the EAC of the EVF first. There are no taxes since the university is tax-exempt, so the maintenance costs are the operating cash flows. The PV of costs of the decision to buy one EVF is:

PV of costs = –$6,800 – $1,430(PVIFA$_{9\%,4}$)
PV of costs = –$11,432.80

In order to calculate the equivalent annual cost, set the NPV of the equipment equal to an annuity with the same economic life. Since the project has an economic life of four years and is discounted at 9 percent, set the NPV equal to a four-year annuity, discounted at 9 percent. So, the EAC per unit is:

EAC = –$11,432.80/(PVIFA$_{9\%,4}$)
EAC = –$3,528.95

Since the university must buy five of the mowers, the total EAC of the decision to buy the EVF mower is:

Total EAC = 5(–$3,528.95)
Total EAC = –$17,644.73

Note, we could have found the total EAC for this decision by multiplying the initial cost by the number of mowers needed and multiplying the annual maintenance cost of each by the same number. We would have arrived at the same EAC.

We can find the EAC of the AEH mowers using the same method, but we need to include the salvage value as well. There are no taxes on the salvage value since the university is tax-exempt, so the PV of costs of buying one AEH will be:

PV of costs = –$6,100 – $1,570(PVIFA$_{9\%,7}$) + $900/1.09^7
PV of costs = –$13,509.41

So, the EAC per mower is:

EAC = –$13,509.41/(PVIFA$_{9\%,7}$)
EAC = –$2,684.19

Since the university must buy six of the mowers, the total EAC of the decision to buy the AEH mowers is:

Total EAC = 6(–$2,684.19)
Total EAC = –$16,105.14

The university should buy the AEH mowers since the EAC is less negative.

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25. We will calculate the aftertax salvage value first. The aftertax salvage value of the equipment will be:

Taxes on salvage value = (BV – MV)T_C
Taxes on salvage value = ($0 – 35,000)(.21)
Taxes on salvage value = –$7,350

Market price	$35,000
Tax on sale	–7,350
Aftertax salvage value	$27,650

Next, we will calculate the initial cash outlay, that is, the cash flow at Year 0. To undertake the project, we will have to purchase the equipment. The new project will decrease the net working capital, so this is a cash inflow at the beginning of the project. So, the cash outlay today for the project will be:

Equipment	–$755,000
NWC	55,000
Total	–$700,000

Now we can calculate the operating cash flow each year for the project. Using the bottom up approach, the operating cash flow will be:

Saved salaries	$185,000
Depreciation	151,000
EBT	$ 34,000
Taxes	7,140
Net income	$ 26,860

And the OCF will be:

OCF = $26,860 + 151,000
OCF = $177,860

Now we can find the NPV of the project, which is:

NPV = –$700,000 + $177,860(PVIFA$_{10\%,5}$) + ($27,650 – 55,000)/1.10^5
NPV = –$42,752.86

26. *a.* Replacement decision analysis is the same as the analysis of two competing projects, in this case, keep the current equipment, or purchase the new equipment. We will consider the purchase of the new machine first.

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Purchase new machine:

The initial cash outlay for the new machine is the cost of the new machine, plus the increased net working capital. So, the initial cash outlay will be:

Purchase new machine	–$9,260,000
Net working capital	–165,000
Total	–$9,425,000

Next, we can calculate the operating cash flow created if the company purchases the new machine. The saved operating expense is an incremental cash flow. Additionally, the reduced operating expense is a cash inflow, so it should be treated as such in the income statement. The pro forma income statement and the operating cash flow each year created by purchasing the new machine will be:

Operating expense	$2,100,000
Depreciation	2,315,000
EBT	–$215,000
Taxes	– 45,150
Net income	–$169,850
OCF	$2,145,150

So, the NPV of purchasing the new machine, including the recovery of the net working capital, is:

$NPV = –\$9,425,000 + \$2,145,150(PVIFA_{10\%,4}) + \$165,000/1.10^4$
$NPV = –\$2,198,711.18$

And the IRR is:

$0 = –\$9,425,000 + \$2,145,150(PVIFA_{IRR,4}) + \$165,000/(1 + IRR)^4$

Using a spreadsheet or financial calculator, we find the IRR is:

IRR = –2.89%

Now we can calculate the decision to keep the old machine:

Keep old machine:

The initial cash outlay for the new machine is the market value of the old machine, including any potential tax. The decision to keep the old machine has an opportunity cost, namely, the company could sell the old machine. Also, if the company sells the old machine at its current value, it will incur taxes. Both of these cash flows need to be included in the analysis. So, the initial cash flow of keeping the old machine will be:

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Keep machine	–$4,160,000
Taxes	352,800
Total	–$3,807,200

Next, we can calculate the operating cash flow created if the company keeps the old machine. There are no incremental cash flows from keeping the old machine, but we need to account for the cash flow effects of depreciation. The income statement, adding depreciation to net income to calculate the operating cash flow will be:

Depreciation	$620,000
EBT	–$620,000
Taxes	– 130,200
Net income	–$489,800
OCF	$130,200

So, the NPV of the decision to keep the old machine will be:

NPV = –$3,807,200 + $130,200($PVIFA_{10\%,4}$)
NPV = –$3,375,961.09

And the IRR is:

0 = –$3,807,200 + $130,200($PVIFA_{IRR,4}$)

Using a spreadsheet or financial calculator, we find the IRR is:

IRR = –49.61%

The company should buy the new machine since it has a greater NPV.

There is another way to analyze a replacement decision that is often used. It is an incremental cash flow analysis of the change in cash flows from the existing machine to the new machine, assuming the new machine is purchased. In this type of analysis, the initial cash outlay would be the cost of the new machine, the increased inventory, and the cash inflow (including any applicable taxes) of selling the old machine. In this case, the initial cash flow under this method would be:

Purchase new machine	–$9,260,000
Net working capital	–165,000
Sell old machine	4,160,000
Taxes on old machine	–352,800
Total	–$5,617,800

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The cash flows from purchasing the new machine would be the saved operating expenses. We would also need to include only the change in depreciation. The old machine has a depreciation of $620,000 per year, and the new machine has a depreciation of $2,315,000 per year, so the increased depreciation will be $1,695,000 per year. The pro forma income statement and operating cash flow under this approach will be:

Operating expense	$2,100,000
Depreciation	–1,695,000
EBT	$405,000
Taxes	85,050
Net income	$319,950
OCF	$2,014,950

The NPV under this method is:

$NPV = –\$5,617,800 + \$2,014,950(PVIFA_{10\%,4}) + \$165,000/1.10^4$
$NPV = \$1,177,249.90$

And the IRR is:

$0 = –\$5,617,800 + \$2,014,950(PVIFA_{IRR,4}) + \$165,000/(1 + IRR)^4$

Using a spreadsheet or financial calculator, we find the IRR is:

$IRR = 16.98\%$

So, this analysis still tells us the company should purchase the new machine. This is really the same type of analysis we originally did. Consider this: Subtract the NPV of the decision to keep the old machine from the NPV of the decision to purchase the new machine. You will get:

Differential NPV = –$3,375,961.09 – (–2,198,711.18) = –$1,177,249.90

This is the exact same NPV we calculated when using the second analysis method.

b. Even though the saved expenses are less than the cost of the machine, the cash flows are also increased because of the higher depreciation of the new machine. The depreciation tax shield increases the cash flows enough to help make the NPV positive. Additionally, the opportunity cost of selling the old machine helps to defray the cost of the new machine.

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27. We can find the NPV of a project using nominal cash flows or real cash flows. Either method will result in the same NPV. For this problem, we will calculate the NPV using nominal cash flows. The initial investment in either case is $2,350,000 since it will be spent today. We will begin with the nominal cash flows. The revenues and production costs increase at different rates, so we must be careful to increase each at the appropriate growth rate. The nominal cash flows for each year will be:

	Year 0	Year 1	Year 2	Year 3
Revenues		$1,025,000.00	$1,076,250.00	$1,130,062.50
Costs		$425,000.00	442,000.00	459,680.00
Depreciation		335,714.29	335,714.29	335,714.29
EBT		$264,285.71	$298,535.71	$334,668.21
Taxes		60,785.71	68,663.21	76,973.69
Net income		$203,500.00	$229,872.50	$257,694.53
OCF		$539,214.29	$565,586.79	$593,408.81

	Year 4	Year 5	Year 6	Year 7
Revenues	$1,186,565.63	$1,245,893.91	$1,308,188.60	$1,373,598.03
Costs	478,067.20	497,189.89	517,077.48	537,760.58
Depreciation	335,714.29	335,714.29	335,714.29	335,714.29
EBT	$372,784.14	$412,989.73	$455,396.83	$500,123.16
Taxes	85,740.35	94,987.64	104,741.27	115,028.33
Net income	$287,043.79	$318,002.09	$350,655.56	$385,094.84
OCF	$622,758.07	$653,716.38	$686,369.85	$720,809.12

Now that we have the nominal cash flows, we can find the NPV. We must use the nominal required return with nominal cash flows. Using the Fisher equation to find the nominal required return, we get:

$(1 + R) = (1 + r)(1 + h)$
$(1 + R) = (1 + .07)(1 + .05)$
$R = .1235$, or 12.35%

So, the NPV of the project using nominal cash flows is:

$$NPV = -\$2,350,000 + \$539,214.29/1.1235 + \$565,586.79/1.1235^2 + \$593,408.81/1.1235^3 + \$622,758.07/1.1235^4 + \$653,716.38/1.1235^5 + \$686,369.85/1.1235^6 + \$720,809.12/1.1235^7$$
$$NPV = \$412,820.28$$

Because the revenues and costs are growing annuities, we can find the present value of these cash flows using the growing annuity equation. This will allow us to find the operating cash flow using the tax shield approach. Since revenues and expenses are growing at different rates, we must find the present value of each separately. These are nominal cash flows, so we must use the nominal required return. We also need to account for the effect of taxes, so we will multiply by one minus the tax rate. So, the present value of the aftertax revenues using the growing annuity equation is:

PV of aftertax revenues = $C\{[1/(r - g)] - [1/(r - g)] \times [(1 + g)/(1 + r)]^t\}(1 - T_C)$
PV of aftertax revenues = \$1,025,000{[1/(.1235 – .05)] – [1/(.1235 – .05)]
× [(1 + .05)/(1 + .1235)]^7}(1 – .23)
PV of aftertax revenues = \$4,050,949.20

And the present value of the aftertax costs will be:

PV of aftertax costs = $C\{[1/(r - g)] - [1/(r - g)] \times [(1 + g)/(1 + r)]^t\}(1 - T_C)$
PV of aftertax costs = \$425,000{[1/(.1235 – .04)] – [1/(.1235 – .04)]
× [(1 + .04)/(1 + .1235)]^7}(1 – .23)
PV of aftertax costs = \$1,636,639.44

Now we need to find the present value of the depreciation tax shield. The depreciation amount in the first year is a nominal value, so we can find the present value of the depreciation tax shield as an ordinary annuity using the nominal required return. So, the present value of the depreciation tax shield will be:

PV of depreciation tax shield = (\$2,350,000/7)(.23)($PVIFA_{12.35\%,7}$)
PV of depreciation tax shield = \$348,510.51

Using the present value of the nominal cash flows to find the NPV, we get:

NPV = Initial cost + PV of aftertax revenues – PV of aftertax costs + PV of depreciation tax shield
NPV = –\$2,350,000 + 4,050,949.20 – 1,636,639.44 + 348,510.51
NPV = \$412,820.28

28. Here we have a project in which the quantity sold each year increases. First, we need to calculate the quantity sold each year by increasing the current year's quantity by the growth rate. So, the quantity sold each year will be:

Year 1 quantity = 10,200
Year 2 quantity = 10,200(1 + .07) = 10,914
Year 3 quantity = 10,914(1 + .07) = 11,678
Year 4 quantity = 11,678(1 + .07) = 12,495
Year 5 quantity = 12,495(1 + .07) = 13,370

Now we can calculate the sales revenue and variable costs each year. The pro forma income statements and operating cash flow each year will be:

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	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Revenues		$683,400.00	$731,238.00	$782,424.66	$837,194.39	$895,797.99
Fixed costs		285,000.00	285,000.00	285,000.00	285,000.00	285,000.00
Variable costs		183,600.00	196,452.00	210,203.64	224,917.89	240,662.15
Depreciation		109,000.00	109,000.00	109,000.00	109,000.00	109,000.00
EBT		$105,800.00	$140,786.00	$178,221.02	$218,276.49	$261,135.85
Taxes		23,276.00	30,972.92	39,208.62	48,020.83	57,449.89
Net income		$82,524.00	$109,813.08	$139,012.40	$170,255.66	$203,685.96
OCF		$191,524.00	$218,813.08	$248,012.40	$279,255.66	$312,685.96
Equipment	–$545,000					
NWC	65,000					65,000
Total CF	–$610,000	$191,524.00	$218,813.08	$248,012.40	$279,255.66	$377,685.96

So, the NPV of the project is:

$$NPV = -\$610,000 + \$191,524/1.15 + \$218,813.08/1.15^2 + \$248,012.40/1.15^3 + \$279,255.66/1.15^4 + \$377,685.96/1.15^5$$
$$NPV = \$232,510.91$$

We could also have calculated the cash flows using the tax shield approach, with growing annuities and ordinary annuities. The sales and variable costs increase at the same rate as sales, so both are growing annuities. The fixed costs and depreciation are both ordinary annuities. Using the growing annuity equation, the present value of the revenues is:

$$\text{PV of revenues} = C\{[1/(r-g)] - [1/(r-g)] \times [(1+g)/(1+r)]^t\}(1-T_C)$$
$$\text{PV of revenues} = \$683,400\{[1/(.15-.07)] - [1/(.15-.07)] \times [(1+.07)/(1+.15)]^5\}$$
$$\text{PV of revenues} = \$2,585,677.30$$

And the present value of the variable costs will be:

$$\text{PV of variable costs} = C\{[1/(r-g)] - [1/(r-g)] \times [(1+g)/(1+r)]^t\}(1-T_C)$$
$$\text{PV of variable costs} = \$183,600\{[1/(.15-.07)] - [1/(.15-.07)] \times [(1+.07)/(1+.15)]^5\}$$
$$\text{PV of variable costs} = \$694,659.57$$

The fixed costs and depreciation are both ordinary annuities. The present value of each is:

$$\text{PV of fixed costs} = C(\{1 - [1/(1+r)]^t\}/r)$$
$$\text{PV of fixed costs} = \$285,000(\{1 - [1/(1+.15)]^5\}/.15)$$
$$\text{PV of fixed costs} = \$955,364.20$$

$$\text{PV of depreciation} = C(\{1 - [1/(1+r)]^t\}/r)$$
$$\text{PV of depreciation} = \$109,000(\{1 - [1/(1+.15)]^5\}/.15)$$
$$\text{PV of depreciation} = \$365,384.91$$

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Now, we can use the depreciation tax shield approach to find the NPV of the project, which is:

NPV = –$610,000 + ($2,585,677.30 – 694,659.57 – 955,364.20)(1 – .22) + ($365,384.91)(.22)
+ $65,000/1.15^5
NPV = $232,510.91

29. We will begin by calculating the aftertax salvage value of the equipment at the end of the project's life. The aftertax salvage value is the market value of the equipment minus any taxes paid (or refunded), so the aftertax salvage value in four years will be:

Taxes on salvage value = (BV – MV)T_C
Taxes on salvage value = ($0 – 500,000)(.21)
Taxes on salvage value = –$105,000

Market price	$500,000
Tax on sale	–105,000
Aftertax salvage value	$395,000

Now we need to calculate the operating cash flow each year. Using the bottom up approach to calculating operating cash flow, we find:

	Year 0	Year 1	Year 2	Year 3	Year 4
Revenues		$3,220,000	$4,567,500	$5,127,500	$3,395,000
Fixed costs		725,000	725,000	725,000	725,000
Variable costs		483,000	685,125	769,125	509,250
Depreciation		1,766,490	2,355,850	784,930	392,730
EBT		$245,510	$801,525	$2,848,445	$1,768,020
Taxes		51,557	168,320	598,173	371,284
Net income		$193,953	$633,205	$2,250,272	$1,396,736
OCF		$1,960,443	$2,989,055	$3,035,202	$1,789,466
Capital spending	–$5,300,000				395,000
Land	–2,100,000				2,350,000
NWC	–450,000				450,000
Total cash flow	–$7,850,000	$1,960,443	$2,989,055	$3,035,202	$4,984,466

Notice the calculation of the cash flow at Year 0. The capital spending on equipment and investment in net working capital are both cash outflows. The aftertax selling price of the land is also a cash outflow. Even though no cash is actually spent on the land because the company already owns it, the aftertax cash flow from selling the land is an opportunity cost, so we need to include it in the analysis. Additionally, at the end of the project, the land can be sold. With all the project cash flows, we can calculate the NPV, which is:

$$NPV = -\$7,850,000 + \$1,960,443/1.13 + \$2,989,055/1.13^2 + \$3,035,202/1.13^3 + \$4,984,466/1.13^4$$
$$NPV = \$1,386,386.68$$

The company should proceed with the manufacture of the zithers.

30. We need to follow the same calculations for the aftertax salvage value and land as in the previous problem. The only difference is that the equipment will be fully depreciated in Year 1. The new cash flows for the project will be:

	Year 0	Year 1	Year 2	Year 3	Year 4
Revenues		$3,220,000	$4,567,500	$5,127,500	$3,395,000
Fixed costs		725,000	725,000	725,000	725,000
Variable costs		483,000	685,125	769,125	509,250
Depreciation		5,300,000	-	-	-
EBT		–$3,288,000	$3,157,375	$3,633,375	$2,160,750
Taxes		– 690,480	663,049	763,009	453,758
Net income		–$2,597,520	$2,494,326	$2,870,366	$1,706,993
OCF		$2,702,480	$2,494,326	$2,870,366	$1,706,993
Capital spending	–$5,300,000				395,000
Land	–2,100,000				2,350,000
NWC	–450,000				450,000
Total cash flow	–$7,850,000	$2,702,480	$2,494,326	$2,870,366	$4,901,993

With these cash flows, the NPV will now be:

$$NPV = -\$7,850,000 + \$2,702,480/1.13 + \$2,494,326/1.13^2 + \$2,870,366/1.13^3 + \$4,901,993/1.13^4$$
$$NPV = \$1,490,790.15$$

The company should still proceed with the manufacture of the zithers.

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31. Replacement decision analysis is the same as the analysis of two competing projects, in this case, keep the current equipment, or purchase the new equipment. We will consider the purchase of the new machine first.

Purchase new machine:

The initial cash outlay for the new machine is the cost of the new machine. We can calculate the operating cash flow created if the company purchases the new machine. The maintenance cost is an incremental cash flow, so using the pro forma income statement, and adding depreciation to net income, the operating cash flow created each year by purchasing the new machine will be:

Maintenance cost	$275,200
Depreciation	874,000
EBT	–$1,149,200
Taxes	–241,332
Net income	–$907,868
OCF	–$33,868

Notice the taxes are negative, implying a tax credit. The new machine also has a salvage value at the end of five years, so we need to include this in the cash flows analysis. The aftertax salvage value will be:

Sell machine	$624,000
Taxes	–131,040
Total	$492,960

The NPV of purchasing the new machine is:

$NPV = –\$4,370,000 – \$33,868(PVIFA_{12\%,5}) + \$492,960/1.12^5$
$NPV = –\$4,212,367.82$

Notice the NPV is negative. This does not necessarily mean we should not purchase the new machine. In this analysis, we are only dealing with costs, so we would expect a negative NPV. The revenue is not included in the analysis since it is not incremental to the machine. Similar to an EAC analysis, we will use the machine with the least negative NPV. Now we can calculate the decision to keep the old machine:

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Keep old machine:

The initial cash outlay for keeping the old machine is the market value of the old machine, including any potential tax. The decision to keep the old machine has an opportunity cost, namely, the company could sell the old machine. Also, if the company sells the old machine at its current value, it will incur taxes. Both of these cash flows need to be included in the analysis. So, the initial cash flow of keeping the old machine will be:

Keep machine	–$1,870,000
Taxes	153,300
Total	–$1,716,700

Next, we can calculate the operating cash flow created if the company keeps the old machine. We need to account for the cost of maintenance, as well as the cash flow effects of depreciation. The income statement, adding depreciation to net income to calculate the operating cash flow will be:

Maintenance cost	$780,000
Depreciation	228,000
EBT	–$1,008,000
Taxes	–211,680
Net income	–$796,320
OCF	–$568,320

The old machine also has a salvage value at the end of five years, so we need to include this in the cash flows analysis. The aftertax salvage value will be:

Sell machine	$182,000
Taxes	–38,220
Total	$143,780

So, the NPV of the decision to keep the old machine will be:

$NPV = –\$1,716,700 – \$568,320(PVIFA_{12\%,5}) + \$143,780/1.12^5$
$NPV = –\$3,683,781.78$

The company should keep the old machine since it has a greater (less negative) NPV.

There is another way to analyze a replacement decision that is often used. It is an incremental cash flow analysis of the change in cash flows from the existing machine to the new machine, assuming the new machine is purchased. In this type of analysis, the initial cash outlay would be the cost of the new machine, and the cash inflow (including any applicable taxes) of selling the old machine. In this case, the initial cash flow under this method would be:

Purchase new machine	–$4,370,000
Sell old machine	1,870,000
Taxes on old machine	– 153,300
Total	–$2,653,300

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The cash flows from purchasing the new machine would be the difference in the operating expenses. We would also need to include only the change in depreciation. The old machine has a depreciation of $228,000 per year, and the new machine has a depreciation of $874,000 per year, so the increased depreciation will be $646,000 per year. The pro forma income statement and operating cash flow under this approach will be:

Maintenance cost	–$504,800
Depreciation	646,000
EBT	–$141,200
Taxes	–29,652
Net income	–$111,548
OCF	$534,452

The salvage value of the differential cash flow approach is more complicated. The company will sell the new machine and incur taxes on the sale in five years. However, we must also include the lost sale of the old machine. Since we assumed we sold the old machine in the initial cash outlay, we lose the ability to sell the machine in five years. This is an opportunity loss that must be accounted for. So, the salvage value is:

Sell machine	$624,000
Taxes	–131,040
Lost sale of old	–182,000
Taxes on lost sale of old	38,220
Total	$349,180

The NPV under this method is:

$NPV = –\$2,653,300 + \$534,452(PVIFA_{12\%,5}) + \$349,180/1.12^5$
$NPV = –\$528,586.04$

So, this analysis still tells us the company should not purchase the new machine. This is really the same type of analysis as we did considering the replacement decision as mutually exclusive projects. Consider this: Subtract the NPV of the decision to keep the old machine from the NPV of the decision to purchase the new machine. You will get:

Differential NPV = –$4,212,367.82 – (–3,683,781.78) = –$528,586.04

This is the exact same NPV we calculated when using the second analysis method.

32. Here we have a situation where a company is going to buy one of two assets, so we need to calculate the EAC of each asset. To calculate the EAC, we can calculate the EAC of the combined costs of each computer, or calculate the EAC of an individual computer, then multiply by the number of computers the company is purchasing. In this instance, we will calculate the EAC of each individual computer. For the SAL 5000, we will begin by calculating the aftertax salvage value, then the operating cash flows. So:

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SAL 5000:

Taxes on salvage value = (BV – MV)T_C
Taxes on salvage value = ($0 – 200)(.23)
Taxes on salvage value = –$46

Market price	$200
Tax on sale	– 46
Aftertax salvage value	$154

The incremental costs will include the maintenance costs, depreciation, and taxes. Notice the taxes are negative, signifying a lower tax bill. So, the incremental cash flows will be:

Maintenance cost	$390.00
Depreciation	450.00
EBT	–$840.00
Taxes	–193.20
Net income	–$646.80
OCF	–$196.80

So, the PV of the costs of the decision to buy one unit is:

NPV = –$3,600 – $196.80(PVIFA$_{11\%,8}$) + $154/1.11^8
NPV = –$4,545.93

And the EAC on a per unit basis is:

–$4,545.93 = EAC(PVIFA$_{11\%,8}$)
EAC = –$883.37

Since the company must buy 9 units, the total EAC of the decision is:

Total EAC = 9(–$883.37)
Total EAC = –$7,950.33

And the EAC for the HAL 1000:

Taxes on salvage value = (BV – MV)T_C
Taxes on salvage value = ($0 – 220)(.23)
Taxes on salvage value = –$50.60

Market price	$220.00
Tax on sale	–50.60
Aftertax salvage value	$169.40

The incremental costs will include the maintenance costs, depreciation, and taxes. Notice the taxes are negative, signifying a lower tax bill. So, the incremental cash flows will be:

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Maintenance cost	$355.00
Depreciation	716.67
EBT	–$1,071.67
Tax	–246.48
Net income	–$825.18
OCF	–$108.52

So, the PV of the costs of the decision to buy one unit is:

NPV = –$4,300 – $108.52(PVIFA$_{11\%,6}$) + $169.40/1.11^6
NPV = –$4,668.52

And the EAC on a per unit basis is:

–$4,668.52 = EAC(PVIFA$_{11\%,6}$)
EAC = –$1,103.53

Since the company must buy 7 units, the total EAC of the decision is:

Total EAC = 7(–$1,103.53)
Total EAC = –$7,724.69

The company should choose the HAL 1000 since the total EAC is less negative.

33. Here we are comparing two mutually exclusive projects with inflation. Since each will be replaced when it wears out, we need to calculate the EAC for each. We have real cash flows. Similar to other capital budgeting projects, when calculating the EAC, we can use real cash flows with the real interest rate, or nominal cash flows and the nominal interest rate. Using the Fisher equation to find the real required return, we get:

$(1 + R) = (1 + r)(1 + h)$
$(1 + .12) = (1 + r)(1 + .05)$
$r = .0667$, or 6.67%

This is the interest rate we need to use with real cash flows. We are given the real aftertax cash flows for each asset, so the PV of the costs for the XX40 is:

NPV = –$2,400 – $160(PVIFA$_{6.67\%,3}$)
NPV = –$2,822.46

So, the EAC for the XX40 is:

–$2,822.46 = EAC(PVIFA$_{6.67\%,3}$)
EAC = –$1,068.96

And the EAC for the RH45 is:

NPV = –$2,900 – $255(PVIFA$_{6.67\%,5}$)
NPV = –$3,954.95

So, the EAC for the RH45 is:

$-\$3,954.95 = EAC(PVIFA_{6.67\%,5})$
EAC = –$955.98

The company should choose the RH45 because it has the lower (less negative) EAC.

34. The project has a sales price that increases at 5 percent per year, and a variable cost per unit that increases at 7 percent per year. First, we need to find the sales price and variable cost for each year. The table below shows the price per unit and the variable cost per unit each year.

	Year 1	Year 2	Year 3	Year 4	Year 5
Sales price	$91.00	$95.55	$100.33	$105.34	$110.61
Cost per unit	$26.00	$27.82	$29.77	$31.85	$34.08

Using the sales price and variable cost, we can now construct the pro forma income statement for each year. We can use this income statement to calculate the cash flow each year. We must also make sure to include the net working capital outlay at the beginning of the project, and the recovery of the net working capital at the end of the project. The pro forma income statement and cash flows for each year will be:

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Revenues		$1,547,000.00	$1,624,350.00	$1,705,567.50	$1,790,845.88	$1,880,388.17
Fixed costs		785,000.00	785,000.00	785,000.00	785,000.00	785,000.00
VC		442,000.00	472,940.00	506,045.80	541,469.01	579,371.84
Dep.		175,000.00	175,000.00	175,000.00	175,000.00	175,000.00
EBT		$145,000.00	$191,410.00	$239,521.70	$289,376.87	$341,016.33
Taxes		30,450.00	40,196.10	50,299.56	60,769.14	71,613.43
Net income		$114,550.00	$151,213.90	$189,222.14	$228,607.73	$269,402.90
OCF		$289,550.00	$326,213.90	$364,222.14	$403,607.73	$444,402.90
Equipment	–$875,000					
NWC	–145,000					145,000
Total CF	–$1,020,000	$289,550.00	$326,213.90	$364,222.14	$403,607.73	$589,402.90

With these cash flows, the NPV of the project is:

$NPV = -\$1,020,000 + \$289,550/1.11 + \$326,213.90/1.11^2 + \$364,222.14/1.11^3 + \$403,607.73/1.11^4 + \$589,402.90/1.11^5$
NPV = $387,585.31

We could also answer this problem using the depreciation tax shield approach. The revenues and variable costs are growing annuities, growing at different rates. The fixed costs and depreciation are ordinary annuities. Using the growing annuity equation, the present value of the revenues is:

PV of revenues = $C\{[1/(r - g)] - [1/(r - g)] \times [(1 + g)/(1 + r)]^t\}$
PV of revenues = $\$1,547,000\{[1/(.11 - .05)] - [1/(.11 - .05)] \times [(1 + .05)/(1 + .11)]^5\}$
PV of revenues = $6,254,753.35

And the present value of the variable costs will be:

PV of variable costs = $C\{[1/(r - g)] - [1/(r - g)] \times [(1 + g)/(1 + r)]^t\}$
PV of variable costs = $\$442,000\{[1/(.11 - .07)] - [1/(.11 - .07)] \times [(1 + .07)/(1 + .11)]^5\}$
PV of variable costs = $1,852,574.63

The fixed costs and depreciation are both ordinary annuities. The present value of each is:

PV of fixed costs = $C(\{1 - [1/(1 + r)]^t\}/r)$
PV of fixed costs = $\$785,000(\{1 - [1/(1 + .11)]^5\}/.11)$
PV of fixed costs = $2,901,279.16

PV of depreciation = $C(\{1 - [1/(1 + r)]^t\}/r)$
PV of depreciation = $\$175,000(\{1 - [1/(1 + .11)]^5\}/.11)$
PV of depreciation = $646,781.98

Now, we can use the depreciation tax shield approach to find the NPV of the project, which is:

NPV = –$1,020,000 + ($6,254,753.35 – 1,852,574.63 – 2,901,279.16)(1 – .21)
+ ($646,781.98)(.21) + $145,000/$1.11^5$
NPV = $387,585.31

Challenge

35. Probably the easiest OCF calculation for this problem is the bottom up approach, so we will construct an income statement for each year. Beginning with the initial cash flow at Year 0, the project will require an investment in equipment. The project will also require an investment in NWC. So, the cash flow required for the project today will be:

Capital spending	–$28,400,000
Change in NWC	–1,400,000
Total cash flow	–$29,800,000

Now we can begin the remaining calculations. Sales figures are given for each year, along with the price per unit. The variable costs per unit are used to calculate total variable costs, and fixed costs are given at $1.75 million per year. To calculate depreciation each year, we use the initial equipment cost of $28.4 million, times the appropriate MACRS depreciation each year. The remainder of each income statement is calculated below. Notice at the bottom of the income statement we added back depreciation to get the OCF for each year. The section labeled "Net cash flows" will be discussed below:

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Year	0	Year 1	Year 2	Year 3	Year 4	Year 5
Ending book value		$24,341,640	$17,386,480	$12,419,320	$8,872,160	$6,336,040
Sales		$23,625,000	$27,090,000	$29,610,000	$34,020,000	$23,310,000
Variable costs		10,125,000	11,610,000	12,690,000	14,580,000	9,990,000
Fixed costs		1,750,000	1,750,000	1,750,000	1,750,000	1,750,000
Depreciation		4,058,360	6,955,160	4,967,160	3,547,160	2,536,120
EBIT		$7,691,640	$6,774,840	$10,202,840	$14,142,840	$9,033,880
Taxes		1,615,244	1,422,716	2,142,596	2,969,996	1,897,115
Net income		$6,076,396	$5,352,124	$8,060,244	$11,172,844	$7,136,765
Depreciation		4,058,360	6,955,160	4,967,160	3,547,160	2,536,120
OCF		$10,134,756	$12,307,284	$13,027,404	$14,720,004	$9,672,885
Net cash flows						
OCF	$0	$10,134,756	$12,307,284	$13,027,404	$14,720,004	$9,672,885
Change in NWC	–1,400,000	–519,750	–378,000	–661,500	1,606,500	1,352,750
Capital spending	–28,400,000	0	0	0	0	5,817,768
Total cash flow	–$29,800,000	$9,615,006	$11,929,284	$12,365,904	$16,326,504	$16,843,404

After we calculate the OCF for each year, we need to account for any other cash flows. The other cash flows in this case are NWC cash flows and capital spending, which is the aftertax salvage value of the equipment. The required NWC capital is 15 percent of the sales change. We will work through the NWC cash flow for Year 1. The total NWC in Year 1 will be 15 percent of the sales increase from Year 1 to Year 2, or:

Increase in NWC for Year 1 = .15($23,625,000 – 27,090,000)
Increase in NWC for Year 1 = –$519,750

Notice that the NWC cash flow is negative. Since the sales are increasing, we will have to spend more money to increase NWC. In Year 3 and Year 4, the NWC cash flow is positive since sales are declining. And, in Year 5, the NWC cash flow is the recovery of all NWC the company still has in the project.

To calculate the aftertax salvage value, we first need the book value of the equipment. The book value at the end of the five years will be the purchase price minus the total depreciation. So, the ending book value is:

Ending book value = $28,400,000 – ($4,058,360 + 6,955,160 + 4,967,160 + 3,547,160 + 2,536,120)
Ending book value = $6,336,040

The market value of the used equipment is 20 percent of the purchase price, or $5.68 million, so the aftertax salvage value will be:

Aftertax salvage value = $5,680,000 + ($6,336,040 – 5,680,000)(.21)
Aftertax salvage value = $5,817,768

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The aftertax salvage value is included in the total cash flows as capital spending. Now we have all the cash flows for the project. The NPV of the project is:

$$NPV = -\$29,800,000 + \$9,615,006/1.17 + \$11,929,284/1.17^2 + \$12,365,904/1.17^3 + \$16,326,504/1.17^4 + \$16,843,404/1.17^5$$
$$NPV = \$11,248,466.60$$

And the IRR is:

$$NPV = 0 = -\$29,800,000 + \$9,615,006/(1 + IRR) + \$11,929,284/(1 + IRR)^2 + \$12,365,904/(1 + IRR)^3 + \$16,326,504/(1 + IRR)^4 + \$16,843,404/(1 + IRR)^5$$
$$IRR = 30.84\%$$

The company should accept the project.

36. To find the initial pretax cost savings necessary to buy the new machine, we should use the tax shield approach to find the OCF. We begin by calculating the depreciation each year using the MACRS depreciation schedule. The depreciation each year is:

$D_1 = \$580,000(.3333) = \$193,314$
$D_2 = \$580,000(.4445) = \$257,810$
$D_3 = \$580,000(.1481) = \$85,898$
$D_4 = \$580,000(.0741) = \$42,978$

Using the tax shield approach, the OCF each year is:

$OCF_1 = (S - C)(1 - .24) + .24(\$193,314)$
$OCF_2 = (S - C)(1 - .24) + .24(\$257,810)$
$OCF_3 = (S - C)(1 - .24) + .24(\$85,898)$
$OCF_4 = (S - C)(1 - .24) + .24(\$42,978)$
$OCF_5 = (S - C)(1 - .24)$

Now we need the aftertax salvage value of the equipment. The aftertax salvage value is:

Aftertax salvage value = $\$45,000(1 - .24) = \$34,200$

To find the necessary cost reduction, we must realize that we can split the cash flows each year. The OCF in any given year net of the depreciation tax shield is the cost reduction (S – C) times one minus the tax rate, which is an annuity for the project life, and the depreciation tax shield. To calculate the necessary cost reduction, we would require a zero NPV. The equation for the NPV of the project is:

$$NPV = 0 = -\$580,000 - 40,000 + (S - C)(.76)(PVIFA_{12\%,5}) + .24[(\$193,314/1.12) + \$257,810/1.12^2 + \$85,898/1.12^3 + \$42,978/1.12^4)] + (\$40,000 + 34,200)/1.12^5$$

Solving this equation for the sales minus costs, we get:

$(S - C)(.74)(PVIFA_{12\%,5}) = \$465,917.69$
$S - C = \$170,065.92$

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37. To find the bid price, we need to calculate all other cash flows for the project, and then solve for the bid price. The aftertax salvage value of the equipment is:

Aftertax salvage value = $150,000(1 – .21) = $118,500

Now we can solve for the necessary OCF that will give the project a zero NPV. The equation for the NPV of the project is:

NPV = 0 = –$1,900,000 – 175,000 + OCF(PVIFA$_{13\%,5}$) + [($175,000 + 118,500)/1.13^5]

Solving for the OCF, we find the OCF that makes the project NPV equal to zero is:

OCF = $1,915,699.96/PVIFA$_{13\%,5}$ = $544,661.36

The easiest way to calculate the bid price is the tax shield approach, so:

OCF = $544,661.36 = [(P – v)Q – FC](1 – T_C) + $T_C D$
$544,661.36 = [(P – $13.25)(165,000) – $315,000](1 – .21) + .21($1,900,000/5)
P = $18.73

38. *a.* The cash flow at Year 0 for all three parts of this question will be:

Capital spending	–$1,900,000
Change in NWC	–175,000
Total cash flow	–$2,075,000

We will use the initial cash flow and the salvage value we already found in that problem. Using the bottom up approach to calculating the OCF, we get:

Assume price per unit = $20 and units/year = 165,000

Year	1	2	3	4	5
Sales	$3,300,000	$3,300,000	$3,300,000	$3,300,000	$3,300,000
Variable costs	2,186,250	2,186,250	2,186,250	2,186,250	2,186,250
Fixed costs	315,000	315,000	315,000	315,000	315,000
Depreciation	380,000	380,000	380,000	380,000	380,000
EBIT	$418,750	$418,750	$418,750	$418,750	$418,750
Taxes	87,938	87,938	87,938	87,938	87,938
Net Income	$330,813	$330,813	$330,813	$330,813	$330,813
Depreciation	380,000	380,000	380,000	380,000	380,000
Operating CF	$710,813	$710,813	$710,813	$710,813	$710,813
Operating CF	$710,813	$710,813	$710,813	$710,813	$710,813
Change in NWC					175,000
Capital spending					118,500
Total CF	$710,813	$710,813	$710,813	$710,813	$1,004,313

With these cash flows, the NPV of the project is:

$NPV = –\$2,075,000 + \$710,813(PVIFA_{13\%,5}) + [(\$175,000 + 118,500)/1.13^5]$
$NPV = \$584,391.99$

If the actual price is above the bid price that results in a zero NPV, the project will have a positive NPV. As for the cartons sold, if the number of cartons sold increases, the NPV will increase, and if the costs increase, the NPV will decrease.

b. To find the minimum number of cartons sold to still break even, we need to use the tax shield approach to calculating OCF, and solve the problem similar to finding a bid price. Using the initial cash flow and salvage value we already calculated, the equation for a zero NPV of the project is:

$NPV = 0 = –\$2,075,000 + OCF(PVIFA_{13\%,5}) + [(\$175,000 + 118,500)/1.13^5]$

So, the necessary OCF for a zero NPV is:

$OCF = \$1,915,699.96/PVIFA_{13\%,5} = \$544,661.36$

Now we can use the tax shield approach to solve for the minimum quantity as follows:

$OCF = \$544,661.36 = [(P – v)Q – FC](1 – T_C) + T_C D$
$\$544,661.36 = [(\$20 – 13.25)Q – 315,000](1 – .21) + .21(\$1,900,000/5)$
$Q = 133,842$

As a check, we can calculate the NPV of the project with this quantity. The calculations are:

Year	1	2	3	4	5
Sales	\$2,676,836	\$2,676,836	\$2,676,836	\$2,676,836	\$2,676,836
Variable costs	1,773,404	1,773,404	1,773,404	1,773,404	1,773,404
Fixed costs	315,000	315,000	315,000	315,000	315,000
Depreciation	380,000	380,000	380,000	380,000	380,000
EBIT	\$208,432	\$208,432	\$208,432	\$208,432	\$208,432
Taxes	43,771	43,771	43,771	43,771	43,771
Net Income	\$164,661	\$164,661	\$164,661	\$164,661	\$164,661
Depreciation	380,000	380,000	380,000	380,000	380,000
Operating CF	\$544,661	\$544,661	\$544,661	\$544,661	\$544,661
Operating CF	\$544,661	\$544,661	\$544,661	\$544,661	\$544,661
Change in NWC					175,000
Capital spending					118,500
Total CF	\$544,661	\$544,661	\$544,661	\$544,661	\$838,161

$NPV = –\$2,075,000 + \$544,661(PVIFA_{13\%,5}) + [(\$175,000 + 118,500)/1.13^5] \approx \$0$

c. To find the highest level of fixed costs and still break even, we need to use the tax shield approach to calculating OCF, and solve the problem similar to finding a bid price. Using the initial cash flow and salvage value we already calculated, the equation for a zero NPV of the project is:

$NPV = 0 = –2,075,000 + OCF(PVIFA_{13\%,5}) + [(\$175,000 + 118,500)/1.13^5]$
$OCF = \$1,915,699.96/PVIFA_{13\%,5} = \$544,661.36$

Notice this is the same OCF we calculated in part (b). Now we can use the tax shield approach to solve for the maximum level of fixed costs as follows:

$OCF = \$544,661.36 = [(P – v)Q – FC](1 – T_C) + T_CD$
$\$544,661.36 = [(\$20 – \$13.25)(165,000) – FC](1 – .21) + .21(\$1,900,000/5)$
$FC = \$525,317.90$

As a check, we can calculate the NPV of the project with this quantity. The calculations are:

Year	1	2	3	4	5
Sales	$3,300,000	$3,300,000	$3,300,000	$3,300,000	$3,300,000
Variable costs	2,186,250	2,186,250	2,186,250	2,186,250	2,186,250
Fixed costs	525,318	525,318	525,318	525,318	525,318
Depreciation	380,000	380,000	380,000	380,000	380,000
EBIT	$208,432	$208,432	$208,432	$208,432	$208,432
Taxes	43,771	43,771	43,771	43,771	43,771
Net Income	$164,661	$164,661	$164,661	$164,661	$164,661
Depreciation	380,000	380,000	380,000	380,000	380,000
Operating CF	$544,661	$544,661	$544,661	$544,661	$544,661
Operating CF	$544,661	$544,661	$544,661	$544,661	$544,661
Change in NWC					175,000
Capital spending					118,500
Total CF	$544,661	$544,661	$544,661	$544,661	$838,161

$NPV = –\$2,075,000 + \$544,661(PVIFA_{13\%,5}) + [(\$175,000 + 118,500)/1.13^5] \approx \$0$

39. We need to find the bid price for a project, but the project has extra cash flows. Since we don't already produce the keyboard, the sales of the keyboard outside the contract are relevant cash flows. Since we know the extra sales number and price, we can calculate the cash flows generated by these sales. The cash flow generated from the sale of the keyboard outside the contract is:

	Year 1	Year 2	Year 3	Year 4
Sales	$2,392,500	$2,860,000	$3,217,500	$1,842,500
Variable costs	1,174,500	1,404,000	1,579,500	904,500
EBT	$1,218,000	$1,456,000	$1,638,000	$938,000
Tax	280,140	334,880	376,740	215,740
Net income (and OCF)	$937,860	$1,121,120	$1,261,260	$722,260

So, the addition to NPV of these market sales is:

NPV of market sales = $937,860/1.13 + $1,121,120/$1.13^2$ + $1,261,260/$1.13^3$ + $722,260/$1.13^4$
NPV of market sales = $3,025,058.04

You may have noticed that we did not include the initial cash outlay, depreciation, or fixed costs in the calculation of cash flows from the market sales. The reason is that it is irrelevant whether we include these here. Remember that we are not only trying to determine the bid price, but we are also determining whether the project is feasible. In other words, we are trying to calculate the NPV of the project, not just the NPV of the bid price. We will include these cash flows in the bid price calculation. The reason we stated earlier that whether we included these costs in this initial calculation was irrelevant is that you will come up with the same bid price if you include these costs in this calculation, or if you include them in the bid price calculation.

Next, we need to calculate the aftertax salvage value, which is:

Aftertax salvage value = $650,000(1 – .23)
Aftertax salvage value = $500,500

Instead of solving for a zero NPV as is usual in setting a bid price, the company president requires an NPV of $500,000, so we will solve for an NPV of that amount. The NPV equation for this project is (remember to include the NWC cash flow at the beginning of the project, and the NWC recovery at the end):

NPV = $500,000 = –$5,400,000 – 325,000 + 3,025,058.04 + OCF($PVIFA_{13\%,4}$)
+ [($325,000 + 500,500)/$1.13^4$]

Solving for the OCF, we get:

OCF = $2,693,647.35/$PVIFA_{13\%,4}$
OCF = $905,588.61

Now we can solve for the bid price as follows:

OCF = $905,588.61 = [($P$ – v)Q – FC](1 – T_C) + $T_C D$
$905,588.61 = [(P – $135)(20,000) – $1,350,000](1 – .40) + .40($5,400,000/4)
P = $241.14

40. Since the two computers have unequal lives, the correct method to analyze the decision is the EAC. We will begin with the EAC of the new computer. Using the depreciation tax shield approach, the OCF for the new computer system is:

OCF = ($55,000)(1 – .21) + ($371,000/5)(.21)
OCF = $59,032

Notice that the costs are positive, which represents a cash inflow. The costs are positive in this case since the new computer will generate a cost savings. The only initial cash flow for the new computer is a cost of $371,000. We next need to calculate the aftertax salvage value, which is:

Aftertax salvage value = $36,000(1 – .21)
Aftertax salvage value = $28,440

Now we can calculate the PV of costs of the new computer as:

PV of costs = –$371,000 + $59,032($PVIFA_{11\%,5}$) + $28,440/$1.11^5$
PV of costs = –$135,946.05

And the EAC of the new computer is:

EAC = –$135,946.05/($PVIFA_{11\%,5}$)
EAC = –$36,782.97

Analyzing the old computer, the only OCF is the depreciation tax shield, so:

OCF = $32,000(.21)
OCF = $6,720

The initial cost of the old computer is a little trickier. You might assume that since we already own the old computer there is no initial cost, but we can sell the old computer, so there is an opportunity cost. We need to account for this opportunity cost. To do so, we will calculate the aftertax salvage value of the old computer today. We need the book value of the old computer to do so. The book value is not given directly, but we are told that the old computer has depreciation of $32,000 per year for the next three years, so we can assume the book value is the total amount of depreciation over the remaining life of the system, or $96,000. So, the aftertax salvage value of the old computer is:

Aftertax salvage value = $132,000 + ($96,000 – 132,000)(.21)
Aftertax salvage value = $124,440

This is the initial cost of the old computer system today because we are forgoing the opportunity to sell it today. We next need to calculate the aftertax salvage value of the computer system in two years since we are "buying" it today. The aftertax salvage value in two years is:

Aftertax salvage value = $20,000 + ($32,000 – 20,000)(.21)
Aftertax salvage value = $22,520

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Now we can calculate the PV of costs of the old computer as:

PV of costs = –$124,440 + $6,720(PVIFA$_{11\%,2}$) + 22,520/1.11^2
PV of costs = –$94,654.11

And the EAC of the old computer is:

EAC = –$94,654.11/(PVIFA$_{11\%,2}$)
EAC = –$55,271.72

If we are going to replace the system in two years no matter what our decision today, we should instead replace it today since the EAC is less negative.

If we are only concerned with whether to replace the machine now, and are not worrying about what will happen in two years, the correct analysis is NPV. To calculate the NPV of the decision on the computer system now, we need the difference in the total cash flows of the old computer system and the new computer system. From our previous calculations, we can say the cash flows for each computer system are:

t	New computer	Old computer	Difference
0	–$371,000	$124,440	–$246,560
1	59,032	6,720	52,312
2	59,032	29,240	29,792
3	59,032	0	59,032
4	59,032	0	59,032
5	87,472	0	87,472

Since we are only concerned with marginal cash flows, the cash flows of the decision to replace the old computer system with the new computer system are the differential cash flows. The NPV of the decision to replace, ignoring what will happen in two years is:

NPV = –$246,560 + $52,312/1.11 + $29,792/1.11^2 + $59,032/1.11^3 + $59,032/1.11^4
+ $87,472/1.11^5
NPV = –$41,291.95

If we are not concerned with what will happen in two years, we should not replace the old computer system.

41. To answer this question, we need to compute the NPV of all three alternatives, specifically, continue to rent the building or use it for Product A or Product B. If all three of the products have a positive NPV, the product that is most favorable is the one with the highest NPV

There are several important cash flows we should not consider in the incremental cash flow analysis. The remaining fraction of the value of the building and depreciation are not incremental and should not be included in the analysis of the two alternatives. The $2,800,000 purchase price of the building is a sunk cost and should be ignored. In effect, what we are doing is finding the NPV of the future cash flows of each option, so the only cash flow today would be the building modifications needed for Product A and Product B. If we did include these costs, the effect would be to lower the NPV of all three options by the same amount, thereby leading to the same conclusion. The cash flows from renting

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the building after Year 15 are also irrelevant. No matter what the company chooses today, it will rent the building after Year 15, so these cash flows are not incremental to any product.

We will begin by calculating the NPV of the decision of continuing to rent the building first.

Continue to rent:

Rent	$85,000
Taxes	17,850
Net income	$67,150

Since there is no incremental depreciation, the operating cash flow is equal to the net income. So, the NPV of the decision to continue to rent is:

NPV = $67,150(PVIFA$_{12\%,15}$)
NPV = $457,349.55

Product A:

Next, we will calculate the NPV of the decision to modify the building to produce Product A. The income statement for this modification is the same for the first 14 years, and in Year 15, the company will have an additional expense to convert the building back to its original form. This will be an expense in Year 15, so the income statement for that year will be slightly different. The cash flow at Year 0 will be the cost of the equipment, and the cost of the initial building modifications, both of which are depreciable on a straight-line basis. So, the pro forma cash flows for Product A are:

Initial cash outlay:

Building modifications	–$148,000
Equipment	–305,000
Total cash flow	–$453,000

	Years 1-14	Year 15
Revenue	$395,000	$395,000
Expenditures	235,000	235,000
Depreciation	30,200	30,200
Restoration cost	0	85,000
EBT	$129,800	$44,800
Tax	27,258	9,408
NI	$102,542	$35,392
OCF	$132,742	$65,592

The OCF each year is net income plus depreciation. So, the NPV for modifying the building to manufacture Product A is:

NPV = –$453,000 + $132,742(PVIFA$_{12\%,14}$) + $65,592/1.12^{15}
NPV = $438,819.72

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Product B:

Now we will calculate the NPV of the decision to modify the building to produce Product B. The income statement for this modification is the same for the first 14 years, and in Year 15, the company will have an additional expense to convert the building back to its original form. This will be an expense in Year 15, so the income statement for that year will be slightly different. The cash flow at Year 0 will be the cost of the equipment, and the cost of the initial building modifications, both of which are depreciable on a straight-line basis. So, the pro forma cash flows for Product A are:

Initial cash outlay:

Building modifications	–$170,000
Equipment	–365,000
Total cash flow	–$535,000

	Years 1-14	Year 15
Revenue	$484,000	$484,000
Expenditures	295,000	295,000
Depreciation	35,667	35,667
Restoration cost	0	100,000
EBT	$153,333	$53,333
Tax	32,200	11,200
NI	$121,133	$42,133
OCF	$156,800	$77,800

The OCF each year is net income plus depreciation. So, the NPV for modifying the building to manufacture Product B is:

$NPV = –\$535,000 + \$156,800(PVIFA_{12\%,14}) + \$77,800/1.12^{15}$
NPV = $518,510.55

We could have also done the analysis as the incremental cash flows between Product A and continuing to rent the building, and the incremental cash flows between Product B and continuing to rent the building. The results of this type of analysis would be:

NPV of differential cash flows between Product A and continuing to rent:

$NPV = NPV_{Product\ A} - NPV_{Rent}$
NPV = $438,819.72 – 457,349.55
NPV = –$18,529.83

NPV of differential cash flows between Product B and continuing to rent:

$NPV = NPV_{Product\ B} - NPV_{Rent}$
NPV = $518,510.55 – 457,349.55
NPV = $61,161.00

Both incremental analyses have a positive NPV, so the company should choose Product B since it has the highest marginal NPV, which is the same as our original result.

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42. The discount rate is expressed in real terms, and the cash flows are expressed in nominal terms. We can answer this question by converting all the cash flows to real dollars. We can then use the real interest rate. The real value of each cash flow is the present value of the Year 1 nominal cash flows, discounted back to the present at the inflation rate. So, the real value of the revenue and costs will be:

Revenue in real terms = $315,000/1.04 = $302,884.62
Labor costs in real terms = $236,000/1.04 = $226,923.08
Other costs in real terms = $71,000/1.04 = $68,269.23
Lease payment in real terms = $95,000/1.04 = $91,346.15

Revenues, labor costs, and other costs are all growing perpetuities. Each has a different growth rate, so we must calculate the present value of each separately. Other costs are a growing perpetuity with a negative growth rate. Using the real required return, the present value of each of these is:

$PV_{Revenue}$ = $302,884.62/(.07 – .02) = $6,057,692.31
$PV_{Labor\ costs}$ = $226,923.08/(.07 – .01) = $3,782,051.28
$PV_{Other\ costs}$ = $68,269.23/[.07 – (–.01)] = $853,365.38

The lease payments are constant in nominal terms, so they are declining in real terms by the inflation rate. Therefore, the lease payments form a growing perpetuity with a negative growth rate. The real present value of the lease payments is:

$PV_{Lease\ payments}$ = $91,346.15/[.07 – (–.04)]
$PV_{Lease\ payments}$ = $830,419.58

Now we can use the tax shield approach to calculate the net present value. Since there is no investment in equipment, there is no depreciation; therefore, no depreciation tax shield, so we will ignore this in our calculation. This means the cash flows each year are equal to net income. There is also no initial cash outlay, so the NPV is the present value of the future aftertax cash flows. The NPV of the project is:

$NPV = PV_{Revenue} - PV_{Labor\ costs} - PV_{Other\ costs} - PV_{Lease\ payments}(1 - T_C)$
NPV = ($6,057,692.31 – 3,782,051.28 – 853,365.38 – 830,419.58)(1 – .22)
NPV = $461,647.73

Alternatively, we could have solved this problem by expressing everything in nominal terms. This approach yields the same answer as given above. However, in this case, the computation would have been much more difficult. The reason is that we are dealing with growing perpetuities. In other problems, when calculating the NPV of nominal cash flows, we could calculate the nominal cash flow each year since the cash flows were finite. Because of the perpetual nature of the cash flows in this problem, we cannot calculate the nominal cash flows each year until the end of the project. In this case, using real cash flow is the only practical method.

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43. We are given the real revenue and costs, and the real growth rates, so the simplest way to solve this problem is to calculate the NPV with real values. While we could calculate the NPV using nominal values, we would need to find the nominal growth rates, and convert all values to nominal terms. The real labor costs will increase at a real rate of two percent per year, and the real energy costs will increase at a real rate of three percent per year, so the real costs each year will be:

	Year 1	Year 2	Year 3	Year 4
Real labor cost each year	$20.43	$20.84	$21.26	$21.68
Real energy cost each year	$6.25	$6.44	$6.63	$6.83

Remember that the depreciation tax shield also affects a firm's aftertax cash flows. The present value of the depreciation tax shield must be added to the present value of a firm's revenues and expenses to find the present value of the cash flows related to the project. The depreciation the firm will recognize each year is:

Annual depreciation = Investment/Economic Life
Annual depreciation = $95,000,000/4
Annual depreciation = $23,750,000

Depreciation is a nominal cash flow, so to find the real value of depreciation each year, we discount the real depreciation amount by the inflation rate. Doing so, we find the real depreciation each year is:

Year 1 real depreciation = $23,750,000/1.04 = $22,836,538.46
Year 2 real depreciation = $23,750,000/$1.04^2$ = $21,958,210.06
Year 3 real depreciation = $23,750,000/$1.04^3$ = $21,113,663.52
Year 4 real depreciation = $23,750,000/$1.04^4$ = $20,301,599.54

Now we can calculate the pro forma income statement each year in real terms. We can then add back depreciation to net income to find the operating cash flow each year. Doing so, we find the cash flow of the project each year is:

	Year 1	Year 2	Year 3	Year 4
Revenues	$82,400,000.00	$95,275,000.00	$126,175,000.00	$72,100,000.00
Labor cost	43,924,500.00	51,471,342.00	62,703,347.40	42,276,934.91
Energy cost	1,125,000.00	1,384,062.50	1,856,575.00	1,143,948.58
Depreciation	22,836,538.46	21,958,210.06	21,113,663.52	20,301,599.54
EBT	$14,513,961.54	$20,461,385.44	$40,501,414.08	$8,377,516.98
Taxes	3,047,931.92	4,296,890.94	8,505,296.96	1,759,278.57
Net income	$11,466,029.62	$16,164,494.50	$31,996,117.12	$6,618,238.41
OCF	$34,302,568.08	$38,122,704.56	$53,109,780.64	$26,919,837.95

We can use the total cash flows each year to calculate the NPV, which is:

NPV = –$95,000,000 + $34,302,568.08/1.08 + $38,122,704.56/$1.08^2$ + $53,109,780.64/$1.08^3$
+ $26,919,837.95
NPV = $31,392,852.37

44. Here we have the sales price and production costs in real terms. The simplest method to calculate the project cash flows is to use the real cash flows. In doing so, we must be sure to adjust the depreciation, which is in nominal terms. We could analyze the cash flows using nominal values, which would require calculating the nominal discount rate, nominal price, and nominal production costs. This method would be more complicated, so we will use the real numbers. We will calculate the NPV of the headache-only pill first.

Headache-only:

We can find the real revenue and production costs by multiplying each by the units sold. We must be sure to discount the depreciation, which is in nominal terms. We can then find the pro forma net income and add back depreciation to find the operating cash flow. Discounting the depreciation each year by the inflation rate, we find the following cash flows each year:

	Year 1	Year 2	Year 3
Sales	$29,830,000	$29,830,000	$29,830,000
Production costs	12,920,000	12,920,000	12,920,000
Depreciation	9,615,385	9,245,562	8,889,964
EBT	$7,294,615	$7,664,438	$8,020,036
Tax	1,531,869	1,609,532	1,684,208
Net income	$5,762,746	$6,054,906	$6,335,829
OCF	$15,378,131	$15,300,468	$15,225,792

And the NPV of the headache-only pill is:

$NPV = –\$30,000,000 + \$15,378,131/1.06 + \$15,300,468/1.06^2 + \$15,225,792/1.06^3$
$NPV = \$10,908,901.49$

Headache and arthritis:

For the headache and arthritis pill project, the equipment has a salvage value. We will find the aftertax salvage value of the equipment first, which will be:

Market value	$1,000,000
Taxes	–210,000
Total	$790,000

Remember, to calculate the taxes on the equipment salvage value, we take the book value minus the market value, times the tax rate. Using the same method as the headache-only pill, the cash flows each year for the headache and arthritis pill will be:

	Year 1	Year 2	Year 3
Sales	$35,325,000	$35,325,000	$35,325,000
Production costs	17,775,000	17,775,000	17,775,000
Depreciation	10,897,436	10,478,304	10,075,292
EBT	$6,652,564	$7,071,696	$7,474,708
Tax	1,397,038	1,485,056	1,569,689
Net income	$5,255,526	$5,586,640	$5,905,019
OCF	$16,152,962	$16,064,944	$15,980,311

So, the NPV of the headache and arthritis pill is:

$$NPV = -\$34,000,000 + \$16,152,962/1.06 + \$16,064,944/1.06^2 + (\$15,980,311 + 790,000)/1.06^3$$
$$NPV = \$9,617,062.52$$

The company should manufacture the headache-only remedy since the project has a higher NPV.

45. Since the project requires an initial investment in inventory as a percentage of sales, we will calculate the sales figures for each year first. The incremental sales will include the sales of the new table, but we also need to include the lost sales of the existing model. This is an erosion cost of the new table. The lost sales of the existing table are constant for every year, but the table will be discontinued after three years, so there are no lost sales for the existing table in Years 4 and 5. Sales of the new table change every year. So, the total incremental sales figure for the five years of the project will be:

	Year 1	Year 2	Year 3	Year 4	Year 5
New	$13,975,000	$14,495,000	$16,640,000	$14,170,000	$11,310,000
Lost sales	–1,225,000	–1,225,000	–1,225,000		
Total	$12,750,000	$13,270,000	$15,415,000	$14,170,000	$11,310,000

Now we will calculate the initial cash outlay that will occur today. The company has the necessary production capacity to manufacture the new table without adding equipment today. So, the equipment will not be purchased today, but rather in two years. The reason is that the existing capacity is not being used. If the existing capacity were being used, the new equipment would be required, so it would be a cash flow today. The old equipment would have an opportunity cost if it could be sold. As there is no discussion that the existing equipment could be sold, we must assume it cannot be sold. The only initial cash flow is the cost of the inventory. The company will have to spend money for inventory in the new table but will be able to reduce inventory of the existing table. So, the initial cash flow today is:

New table	–$1,397,500
Old table	122,500
Total	–$1,275,000

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In Year 2, the company will have a cash outflow to pay for the cost of the new equipment. Since the equipment will be purchased in two years rather than now, the equipment will have the higher salvage value. The book value of the equipment in five years will be the initial cost, minus the accumulated depreciation, or:

Book value = $12,900,000 – 1,843,410 – 3,159,210 – 2,256,210
Book value = $5,641,170

The taxes on the salvage value will be:

Taxes on salvage = ($5,641,170 – 7,500,000)(.24)
Taxes on salvage = –$446,119

So, the aftertax salvage value of the equipment in five years will be:

Sell equipment	$7,500,000
Taxes	–446,119
Total	$7,053,881

Next, we need to calculate the variable costs each year. The variable costs of the lost sales are included as a variable cost savings, so the variable costs will be:

	Year 1	Year 2	Year 3	Year 4	Year 5
New	$4,891,250	$5,073,250	$5,824,000	$4,959,500	$3,958,500
Lost sales	–490,000	–490,000	–490,000		
Total	$4,401,250	$4,583,250	$5,334,000	$4,959,500	$3,958,500

Now we can prepare the rest of the pro forma income statements for each year. The project will have no incremental depreciation for the first two years as the equipment is not purchased for two years. Adding back depreciation to net income to calculate the operating cash flow, we get:

	Year 1	Year 2	Year 3	Year 4	Year 5
Sales	$12,750,000	$13,270,000	$15,415,000	$14,170,000	$11,310,000
VC	4,401,250	4,583,250	5,334,000	4,959,500	3,958,500
Fixed costs	4,500,000	4,500,000	4,500,000	4,500,000	4,500,000
Dep.	0	0	1,843,410	3,159,210	2,256,210
EBT	$3,848,750	$4,186,750	$3,737,590	$1,551,290	$595,290
Tax	923,700	1,004,820	897,022	372,310	142,870
NI	$2,925,050	$3,181,930	$2,840,568	$1,178,980	$452,420
Dep.	0	0	1,843,410	3,159,210	2,256,210
OCF	$2,925,050	$3,181,930	$4,683,978	$4,338,190	$2,708,630

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Next, we need to account for the changes in inventory each year. The inventory is a percentage of sales. The way we will calculate the change in inventory is the beginning of period inventory minus the end of period inventory. The sign of this calculation will tell us whether the inventory change is a cash inflow or a cash outflow. Note, in Year 3 there is an outflow of inventory for the old table. Because the old table will be discontinued at that time, and since we accounted for the saving in net working capital at Year 0 since the sales would be reduced at that time, we need to account for the fact that the company will not be able to recover this inventory when sales of the old table are discontinued in Year 3. This is an opportunity cost. The inventory each year, and the inventory change, will be:

Beginning	$1,397,500	$1,449,500	$1,664,000	$1,417,000	$1,131,000
Ending	1,449,500	1,664,000	1,417,000	1,131,000	0
Existing			–122,500		
Change	–$52,000	–$214,500	$124,500	$286,000	$1,131,000

Notice that we recover the remaining inventory at the end of the project. The total cash flows for the project will be the operating cash flow, the capital spending, and the inventory cash flows, so:

	Year 1	Year 2	Year 3	Year 4	Year 5
OCF	$2,925,050	$3,181,930	$4,683,978	$4,338,190	$2,708,630
Equipment	0	–12,900,000	0	0	7,053,881
Inventory	–52,000	–214,500	124,500	286,000	1,131,000
Total	$2,873,050	–$9,932,570	$4,808,478	$4,624,190	$10,893,511

The NPV of the project, including the inventory cash flow at the beginning of the project, will be:

$$NPV = -\$1,275,000 + \$2,873,050/1.14 - \$9,932,570/1.14^2 + \$4,808,478/1.14^3 + \$4,624,190/1.14^4 + \$10,893,511/1.14^5$$
$$NPV = \$5,243,655.46$$

The company should go ahead with the new table.

You can perform an IRR analysis, and would expect to find up to three IRRs since the cash flows change signs three times.

The profitability index is intended as a “bang for the buck” measure; that is, it shows how much shareholder wealth is created for every dollar of initial investment. In this case, the largest investment is not at the beginning of the project, but later in its life. However, since the future negative cash flow is discounted, the profitability index will still measure the amount of shareholder wealth created for every dollar spent today.

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CHAPTER 9
RISK ANALYSIS, REAL OPTIONS, AND CAPITAL BUDGETING

Answers to Concept Questions

1. Forecasting risk is the risk that a poor decision is made because of errors in projected cash flows. The danger is greatest with a new product because the cash flows are probably harder to predict.

2. With a sensitivity analysis, one variable is examined over a broad range of values. With a scenario analysis, all variables are examined for a limited range of values.

3. It is true that if average revenue is less than average cost, the firm is losing money. This much of the statement is therefore correct. At the margin, however, accepting a project with marginal revenue in excess of its marginal cost clearly acts to increase operating cash flow.

4. From the shareholder perspective, the financial break-even point is the most important. A project can exceed the accounting and cash break-even points but still be below the financial break-even point. This causes a reduction in shareholder (your) wealth.

5. The project will reach the cash break-even first, the accounting break-even next and finally the financial break-even. For a project with an initial investment and sales after, this ordering will always apply. The cash break-even is achieved first since it excludes depreciation. The accounting break-even is next since it includes depreciation. Finally, the financial break-even, which includes the time value of money, is achieved.

6. Traditional NPV analysis is often too conservative because it ignores profitable options such as the ability to expand the project if it is profitable or abandon the project if it is unprofitable. The option to alter a project when it has already been accepted has value, which increases the NPV of the project.

7. The type of option most likely to affect the decision is the option to expand. If the country just liberalized its markets, there is likely the potential for growth. First entry into a market, whether in an entirely new market, or with a new product, can give a company name recognition and market share. This may make it more difficult for competitors entering the market.

8. Sensitivity analysis can determine how the financial break-even point changes when some factors (such as fixed costs, variable costs, or revenue) change.

9. There are two sources of value with this decision to wait. Potentially, the price of the timber can increase, and the amount of timber will almost definitely increase, barring a natural catastrophe or forest fire. The option to wait for a logging company is quite valuable, and companies in the industry have models to estimate the future growth of a forest depending on its age.

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10. When the additional analysis has a negative NPV. Since the additional analysis is likely to occur almost immediately, this means when the benefits of the additional analysis outweigh the costs. The benefits of the additional analysis are the reduction in the possibility of making a bad decision. Of course, the additional benefits are often difficult, if not impossible, to measure, so much of this decision is based on experience.

Solutions to Questions and Problems

NOTE: All end-of-chapter problems were solved using a spreadsheet. Many problems require multiple steps. Due to space and readability constraints, when these intermediate steps are included in this solutions manual, rounding may appear to have occurred. However, the final answer for each problem is found without rounding during any step in the problem.

Basic

1. *a.* To calculate the accounting break-even, we first need to find the depreciation for each year. The depreciation is:

Depreciation = $772,000/8
Depreciation = $96,500 per year

And the accounting breakeven is:

Q_A = ($1,350,000 + 96,500)/($39 – 21)
Q_A = 80,361.11 units

b. We will use the tax shield approach to calculate the OCF. The OCF is:

$OCF_{base} = [(P - v)Q - FC](1 - T_C) + T_C D$
OCF_{base} = [($39 – 21)(96,000) – $1,350,000](.79) + .21($96,500)
OCF_{base} = $318,885

Now we can calculate the NPV using our base-case projections. There is no salvage value or NWC, so the NPV is:

NPV_{base} = –$772,000 + $318,885($PVIFA_{15\%,8}$)
NPV_{base} = $658,939.52

To calculate the sensitivity of the NPV to changes in the quantity sold, we will calculate the NPV at a different quantity. We will use sales of 100,000 units. The NPV at this sales level is:

OCF_{new} = [($39 – 21)(100,000) – $1,350,000](.79) + .21($96,500)
OCF_{new} = $375,765

And the NPV is:

NPV_{new} = –$772,000 + $375,765($PVIFA_{15\%,8}$)
NPV_{new} = $914,178.37

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So, the change in NPV for every unit change in sales is:

$\Delta NPV/\Delta S = (\$658,939.52 – 914,178.37)/(96,000 – 100,000)$
$\Delta NPV/\Delta S = +\$63.81$

If sales were to drop by 500 units, then NPV would change by:

NPV change = $\$63.81(–500)$
NPV change = $–\$31,904.86$

You may wonder why we chose 100,000 units. Because it doesn't matter! Whatever sales number we use, when we calculate the change in NPV per unit sold, the ratio will be the same.

c. To find out how sensitive OCF is to a change in variable costs, we will compute the OCF at a variable cost of $22. Again, the number we choose to use here is irrelevant: We will get the same ratio of OCF to a one dollar change in variable cost no matter what variable cost we use. So, using the tax shield approach, the OCF at a variable cost of $22 is:

$OCF_{new} = [(\$39 – 22)(96,000) – 1,350,000](.79) + .21(\$96,500)$
$OCF_{new} = \$243,045$

So, the change in OCF for a $1 change in variable costs is:

$\Delta OCF/\Delta v = (\$318,885 – 243,045)/(\$21 – 22)$
$\Delta OCF/\Delta v = –\$75,840$

If variable costs decrease by $1, then OCF would increase by $75,840.

2. We will use the tax shield approach to calculate the OCF for the best- and worst-case scenarios. For the best-case scenario, the price and quantity increase by 10 percent, so we will multiply the base case numbers by 1.10, a 10 percent increase. The variable and fixed costs both decrease by 10 percent, so we will multiply the base case numbers by .90, a 10 percent decrease. Doing so, we get:

$OCF_{best} = \{[(\$39)(1.10) – (\$21)(.90)](96,000)(1.10) – \$1,350,000(.90)\}(.79) + .21(\$96,500)$
$OCF_{best} = \$1,062,591$

The best-case NPV is:

$NPV_{best} = –\$772,000 + \$1,062,591(PVIFA_{15\%,8})$
$NPV_{best} = \$3,996,187.45$

For the worst-case scenario, the price and quantity decrease by 10 percent, so we will multiply the base case numbers by .90, a 10 percent decrease. The variable and fixed costs both increase by 10 percent, so we will multiply the base case numbers by 1.10, a 10 percent increase. Doing so, we get:

$OCF_{worst} = \{[(\$39)(.90) – (\$21)(1.10)](96,000)(.90) – \$1,350,000(1.10)\}(.79) + .21(\$96,500)$
$OCF_{worst} = –\$333,813$

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The worst-case NPV is:

$NPV_{worst} = -\$772,000 - \$333,813(PVIFA_{15\%,8})$
$NPV_{worst} = -\$2,269,926.25$

3. We can use the accounting break-even equation:

$Q_A = (FC + D)/(P - v)$

to solve for the unknown variable in each case. Doing so, we find:

(1): $Q_A = 96,200 = (\$740,000 + D)/(\$37 - 23)$
$D = \$606,800$

(2): $Q_A = 12,318 = (\$855,000 + 725,000)/(P - \$49)$
$P = \$177.27$

(3): $Q_A = 7,583 = (\$245,000 + 143,000)/(\$127 - v)$
$v = \$75.83$

4. When calculating the financial break-even point, we express the initial investment as an equivalent annual cost (EAC). Dividing the initial investment by the five-year annuity factor, discounted at 10 percent, the EAC of the initial investment is:

$EAC = \text{Initial investment}/PVIFA_{10\%,5}$
$EAC = \$538,000/3.79079$
$EAC = \$141,923.04$

Note that this calculation solves for the annuity payment with the initial investment as the present value of the annuity. In other words:

$PVA = C(\{1 - [1/(1 + R)]^t\}/R)$
$\$538,000 = C\{[1 - (1/1.10)^5]/.10\}$
$C = \$141,923.04$

The annual depreciation is the cost of the equipment divided by the economic life, or:

Annual depreciation = $538,000/5
Annual depreciation = $107,600

Now we can calculate the financial break-even point. The financial break-even point for this project is:

$Q_F = [EAC + FC(1 - T_C) - \text{Depreciation}(T_C)]/[(P - VC)(1 - T_C)]$
$Q_F = [\$141,923.04 + \$365,000(1 - .22) - \$107,600(.22)]/[(\$34 - 9)(1 - .22)]$
$Q_F = 20,664.16$, or about 20,664 units

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5. If we purchase the machine today, the NPV is the cost plus the present value of the increased cash flows, so:

$NPV_0 = –\$2{,}700{,}000 + \$495{,}000(PVIFA_{12\%,10})$
$NPV_0 = \$96{,}860.40$

We should not necessarily purchase the machine today. We would want to purchase the machine when the NPV is the highest. So, we need to calculate the NPV each year. The NPV each year will be the cost plus the present value of the increased cash savings. We must be careful, however. In order to make the correct decision, the NPV for each year must be taken to a common date. We will discount all the NPVs to today. Doing so, we get:

Year 1: $NPV_1 = [–\$2{,}495{,}000 + \$495{,}000(PVIFA_{12\%,9})]/1.12$
$NPV_1 = \$127{,}217.54$

Year 2: $NPV_2 = [–\$2{,}290{,}000 + \$495{,}000(PVIFA_{12\%,8})]/1.12^2$
$NPV_2 = \$134{,}711.16$

Year 3: $NPV_3 = [–\$2{,}085{,}000 + \$495{,}000(PVIFA_{12\%,7})]/1.12^3$
$NPV_3 = \$123{,}892.10$

Year 4: $NPV_4 = [–\$1{,}880{,}000 + \$495{,}000(PVIFA_{12\%,6})]/1.12^4$
$NPV_4 = \$98{,}598.49$

Year 5: $NPV_5 = [–\$1{,}675{,}000 + \$495{,}000(PVIFA_{12\%,5})]/1.12^5$
$NPV_5 = \$62{,}056.20$

Year 6: $NPV_6 = [–\$1{,}470{,}000 + \$495{,}000(PVIFA_{12\%,4})]/1.12^6$
$NPV_6 = \$16{,}966.03$

The company should purchase the machine two years from now when the NPV is the highest.

6. We need to calculate the NPV of the two options, go directly to market now, or utilize test marketing first. The NPV of going directly to market now is:

$NPV = C_{Success}$ (Prob. of Success) + $C_{Failure}$ (Prob. of Failure)
$NPV = \$24{,}000{,}000(.50) + \$6{,}500{,}000(.50)$
$NPV = \$16{,}125{,}000$

Now we can calculate the NPV of test marketing first. Test marketing requires a \$1.8 million cash outlay. Choosing the test marketing option will also delay the launch of the product by one year. Thus, the expected payoff is delayed by one year and must be discounted back to Year 0.

$NPV= C_0 + \{[C_{Success}$ (Prob. of Success)] + [$C_{Failure}$ (Prob. of Failure)]$\}/(1 + R)^t$
$NPV = –\$1{,}800{,}000 + \{[\$24{,}000{,}000(.75)] + [\$6{,}500{,}000(.25)]\}/1.11$
$NPV = \$15{,}880{,}180.18$

The company should go to market now since that option has the highest expected payoff.

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7. We need to calculate the NPV of each option and choose the option with the highest NPV. So, the NPV of going directly to market is:

NPV = $C_{Success}$ (Prob. of Success)
NPV = $1,230,000(.40)
NPV = $492,000
The NPV of the focus group is:

NPV = C_0 + $C_{Success}$ (Prob. of Success)
NPV = –$60,000 + $1,230,000(.60)
NPV = $678,000

And the NPV of using the consulting firm is:

NPV = C_0 + $C_{Success}$ (Prob. of Success)
NPV = –$355,000 + $1,230,000(.85)
NPV = $690,500

The firm should hire the consulting firm since that option has the highest NPV.

8. The company should analyze both options, and choose the option with the greatest NPV. So, if the company goes to market immediately, the NPV is:

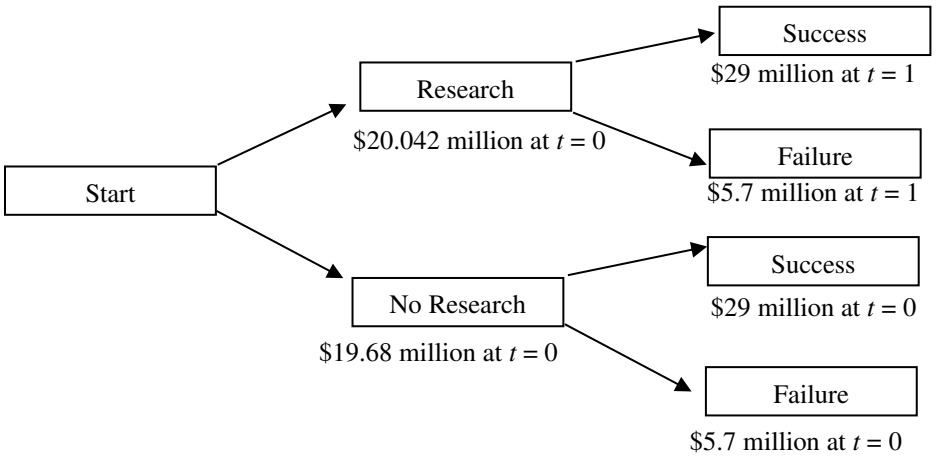
NPV = $C_{Success}$ (Prob. of Success) + $C_{Failure}$ (Prob. of Failure)
NPV = $29,000,000(.60) + $5,700,000(.40)
NPV = $19,680,000

Customer segment research requires a cash outlay of $650,000. Choosing the research option will also delay the launch of the product by one year. Thus, the expected payoff is delayed by one year and must be discounted back to Year 0. So, the NPV of the customer segment research is:

NPV= C_0 + {[$C_{Success}$ (Prob. of Success)] + [$C_{Failure}$ (Prob. of Failure)]}/$(1 + R)^t$
NPV = –$650,000 + {[$29,000,000(.75)] + [$5,700,000(.25)]}/1.12
NPV = $20,041,964.29

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Graphically, the decision tree for the project is:



The company should conduct the market research since it has the largest NPV.

9. *a.* The accounting break-even is the aftertax sum of the fixed costs and depreciation charge divided by the aftertax contribution margin (selling price minus variable cost). So, the accounting break-even level of sales is:

$Q_A = [(FC + Depreciation)(1 - T_C)]/[(P - VC)(1 - T_C)]$
$Q_A = [(\$580{,}000 + \$65{,}000)(1 - .21)]/[(\$52.25 - 14.60)(1 - .21)]$
$Q_A = 17{,}131.47$

b. When calculating the financial break-even point, we express the initial investment as an equivalent annual cost (EAC). Dividing the initial investment by the seven-year annuity factor, discounted at 13 percent, the EAC of the initial investment is:

EAC = Initial investment/$PVIFA_{13\%,7}$
EAC = \$455,000/$PVIFA_{13\%,7}$
EAC = \$102,880.42

Note that this calculation solves for the annuity payment with the initial investment as the present value of the annuity. In other words:

$PVA = C(\{1 - [1/(1 + R)]^t\}/R)$
$\$455{,}000 = C\{[1 - (1/1.13)^7]/.13\}$
$C = \$102{,}880.42$

Now we can calculate the financial break-even point. The financial break-even point for this project is:

$Q_F = [EAC + FC(1 - T_C) - Depreciation(T_C)]/[(P - VC)(1 - T_C)]$
$Q_F = [\$102{,}880.42 + \$580{,}000(.79) - \$65{,}000(.21)]/[(\$52.25 - 14.60)(.79)]$
$Q_F = 18{,}405.04$

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10. When calculating the financial break-even point, we express the initial investment as an equivalent annual cost (EAC). Dividing the initial investment by the six-year annuity factor, discounted at 12 percent, the EAC of the initial investment is:

EAC = Initial investment/PVIFA$_{12\%,6}$
EAC = \$735,000/PVIFA$_{12\%,6}$
EAC = \$178,770.90

Note that this calculation solves for the annuity payment with the initial investment as the present value of the annuity. In other words:

PVA = $C(\{1 - [1/(1 + R)^t]\}/R)$
\$735,000 = $C\{[1 - (1/1.12)^6]/.12\}$
C = \$178,770.90

The annual depreciation is the cost of the equipment divided by the economic life, or:

Annual depreciation = \$735,000/6
Annual depreciation = \$122,500

Now we can calculate the financial break-even point. The financial break-even point for this project is:

Q_F = [EAC + FC$(1 - T_C)$ – Depreciation(T_C)]/[$(P$ – VC$)(1 - T_C)$]
Q_F = [\$178,770.90 + \$475,000$(1 - .23)$ – \$122,500$(.23)$]/[($94 – 26)$(1 - .23)$]
Q_F = 9,861.46

Intermediate

11. *a.* At the accounting break-even, the IRR is zero percent since the project recovers the initial investment. The payback period is N years, the length of the project since the initial investment is exactly recovered over the project life. The NPV at the accounting break-even is:

NPV = I [(I/N)(PVIFA$_{R\%,N}$) – 1]

b. At the cash break-even level, the IRR is –100 percent, the payback period is negative, and the NPV is negative and equal to the initial cash outlay.

c. The definition of the financial break-even is where the NPV of the project is zero. If this is true, then the IRR of the project is equal to the required return. It is impossible to state the payback period, except to say that the payback period must be less than the length of the project. Since the discounted cash flows are equal to the initial investment, the undiscounted cash flows are greater than the initial investment, so the payback must be less than the project life.

12. Using the tax shield approach, the OCF at 73,000 units will be:

OCF = $[(P - v)Q - FC](1 - T_C) + T_C(D)$
OCF = [($26 – 17)(73,000) – 395,000](.78) + .22(\$385,000/4)
OCF = \$225,535

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We will calculate the OCF at 74,000 units. The choice of the second level of quantity sold is arbitrary and irrelevant. No matter what level of units sold we choose, we will still get the same sensitivity. So, the OCF at this level of sales is:

OCF = [($26 – 17)(74,000) – 395,000](.78) + .22($385,000/4)
OCF = $232,555

The sensitivity of the OCF to changes in the quantity sold is:

Sensitivity = ΔOCF/ΔQ = ($225,535 – 232,555)/(73,000 – 74,000)
ΔOCF/ΔQ = +$7.02

OCF will increase by $7.02 for every additional unit sold.

13. *a.* The base-case, best-case, and worst-case values are shown below. Remember that in the best-case, sales and price increase, while costs decrease. In the worst-case, sales and price decrease, and costs increase.

Scenario	Unit sales	Variable cost	Fixed costs
Base	250	$13,200	$595,000
Best	275	$11,880	$535,500
Worst	225	$14,520	$654,500

Using the tax shield approach, the OCF and NPV for the base-case estimate are:

OCF_{base} = [($18,300 – 13,200)(250) – $595,000](.79) + .21($830,000/4)
OCF_{base} = $580,775

NPV_{base} = –$830,000 + $580,775($PVIFA_{15\%,4}$)
NPV_{base} = $828,100.06

The OCF and NPV for the worst-case estimate are:

OCF_{worst} = [($18,300 – 14,520)(225) – $654,500](.79) + .21($830,000/4)
OCF_{worst} = $198,415

NPV_{worst} = –$830,000 + $198,415($PVIFA_{15\%,4}$)
NPV_{worst} = –$263,529.47

And the OCF and NPV for the best-case estimate are:

OCF_{best} = [($18,300 – 11,880)(275) – $535,500](.79) + .21($830,000/4)
OCF_{best} = $1,015,275

NPV_{best} = –$830,000 + $1,015,275($PVIFA_{15\%,4}$)
NPV_{best} = $2,068,588.16

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b. To calculate the sensitivity of the NPV to changes in fixed costs, we choose another level of fixed costs. We will use fixed costs of $600,000. The OCF using this level of fixed costs and the other base-case values with the tax shield approach, we get:

OCF = [($18,300 – 13,200)(250) – $600,000](.79) + .21($830,000/4)
OCF = $576,825

And the NPV is:

NPV = –$830,000 + $576,825($PVIFA_{15\%,4}$)
NPV = $816,822.89

The sensitivity of NPV to changes in fixed costs is:

ΔNPV/ΔFC = ($828,100.06 – 816,822.89)/($595,000 – 600,000)
ΔNPV/ΔFC = –$2.26

For every dollar FC increase, NPV falls by $2.26

c. The accounting break-even is:

Q_A = (FC + *D*)/(*P* – v)
Q_A = [$595,000 + ($830,000/4)]/($18,300 – 13,200)
Q_A = 157.35

14. The marketing study and the research and development are both sunk costs and should be ignored. We will calculate the sales and variable costs first. Since we will lose sales of the expensive clubs and gain sales of the cheap clubs, these must be accounted for as erosion. The total sales for the new project will be:

Sales		
New clubs	$850 × 45,000 =	$38,250,000
Exp. clubs	$1,300 × (–12,000) =	–15,600,000
Cheap clubs	$415 × 10,000 =	4,150,000
		$26,800,000

For the variable costs, we must include the units gained or lost from the existing clubs. Note that the variable costs of the expensive clubs are an inflow. If we are not producing the sets anymore, we will save these variable costs, which is an inflow. So:

Var. costs		
New clubs	–$445 × 45,000 =	–$20,025,000
Exp. clubs	–$720 × (–12,000) =	8,640,000
Cheap clubs	–$185 × 10,000 =	–1,850,000
		–$13,235,000

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The pro forma income statement will be:

Sales	$26,800,000
Variable costs	13,235,000
Costs	6,200,000
Depreciation	2,071,429
EBT	$ 5,293,571
Taxes	1,111,650
Net income	$ 4,181,921

Using the bottom up OCF calculation, we get:

OCF = NI + Depreciation
OCF = $4,181,921 + 2,071,429
OCF = $6,253,350

So, the payback period is:

Payback period = $16,600,000/$6,253,350
Payback period = 2.65 years

The NPV is:

$NPV = -\$14,500,000 - 2,100,000 + \$6,253,350(PVIFA_{14\%,7}) + \$2,100,000/1.14^7$
NPV = $11,055,509.44

And the IRR is:

$IRR = -\$14,500,000 - 2,100,000 + \$6,253,350(PVIFA_{IRR\%,7}) + \$2,100,000/(1 + IRR)^7$
IRR = .3316, or 33.16%

15. The best case and worst case for the variables are:

	Base Case	Best Case	Worst Case
Unit sales (new)	45,000	49,500	40,500
Price (new)	$850	$935	$765
VC (new)	$445	$401	$490
Fixed costs	$6,200,000	$5,580,000	$6,820,000
Sales lost (expensive)	12,000	10,800	13,200
Sales gained (cheap)	10,000	11,000	9,000

Best case
We will calculate the sales and variable costs first. Since we will lose sales of the expensive clubs and gain sales of the cheap clubs, these must be accounted for as erosion. The total sales for the new project will be:

Sales		
New clubs	$935 × 49,500 =	$46,282,500
Exp. clubs	$1,300 × (–10,800) =	– 14,040,000
Cheap clubs	$415 × 11,000 =	4,565,000
		$36,807,500

For the variable costs, we must include the units gained or lost from the existing clubs. Note that the variable costs of the expensive clubs are an inflow. If we are not producing the sets anymore, we will save these variable costs, which is an inflow. So:

Var. costs		
New clubs	–$401 × 49,500 =	–$19,824,750
Exp. clubs	–$720 × (–10,800) =	7,776,000
Cheap clubs	–$185 × 11,000 =	– 2,035,000
		–$14,083,750

The pro forma income statement will be:

Sales	$36,807,500
Variable costs	14,083,750
Costs	5,580,000
Depreciation	2,071,429
EBT	$15,072,321
Taxes	3,165,188
Net income	$11,907,134

Using the bottom up OCF calculation, we get:

OCF = Net income + Depreciation
OCF = $11,907,134 + 2,071,429
OCF = $13,978,563

And the best-case NPV is:

$NPV = -\$14,500,000 - 2,100,000 + \$13,978,563(PVIFA_{14\%,7}) + 2,100,000/1.14^7$
NPV = $44,183,575.59

Worst case
We will calculate the sales and variable costs first. Since we will lose sales of the expensive clubs and gain sales of the cheap clubs, these must be accounted for as erosion. The total sales for the new project will be:

Sales		
New clubs	$765 × 40,500 =	$30,982,500
Exp. clubs	$1,300 × (–13,200) =	– 17,160,000
Cheap clubs	$415 × 9,000 =	3,735,000
		$17,557,500

For the variable costs, we must include the units gained or lost from the existing clubs. Note that the variable costs of the expensive clubs are an inflow. If we are not producing the sets any more, we will save these variable costs, which is an inflow. So:

Var. costs		
New clubs	–$490 × 40,500 =	–$19,824,750
Exp. clubs	–$720 × (–13,200) =	9,504,000
Cheap clubs	–$185 × 9,000 =	–1,665,000
		–$11,985,750

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The pro forma income statement will be:

Sales	$17,557,500	
Variable costs	11,985,750	
Costs	6,820,000	
Depreciation	2,071,429	
EBT	–$ 3,319,679	
Taxes	– 697,133	*assumes a tax credit
Net income	–$2,622,546	

Using the bottom up OCF calculation, we get:

OCF = NI + Depreciation
OCF = –$2,622,546 + 2,071,429
OCF = –$551,118

And the worst case NPV is:

NPV = –$14,500,000 – 2,100,000 – $551,118(PVIFA$_{14\%,7}$) + 2,100,000/1.14^7
NPV = –$18,124,121.46

16. To calculate the sensitivity of the NPV to changes in the price of the new club, we need to change the price of the new club. We will choose $860, but the choice is irrelevant as the sensitivity will be the same no matter what price we choose.

We will calculate the sales and variable costs first. Since we will lose sales of the expensive clubs and gain sales of the cheap clubs, these must be accounted for as erosion. The total sales for the new project will be:

Sales		
New clubs	$860 × 45,000 =	$38,700,000
Exp. clubs	$1,300 × (–12,000) =	–15,600,000
Cheap clubs	$415 × 10,000 =	4,150,000
		$27,250,000

For the variable costs, we must include the units gained or lost from the existing clubs. Note that the variable costs of the expensive clubs are an inflow. If we are not producing the sets anymore, we will save these variable costs, which is an inflow. So:

Var. costs		
New clubs	–$445 × 45,000 =	–$20,025,000
Exp. clubs	–$720 × (–12,000) =	8,640,000
Cheap clubs	–$185 × 10,000 =	–1,850,000
		–$13,235,000

The pro forma income statement will be:

Sales	$27,250,000
Variable costs	13,235,000
Costs	6,200,000
Depreciation	2,071,429
EBT	$ 5,743,571
Taxes	1,206,150
Net income	$ 4,537,421

Using the bottom up OCF calculation, we get:

OCF = NI + Depreciation
OCF = $4,537,421+ 2,071,429
OCF = $6,608,850

And the NPV is:

NPV = –$14,500,000 – 2,100,000 + $6,608,850($PVIFA_{14\%,7}$) + 2,100,000/$1.14^7$
NPV = $12,580,001.81

So, the sensitivity of the NPV to changes in the price of the new club is:

ΔNPV/ΔP = ($11,055,509.44 – 12,580,001.81)/($850 – 860)
ΔNPV/ΔP = $152,449.24

For every dollar increase (decrease) in the price of the clubs, the NPV increases (decreases) by $152,449.24.

To calculate the sensitivity of the NPV to changes in the quantity sold of the new club, we need to change the quantity sold. We will choose 46,000 units, but the choice is irrelevant as the sensitivity will be the same no matter what quantity we choose.

We will calculate the sales and variable costs first. Since we will lose sales of the expensive clubs and gain sales of the cheap clubs, these must be accounted for as erosion. The total sales for the new project will be:

Sales		
New clubs	$850 × 46,000 =	$39,100,000
Exp. clubs	$1,300 × (–12,000) =	–15,600,000
Cheap clubs	$415 × 10,000 =	4,150,000
		$27,650,000

For the variable costs, we must include the units gained or lost from the existing clubs. Note that the variable costs of the expensive clubs are an inflow. If we are not producing the sets anymore, we will save these variable costs, which is an inflow. So:

Var. costs		
New clubs	–$445 × 46,000 =	–$20,470,000
Exp. clubs	–$720 × (–12,000) =	8,640,000
Cheap clubs	–$185 × 10,000 =	–1,850,000
		–$13,680,000

The pro forma income statement will be:

Sales	$27,650,000
Variable costs	13,680,000
Costs	6,200,000
Depreciation	2,071,429
EBT	$ 5,698,571
Taxes	1,196,700
Net income	$ 4,501,871

Using the bottom up OCF calculation, we get:

OCF = NI + Depreciation
OCF = $4,501,871 + 2,071,429
OCF = $6,573,300

The NPV at this quantity is:

NPV = –$14,500,000 – 2,100,000 + $6,573,300($PVIFA_{14\%,7}$) + $2,100,000/$1.14^7$
NPV = $12,427,552.58

So, the sensitivity of the NPV to changes in the quantity sold is:

ΔNPV/ΔQ = ($11,055,509.44 – 12,427,552.58)/(45,000 – 46,000)
ΔNPV/ΔQ = $1,372.04

For an increase (decrease) of one set of clubs sold per year, the NPV increases (decreases) by $1,372.04.

17. *a.* The base-case NPV is:

NPV = –$3,950,000 + $896,000($PVIFA_{11\%,10}$)
NPV = $1,326,751.88

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b. We would abandon the project if the cash flow from selling the equipment is greater than the present value of the future cash flows. We need to find the sales quantity where the two are equal, so:

$1,750,000 = ($64)Q(PVIFA$_{11\%,9}$)
Q = $1,750,000/[$64(5.5370)]
Q = 4,938.33

Abandon the project if Q < 4,938, because the NPV of abandoning the project is greater than the NPV of the future cash flows.

c. The $1,750,000 is the market value of the project. If you continue with the project in one year, you forego the $1,750,000 that could have been used for something else.

18. *a.* If the project is a success, the present value of the future cash flows will be:

PV future CFs = $64(19,000)(PVIFA$_{11\%,9}$)
PV future CFs = $6,733,049.80

From the previous question, if the quantity sold is 3,700, we would abandon the project, and the cash flow would be $1,750,000. Since the project has an equal likelihood of success or failure in one year, the expected value of the project in one year is the average of the success and failure cash flows, plus the cash flow in one year, so:

Expected value of project at year 1 = [($6,733,049.80 + 1,750,000)/2] + $896,000
Expected value of project at year 1 = $5,137,524.90

The NPV is the present value of the expected value in one year plus the cost of the equipment, so:

NPV = –$3,950,000 + $5,137,524.90/1.11
NPV = $678,400.81

b. If we couldn't abandon the project, the present value of the future cash flows when the quantity is 3,700 will be:

PV future CFs = $64(3,700)(PVIFA$_{11\%,9}$)
PV future CFs = $1,311,172.86

The gain from the option to abandon is the abandonment value minus the present value of the cash flows if we cannot abandon the project, so:

Gain from option to abandon = $1,750,000 – 1,311,172.86
Gain from option to abandon = $438,827.14

We need to find the value of the option to abandon times the likelihood of abandonment. So, the value of the option to abandon today is:

Option value = (.50)($438,827.14)/1.11
Option value = $197,669.88

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19. If the project is a success, the present value of the future cash flows will be:

PV future CFs = \$64(28,000)($PVIFA_{11\%,9}$)
PV future CFs = \$9,922,389.18

If the sales are only 3,700 units, from Problem 17, we know we will abandon the project, with a value of \$1,750,000. Since the project has an equal likelihood of success or failure in one year, the expected value of the project in one year is the average of the success and failure cash flows, plus the cash flow in one year, so:

Expected value of project at year 1 = [(\$9,922,389.18 + \$1,750,000)/2] + \$896,000
Expected value of project at year 1 = \$6,732,194.59

The NPV is the present value of the expected value in one year plus the cost of the equipment, so:

NPV = –\$3,950,000 + \$6,732,194.59/1.11
NPV = \$2,115,040.17

The gain from the option to expand is the present value of the cash flows from the additional units sold, so:

Gain from option to expand = \$64(19,000)($PVIFA_{11\%,9}$)
Gain from option to expand = \$6,733,049.80

We need to find the value of the option to expand times the likelihood of expansion. We also need to find the value of the option to expand today, so:

Option value = (.50)(\$6,733,049.80)/1.11
Option value = \$3,032,905.32

20. *a.* The accounting break-even is the aftertax sum of the fixed costs and depreciation charge divided by the contribution margin (selling price minus variable cost). In this case, there are no fixed costs, and the depreciation is the entire price of the press in the first year. So, the accounting break-even level of sales is:

Q_A = [(FC + Depreciation)(1 – T_C)]/[(P – VC)(1 – T_C)]
Q_A = [(\$0 + 10,500) (1 – .21)]/[(\$14 – 3.85)(1 – .21)]
Q_A = 1,034.48

b. When calculating the financial break-even point, we express the initial investment as an equivalent annual cost (EAC). The initial investment is the \$25,000 in licensing fees. Dividing the initial investment by the 3-year annuity factor, discounted at 12 percent, the EAC of the initial investment is:

EAC = Initial investment/$PVIFA_{12\%,3}$
EAC = \$25,000/$PVIFA_{12\%,3}$
EAC = \$10,408.72

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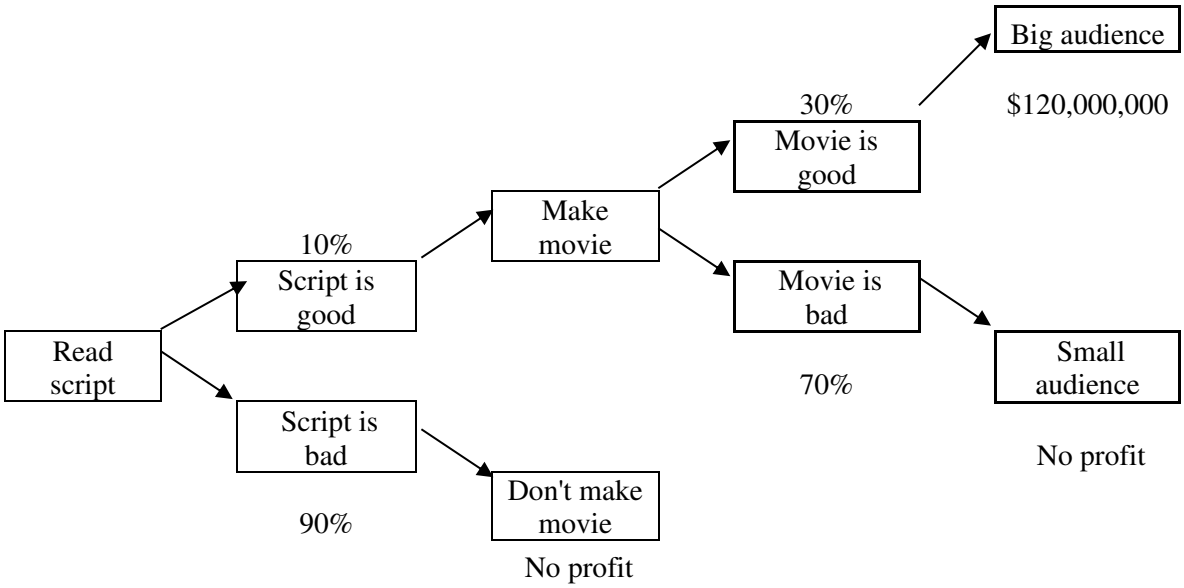
Note, this calculation solves for the annuity payment with the initial investment as the present value of the annuity, in other words:

PVA = $C(\{1 - [1/(1 + R)^t]\}/R)$
$\$25{,}000 = C\{[1 - (1/1.12)^3]/.12\}$
$C = \$10{,}408.72$

Now we can calculate the financial break-even point. Notice that there are no fixed costs or depreciation. The financial break-even point for this project is:

$Q_F = [EAC + FC(1 - T_C) - Depreciation(T_C)]/[(P - VC)(1 - T_C)]$
$Q_F = (\$10{,}408.72 + 0 - 0)/[(\$14 - 3.85)(.79)]$
$Q_F = 1{,}298.09$

21. The payoff from taking the lump sum is $50,000, so we need to compare this to the expected payoff from taking 1 percent of the profit. The decision tree for the movie project is:



The value of 1 percent of the profits is as follows. There is a 30 percent probability the movie is good, and the audience is big, so the expected value of this outcome is:

Value = $\$120{,}000{,}000 \times .30$
Value = $\$36{,}000{,}000$

The expected value that the movie is good, and has a big audience, assuming the script is good is:

Value = $\$36{,}000{,}000 \times .10$
Value = $\$3{,}600{,}000$

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This is the expected value for the studio, but the screenwriter will only receive 1 percent of this amount, so the payment to the screenwriter will be:

Payment to screenwriter = $3,600,000 × .01
Payment to screenwriter = $36,000

The screenwriter should take the cash offered today.

22. Apply the accounting profit break-even point formula and solve for the sales price, *P*, that allows the firm to break even when producing 45,000 calculators. In order for the firm to break even, the revenues from the calculator sales must equal the total annual cost of producing the calculators. The depreciation charge each year will be:

Depreciation = Initial investment/Economic life
Depreciation = $726,000/5
Depreciation = $145,200 per year

Now we can solve the accounting break-even equation for the sales price at 45,000 units. The accounting break-even is the point at which the net income of the product is zero. So, solving the accounting break-even equation for the sales price, we get:

$Q_A = [(FC + Depreciation)(1 - T_C)]/[(P - VC)(1 - T_C)]$
$45{,}000 = [(\$875{,}000 + 145{,}200)(1 - .21)]/[(P - \$12.70)(1 - .21)]$
$P = \$35.37$

23. *a.* The NPV of the project is sum of the present value of the cash flows generated by the project. The cash flows from this project are an annuity, so the NPV is:

$NPV = -\$27{,}500{,}000 + \$6{,}800{,}000(PVIFA_{14\%,10})$
$NPV = \$7{,}969{,}586.39$

b. The company should abandon the project if the PV of the revised cash flows for the next nine years is less than the project's aftertax salvage value. Since the option to abandon the project occurs in Year 1, discount the revised cash flows to Year 1 as well. To determine the level of expected cash flows below which the company should abandon the project, calculate the equivalent annual cash flows the project must earn to equal the aftertax salvage value. We will solve for C_2, the revised cash flow beginning in Year 2. So, the revised annual cash flow below which it makes sense to abandon the project is:

Aftertax salvage value = $C_2(PVIFA_{14\%,9})$
$\$17{,}000{,}000 = C_2(PVIFA_{14\%,9})$
$C_2 = \$17{,}000{,}000/PVIFA_{14\%,9}$
$C_2 = \$3{,}436{,}862.52$

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24. *a.* The NPV of the project is sum of the present value of the cash flows generated by the project. The annual cash flow for the project is the number of units sold times the cash flow per unit, which is:

Annual cash flow = 10($153,000)
Annual cash flow = $1,530,000

The cash flows from this project are an annuity, so the NPV is:

NPV = –$5,900,000 + $1,530,000($PVIFA_{13\%,5}$)
NPV = –$518,636.17

b. The company will abandon the project if unit sales are not revised upward. If the unit sales are revised upward, the aftertax cash flows for the project over the last four years will be:

New annual cash flow = 20($153,000)
New annual cash flow = $3,060,000

The NPV of the project will be the initial cost, plus the expected cash flow in Year 1 based on the 10-unit sales projection, plus the expected value of abandonment, plus the expected value of expansion. We need to remember that the abandonment value occurs in Year 1, and the present value of the expansion cash flows are in Year 1, so each of these must be discounted back to today. So, the project NPV under the abandonment or expansion scenario is:

NPV = –$5,900,000 + $1,530,000/1.13 + .50($3,100,000)/1.13
+ [.50($3,060,000)($PVIFA_{13\%,4}$)]/1.13
NPV = $853,045.25

25. To calculate the unit sales for each scenario, we multiply the market sales times the company's market share. We can then use the quantity sold to find the revenue each year, and the variable costs each year. After doing these calculations, we will construct the pro forma income statement for each scenario. We can then find the operating cash flow using the bottom up approach, which is net income plus depreciation. Doing so, we find:

	Pessimistic	*Expected*	*Optimistic*
Units per year	11,340	16,490	21,280
Revenue	$1,247,400	$1,912,840	$2,532,320
Variable costs	430,920	593,640	723,520
Fixed costs	615,000	575,000	550,000
Depreciation	310,000	290,000	270,000
EBT	–$108,520	$454,200	$988,800
Tax	–24,960	104,466	227,424
Net income	–$83,560	$349,734	$761,376
OCF	$226,440	$639,734	$1,031,376

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Note that under the pessimistic scenario, the taxable income is negative. We assumed a tax credit in this case. Now we can calculate the NPV under each scenario, which will be:

$NPV_{Pessimistic} = -\$1,550,000 + 226,400(PVIFA_{13\%,5})$
$NPV_{Pessimistic} = -\$753,559.56$

$NPV_{Expected} = -\$1,450,000 + 639,734(PVIFA_{13\%,5})$
$NPV_{Expected} = \$800,092.42$

$NPV_{Optimistic} = -\$1,350,000 + 1,031,376(PVIFA_{13\%,5})$
$NPV_{Optimistic} = \$2,277,587.91$

The NPV under the pessimistic scenario is negative, but the company should probably accept the project since the NPV is positive for the expected and optimistic scenarios

Challenge

26. *a*. Using the tax shield approach, the OCF is:

$OCF = [(\$219 - 124)(35,000) - 850,000](.76) + .24(\$6,500,000/5)$
$OCF = \$2,193,000$

And the NPV is:

$NPV = -\$6,500,000 - 550,000 + 2,193,000(PVIFA_{13\%,5}) + [\$550,000 + 400,000(1 - .24)]/1.13^5$
$NPV = \$1,126,805.14$

b. The worst-case OCF is:

$OCF_{worst} = \{[(\$219)(.9) - 124](35,000) - \$850,000\}(.76) + .24(1.15)(\$6,500,000/5)$
$OCF_{worst} = \$1,657,260$

And the worst-case NPV is:

$NPV_{worst} = -\$6,500,000(1.15) - 550,000(1.05) + 1,657,260(PVIFA_{13\%,5}) + [\$550,000(1.05) + \$400,000(.85)(1 - .24)]/1.13^5$
$NPV_{worst} = -\$1,769,840.29$

The best-case OCF is:

$OCF_{best} = \{[\$219(1.1) - 124](35,000) - \$850,000\}(.76) + .24(.85)(\$6,500,000/5)$
$OCF_{best} = \$2,728,740$

And the best-case NPV is:

$NPV_{best} = -\$6,500,000(.85) - 550,000(.95) + 2,728,740(PVIFA_{13\%,5}) + [\$550,000(.95) + \$400,000(1.15)(1 - .24)]/1.13^5$
$NPV_{best} = \$4,023,450.57$

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27. To calculate the sensitivity to changes in quantity sold, we will choose a quantity of 34,000. The OCF at this level of sales is:

OCF = [($219 – 124)(34,000) – $850,000](.76) + .24($6,500,000/5)
OCF = $2,120,800

The sensitivity of changes in the OCF to quantity sold is:

ΔOCF/ΔQ = ($2,193,000 – 2,120,800)/(35,000 – 34,000)
ΔOCF/ΔQ = +$72.20

The NPV at this level of sales is:

NPV = –$6,500,000 – 550,000 + 2,120,800($PVIFA_{13\%,5}$) + [$550,000 + 400,000(1 – .24)]/1.13^5
NPV = $872,861.04

And the sensitivity of NPV to changes in the quantity sold is:

ΔNPV/ΔQ = ($1,126,805.14 – 872,861.04)/(35,000 – 34,000)
ΔNPV/ΔQ = +$253.94

You wouldn't want the quantity to fall below the point where the NPV is zero. We know the NPV changes $253.94 for every unit sale, so we can divide the NPV for 35,000 units by the sensitivity to get a change in quantity. Doing so, we get:

$1,126,805.14 = $253.94(ΔQ)
ΔQ = 4,437

If sales decreased by 4,437 units the NPV would be zero, so the minimum quantity is:

Q_{Min} = 35,000 – 4,437
Q_{Min} = 30,563

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28. We will use the bottom up approach to calculate the operating cash flow. Assuming we operate the project for all four years, the cash flows are:

Year	0	1	2	3	4
Sales		$10,990,000	$10,990,000	$10,990,000	$10,990,000
Operating costs		4,524,000	4,524,000	4,524,000	4,524,000
Depreciation		3,175,000	3,175,000	3,175,000	3,175,000
EBT		$3,291,000	$3,291,000	$3,291,000	$3,291,000
Tax		691,110	691,110	691,110	691,110
Net income		$2,599,890	$2,599,890	$2,599,890	$2,599,890
+Depreciation		3,175,000	3,175,000	3,175,000	3,175,000
Operating CF		$5,774,890	$5,774,890	$5,774,890	$5,774,890
Change in NWC	–$2,028,000	0	0	0	$2,028,000
Capital spending	–12,700,000	0	0	0	0
Total cash flow	–$14,728,000	$5,774,890	$5,774,890	$5,774,890	$7,802,890

There is no salvage value for the equipment. The NPV is:

NPV = –$14,728,000 + $5,774,890(PVIFA$_{16\%,4}$) + $2,028,000/1.16^4
NPV = $2,551,231.73

The cash flows if we abandon the project after one year are:

Year	0	1
Sales		$10,990,000
Operating costs		4,524,000
Depreciation		3,175,000
EBT		$3,291,000
Tax		691,110
Net income		$2,599,890
+Depreciation		3,175,000
Operating CF		$5,774,890
Change in NWC	–$2,028,000	$2,028,000
Capital spending	–12,700,000	8,952,250
Total cash flow	–$14,728,000	$16,755,140

The book value of the equipment is:

Book value = $12,700,000 – (1)($12,700,000/4)
Book value = $9,525,000

So the taxes on the salvage value will be:

Taxes = ($9,525,000 – 8,800,000)(.21)
Taxes = $152,250

This makes the aftertax salvage value:

Aftertax salvage value = $8,800,000 + 152,250
Aftertax salvage value = $8,952,250

The NPV if we abandon the project after one year is:

NPV = –$14,728,000 + $16,755,140/1.16
NPV = –$283,913.79

If we abandon the project after two years, the cash flows are:

Year	0	1	2
Sales		$10,990,000	$10,990,000
Operating costs		4,524,000	4,524,000
Depreciation		3,175,000	3,175,000
EBT		$3,291,000	$3,291,000
Tax		691,110	691,110
Net income		$2,599,890	$2,599,890
+Depreciation		3,175,000	3,175,000
Operating CF		$5,774,890	$5,774,890
Change in NWC	–$2,028,000	0	$2,028,000
Capital spending	–12,700,000	0	7,621,900
Total cash flow	–$14,728,000	$5,774,890	$15,424,790

The book value of the equipment is:

Book value = $12,700,000 – (2)($12,700,000/4)
Book value = $6,350,000

So the taxes on the salvage value will be:

Taxes = ($6,350,000 – 7,960,000)(.21)
Taxes = –$338,100

This makes the aftertax salvage value:

Aftertax salvage value = $7,960,000 – 338,100
Aftertax salvage value = $7,621,900

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The NPV if we abandon the project after two years is:

NPV = –$14,728,000 + $5,774,890/1.16 + $15,424,790/$1.16^2$
NPV = $1,713,485.14

If we abandon the project after three years, the cash flows are:

Year	0	1	2	3
Sales		$10,990,000	$10,990,000	$10,990,000
Operating costs		4,524,000	4,524,000	4,524,000
Depreciation		3,175,000	3,175,000	3,175,000
EBT		$3,291,000	$3,291,000	$3,291,000
Tax		691,110	691,110	691,110
Net income		$2,599,890	$2,599,890	$2,599,890
+Depreciation		3,175,000	3,175,000	3,175,000
Operating CF		$5,774,890	$5,774,890	$5,774,890
Change in NWC	–$2,028,000	0	0	$2,028,000
Capital spending	–12,700,000	0	0	4,853,750
Total cash flow	–$14,728,000	$5,774,890	$5,774,890	$12,656,640

The book value of the equipment is:

Book value = $12,700,000 – (3)($12,700,000/4)
Book value = $3,175,000

So the taxes on the salvage value will be:

Taxes = ($3,175,000 – 5,300,000)(.21)
Taxes = –$446,250

This makes the aftertax salvage value:

Aftertax salvage value = $5,300,000 – 446,250
Aftertax salvage value = $4,853,750

The NPV if we abandon the project after three years is:

NPV = –$14,728,000 + $5,774,890($PVIFA_{16\%,2}$) + $12,656,640/$1.16^3$
NPV = $2,650,610.99

We should abandon the equipment after three years since the NPV of abandoning the project after three years has the highest NPV.

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29. *a.* The NPV of the project is sum of the present value of the cash flows generated by the project. The cash flows from this project are an annuity, so the NPV is:

NPV = –$3,700,000 + $600,000(PVIFA$_{11\%,10}$)
NPV = –$166,460.79

b. The company will abandon the project if the value of abandoning the project is greater than the value of the future cash flows. The present value of the future cash flows if the company revises its sales downward will be:

PV of downward revision = $340,000(PVIFA$_{11\%,9}$)
PV of downward revision = $1,882,596.16

Since this is less than the value of abandoning the project, the company should abandon in one year. So, the revised NPV of the project will be the initial cost, plus the expected cash flow in year one based on the upward sales projection, plus the expected value of abandonment. We need to remember that the abandonment value occurs in Year 1, and the present value of the expansion cash flows are in Year 1, so each of these must be discounted back to today. So, the project NPV under the abandonment or expansion scenario is:

NPV = –$3,700,000 + $600,000/1.11 + .50($2,460,000)/1.11
+ [.50($940,000)(PVIFA$_{11\%,9}$)]/1.11
NPV = $293,164.27

30. First, determine the cash flow from selling the old harvester. When calculating the salvage value, remember that tax liabilities or credits are generated on the difference between the resale value and the book value of the asset. Using the original purchase price of the old harvester to determine annual depreciation, the annual depreciation for the old harvester is:

Depreciation$_{Old}$ = $67,000/15
Depreciation$_{Old}$ = $4,466.67

Since the machine is five years old, the firm has accumulated five annual depreciation charges, reducing the book value of the machine. The current book value of the machine is equal to the initial purchase price minus the accumulated depreciation, so:

Book value = Initial purchase price – Accumulated depreciation
Book value = $67,000 – ($4,466.67 × 5 years)
Book value = $44,666.67

Since the firm is able to resell the old harvester for $21,000, which is less than the $44,666.67 book value of the machine, the firm will generate a tax credit on the sale. The aftertax salvage value of the old harvester will be:

Aftertax salvage value = Market value + T_C(Book value – Market value)
Aftertax salvage value = $21,000 + .21($44,666.67 – 21,000)
Aftertax salvage value = $25,970

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Next, we need to calculate the incremental depreciation. We need to calculate the depreciation tax shield generated by the new harvester less the forgone depreciation tax shield from the old harvester. Let P be the break-even purchase price of the new harvester. So, we find:

$\text{Depreciation tax shield}_{\text{New}} = (\text{Initial investment/Economic life}) \times T_C$
$\text{Depreciation tax shield}_{\text{New}} = (P/10)(.21)$

And the depreciation tax shield on the old harvester is:

$\text{Depreciation tax shield}_{\text{Old}} = (\$67{,}000/15)(.21)$
$\text{Depreciation tax shield}_{\text{Old}} = (\$4{,}466.67)(.21)$

So, the incremental depreciation tax, which is the depreciation tax shield from the new harvester, minus the depreciation tax shield from the old harvester, is:

Incremental depreciation tax shield $= (P/10)(.21) - (\$4{,}466.67)(.21)$
Incremental depreciation tax shield $= (P/10 - \$4{,}466.67)(.21)$

The present value of the incremental depreciation tax shield will be:

$\text{PV}_{\text{Depreciation tax shield}} = (P/10)(.21)(\text{PVIFA}_{13\%,10}) - \$4{,}466.67(.21)(\text{PVIFA}_{13\%,10})$

The new harvester will generate year-end pre-tax cash flow savings of $9,000 per year for 10 years. We can find the aftertax present value of the cash flows savings as:

$\text{PV}_{\text{Savings}} = C_1(1 - T_C)(\text{PVIFA}_{13\%,10})$
$\text{PV}_{\text{Savings}} = \$9{,}000(1 - T_C)(\text{PVIFA}_{13\%,10})$
$\text{PV}_{\text{Savings}} = \$38{,}580.59$

The break-even purchase price of the new harvester is the price, P, which makes the NPV of the machine equal to zero.

$\text{NPV} = -P + \text{Salvage value}_{\text{Old}} + \text{PV}_{\text{Depreciation tax shield}} + \text{PV}_{\text{Savings}}$
$\$0 = -P + \$25{,}970 + (P/10)(.21)(\text{PVIFA}_{13\%,10}) - \$4{,}466.67(.21)(\text{PVIFA}_{13\%,10}) + \$38{,}580.59$
$P - (P/10)(.21)(\text{PVIFA}_{13\%,10}) = \$64{,}550.59 - \$4{,}466.67(.21)(\text{PVIFA}_{13\%,10})$
$P[1 - (1/10)(.21)(\text{PVIFA}_{13\%,10}) = \$59{,}460.77$
$P = \$67{,}107.78$

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CHAPTER 10
RISK AND RETURN LESSONS FROM MARKET HISTORY

Answers to Concept Questions

1. They all wish they had! Since they didn't, it must have been the case that the stellar performance was not foreseeable, at least not by most.

2. As in the previous question, it's easy to see after the fact that the investment was terrible, but it probably wasn't so easy ahead of time.

3. No, stocks are riskier. Some investors are highly risk averse, and the extra possible return doesn't attract them relative to the extra risk.

4. Unlike gambling, the stock market is a positive sum game; everybody can win. Also, speculators provide liquidity to markets and thus help to promote efficiency.

5. T-bill rates were highest in the early 1980s. This was during a period of high inflation and is consistent with the Fisher effect.

6. Before the fact, for most assets the risk premium will be positive; investors demand compensation over and above the risk-free return to invest their money in the risky asset. After the fact, the observed risk premium can be negative if the asset's nominal return is unexpectedly low, the risk-free return is unexpectedly high, or if some combination of these two events occurs.

7. Yes, the stock prices are currently the same. Below is a table that depicts the stocks' price movements. Two years ago, each stock had the same price, P_0. Over the first year, General Materials' stock price increased by 10 percent, or $(1.1) \times P_0$. Standard Fixtures' stock price declined by 10 percent, or $(.9) \times P_0$. Over the second year, General Materials' stock price decreased by 10 percent, or $(.9)(1.1) \times P_0$, while Standard Fixtures' stock price increased by 10 percent, or $(1.1)(.9) \times P_0$. Today, each of the stocks is worth 99 percent of its original value.

	2 years ago	1 year ago	Today	
General Materials	P_0	$(1.1)P_0$	$(1.1)(.9)P_0$	$= (.99)P_0$
Standard Fixtures	P_0	$(.9)P_0$	$(.9)(1.1)P_0$	$= (.99)P_0$

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8. The stock prices are not the same. The return quoted for each stock is the arithmetic return, not the geometric return. The geometric return tells you the wealth increase from the beginning of the period to the end of the period, assuming the asset had the same return each year. As such, it is a better measure of ending wealth. To see this, assuming each stock had a beginning price of $100 per share, the ending price for each stock would be:

Lake Minerals ending price = $100(1.10)(1.10) = $121.00
Small Town Furniture ending price = $100(1.25)(.95) = $118.75

Whenever there is any variance in returns, the asset with the larger variance will always have the greater difference between the arithmetic and geometric return.

9. To calculate an arithmetic return, you sum the returns and divide by the number of returns. As such, arithmetic returns do not account for the effects of compounding. Geometric returns do account for the effects of compounding. As an investor, the more important return of an asset is the geometric return.

10. Risk premiums are about the same whether or not we account for inflation. The reason is that risk premiums are the difference between two returns, so inflation essentially nets out. Returns, risk premiums, and volatility would all be lower than we estimated because aftertax returns are smaller than pretax returns.

Solutions to Questions and Problems

NOTE: All end of chapter problems were solved using a spreadsheet. Many problems require multiple steps. Due to space and readability constraints, when these intermediate steps are included in this solutions manual, rounding may appear to have occurred. However, the final answer for each problem is found without rounding during any step in the problem.

Basic

1. The return of any asset is the increase in price, plus any dividends or cash flows, all divided by the initial price. The return of this stock is:

R = ($87 – 76 + 1.31)/$76
R = .1620, or 16.20%

2. The dividend yield is the dividend divided by the beginning of the period price, so:

Dividend yield = $1.31/$76
Dividend yield = .0172, or 1.72%

And the capital gains yield is the increase in price divided by the initial price, so:

Capital gains yield = ($87 – 76)/$76
Capital gains yield = .1447, or 14.47%

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3. Using the equation for total return, we find:

$R = [(\$64 - 76) + 1.31]/\$76$
$R = -.1407$, or -14.07%

And the dividend yield and capital gains yield are:

Dividend yield = $\$1.31/\$76$
Dividend yield = .0172, or 1.72%

Capital gains yield = $(\$64 - 76)/\$76$
Capital gains yield = $-.1579$, or -15.79%

Here's a question for you: Can the dividend yield ever be negative? No, that would mean you were paying the company for the privilege of owning the stock. It has happened on bonds issued by Berkshire Hathaway, the company operated by the noted investor Warren Buffett.

4. *a.* The total dollar return is the change in price plus the coupon payment, so:

Total dollar return = $\$1,032 - 1,015 + 52$
Total dollar return = $\$69$

b. The total percentage return of the bond is:

$R = (\$1,032 - 1,015 + 52)/\$1,015$
$R = .0680$, or 6.80%

Notice here that we could have used the total dollar return of $69 in the numerator of this equation.

c. Using the Fisher equation, the real return was:

$(1 + R) = (1 + r)(1 + h)$

$r = (1.0680/1.032) - 1$
$r = .0349$, or 3.49%

5. The nominal return is the stated return, which is 11.90 percent. Using the Fisher equation, the real return was:

$(1 + R) = (1 + r)(1 + h)$

$r = 1.1190/1.030 - 1$
$r = .0864$, or 8.64%

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6. Using the Fisher equation, the real returns for government and corporate bonds were:

$1 + R = (1 + r)(1 + h)$

$r_G = 1.059/1.030 - 1$
$r_G = .0282$, or 2.82%

$r_C = 1.063/1.030 - 1$
$r_C = .0320$, or 3.20%

7. The average return is the sum of the returns, divided by the number of returns. The average return for each stock was:

$$\bar{X} = \sum_{i=1}^{N} x_i/N = \frac{.19 + .13 + .08 - .09 + .17}{5} = .0960, \text{or } 9.60\%$$

$$\bar{Y} = \sum_{i=1}^{N} y_i/N = \frac{.38 + .16 + .19 - .27 + .18}{5} = .1280, \text{or } 12.80\%$$

We calculate the variance of each stock as:

$$\sigma_X^2 = \left[\sum_{i=1}^{N}(x_i - \bar{x})^2\right] \Big/ (N-1)$$

$$\sigma_X^2 = \frac{1}{5-1}\left\{(.19-.096)^2 + (.13-.096)^2 + (.08-.096)^2 + (-.09-.096)^2 + (.17-.096)^2\right\} = .01258$$

$$\sigma_Y^2 = \frac{1}{5-1}\left\{(.38-.128)^2 + (.16-.128)^2 + (.19-.128)^2 + (-.27-.128)^2 + (.18-.128)^2\right\} = .05737$$

The standard deviation is the square root of the variance, so the standard deviation of each stock is:

$\sigma_X = .01258^{1/2}$
$\sigma_X = .1122$, or 11.22%

$\sigma_Y = .05737^{1/2}$
$\sigma_Y = .2395$, or 23.95%

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8. We will calculate the sum of the returns for each asset and the observed risk premium first. Doing so, we get:

Year	Large-co. stock return	T-bill return	Risk premium
1973	–14.69%	6.93%	–21.62%
1974	–26.47	8.00	–34.47
1975	37.23	5.80	31.43
1976	23.93	5.08	18.85
1977	–7.16	5.12	–12.28
1978	6.57	7.18	–.61
	19.41	38.11	–18.70

a. The average return for large-company stocks over this period was:

Large-company stock average return = 19.41%/6
Large-company stock average return = 3.24%

And the average return for T-bills over this period was:

T-bills average return = 38.11%/6
T-bills average return = 6.35%

b. Using the equation for variance, we find the variance for large company stocks over this period was:

$$\text{Variance} = 1/5[(-.1469 - .0324)^2 + (-.2647 - .0324)^2 + (.3723 - .0324)^2 + (.2393 - .0324)^2 + (-.0716 - .0324)^2 + (.0657 - .0324)^2]$$
$$\text{Variance} = .058136$$

And the standard deviation for large company stocks over this period was:

$$\text{Standard deviation} = .058136^{1/2}$$
Standard deviation = .2411, or 24.11%

Using the equation for variance, we find the variance for T-bills over this period was:

$$\text{Variance} = 1/5[(.0693 - .0635)^2 + (.0800 - .0635)^2 + (.0580 - .0635)^2 + (.0508 - .0635)^2 + (.0512 - .0635)^2 + (.0718 - .0635)^2]$$
$$\text{Variance} = .000144$$

And the standard deviation for T-bills over this period was:

$$\text{Standard deviation} = .000144^{1/2}$$
Standard deviation = .0120, or 1.20%

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c. The average observed risk premium over this period was:

Average observed risk premium = –18.70%/6
Average observed risk premium = –3.12%

The variance of the observed risk premium was:

Variance = 1/5[(–.2162 – .0312)^2 + (–.3447 – .0312)^2 + (.3143 – .0312)^2 +
(.1885 – .0312)^2 + (–.1228 – .0312)^2 + (–.0061 – .0312)^2]
Variance = .061833

And the standard deviation of the observed risk premium was:

Standard deviation = .061833$^{1/2}$
Standard deviation = .2487, or 24.87%

9. *a*. To find the average return, we sum all the returns and divide by the number of returns, so:

Arithmetic average return = (.21 – .11 + .08 + .17 + .13)/5
Arithmetic average return = .0960, or 9.60%

b. Using the equation to calculate variance, we find:

Variance = 1/4[(.21 – .096)^2 + (–.11 – .096)^2 + (.08 – .096)^2 + (.17 – .096)^2 +
(.13 – .096)^2]
Variance = .01558

So, the standard deviation is:

Standard deviation = .01558$^{1/2}$
Standard deviation = .1248, or 12.48%

10. *a*. To calculate the average real return, we can use the average return of the asset, and the average inflation rate in the Fisher equation. Doing so, we find:

$(1 + R) = (1 + r)(1 + h)$

$\bar{r}$ = (1.096/1.026) – 1
$\bar{r}$ = .0682, or 6.82%

b. The average risk premium is the average return of the asset, minus the average risk-free rate, so, the average risk premium for this asset would be:

$\overline{RP} = \bar{R} - \overline{R_f}$
$\overline{RP}$ = .0960 – .0325
$\overline{RP}$ = .0635, or 6.35%

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11. We can find the average real risk-free rate using the Fisher equation. The average real risk-free rate was:

$(1 + R) = (1 + r)(1 + h)$

$\bar{r}_f = (1.0325/1.026) - 1$
$\bar{r}_f = .0063$, or .63%

And to calculate the average real risk premium, we can subtract the average real risk-free rate from the average real return. So, the average real risk premium was:

$\overline{rp} = \bar{r} - \bar{r}_f$
$\overline{rp} = 6.82\% - .63\%$
$\overline{rp} = .0619$, or 6.19%

12. Apply the 5-year holding-period return formula to calculate the total return of the stock over the 5-year period, we find:

5-year holding-period return = $[(1 + R_1)(1 + R_2)(1 + R_3)(1 + R_4)(1 + R_5)] - 1$
5-year holding-period return = $[(1 - .1318)(1 + .1763)(1 + .2487)(1 + .0832)(1 + .1341)] - 1$
5-year holding-period return = .5666, or 56.66%

13. To find the return on the zero coupon bond, we first need to find the price of the bond today. Remember that a zero coupon bond price is calculated with semiannual periods. Since one year has elapsed, the bond now has 19 years to maturity, so the price today is:

$P_1 = \$1{,}000/1.0215^{38}$
$P_1 = \$445.60$

There are no intermediate cash flows on a zero coupon bond, so the return is the capital gains, or:

$R = (\$445.60 - 425.32)/\$425.32$
$R = .0477$, or 4.77%

14. The return of any asset is the increase in price, plus any dividends or cash flows, all divided by the initial price. This preferred stock paid a dividend of $2.80, so the return for the year was:

$R = (\$96.20 - 94.16 + 2.80)/\$94.16$
$R = .0514$, or 5.14%

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15. The return of any asset is the increase in price, plus any dividends or cash flows, all divided by the initial price. This stock paid no dividend, so the return was:

R = ($64.32 – 61.18)/$61.18
R = .0513, or 5.13%

This is the return for three months, so the APR is:

APR = 4(5.13%)
APR = 20.53%

And the EAR is:

EAR = $(1 + .0513)^4 – 1$
EAR = .2216, or 22.16%

16. To find the real return each year, we will use the Fisher equation, which is:

$1 + R = (1 + r)(1 + h)$

Using this relationship for each year, we find:

	T-bills	Inflation	Real Return
1926	.0327	–.0149	.0483
1927	.0312	–.0208	.0531
1928	.0356	–.0097	.0457
1929	.0475	.0020	.0454
1930	.0241	–.0603	.0898
1931	.0107	–.0952	.1170
1932	.0096	–.1030	.1255

So, the average real return was:

Average = (.0483 + .0531 + .0457 + .0454 + .0898 + .1170 + .1255)/7
Average = .0750, or 7.50%

Notice the real return was higher than the nominal return during this period because of deflation, or negative inflation.

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17. Looking at the long-term corporate bond return history in Table 10.2, we see that the mean return was 6.3 percent, with a standard deviation of 8.4 percent. The range of returns you would expect to see 68 percent of the time is the mean plus or minus 1 standard deviation, or:

$R \in \mu \pm 1\sigma = 6.3\% \pm 8.4\% = -2.10\%$ to 14.70%

The range of returns you would expect to see 95 percent of the time is the mean plus or minus 2 standard deviations, or:

$R \in \mu \pm 2\sigma = 6.3\% \pm 2(8.4\%) = -10.50\%$ to 23.10%

18. Looking at the large-company stock return history in Table 10.2, we see that the mean return was 11.9 percent, with a standard deviation of 19.8 percent. The range of returns you would expect to see 68 percent of the time is the mean plus or minus 1 standard deviation, or:

$R \in \mu \pm 1\sigma = 11.9\% \pm 19.8\% = -7.9\%$ to 31.7%

The range of returns you would expect to see 95 percent of the time is the mean plus or minus 2 standard deviations, or:

$R \in \mu \pm 2\sigma = 11.9\% \pm 2(19.8\%) = -27.7\%$ to 51.5%

Intermediate

19. Here we know the average stock return, and four of the five returns used to compute the average return. We can work the average return equation backward to find the missing return. The average return is calculated as:

$5(.1035) = .13 + .09 - .07 + .11 + R$
$R = .2575$, or 25.75%

The missing return has to be 25.75 percent. Now we can use the equation for the variance to find:

Variance $= 1/4[(.13 - .1035)^2 + (.09 - .1035)^2 + (-.07 - .1035)^2 + (.11 - .1035)^2 + (.2575 - .1035)^2]$
Variance $= .013686$

And the standard deviation is:

Standard deviation $= .013686^{1/2}$
Standard deviation $= .1170$, or 11.70%

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20. The arithmetic average return is the sum of the known returns divided by the number of returns, so:

Arithmetic average return = (–.24 + .32 + .17 – .06 + .29 + .13)/6
Arithmetic average return = .1017, or 10.17%

Using the equation for the geometric return, we find:

Geometric average return = $[(1 + R_1) \times (1 + R_2) \times \ldots \times (1 + R_T)]^{1/T} - 1$
Geometric average return = $[(1 - .24)(1 + .32)(1 + .17)(1 - .06)(1 + .29)(1 + .13)]^{1/6} - 1$
Geometric average return = .0824, or 8.24%

Remember, the geometric average return will always be less than the arithmetic average return if the returns have any variation.

21. To calculate the arithmetic and geometric average returns, we must first calculate the return for each year. The return for each year is:

R_1 = ($68.95 – 64.27 + .95)/$64.27 = .0876, or 8.76%
R_2 = ($76.38 – 68.95 + 1.15)/$68.95 = .1244, or 12.44%
R_3 = ($71.27 – 76.38 + 1.40)/$76.38 = –.0486, or –4.86%
R_4 = ($85.16 – 71.27 + 1.65)/$71.27 = .2180, or 21.80%
R_5 = ($95.87 – 85.16 + 1.85)/$85.16 = .1475, or 14.75%

The arithmetic average return was:

R_A = (.0876 + .1244 – .0486 + .2180 + .1475)/5
R_A = .1058, or 10.58%

And the geometric average return was:

$R_G = [(1 + .0876)(1 + .1244)(1 - .0486)(1 + .2180)(1 + .1475)]^{1/5} - 1$
R_G = .1021, or 10.21%

22. To find the real return we need to use the Fisher equation. Re-writing the Fisher equation to solve for the real return, we get:

$r = [(1 + R)/(1 + h)] - 1$

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So, the real return each year was:

Year	T-bill return	Inflation	Real return
1973	.0693	.0890	–.0172
1974	.0800	.1220	–.0374
1975	.0580	.0701	–.0113
1976	.0508	.0481	.0026
1977	.0512	.0677	–.0155
1978	.0718	.0903	–.0170
1979	.1038	.1331	–.0259
1980	.1124	.1240	–.0103
	.5973	.7433	–.1320

a. The average return for T-bills over this period was:

Average return = .5973/8
Average return = .0747, or 7.47%

And the average inflation rate was:

Average inflation = .7433/8
Average inflation = .0929, or 9.29%

b. Using the equation for variance, we find the variance for T-bills over this period was:

$$\text{Variance} = 1/7[(.0693 - .0747)^2 + (.0800 - .0747)^2 + (.0580 - .0747)^2 + (.0508 - .0747)^2 + (.0512 - .0747)^2 + (.0718 - .0747)^2 + (.1038 - .0747)^2 + (.1124 - .0747)^2]$$
$$\text{Variance} = .000534$$

And the standard deviation for T-bills was:

$$\text{Standard deviation} = .000534^{1/2}$$
$$\text{Standard deviation} = .0231, \text{ or } 2.31\%$$

The variance of inflation over this period was:

$$\text{Variance} = 1/7[(.0880 - .0929)^2 + (.1220 - .0929)^2 + (.0701 - .0929)^2 + (.0481 - .0929)^2 + (.0677 - .0929)^2 + (.0903 - .0929)^2 + (.1331 - .0929)^2 + (.1240 - .0929)^2]$$
$$\text{Variance} = .000946$$

And the standard deviation of inflation was:

$$\text{Standard deviation} = .000946^{1/2}$$
$$\text{Standard deviation} = .0308, \text{ or } 3.08\%$$

c. The average observed real return over this period was:

Average observed real return = –.1320/8
Average observed real return = –.0165, or –1.65%

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d. The statement that T-bills have no risk refers to the fact that there is only an extremely small chance of the government defaulting, so there is little default risk. Since T-bills are short term, there is also very limited interest rate risk. However, as this example shows, there is inflation risk, i.e., the purchasing power of the investment can actually decline over time even if the investor is earning a positive return.

23. To find the return on the coupon bond, we first need to find the price of the bond today. Since one year has elapsed, the bond now has eight years to maturity, so the price today is:

$P_1 = \$54(\text{PVIFA}_{5.1\%,8}) + \$1{,}000/1.051^8$
$P_1 = \$1{,}019.31$

You received the coupon payments on the bond, so the nominal return was:

$R = (\$1{,}019.31 - 1{,}030 + 54)/\$1{,}030$
$R = .0420$, or 4.20%

And using the Fisher equation to find the real return, we get:

$r = (1.0420/1.029) - 1$
$r = .0127$, or 1.27%

24. Looking at the long-term government bond return history in Table 10.2, we see that the mean return was 5.9 percent, with a standard deviation of 9.8 percent. In the normal probability distribution, approximately 2/3 of the observations are within one standard deviation of the mean. This means that 1/3 of the observations are outside one standard deviation away from the mean. Or:

$\Pr(R < -3.9 \text{ or } R > 15.7) \approx {}^1/_3$

But we are only interested in one tail here, that is, returns less than –3.9 percent, so:

$\Pr(R < -3.9) \approx {}^1/_{5.9}$

You can use the z-statistic and the cumulative normal distribution table to find the answer as well. Doing so, we find:

$z = (X - \mu)/\sigma$

$z = (-3.9\% - 5.9)/9.8\% = -1.00$

Looking at the z-table, this gives a probability of 15.87%, or:

$\Pr(R < -3.9) \approx .1587$, or 15.87%

The range of returns you would expect to see 95 percent of the time is the mean plus or minus 2 standard deviations, or:

95% level: $R \in \mu \pm 2\sigma = 5.9\% \pm 2(19.8) = -13.7\%$ to 25.5%

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The range of returns you would expect to see 99 percent of the time is the mean plus or minus 3 standard deviations, or:

99% level: $R \in \mu \pm 3\sigma = 5.9\% \pm 3(9.8\%) = -23.5\%$ to 35.3%

Challenge

25. The mean return for small-company stocks was 16.2 percent, with a standard deviation of 31.6 percent. Doubling your money is a 100% return, so if the return distribution is normal, we can use the z-statistic. So:

$z = (X - \mu)/\sigma$

$z = (100\% - 16.2)/31.6\% = 2.652$ standard deviations above the mean

This corresponds to a probability of ≈ .400%, or about once every 250 years. Tripling your money would be:

$z = (200\% - 16.2)/31.6\% = 5.8165$ standard deviations above the mean

This corresponds to a probability of (much) less than .5%, or once every 200 years. The actual answer is ≈.00000030054%, or about once every 332 million years.

26. It is impossible to lose more than 100 percent of your investment. Therefore, return distributions are truncated on the lower tail at –100 percent.

27. Using the z-statistic, we find:

$z = (X - \mu)/\sigma$

$z = (0\% - 11.9)/19.8\% = -.6010$

$\Pr(R \leq 0) \approx 27.39\%$

28. For each of the questions asked here, we need to use the z-statistic, which is:

$z = (X - \mu)/\sigma$

a. $z_1 = (10\% - 6.3\%)/8.4\% = .4405$

This z-statistic gives us the probability that the return is less than 10 percent, but we are looking for the probability the return is greater than 10 percent. Given that the total probability is 100 percent (or 1), the probability of a return greater than 10 percent is 1 minus the probability of a return less than 10 percent. Using the cumulative normal distribution table, we get:

$\Pr(R \geq 10\%) = 1 - \Pr(R \leq 10\%) = 1 - .6702 \approx 32.98\%$

For a return less than 0 percent:

$\Pr(R < 0\%) = 1 - \Pr(R > 0\%) = 1 - .7734 \approx 22.66\%$

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b. The probability that T-bill returns will be greater than 10 percent is:

$z_3 = (10\% - 3.4\%)/3.1\% = 2.129$

$\Pr(R \geq 10\%) = 1 - \Pr(R \leq 10\%) = 1 - .9834 \approx 1.66\%$

And the probability that T-bill returns will be less than 0 percent is:

$z_4 = (0\% - 3.4\%)/3.1\% = -1.097$

$\Pr(R \leq 0) \approx 13.64\%$

c. The probability that the return on long-term corporate bonds will be less than –4.18 percent is:

$z_5 = (-4.18\% - 6.3\%)/8.4\% = -1.2476$

$\Pr(R \leq -4.18\%) \approx 10.61\%$

And the probability that T-bill returns will be greater than 10.38 percent is:

$z_6 = (10.38\% - 3.4\%)/3.1\% = 2.2516$

$\Pr(R \geq 10.38\%) = 1 - \Pr(R \leq 10.38\%) = 1 - .9878 \approx 1.22\%$

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CHAPTER 11
RISK AND RETURN: *THE CAPITAL ASSET PRICING MODEL (CAPM)*

Answers to Concept Questions

1. Some of the risk in holding any asset is unique to the asset in question. By investing in a variety of assets, this unique portion of the total risk can be eliminated at little cost. On the other hand, there are some risks that affect all investments. This portion of the total risk of an asset cannot be costlessly eliminated. In other words, systematic risk can be controlled, but only by a costly reduction in expected returns.

2. If the market expected the growth rate in the coming year to be 2 percent, then there would be no change in security prices if this expectation had been fully anticipated and priced. However, if the market had been expecting a growth rate other than 2 percent and the expectation was incorporated into security prices, then the government's announcement would most likely cause security prices in general to change; prices would drop if the anticipated growth rate had been more than 2 percent, and prices would rise if the anticipated growth rate had been less than 2 percent.

3. *a.* systematic
b. unsystematic
c. both; probably mostly systematic
d. unsystematic
e. unsystematic
f. systematic

4. *a.* a change in systematic risk has occurred; market prices in general will most likely decline.
b. no change in unsystematic risk; company price will most likely stay constant.
c. no change in systematic risk; market prices in general will most likely stay constant.
d. a change in unsystematic risk has occurred; company price will most likely decline.
e. no change in systematic risk; market prices in general will most likely stay constant.

5. No to both questions. The portfolio expected return is a weighted average of the asset returns, so it must be less than the largest asset return and greater than the smallest asset return.

6. False. The variance of the individual assets is a measure of the total risk. The variance on a well-diversified portfolio is a function of systematic risk only.

7. Yes, the standard deviation can be less than that of every asset in the portfolio. However, β_p cannot be less than the smallest beta because β_p is a weighted average of the individual asset betas.

8. Yes. It is possible, in theory, to construct a zero beta portfolio of risky assets whose return would be equal to the risk-free rate. It is also possible to have a negative beta; the return would be less than the risk-free rate. A negative beta asset would carry a negative risk premium because of its value as a diversification instrument.

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9. Such layoffs generally occur in the context of corporate restructurings. To the extent that the market views a restructuring as value-creating, stock prices will rise. So, it's not layoffs per se that are being cheered on. Nonetheless, Wall Street does encourage corporations to take actions to create value, even if such actions involve layoffs.

10. Earnings contain information about recent sales and costs. This information is useful for projecting future growth rates and cash flows. Thus, unexpectedly low earnings often lead market participants to reduce estimates of future growth rates and cash flows; price drops are the result. The reverse is often true for unexpectedly high earnings.

11. The covariance is a more appropriate measure of a security's risk in a well-diversified portfolio because the covariance reflects the effect of the security on the variance of the portfolio. Investors are concerned with the variance of their portfolios and not the variance of the individual securities. Since covariance measures the impact of an individual security on the variance of the portfolio, covariance is the appropriate measure of risk.

12. If we assume that the market has not stayed constant during the past three years, then the lack in movement of Mid-South Electric's stock price only indicates that the stock either has a standard deviation or a beta that is very near to zero. The large amount of movement in Tech Flyer's stock price does not imply that the firm's beta is high. Total volatility (the price fluctuation) is a function of both systematic and unsystematic risk. The beta only reflects the systematic risk. Observing the standard deviation of price movements does not indicate whether the price changes were due to systematic factors or firm specific factors. Thus, if you observe large stock price movements like that of Tech Flyer, you cannot claim that the beta of the stock is high. All you know is that the total risk of Tech Flyer is high.

13. The wide fluctuations in the price of oil stocks do not indicate that these stocks are a poor investment. If an oil stock is purchased as part of a well-diversified portfolio, only its contribution to the risk of the entire portfolio matters. This contribution is measured by systematic risk or beta. Since price fluctuations in oil stocks reflect diversifiable plus non-diversifiable risk, observing the standard deviation of price movements is not an adequate measure of the appropriateness of adding oil stocks to a portfolio.

14. The statement is false. If a security has a negative beta, investors would want to hold the asset to reduce the variability of their portfolios. Those assets will have expected returns that are lower than the risk-free rate. To see this, examine the Capital Asset Pricing Model:

$$E(R_S) = R_f + \beta_S[E(R_M) - R_f]$$

If $\beta_S < 0$, then the $E(R_S) < R_f$.

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Solutions to Questions and Problems

NOTE: All end-of-chapter problems were solved using a spreadsheet. Many problems require multiple steps. Due to space and readability constraints, when these intermediate steps are included in this solutions manual, rounding may appear to have occurred. However, the final answer for each problem is found without rounding during any step in the problem.

Basic

1. The portfolio weight of an asset is the total investment in that asset divided by the total portfolio value. First, we will find the portfolio value, which is:

Total value = 165($41) + 280($29)
Total value = $14,885

The portfolio weight for each stock is:

X_A = 165($41)/$14,885
X_A = .4545

X_B = 280($29)/$14,885
X_B = .5455

2. The expected return of a portfolio is the sum of the weight of each asset times the expected return of each asset. The total value of the portfolio is:

Total value = $4,260 + 6,490
Total value = $10,750

So, the expected return of this portfolio is:

E(R_P) = ($4,260/$10,750)(.084) + ($6,490/$10,750)(.123)
E(R_P) = .1075, or 10.75%

3. The expected return of a portfolio is the sum of the weight of each asset times the expected return of each asset. So, the expected return of the portfolio is:

E(R_P) = .45(.092) + .35(.118) + .20(.143)
E(R_P) = .1113, or 11.13%

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4. Here we are given the expected return of the portfolio and the expected return of each asset in the portfolio and are asked to find the weight of each asset. We can use the equation for the expected return of a portfolio to solve this problem. Since the total weight of a portfolio must equal 1 (100%), the weight of Stock Y must be one minus the weight of Stock X. Mathematically speaking, this means:

$E(R_P) = .103 = .119X_X + .097(1 - X_X)$

We can now solve this equation for the weight of Stock X as:

$.103 = .119X_X + .097 - .097X_X$
$.006 = .022X_X$
$X_X = .2727$

So, the dollar amount invested in Stock X is the weight of Stock X times the total portfolio value, or:

Investment in X = .2727($10,000)
Investment in X = $2,727.27

And the dollar amount invested in Stock Y is:

Investment in Y = (1 – .2727)($10,000)
Investment in Y = $7,272.73

5. The expected return of an asset is the sum of each return times the probability of that return occurring. So, the expected return of the asset is:

$E(R) = .35(-.14) + .50(.16) + .15(.43)$
$E(R) = .0955$, or 9.55%

6. The expected return of an asset is the sum of each return times the probability of that return occurring. So, the expected return of each stock asset is:

$E(R_A) = .10(.01) + .60(.09) + .30(.13)$
$E(R_A) = .0940$, or 9.40%

$E(R_B) = .10(-.19) + .60(.11) + .30(.37)$
$E(R_B) = .1580$, or 15.80%

To calculate the standard deviation, we first need to calculate the variance. To find the variance, we find the squared deviations from the expected return. We then multiply each possible squared deviation by its probability, and then add all of these up. The result is the variance. So, the variance and standard deviation of each stock are:

$\sigma_A^2 = .10(.01 - .0940)^2 + .60(.09 - .0940)^2 + .30(.13 - .0940)^2$
$\sigma_A^2 = .00110$

$\sigma_A = .00110^{1/2}$
$\sigma_A = .0332$, or 3.32%

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$\sigma_B^2 = .10(-.19 - .1580)^2 + .60(.11 - .1580)^2 + .30(.37 - .1580)^2$
$\sigma_B^2 = .02698$

$\sigma_B = .02698^{1/2}$
$\sigma_B = .1642$, or 16.42%

7. The expected return of an asset is the sum of each return times the probability of that return occurring. So, the expected return of the stock is:

$E(R_A) = .10(-.243) + .20(-.116) + .45(.138) + .25(.328)$
$E(R_A) = .0966$, or 9.66%

To calculate the standard deviation, we first need to calculate the variance. To find the variance, we find the squared deviations from the expected return. We then multiply each possible squared deviation by its probability, and then add all of these up. The result is the variance. So, the variance and standard deviation of the stock are:

$\sigma^2 = .10(-.243 - .0966)^2 + .20(-.116 - .0966)^2 + .45(.138 - .0966)^2 + .25(.328 - .0966)^2$
$\sigma^2 = .03473$

$\sigma = .03473^{1/2}$
$\sigma = .1864$, or 18.64%

8. The expected return of a portfolio is the sum of the weight of each asset times the expected return of each asset. So, the expected return of the portfolio is:

$E(R_P) = .20(.086) + .65(.108) + .15(.134)$
$E(R_P) = .1075$, or 10.75%

If we own this portfolio, we would expect to get a return of 10.75 percent.

9. *a.* This portfolio does not have an equal weight in each asset. We first need to find the return of the portfolio in each state of the economy. To do this, we will multiply the return of each asset by its portfolio weight and then sum the products to get the portfolio return in each state of the economy. Doing so, we get:

Boom: $R_P = .35(.24) + .30(.43) + .35(.36) = .3390$, or 33.90%
Good: $R_P = .35(.11) + .30(.19) + .35(.15) = .1480$, or 14.80%
Poor: $R_P = .35(.03) + .30(-.16) + .35(-.04) = -.0515$, or –5.15%
Bust: $R_P = .35(-.09) + .30(-.29) + .35(-.08) = -.1465$, or –14.65%

And the expected return of the portfolio is:

$E(R_P) = .15(.3390) + .45(.1480) + .35(-.0515) + .05(-.1465)$
$E(R_P) = .0921$, or 9.21%

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b. To calculate the standard deviation, we first need to calculate the variance. To find the variance, we find the squared deviations from the expected return. We then multiply each possible squared deviation by its probability, and then add all of these up. The result is the variance. So, the variance and standard deviation of each stock are:

$$\sigma_P^2 = .15(.3390 - .0921)^2 + .45(.1480 - .0921)^2 + .35(-.0515 - .0921)^2 + .05(-.1465 - .0921)^2$$
$$\sigma_P^2 = .02061$$

$$\sigma_P = .02061^{1/2}$$
$$\sigma_P = .1436, \text{ or } 14.36\%$$

10. The beta of a portfolio is the sum of the weight of each asset times the beta of each asset. So, the beta of the portfolio is:

$$\beta_P = .15(.83) + .20(1.24) + .30(1.13) + .35(1.41)$$
$$\beta_P = 1.21$$

11. The beta of a portfolio is the sum of the weight of each asset times the beta of each asset. If the portfolio is as risky as the market it must have the same beta as the market. Since the beta of the market is 1, we know the beta of our portfolio is 1. We also need to remember that the beta of the risk-free asset is zero. It has to be zero since the asset has no risk. Setting up the equation for the beta of our portfolio, we get:

$$\beta_P = 1.0 = {}^1/_3(0) + {}^1/_3(1.27) + {}^1/_3(\beta_X)$$

Solving for the beta of Stock X, we get:

$$\beta_X = 1.73$$

12. CAPM states the relationship between the risk of an asset and its expected return. CAPM is:

$$E(R_i) = R_f + [E(R_M) - R_f] \times \beta_i$$

Substituting the values we are given, we find:

$$E(R_i) = .027 + (.109 - .027)(1.08)$$
$$E(R_i) = .1156, \text{ or } 11.56\%$$

13. We are given the values for the CAPM except for the β of the stock. We need to substitute these values into the CAPM and solve for the β of the stock. One important thing we need to realize is that we are given the market risk premium. The market risk premium is the expected return of the market minus the risk-free rate. We must be careful not to use this value as the expected return of the market. Using the CAPM, we find:

$$E(R_i) = .109 = .031 + .069\beta_i$$

$$\beta_i = 1.13$$

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14. Here we need to find the expected return of the market using the CAPM. Substituting the values given, and solving for the expected return of the market, we find:

$E(R_i) = .097 = .029 + [E(R_M) - .029](.89)$

$E(R_M) = .1054$, or 10.54%

15. Here we need to find the risk-free rate using the CAPM. Substituting the values given, and solving for the risk-free rate, we find:

$E(R_i) = .115 = R_f + (.108 - R_f)(1.09)$

$.115 = R_f + .11772 - 1.09R_f$

$R_f = .0302$, or 3.02%

16. For a portfolio that is equally invested in large-company stocks and long-term bonds:

Return = (11.9% + 5.9%)/2
Return = 8.90%

For a portfolio that is equally invested in small stocks and Treasury bills:

Return = (16.2% + 3.4%)/2
Return = 9.80%

17. First, we need to find the β of the portfolio. The β of the risk-free asset is zero, and the weight of the risk-free asset is one minus the weight of the stock, the β of the portfolio is:

$ß_P = X_W(1.15) + (1 - X_W)(0)$
$ß_P = 1.15X_W$

So, to find the β of the portfolio for any weight of the stock, we multiply the weight of the stock times its β.

Even though we are solving for the β and expected return of a portfolio of one stock and the risk-free asset for different portfolio weights, we are really solving for the SML. Any combination of this stock, and the risk-free asset will fall on the SML. For that matter, a portfolio of any stock and the risk-free asset, or any portfolio of stocks, will fall on the SML. We know the slope of the SML line is the market risk premium, so using the CAPM and the information concerning this stock, the market risk premium is:

$E(R_W) = .108 = .027 + MRP(1.15)$
MRP = .081/1.15
MRP = .0704, or 7.04%

So, now we know the CAPM equation for any stock is:

$E(R_P) = .027 + .0704ß_P$

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The slope of the SML is equal to the market risk premium, which is .0704. Using these equations to fill in the table, we get the following results:

X_W	E(R_P)	ß$_P$
0%	.0270	0
25	.0473	.288
50	.0675	.575
75	.0878	.863
100	.1080	1.150
125	.1283	1.438
150	.1485	1.725

18. There are two ways to correctly answer this question. We will work through both. First, we can use the CAPM. Substituting in the values we are given for each stock, we find:

E(R_Y) = .043 + .067(1.15)
E(R_Y) = .1201, or 12.01%

It is given in the problem that the expected return of Stock Y is 12.6 percent, but according to the CAPM, based on its level of risk, the expected return should be 12.01 percent. This means the stock return is too high, given its level of risk. Stock Y plots above the SML and is undervalued. In other words, its price must increase to decrease the expected return to 12.01 percent. For Stock Z, we find:

E(R_Z) = .043 + .067(.83)
E(R_Z) = .0986, or 9.86%

The return given for Stock Z is 9.5 percent, but according to the CAPM the expected return of the stock should be 9.86 percent based on its level of risk. Stock Z plots below the SML and is overvalued. In other words, its price must decrease to increase the expected return to 9.86 percent.

We can also answer this question using the reward-to-risk ratio. All assets must have the same reward-to-risk ratio, that is, every asset must have the same ratio of the asset risk premium to its beta. This follows from the linearity of the SML in Figure 11.11. The reward-to-risk ratio is the risk premium of the asset divided by its β. This is also known as the Treynor ratio or Treynor index. We are given the market risk premium, and we know the β of the market is 1, so the reward-to-risk ratio for the market is .067, or 6.7 percent. Calculating the reward-to-risk ratio for Stock Y, we find:

Reward-to-risk ratio Y = (.126 – .043)/1.15
Reward-to-risk ratio Y = .0722

The reward-to-risk ratio for Stock Y is too high, which means the stock plots above the SML and the stock is undervalued. Its price must increase until its reward-to-risk ratio is equal to the market reward-to-risk ratio. For Stock Z, we find:

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Reward-to-risk ratio Z = (.095 – .043)/.83
Reward-to-risk ratio Z = .0627

The reward-to-risk ratio for Stock Z is too low, which means the stock plots below the SML, and the stock is overvalued. Its price must decrease until its reward-to-risk ratio is equal to the market reward-to-risk ratio.

19. We need to set the reward-to-risk ratios of the two assets equal to each other (see the previous problem), which is:

$(.126 - R_f)/1.15 = (.095 - R_f)/.83$

We can cross multiply to get:

$.83(.126 - R_f) = 1.15(.095 - R_f)$

Solving for the risk-free rate, we find:

$.10458 - .83R_f = .10925 - 1.15R_f$

$R_f = .0146$, or 1.46%

Intermediate

20. *a.* We have a special case where the portfolio is equally weighted, so we can sum the returns of each asset and divide by the number of assets. The expected return of the portfolio is:

$E(R_P) = (.118 + .026)/2$
$E(R_P) = .0720$, or 7.20%

b. We need to find the portfolio weights that result in a portfolio with a β of .50. We know the β of the risk-free asset is zero. We also know the weight of the risk-free asset is one minus the weight of the stock since the portfolio weights must sum to one, or 100 percent. So:

$\beta_P = .50 = X_S(1.13) + (1 - X_S)(0)$
$.50 = 1.13X_S + 0 - 0X_S$
$X_S = .50/1.13$
$X_S = .4425$

And, the weight of the risk-free asset is:

$X_{Rf} = 1 - .4425$
$X_{Rf} = .5575$

c. We need to find the portfolio weights that result in a portfolio with an expected return of 10 percent. We also know the weight of the risk-free asset is one minus the weight of the stock since the portfolio weights must sum to one, or 100 percent. So:

$E(R_P) = .10 = .118X_S + .026(1 - X_S)$
$.10 = .118X_S + .026 - .026X_S$
$X_S = .8043$

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So, the β of the portfolio will be:

$\beta_P = .8043(1.13) + (1 - .8043)(0)$
$\beta_P = .9089$

d. Solving for the β of the portfolio as we did in part (a), we find:

$\beta_P = 2.26 = X_S(1.13) + (1 - X_S)(0)$

$X_S = 2.26/1.13 = 2$

$X_{Rf} = 1 - 2 = -1$

The portfolio is invested 200% in the stock and –100% in the risk-free asset. This represents borrowing at the risk-free rate to buy more of the stock.

21. We know that the reward-to-risk ratios for all assets must be equal. This can be expressed as:

$[E(R_A) - R_f]/\beta_A = [E(R_B) - R_f]/\beta_B$

The numerator of each equation is the risk premium of the asset, so:

$RP_A/\beta_A = RP_B/\beta_B$

We can rearrange this equation to get:

$\beta_B/\beta_A = RP_B/RP_A$

If the reward-to-risk ratios are the same, the ratio of the betas of the assets is equal to the ratio of the risk premiums of the assets.

22. *a.* We need to find the return of the portfolio in each state of the economy. To do this, we will multiply the return of each asset by its portfolio weight and then sum the products to get the portfolio return in each state of the economy. Doing so, we get:

Boom: $R_P = .25(.26) + .25(.33) + .50(.50) = .3975$, or 39.75%
Normal: $R_P = .25(.14) + .25(.15) + .50(.02) = .0825$, or 8.25%
Bust: $R_P = .25(-.03) + .25(-.18) + .50(-.45) = -.2775$, or –27.75%

And the expected return of the portfolio is:

$E(R_P) = .30(.3975) + .55(.0825) + .15(-.2775)$
$E(R_P) = .1230$, or 12.30%

To calculate the standard deviation, we first need to calculate the variance. To find the variance, we find the squared deviations from the expected return. We then multiply each possible squared deviation by its probability, then add all of these up. The result is the variance. So, the variance and standard deviation of the portfolio are:

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$\sigma^2_P = .25(.3975 - .1230)^2 + .25(.0825 - .1230)^2 + .50(-.2775 - .1230)^2$
$\sigma^2_P = .04757$

$\sigma_P = .04757^{1/2}$
$\sigma_P = .2181$, or 21.81%

b. The risk premium is the return of a risky asset minus the risk-free rate. T-bills are often used as the risk-free rate, so:

$RP_i = E(R_P) - R_f$
$RP_i = .1230 - .041$
$RP_i = .0820$, or 8.20%

c. The approximate expected real return is the expected nominal return minus the inflation rate, so:

Approximate expected real return = .1230 – .035
Approximate expected real return = .0880, or 8.80%

To find the exact real return, we will use the Fisher equation. Doing so, we get:

$1 + E(R_i) = (1 + h)[1 + E(r_i)]$
$1.1230 = 1.0350[1 + E(r_i)]$
$E(r_i) = 1.1230/1.035 - 1$
$E(r_i) = .0850$, or 8.50%

The approximate real risk-free rate is:

Approximate expected real risk-free rate = .041 − .035
Approximate expected real risk-free rate = .006, or .60%

And using the Fisher effect for the exact real risk-free rate, we find:

$1 + E(R_i) = (1 + h)[1 + E(r_i)]$
$1.041 = 1.0350[1 + E(r_i)]$
$E(r_i) = 1.041/1.035 - 1$
$E(r_i) = .0058$, or .58%

The approximate real risk premium is the expected nominal risk premium minus the approximate real risk-free rate, so:

Approximate expected real risk premium = .0880 – .006
Approximate expected real risk premium = .0820, or 8.20%

The exact expected real risk premium is the exact real return minus the exact real risk-free rate, so:

Exact expected real risk premium = .0850 – .0058
Exact expected real risk premium = .0792, or 7.92%

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23. We know the total portfolio value and the investment of two stocks in the portfolio, so we can find the weight of these two stocks. The weights of Stock A and Stock B are:

X_A = \$265,000/\$1,000,000
X_A = .265

X_B = \$390,000/\$1,000,000
X_B = .39

Since the portfolio is as risky as the market, the β of the portfolio must be equal to one. We also know the β of the risk-free asset is zero. We can use the equation for the β of a portfolio to find the weight of the third stock. Doing so, we find:

$\beta_P = 1.0 = X_A(.87) + X_B(1.18) + X_C(1.30) + X_{Rf}(0)$
$1.0 = .265(.87) + .39(1.18) + X_C(1.30)$

Solving for the weight of Stock C, we find:

X_C = .237885

So, the dollar investment in Stock C must be:

Invest in Stock C = .237885(\$1,000,000)
Invest in Stock C = \$237,884.62

We also know the total portfolio weight must be one, so the weight of the risk-free asset must be one minus the asset weight we know, or:

$1 = X_A + X_B + X_C + X_{Rf} = 1 - .265 - .39 - .237885 - X_{Rf}$
X_{Rf} = .107115

So, the dollar investment in the risk-free asset must be:

Invest in risk-free asset = .107115(\$1,000,000)
Invest in risk-free asset = \$107,115.38

24. We are given the expected return of the assets in the portfolio. We also know the sum of the weights of each asset must be equal to one. Using this relationship, we can express the expected return of the portfolio as:

$E(R_P) = .121 = X_X(.113) + X_Y(.091)$
$.121 = X_X(.113) + (1 - X_X)(.091)$
$.121 = .113X_X + .091 - .091X_X$
$.030 = .022X_X$
$X_X = 1.36364$

And the weight of Stock Y is:

$X_Y = 1 - 1.36364$
$X_Y = -.36364$

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The amount to invest in Stock Y is:

Investment in Stock Y = –.36364($100,000)
Investment in Stock Y = –$36,363.64

A negative portfolio weight means that you short sell the stock. If you are not familiar with short selling, it means you borrow a stock today and sell it. You must then purchase the stock at a later date to repay the borrowed stock. If you short sell a stock, you make a profit if the stock decreases in value.

To find the beta of the portfolio, we can multiply the portfolio weight of each asset times its beta and sum. So, the beta of the portfolio is:

$\beta_P = 1.36364(1.15) + (–.36364)(.85)$
$\beta_P = 1.26$

25. The expected return of an asset is the sum of the probability of each return occurring times the probability of that return occurring. So, the expected return of each stock is:

$E(R_A) = .33(–.068) + .33(.104) + .33(.241)$
$E(R_A) = .0923$, or 9.23%

$E(R_B) = .33(–.087) + .33(–.019) + .33(.432)$
$E(R_B) = .1087$, or 10.87%

To calculate the standard deviation, we first need to calculate the variance. To find the variance, we find the squared deviations from the expected return. We then multiply each possible squared deviation by its probability, and then add all of these up. The result is the variance. So, the variance and standard deviation of Stock A are:

$\sigma_A^2 = .33(–.068 – .0923)^2 + .33(.104 – .0923)^2 + .33(.241 – .0923)^2$
$\sigma_A^2 = .01598$

$\sigma_A = .01598^{1/2}$
$\sigma_A = .1264$, or 12.64%

And the standard deviation of Stock B is:

$\sigma_B^2 = .33(–.087 – .1087)^2 + .33(–.019 – .1087)^2 + .33(.432 – .1087)^2$
$\sigma_B^2 = .05304$

$\sigma_B = .05304^{1/2}$
$\sigma_B = .2303$, or 23.03%

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To find the covariance, we multiply the probability of each state times the product of each asset's deviation from the mean in that state. The sum of these products is the covariance. So, the covariance is:

$$\text{Cov}(A,B) = .33(-.068 - .0923)(-.087 - .1087) + .33(.104 - .0923)(-.019 - .1087) + .33(.241 - .0923)(.432 - .1087)$$
$$\text{Cov}(A,B) = .025984$$

And the correlation is:

$$\rho_{A,B} = \text{Cov}(A,B)/\sigma_A\sigma_B$$
$$\rho_{A,B} = .025984/(.1264)(.2303)$$
$$\rho_{A,B} = .8924$$

26. The expected return of an asset is the sum of the probability of each return occurring times the probability of that return occurring. So, the expected return of each stock is:

$$E(R_J) = .15(-.140) + .60(.103) + .25(.328)$$
$$E(R_J) = .1228, \text{ or } 12.28\%$$

$$E(R_K) = .15(.023) + .60(.097) + .25(.032)$$
$$E(R_K) = .0697, \text{ or } 6.97\%$$

To calculate the standard deviation, we first need to calculate the variance. To find the variance, we find the squared deviations from the expected return. We then multiply each possible squared deviation by its probability, and then add all of these up. The result is the variance. So, the variance and standard deviation of Stock A are:

$$\sigma_J^2 = .15(-.140 - .1228)^2 + .60(.103 - .1228)^2 + .25(.328 - .1228)^2$$
$$\sigma_J^2 = .02112$$

$$\sigma_J = .02112^{1/2}$$
$$\sigma_J = .1453, \text{ or } 14.53\%$$

And the standard deviation of Stock B is:

$$\sigma_K^2 = .15(.023 - .0697)^2 + .60(.097 - .0697)^2 + .25(.032 - .0697)^2$$
$$\sigma_K^2 = .00113$$

$$\sigma_K = .00113^{1/2}$$
$$\sigma_K = .0336, \text{ or } 3.36\%$$

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To find the covariance, we multiply the probability of each state times the product of each asset's deviation from the mean in that state. The sum of these products is the covariance. So, the covariance is:

$$\text{Cov}(J,K) = .15(-.140 - .1228)(.023 - .0697) + .60(.103 - .1228)(.097 - .0697) + .25(.328 - .1228)(.032 - .0697)$$
$$\text{Cov}(J,K) = -.000417$$

And the correlation is:

$$\rho_{J,K} = \text{Cov}(J,K)/\sigma_J \sigma_K$$
$$\rho_{J,K} = -.000417/(.1453)(.0336)$$
$$\rho_{J.K} = -.0855$$

27. *a.* The expected return of the portfolio is the sum of the weight of each asset times the expected return of each asset, so:

$$E(R_P) = X_F E(R_F) + X_G E(R_G)$$
$$E(R_P) = .65(.11) + .35(.14)$$
$$E(R_P) = .1205, \text{ or } 12.05\%$$

b. The variance of a portfolio of two assets can be expressed as:

$$\sigma_P^2 = X_F^2 \sigma_F^2 + X_G^2 \sigma_G^2 + 2X_F X_G \sigma_F \sigma_G \rho_{F,G}$$
$$\sigma_P^2 = .65^2(.47^2) + .35^2(.63^2) + 2(.65)(.35)(.47)(.63)(.15)$$
$$\sigma_P^2 = .16216$$

So, the standard deviation is:

$$\sigma = .16216^{1/2}$$
$$\sigma = .4027, \text{ or } 40.27\%$$

28. *a.* The expected return of the portfolio is the sum of the weight of each asset times the expected return of each asset, so:

$$E(R_P) = X_A E(R_A) + X_B E(R_B)$$
$$E(R_P) = .40(.10) + .60(.13)$$
$$E(R_P) = .1180, \text{ or } 11.80\%$$

The variance of a portfolio of two assets can be expressed as:

$$\sigma_P^2 = X_A^2 \sigma_A^2 + X_B^2 \sigma_B^2 + 2X_A X_B \sigma_A \sigma_B \rho_{A,B}$$
$$\sigma_P^2 = .40^2(.41^2) + .60^2(.59^2) + 2(.40)(.60)(.41)(.59)(.50)$$
$$\sigma_P^2 = .21027$$

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So, the standard deviation is:

$\sigma = .21027^{1/2}$
$\sigma = .4585$, or 45.85%

b. The expected return of the portfolio is the sum of the weight of each asset times the expected return of each asset, so:

$E(R_P) = X_A E(R_A) + X_B E(R_B)$
$E(R_P) = .40(.10) + .60(.13)$
$E(R_P) = .1180$, or 11.80%

The variance of a portfolio of two assets can be expressed as:

$$\sigma_P^2 = X_A^2\sigma_A^2 + X_B^2\sigma_B^2 + 2X_AX_B\sigma_A\sigma_B\rho_{A,B}$$
$$\sigma_P^2 = .40^2(.41^2) + .60^2(.59^2) + 2(.40)(.60)(.41)(.59)(-.50)$$
$$\sigma_P^2 = .09416$$

So, the standard deviation is:

$\sigma = .09416^{1/2}$
$\sigma = .3068$, or 30.68%

c. As Stock A and Stock B become less correlated, or more negatively correlated, the standard deviation of the portfolio decreases.

29. *a.* (i) Using the equation to calculate beta, we find:

$\beta_A = (\rho_{A,M})(\sigma_A)/\sigma_M$
$.97 = (\rho_{A,M})(.36)/.19$
$\rho_{I,M} = .51$

(ii) Using the equation to calculate beta, we find:

$\beta_B = (\rho_{B,M})(\sigma_B)/\sigma_M$
$1.24 = (.38)(\sigma_B)/.19$
$\sigma_B = .62$

(iii) Using the equation to calculate beta, we find:

$\beta_C = (\rho_{C,M})(\sigma_C)/\sigma_M$
$\beta_C = (.41)(.42)/.19$
$\beta_C = .91$

(iv) The market has a correlation of 1 with itself.

(v) The beta of the market is 1.

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(vi) The risk-free asset has zero standard deviation.

(vii) The risk-free asset has zero correlation with the market portfolio.

(viii) The beta of the risk-free asset is 0.

b. Using the CAPM to find the expected return of the stock, we find:

Firm A:
$E(R_A) = R_f + \beta_A[E(R_M) - R_f]$
$E(R_A) = .03 + .97(.12 - .03)$
$E(R_A) = .1173$, or 11.73

According to the CAPM, the expected return on Firm A's stock should be 11.73 percent. However, the expected return on Firm A's stock given in the table is 11 percent. Therefore, Firm A's stock is overpriced, and you should sell it.

Firm B:
$E(R_B) = R_f + \beta_B[E(R_M) - R_f]$
$E(R_B) = .03 + 1.24(.12 - .03)$
$E(R_B) = .1416$, or 14.16%

According to the CAPM, the expected return on Firm B's stock should be 14.16 percent. However, the expected return on Firm B's stock given in the table is 14 percent. Therefore, Firm B's stock is overpriced, and you should sell it.

Firm C:
$E(R_C) = R_f + \beta_C[E(R_M) - R_f]$
$E(R_C) = .03 + .91(.12 - .03)$
$E(R_C) = .1116$, or 11.16%

According to the CAPM, the expected return on Firm C's stock should be 11.16 percent. However, the expected return on Firm C's stock given in the table is 13 percent. Therefore, Firm C's stock is underpriced, and you should buy it.

30. Because a well-diversified portfolio has no unsystematic risk, this portfolio should lie on the Capital Market Line (CML). The slope of the CML equals:

$\text{Slope}_{CML} = [E(R_M) - R_f]/\sigma_M$
$\text{Slope}_{CML} = (.107 - .032)/.19$
$\text{Slope}_{CML} = .39474$

a. The expected return on the portfolio equals:

$E(R_P) = R_f + \text{Slope}_{CML}(\sigma_P)$
$E(R_P) = .032 + .39474(.24)$
$E(R_P) = .1267$, or 12.67%

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b. The expected return on the portfolio equals:

$E(R_P) = R_f + \text{Slope}_{CML}(\sigma_P)$
$.15 = .032 + .39474(\sigma_P)$
$\sigma_P = .2989$, or 29.89%

31. First, we can calculate the standard deviation of the market portfolio using the Capital Market Line (CML). We know that the risk-free asset has a return of 2.9 percent and a standard deviation of zero, and the portfolio has an expected return of 6 percent and a standard deviation of 11 percent. These two points must lie on the Capital Market Line. The slope of the Capital Market Line equals:

Slope_{CML} = Rise/Run
Slope_{CML} = Increase in expected return/Increase in standard deviation
$\text{Slope}_{CML} = (.06 - .029)/(.11 - 0)$
$\text{Slope}_{CML} = .282$

According to the Capital Market Line:

$E(R_I) = R_f + \text{Slope}_{CML}(\sigma_I)$

Since we know the expected return on the market portfolio, the risk-free rate, and the slope of the Capital Market Line, we can solve for the standard deviation of the market portfolio which is:

$E(R_M) = R_f + \text{Slope}_{CML}(\sigma_M)$
$.12 = .029 + (.282)(\sigma_M)$
$\sigma_M = (.12 - .029)/.282$
$\sigma_M = .3229$, or 32.29%

Next, we can use the standard deviation of the market portfolio to solve for the beta of a security using the beta equation. Doing so, we find the beta of the security is:

$\beta_I = (\rho_{I,M})(\sigma_I)/\sigma_M$
$\beta_I = (.55)(.50)/.3229$
$\beta_I = .85$

Now we can use the beta of the security in the CAPM to find its expected return, which is:

$E(R_I) = R_f + \beta_I[E(R_M) - R_f]$
$E(R_I) = .029 + .85(.12 - .029)$
$E(R_I) = .1065$, or 10.65%

32. First, we need to find the standard deviation of the market and the portfolio, which are:

$\sigma_M = .0387^{1/2}$
$\sigma_M = .1967$, or 19.67%

$\sigma_Z = .3287^{1/2}$
$\sigma_Z = .5733$, or 57.33%

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Now we can use the equation for beta to find the beta of the portfolio, which is:

$\beta_Z = (\rho_{Z,M})(\sigma_Z)/\sigma_M$
$\beta_Z = (.29)(.5733)/.1967$
$\beta_Z = .85$

Now, we can use the CAPM to find the expected return of the portfolio, which is:

$E(R_Z) = R_f + \beta_Z[E(R_M) - R_f]$
$E(R_Z) = .021 + .85(.111 - .021)$
$E(R_Z) = .0971$, or 9.71%

Challenge

33. The amount of systematic risk is measured by the β of an asset. Since we know the market risk premium and the risk-free rate, if we know the expected return of the asset we can use the CAPM to solve for the β of the asset. The expected return of Stock I is:

$E(R_I) = .20(.07) + .50(.18) + .30(.09)$
$E(R_I) = .1310$, or 13.10%

Using the CAPM to find the β of Stock I, we find:

$.1310 = .03 + .075\beta_I$
$\beta_I = 1.35$

The total risk of the asset is measured by its standard deviation, so we need to calculate the standard deviation of Stock I. Beginning with the calculation of the stock's variance, we find:

$\sigma_I^2 = .20(.07 - .1310)^2 + .50(.18 - .1310)^2 + .30(.09 - .1310)^2$
$\sigma_I^2 = .00245$

$\sigma_I = .00245^{1/2}$
$\sigma_I = .0495$, or 4.95%

Using the same procedure for Stock II, we find the expected return to be:

$E(R_{II}) = .20(-.27) + .50(.12) + .30(.31)$
$E(R_{II}) = .0990$, or 9.90%

Using the CAPM to find the β of Stock II, we find:

$.0990 = .03 + .075\beta_{II}$
$\beta_{II} = .92$

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And the standard deviation of Stock II is:

$\sigma_{II}^2 = .20(-.27 - .0990)^2 + .50(.12 - .0990)^2 + .30(.31 - .0990)^2$
$\sigma_{II}^2 = .04081$

$\sigma_{II} = .04081^{1/2}$
$\sigma_{II} = .2020$, or 20.20%

Although Stock II has more total risk than I, it has less systematic risk, since its beta is smaller than I's. Thus, I has more systematic risk, and II has more unsystematic and more total risk. Since unsystematic risk can be diversified away, I is actually the "riskier" stock despite the lack of volatility in its returns. Stock I will have a higher risk premium and a greater expected return.

34. Here we have the expected return and beta for two assets. We can express the returns of the two assets using CAPM. If the CAPM is true, then the security market line holds as well, which means all assets have the same risk premium. Setting the reward-to-risk ratios of the assets equal to each other and solving for the risk-free rate, we find:

$(.1165 - R_f)/1.13 = (.0988 - R_f)/.92$
$.92(.1165 - R_f) = 1.13(.0988 - R_f)$
$.10718 - .92R_f = .1116 - 1.13R_f$
$.21R_f = .0045$
$R_f = .0213$, or 2.13%

Now using CAPM to find the expected return on the market with both stocks, we find:

$.1165 = .0213 + 1.13(R_M - .0213)$
$R_M = .1055$, or 10.55%

$.0988 = .0213 + .92(R_M - .0213)$
$R_M = .1055$, or 10.55%

35. *a.* The expected return of an asset is the sum of each return times the probability of that return occurring. To calculate the standard deviation, we first need to calculate the variance. To find the variance, we find the squared deviations from the expected return. We then multiply each possible squared deviation by its probability, and then add all of these up. The result is the variance. So, the expected return and standard deviation of each stock are:

Asset 1:
$E(R_1) = .15(.20) + .35(.15) + .35(.10) + .15(.05) = .1250$, or 12.50%
$\sigma_1^2 = .15(.20 - .1250)^2 + .35(.15 - .1250)^2 + .35(.10 - .1250)^2 + .15(.05 - .1250)^2 = .00213$
$\sigma_1 = .00213^{1/2} = .0461$, or 4.61%

Asset 2:
$E(R_2) = .15(.20) + .35(.10) + .35(.15) + .15(.05) = .1250$ or 12.50%
$\sigma_2^2 = .15(.20 - .1250)^2 + .35(.10 - .1250)^2 + .35(.15 - .1250)^2 + .15(.05 - .1250)^2 = .00213$
$\sigma_2 = .00213^{1/2} = .0461$, or 4.61%

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Asset 3:
$E(R_3) = .15(.05) + .35(.10) + .35(.15) + .15(.20) = .1250$ or 12.50%
$\sigma_3^2 = .15(.05 - .1250)^2 + .35(.10 - .1250)^2 + .35(.15 - .1250)^2 + .15(.20 - .1250)^2 = .00213$
$\sigma_3 = .00213^{1/2} = .0461$, or 4.61%

b. To find the covariance, we multiply each possible state times the product of each asset's deviation from the mean in that state. The sum of these products is the covariance. The correlation is the covariance divided by the product of the two standard deviations. So, the covariance and correlation between each possible set of assets are:

Asset 1 and Asset 2:
$Cov(1,2) = .15(.20 - .1250)(.20 - .1250) + .35(.15 - .1250)(.10 - .1250)$
$+ .35(.10 - .1250)(.15 - .1250) + .15(.05 - .1250)(.05 - .1250)$
$Cov(1,2) = .001250$

$\rho_{1,2} = Cov(1,2)/\sigma_1 \sigma_2$
$\rho_{1,2} = .001250/(.0461)(.0461)$
$\rho_{1,2} = .5882$

Asset 1 and Asset 3:
$Cov(1,3) = .15(.20 - .1250)(.05 - .1250) + .35(.15 - .1250)(.10 - .1250)$
$+ .35(.10 - .1250)(.15 - .1250) + .15(.05 - .1250)(.20 - .1250)$
$Cov(1,3) = -.002125$

$\rho_{1,3} = Cov(1,3)/\sigma_1 \sigma_3$
$\rho_{1,3} = -.002125/(.0461)(.0461)$
$\rho_{1,3} = -1$

Asset 2 and Asset 3:
$Cov(2,3) = .15(.20 - .1250)(.05 - .1250) + .35(.10 - .1250)(.10 - .1250)$
$+ .35(.15 - .1250)(.15 - .1250) + .15(.05 - .1250)(.20 - .1250)$
$Cov(2,3) = -.001250$

$\rho_{2,3} = Cov(2,3)/\sigma_2 \sigma_3$
$\rho_{2,3} = -.001250/(.0461)(.0461)$
$\rho_{2,3} = -.5882$

c. The expected return of the portfolio is the sum of the weight of each asset times the expected return of each asset, so, for a portfolio of Asset 1 and Asset 2:

$E(R_P) = X_1 E(R_1) + X_2 E(R_2)$
$E(R_P) = .50(.1250) + .50(.1250)$
$E(R_P) = .1250$, or 12.50%

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The variance of a portfolio of two assets can be expressed as:

$$\sigma_P^2 = X_1^2\sigma_1^2 + X_2^2\sigma_2^2 + 2X_1X_2\sigma_1\sigma_2\rho_{1,2}$$
$$\sigma_P^2 = .50^2(.0461^2) + .50^2(.0461^2) + 2(.50)(.50)(.0461)(.0461)(.5882)$$
$$\sigma_P^2 = .0016875$$

And the standard deviation of the portfolio is:

$$\sigma_P = .0016875^{1/2}$$
$$\sigma_P = .0411, \text{ or } 4.11\%$$

d. The expected return of the portfolio is the sum of the weight of each asset times the expected return of each asset, so, for a portfolio of Asset 1 and Asset 3:

$$E(R_P) = X_1E(R_1) + X_3E(R_3)$$
$$E(R_P) = .50(.1250) + .50(.1250)$$
$$E(R_P) = .1250, \text{ or } 12.50\%$$

The variance of a portfolio of two assets can be expressed as:

$$\sigma_P^2 = X_1^2\sigma_1^2 + X_3^2\sigma_3^2 + 2X_1X_3\sigma_1\sigma_3\rho_{1,3}$$
$$\sigma_P^2 = .50^2(.0461^2) + .50^2(.0461^2) + 2(.50)(.50)(.0461)(.0461)(-1)$$
$$\sigma_P^2 = .000000$$

Since the variance is zero, the standard deviation is also zero.

e. The expected return of the portfolio is the sum of the weight of each asset times the expected return of each asset, so, for a portfolio of Asset 2 and Asset 3:

$$E(R_P) = X_2E(R_2) + X_3E(R_3)$$
$$E(R_P) = .50(.1250) + .50(.1250)$$
$$E(R_P) = .1250, \text{ or } 12.50\%$$

The variance of a portfolio of two assets can be expressed as:

$$\sigma_P^2 = X_2^2\sigma_2^2 + X_3^2\sigma_3^2 + 2X_2X_3\sigma_2\sigma_3\rho_{2,3}$$
$$\sigma_P^2 = .50^2(.0461^2) + .50^2(.0461^2) + 2(.50)(.50)(.0461)(.0461)(-.5882)$$
$$\sigma_P^2 = .000438$$

And the standard deviation of the portfolio is:

$$\sigma_P = .000438^{1/2}$$
$$\sigma_P = .0209, \text{ or } 2.09\%$$

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f. As long as the correlation between the returns on two securities is below 1, there is a benefit to diversification. A portfolio with negatively correlated stocks can achieve greater risk reduction than a portfolio with positively correlated stocks, holding the expected return on each stock constant. Applying proper weights on perfectly negatively correlated stocks can reduce portfolio variance to 0.

36. *a.* The expected return of an asset is the sum of the probability of each return occurring times the probability of that return occurring. So, the expected return of each stock is:

$E(R_A) = .20(-.09) + .60(.11) + .20(.39)$
$E(R_A) = .1260$, or 12.60%

$E(R_B) = .20(-.11) + .60(.12) + .20(.27)$
$E(R_B) = .1040$, or 10.40%

b. We can use the expected returns we calculated to find the slope of the Security Market Line. We know that the beta of Stock A is .34 greater than the beta of Stock B. Therefore, as beta increases by .34, the expected return on a security increases by .022 (= .1260 – .1040). The slope of the security market line (SML) equals:

Slope_{SML} = Rise/Run
Slope_{SML} = Increase in expected return/Increase in beta
$\text{Slope}_{SML} = (.1260 - .1040)/.34$
$\text{Slope}_{SML} = .0647$, or 6.47%

Since the market's beta is 1 and the risk-free rate has a beta of zero, the slope of the Security Market Line equals the expected market risk premium. So, the expected market risk premium must be 6.47 percent.

We could also solve this problem using CAPM. The equations for the expected returns of the two stocks are:

$.126 = R_f + (\beta_B + .34)(\text{MRP})$
$.104 = R_f + \beta_B(\text{MRP})$

We can rewrite the CAPM equation for Stock A as:

$.126 = R_f + \beta_B(\text{MRP}) + .34(\text{MRP})$

Subtracting the CAPM equation for Stock B from this equation yields:

$.022 = .34\text{MRP}$
$\text{MRP} = .0647$, or 6.47%

which is the same answer as our previous result.

37. *a.* A typical, risk-averse investor seeks high returns and low risks. For a risk-averse investor holding a well-diversified portfolio, beta is the appropriate measure of the risk of an individual security. To assess the two stocks, we need to find the expected return and beta of each of the two securities.

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Stock A:
Since Stock A pays no dividends, the return on Stock A is: $(P_1 - P_0)/P_0$. So, the return for each state of the economy is:

$R_{Recession}$ = (\$40 – 67)/\$67 = –.4030, or –40.30%
R_{Normal} = (\$76 – 67)/\$67 = .1343, or 13.43%
$R_{Expanding}$ = (\$89 – 67)/\$67 = .3284, or 32.84%

The expected return of an asset is the sum of the probability of each return occurring times the probability of that return occurring. So, the expected return of the stock is:

$E(R_A) = .10(-.4030) + .65(.1343) + .25(.3284) = .1291$, or 12.91%

And the variance of the stock is:

$\sigma_A^2 = .10(-.4030 - .1291)^2 + .65(.1343 - .1291)^2 + .25(.3284 - .1291)^2$

$\sigma_A^2 = .0383$

Which means the standard deviation is:

$\sigma_A = (.0383)^{1/2}$
$\sigma_A = .1956$, or 19.56%

Now we can calculate the stock's beta, which is:

$\beta_A = (\rho_{A,M})(\sigma_A)/\sigma_M$
$\beta_A = (.73)(.1956)/.20$
$\beta_A = .714$

For Stock B, we can directly calculate the beta from the information provided. So, the beta for Stock B is:

Stock B:

$\beta_B = (\rho_{B,M})(\sigma_B)/\sigma_M$
$\beta_B = (.35)(.63)/.20$
$\beta_B = 1.103$

Using the CAPM to find the expected return for Stock B, we get:

$E(R_B) = .04 + 1.103(.075)$
$E(R_B) = .1227$, or 12.27%

The expected return on Stock B is lower than the expected return on Stock A. The risk of Stock B, as measured by its beta, is higher than the risk of Stock A. Thus, a typical risk-averse investor holding a well-diversified portfolio will prefer Stock A.

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b. The expected return of the portfolio is the sum of the weight of each asset times the expected return of each asset, so:

$E(R_P) = X_A E(R_A) + X_B E(R_B)$
$E(R_P) = .70(.1291) + .30(.1227)$
$E(R_P) = .1272$, or 12.72%

To find the standard deviation of the portfolio, we first need to calculate the variance. The variance of the portfolio is:

$$\sigma_P^2 = X_A^2\sigma_A^2 + X_B^2\sigma_B^2 + 2X_A X_B \sigma_A \sigma_B \rho_{A,B}$$
$$\sigma_P^2 = (.70)^2(.1956)^2 + (.30)^2(.63)^2 + 2(.70)(.30)(.1956)(.63)(.50)$$
$$\sigma_P^2 = .08034$$

And the standard deviation of the portfolio is:

$\sigma_P = .08034^{1/2}$
$\sigma_P = .2834$, or 28.34%

c. The beta of a portfolio is the weighted average of the betas of its individual securities. So the beta of the portfolio is:

$\beta_P = .70(.714) + .30(1.103)$
$\beta_P = .830$

38. *a.* The variance of a portfolio of two assets equals:

$$\sigma_P^2 = X_A^2\sigma_A^2 + X_B^2\sigma_B^2 + 2X_A X_B \text{Cov}(A,B)$$

Since the weights of the assets must sum to one, we can write the variance of the portfolio as:

$$\sigma_P^2 = X_A^2\sigma_A^2 + (1 - X_A)\sigma_B^2 + 2X_A(1 - X_A)\text{Cov}(A,B)$$

To find the minimum for any function, we find the derivative and set the derivative equal to zero. Finding the derivative of the variance function, setting the derivative equal to zero, and solving for the weight of Asset A, we find:

$$X_A = [\sigma_B^2 - \text{Cov}(A,B)]/[\sigma_A^2 + \sigma_B^2 - 2\text{Cov}(A,B)]$$

Using this expression, we find the weight of Asset A must be:

$X_A = (.58^2 - .01)/[.34^2 + .58^2 - 2(.01)]$
$X_A = .7556$

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This implies the weight of Stock B is:

$X_B = 1 - X_A$
$X_B = 1 - .7556$
$X_B = .2444$

b. Using the weights calculated in part (a) to determine the expected return of the portfolio, we find:

$E(R_P) = X_A E(R_A) + X_B E(R_B)$
$E(R_P) = .7556(.13) + .2444(.11)$
$E(R_P) = .1251$, or 12.51%

c. Using the derivative from part (a), with the new covariance, the weight of each stock in the minimum variance portfolio is:

$X_A = [\sigma_B^2 + \text{Cov}(A,B)]/[\sigma_A^2 + \sigma_B^2 - 2\text{Cov}(A,B)]$
$X_A = (.58^2 - (-.15))/[.34^2 + .58^2 - 2(-.15)]$
$X_A = .6468$

This implies the weight of Stock B is:

$X_B = 1 - X_A$
$X_B = 1 - .6468$
$X_B = .3532$

d. The variance of the portfolio with the weights in part (c) is:

$\sigma_P^2 = X_A^2\sigma_A^2 + X_B^2\sigma_B^2 + 2X_A X_B \text{Cov}(A,B)$
$\sigma_P^2 = (.6468)^2(.34)^2 + (.3532)^2(.58)^2 + 2(.6468)(.3532)(-.15)$
$\sigma_P^2 = .021792$

And the standard deviation of the portfolio is:

$\sigma_P = .021792^{1/2}$
$\sigma_P = .1476$, or 14.76%

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CHAPTER 12
RISK, COST OF CAPITAL, AND VALUATION

Answers to Concepts Review and Critical Thinking Questions

1. No. The cost of capital depends on the risk of the project, not the source of the money.

2. Interest expense is tax-deductible. There is no difference between pretax and aftertax equity costs.

3. You are assuming that the new project's risk is the same as the risk of the firm as a whole and that the firm is financed entirely with equity.

4. Two primary advantages of the SML approach are that the model explicitly incorporates the relevant risk of the stock and the method is more widely applicable than is the DCF model, since the SML doesn't make any assumptions about the firm's dividends. The primary disadvantages of the SML method are (1) three parameters (the risk-free rate, the expected return on the market, and beta) must be estimated, and (2) the method essentially uses historical information to estimate these parameters. The risk-free rate is usually estimated to be the yield on very short maturity T-bills and is, hence, observable; the market risk premium is usually estimated from historical risk premiums and, hence, is not observable. The stock beta, which is unobservable, is usually estimated either by determining some average historical beta from the firm and the market's return data, or by using beta estimates provided by analysts and investment firms.

5. The appropriate aftertax cost of debt to the company is the interest rate it would have to pay if it were to issue new debt today. Hence, if the YTM on outstanding bonds of the company is observed, the company has an accurate estimate of its cost of debt. If the debt is privately-placed, the firm could still estimate its cost of debt by (1) looking at the cost of debt for similar firms in similar risk classes, (2) looking at the average debt cost for firms with the same credit rating (assuming the firm's private debt is rated), or (3) consulting analysts and investment bankers. Even if the debt is publicly traded, an additional complication arises when the firm has more than one issue outstanding; these issues rarely have the same yield because no two issues are ever completely homogeneous.

6. *a.* This only considers the dividend yield component of the required return on equity.
b. This is the current yield only, not the promised yield to maturity. In addition, it is based on the book value of the liability, and it ignores taxes.
c. Equity is inherently riskier than debt (except, perhaps, in the unusual case where a firm's assets have a negative beta). For this reason, the cost of equity exceeds the cost of debt. If taxes are considered in this case, it can be seen that at reasonable tax rates, the cost of equity does exceed the cost of debt.

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7. $R_{Sup} = .12 + .75(.08) = .1800$, or 18.00%
Both should proceed. The appropriate discount rate does not depend on which company is investing; it depends on the risk of the project. Since Superior is in the business, it is closer to a pure play. Therefore, its cost of capital should be used. With an 18% cost of capital, the project has an NPV of $1 million regardless of who takes it.

8. If the different operating divisions were in much different risk classes, then separate cost of capital figures should be used for the different divisions; the use of a single, overall cost of capital would be inappropriate. If the single hurdle rate were used, riskier divisions would tend to receive more funds for investment projects, since their return would exceed the hurdle rate despite the fact that they may actually plot below the SML and, hence, be unprofitable projects on a risk-adjusted basis. The typical problem encountered in estimating the cost of capital for a division is that it rarely has its own securities traded on the market, so it is difficult to observe the market's valuation of the risk of the division. Two typical ways around this are to use a pure play proxy for the division, or to use subjective adjustments of the overall firm hurdle rate based on the perceived risk of the division.

9. The discount rate for the projects should be lower than the rate implied by the security market line. The security market line is used to calculate the cost of equity. The appropriate discount rate for projects is the firm's weighted average cost of capital. Since the firm's cost of debt is generally less that the firm's cost of equity, the rate implied by the security market line will be too high.

10. Beta measures the responsiveness of a security's returns to movements in the market. Beta is determined by the cyclicality of a firm's revenues. This cyclicality is magnified by the firm's operating and financial leverage. The following three factors will impact the firm's beta. (1) Revenues. The cyclicality of a firm's sales is an important factor in determining beta. In general, stock prices will rise when the economy expands and will fall when the economy contracts. As we said above, beta measures the responsiveness of a security's returns to movements in the market. Therefore, firms whose revenues are more responsive to movements in the economy will generally have higher betas than firms with less cyclical revenues. (2) Operating leverage. Operating leverage is the percentage change in earnings before interest and taxes (EBIT) for a percentage change in sales. A firm with high operating leverage will have greater fluctuations in EBIT for a change in sales than a firm with low operating leverage. In this way, operating leverage magnifies the cyclicality of a firm's revenues, leading to a higher beta. (3) Financial leverage. Financial leverage arises from the use of debt in the firm's capital structure. A levered firm must make fixed interest payments regardless of its revenues. The effect of financial leverage on beta is analogous to the effect of operating leverage on beta. Fixed interest payments cause the percentage change in net income to be greater than the percentage change in EBIT, magnifying the cyclicality of a firm's revenues. Thus, returns on highly-levered stocks should be more responsive to movements in the market than the returns on stocks with little or no debt in their capital structure.

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Solutions to Questions and Problems

NOTE: All end-of-chapter problems were solved using a spreadsheet. Many problems require multiple steps. Due to space and readability constraints, when these intermediate steps are included in this solutions manual, rounding may appear to have occurred. However, the final answer for each problem is found without rounding during any step in the problem.

Basic

1. With the information given, we can find the cost of equity using the CAPM. The cost of equity is:

$R_S = .037 + 1.08(.10 - .037)$
$R_S = .1050$, or 10.50%

2. The pretax cost of debt is the YTM of the company's bonds, so:

$P_0 = \$950 = \$29.50(\text{PVIFA}_{R\%,28}) + \$1{,}000(\text{PVIF}_{R\%,28})$
$R = 3.224\%$
$R_B = 2 \times 3.224\% = 6.45\%$

And the aftertax cost of debt is:

Aftertax cost of debt = .0645(1 – .21)
Aftertax cost of debt = .0509, or 5.09%

3. *a.* The pretax cost of debt is the YTM of the company's bonds, so:

$P_0 = \$970 = \$29(\text{PVIFA}_{R\%,46}) + \$1{,}000(\text{PVIF}_{R\%,46})$
$R = 3.022\%$
$R_B = 2 \times 3.022\% = 6.04\%$

b. The aftertax cost of debt is:

Aftertax cost of debt = .0604(1 – .21)
Aftertax cost of debt = .0477, or 4.77%

c. The aftertax rate is more relevant because that is the actual cost to the company.

4. The book value of debt is the total par value of all outstanding debt, so:

$\text{BV}_B = \$65{,}000{,}000 + 50{,}000{,}000$
$\text{BV}_B = \$115{,}000{,}000$

To find the market value of debt, we find the price of the bonds and multiply by the number of bonds. Alternatively, we can multiply the price quote of the bond times the par value of the bonds. Doing so, we find:

$\text{MV}_B = .97(\$65{,}000{,}000) + .67(\$50{,}000{,}000)$
$\text{MV}_B = \$96{,}550{,}000$

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The YTM of the zero coupon bonds is:

$P_Z = \$730 = \$1{,}000(PVIF_{R\%,24})$
$R = 1.683\%$
YTM = 2 × 1.683% = 3.37%

So, the aftertax cost of the zero coupon bonds is:

Aftertax cost of zero coupon bonds = .0337(1 – .21)
Aftertax cost of zero coupon bonds = .0266, or 2.66%

The aftertax cost of debt for the company is the weighted average of the aftertax cost of debt for all outstanding bond issues. We need to use the market value weights of the bonds. The total aftertax cost of debt for the company is:

Aftertax cost of debt = .0477[.97($65)/$96.55] + .0266[.67($50)/$96.55)
Aftertax cost of debt = .0404, or 4.04%

5. Using the equation to calculate the WACC, we find:

WACC = .75(.112) + .25(.058)(1 – .21)
WACC = .0955, or 9.55%

6. Here we need to use the debt-equity ratio to calculate the WACC. Doing so, we find:

WACC = .12(1/1.80) + .07(.80/1.80)(1 – .21)
WACC = .0912, or 9.12%

7. Here we have the WACC and need to find the debt-equity ratio of the company. Setting up the WACC equation, we find:

WACC = .0860 = .112(S/V) + .064(B/V)(1 – .21)

Rearranging the equation, we find:

.0860(V/S) = .112 + .064(.79)(B/S)

Now we must realize that the V/S is just the equity multiplier, which is equal to:

$V/S = 1 + B/S$

.0860(B/S + 1) = .112 + .0506(B/S)

Now we can solve for B/S as:

.0354(B/S) = .026
B/S = .7336

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8. *a.* The book value of equity is the book value per share times the number of shares, and the book value of debt is the face value of the company's debt, so:

Equity = 5,800,000($4)
Equity = $23,200,000

Debt = $50,000,000 + 40,000,000
Debt = $90,000,000

So, the total book value of the company is:

Book value = $23,200,000 + 90,000,000
Book value = $113,200,000

And the book value weights of equity and debt are:

Equity/Value = $23,200,000/$113,200,000
Equity/Value = .2049

Debt/Value = 1 – Equity/Value
Debt/Value = .7951

b. The market value of equity is the share price times the number of shares, so:

S = 5,800,000($52)
S = $301,600,000

Using the relationship that the total market value of debt is the price quote times the par value of the bond, we find the market value of debt is:

B = 1.083($50,000,000) + 1.089($40,000,000)
B = $97,710,000

This makes the total market value of the company:

V = $301,600,000 + 97,710,000
V = $399,310,000

And the market value weights of equity and debt are:

S/V = $301,600,000/$399,310,000
S/V = .7553

B/V = 1 – S/V
B/V = .2447

c. The market value weights are more relevant.

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9. First, we will find the cost of equity for the company. The information provided allows us to solve for the cost of equity using the CAPM, so:

$R_S = .031 + 1.2(.065)$
$R_S = .1090$, or 10.90%

Next, we need to find the YTM on both bond issues. Doing so, we find:

$P_1 = \$1{,}083 = \$30.50(\text{PVIFA}_{R\%,16}) + \$1{,}000(\text{PVIF}_{R\%,16})$
$R = 2.418\%$
YTM = $2.418\% \times 2 = 4.84\%$

$P_2 = \$1{,}089 = \$31.50(\text{PVIFA}_{R\%,54}) + \$1{,}000(\text{PVIF}_{R\%,54})$
$R = 2.827\%$
YTM = $2.827\% \times 2 = 5.65\%$

To find the weighted average aftertax cost of debt, we need the weight of each bond as a percentage of the total debt. We find:

$X_{B1} = 1.083(\$50{,}000{,}000)/\$97{,}710{,}000$
$X_{B1} = .554$

$X_{B2} = 1.089(\$40{,}000{,}000)/\$97{,}710{,}000$
$X_{B2} = .446$

Now we can multiply the weighted average cost of debt times one minus the tax rate to find the weighted average aftertax cost of debt. This gives us:

$R_B = (1 - .21)[(.554)(.0484) + (.446)(.0565)]$
$R_B = .0411$, or 4.11%

Using these costs and the weight of debt we calculated earlier, the WACC is:

WACC = $.7553(.1090) + .2447(.0411)$
WACC = .0924, or 9.24%

10. *a.* Using the equation to calculate WACC, we find:

WACC = $.096 = (1/1.45)(.124) + (.45/1.45)(1 - .21)R_B$
$R_B = .0428$, or 4.28%

b. Using the equation to calculate WACC, we find:

WACC = $.096 = (1/1.45)R_S + (.45/1.45)(.057)$
$R_S = .1136$, or 11.36%

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11. We will begin by finding the market value of each type of financing. We find:

$B = 7{,}000(\$1{,}000)(1.05)$
$B = \$7{,}350{,}000$

$S = 180{,}000(\$58)$
$S = \$10{,}440{,}000$

And the total market value of the firm is:

$V = \$7{,}350{,}000 + 10{,}440{,}000$
$V = \$17{,}790{,}000$

Now, we can find the cost of equity using the CAPM. The cost of equity is:

$R_S = .043 + .85(.065)$
$R_S = .0983$, or 9.83%

The cost of debt is the YTM of the bonds, so:

$P_0 = \$1{,}050 = \$25(\text{PVIFA}_{R\%,40}) + \$1{,}000(\text{PVIF}_{R\%,40})$
$R = 2.307\%$
YTM = 2.307% × 2 = 4.61%

And the aftertax cost of debt is:

$R_B = (1 - .21)(.0461)$
$R_B = .0365$, or 3.65%

Now we have all the components to calculate the WACC. The WACC is:

WACC = .0365($7,350,000/$17,790,000) + .0983($10,440,000/$17,790,000)
WACC = .0727, or 7.27%

Notice that we didn't include the $(1 - T_C)$ term in the WACC equation. We used the aftertax cost of debt in the equation, so the term is not needed here.

12. *a.* We will begin by finding the market value of each type of financing. We find:

$B = 150{,}000(\$1{,}000)(1.04)$
$B = \$156{,}000{,}000$

$S = 8{,}100{,}000(\$41)$
$S = \$332{,}100{,}000$

And the total market value of the firm is:

$V = \$156{,}000{,}000 + 332{,}100{,}000$
$V = \$488{,}100{,}000$

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So, the market value weights of the company's financing are:

B/V = \$156,000,000/\$488,100,000
B/V = .3196

S/V = \$332,100,000/\$488,100,000
S/V = .6804

b. For projects equally as risky as the firm itself, the WACC should be used as the discount rate.

First we can find the cost of equity using the CAPM. The cost of equity is:

R_S = .031 + 1.08(.07)
R_S = .1066, or 10.66%

The cost of debt is the YTM of the bonds, so:

P_0 = \$1,040 = \$29($PVIFA_{R\%,40}$) + \$1,000($PVIF_{R\%,40}$)
R = 2.734%
YTM = 2.734% × 2 = 5.47%

And the aftertax cost of debt is:

R_B = (1 – .23)(.0547)
R_B = .0421, or 4.21%

Now we can calculate the WACC as:

$WACC$ = .6804(.1066) + .3196(.0421)
$WACC$ = .0860, or 8.60%

13. *a.* Projects Y and Z.

b. Using the CAPM to consider the projects, we need to calculate the expected return of each project given its level of risk. This expected return should then be compared to the expected return of the project. If the return calculated using the CAPM is lower than the project expected return, we should accept the project; if not, we reject the project. After considering risk via the CAPM:

E[W] = .035 + .85(.11 – .035) = .0988 < .104, so accept W
E[X] = .035 + .95(.11 – .035) = .1063 > .106, so reject X
E[Y] = .035 + 1.20(.11 – .035) = .1250 > .119, so reject Y
E[Z] = .035 + 1.35 (.11 – .035) = .1363 < .141, so accept Z

c. Project W would be incorrectly rejected; Project Y would be incorrectly accepted.

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14. *a.* He should look at the weighted average flotation cost, not just the debt cost.

b. The weighted average flotation cost is the weighted average of the flotation costs for debt and equity, so:

$f_T = .03(.45/1.45) + .07(1/1.45)$
$f_T = .0576$, or 5.76%

c. The total cost of the equipment including flotation costs is:

Amount raised(1 – .0576) = $45,000,000
Amount raised = $45,000,000/(1 – .0576)
Amount raised = $47,749,726

Even if the specific funds are actually being raised completely from debt, the flotation costs, and hence true investment cost, should be valued as if the firm's target capital structure is used.

15. We first need to find the weighted average flotation cost. Doing so, we find:

$f_T = .65(.07) + .05(.04) + .30(.03)$
$f_T = .0565$, or 5.65%

And the total cost of the equipment including flotation costs is:

Amount raised(1 – .0565) = $75,000,000
Amount raised = $75,000,000/(1 – .0565)
Amount raised = $79,491,256

Intermediate

16. Using the debt-equity ratio to calculate the WACC, we find:

WACC = (.55/1.55)(.049) + (1/1.55)(.117)
WACC = .0929, or 9.29%

Since the project is riskier than the company, we need to adjust the project discount rate for the additional risk. Using the subjective risk factor given, we find:

Project discount rate = 9.29% + 2%
Project discount rate = 11.29%

We would accept the project if the NPV is positive. The NPV is the PV of the cash outflows plus the PV of the cash inflows. Since we have the costs, we just need to find the PV of inflows. The cash inflows are a growing perpetuity. If you remember, the equation for the PV of a growing perpetuity is the same as the dividend growth equation, so:

PV of future CF = $4,100,000/(.1129 – .03)
PV of future cash flows = $49,474,504

The project should only be undertaken if its cost is less than $49,474,504 since costs less than this amount will result in a positive NPV.

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17. We will begin by finding the market value of each type of financing. We will use B1 to represent the coupon bond, and B2 to represent the zero coupon bond. So, the market value of the firm's financing is:

B_{B1} = 80,000($1,000)(1.064)
B_{B1} = $85,120,000

B_{B2} = 230,000($1,000)(.143)
B_{B2} = $32,890,000

P = 150,000($81)
P = $12,150,000

S = 2,300,000($68)
S = $156,400,000

And the total market value of the firm is:

V = $85,120,000 + 32,890,000 + 12,150,000 + 156,400,000
V = $286,560,000

Now, we can find the cost of equity using the CAPM. The cost of equity is:

R_S = .032 + 1.09(.07)
R_S = .1083, or 10.83%

The cost of debt is the YTM of the bonds, so:

P_0 = $1,064 = $29($PVIFA_{R\%,40}$) + $1,000($PVIF_{R\%,40}$)
R = 2.639%
YTM = 2.639% × 2 = 5.28%

And the aftertax cost of debt is:

R_{B1} = (1 – .23)(.0528)
R_{B1} = .0406, or 4.06%

And the aftertax cost of the zero coupon bonds is:

P_0 = $143 = $1,000($PVIF_{R\%,60}$)
R = 3.295%
YTM = 3.295% × 2 = 6.59%

R_{B2} = (1 – .23)(.0659)
R_{B2} = .0507, or 5.07%

Even though the zero coupon bonds make no payments, the calculation for the YTM (or price) still assumes semiannual compounding, consistent with a coupon bond. Also remember that, even though the company does not make interest payments, the accrued interest is still tax deductible for the company.

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To find the required return on preferred stock, we can use the preferred stock pricing equation, which is the level perpetuity equation, so the required return on the company's preferred stock is:

$R_P = D_1/P_0$
$R_P = \$3.80/\$81$
$R_P = .0469$, or 4.69%

Notice that the required return on the preferred stock is lower than the required return on the bonds. This result is not consistent with the risk levels of the two instruments but is a common occurrence. There is a practical reason for this: Assume Company A owns stock in Company B. The tax code allows Company A to exclude at least 50 percent of the dividends received from Company B, meaning Company A does not pay taxes on this amount. In practice, much of the outstanding preferred stock is owned by other companies, who are willing to take the lower return since much of the return is effectively tax exempt for the investing company.

Now we have all the components to calculate the WACC. The WACC is:

WACC = .0406($85,120,000/$286,560,000) + .0507($32,890,000/$286,560,000)
+ .1083($156,400,000/$286,560,000) + .0469($12,150,000/$286,560,000)
WACC = .0790, or 7.90%

18. The total cost of the equipment including flotation costs was:

Total costs = $29,000,000 + 1,570,000
Total costs = $30,570,000

Using the equation to calculate the total cost including flotation costs, we get:

Amount raised$(1 - f_T)$ = Amount needed after flotation costs
$\$30,570,000(1 - f_T) = \$29,000,000$
$f_T = .0514$, or 5.14%

Now, we know the weighted average flotation cost. The equation to calculate the percentage flotation costs is:

$f_T = .0514 = .07(S/V) + .03(B/V)$

We can solve this equation to find the debt-equity ratio as follows:

$.0514(V/S) = .07 + .03(B/S)$

We must recognize that the V/S term is the equity multiplier, which is $(1 + B/S)$, so:

$.0514(B/S + 1) = .07 + .03(B/S)$
$B/S = .8729$

19. *a.* Using the dividend discount model, the cost of equity is:

$R_S = [(\$.95)(1.039)/\$71] + .039$
$R_S = .0529$, or 5.29%

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b. Using the CAPM, the cost of equity is:

$R_S = .043 + 1.15(.11 - .043)$
$R_S = .1201$, or 12.01%

c. When using the dividend growth model or the CAPM, you must remember that both are estimates for the cost of equity. Additionally, and perhaps more importantly, each method of estimating the cost of equity depends upon different assumptions.

20. We are given the total cash flow for the current year. To value the company, we need to calculate the cash flows until the growth rate levels off at a constant perpetual rate. So, the cash flows each year will be:

Year 1: \$7,300,000(1 + .09) = \$7,957,000
Year 2: \$7,957,000(1 + .09) = \$8,673,130
Year 3: \$8,673,130(1 + .09) = \$9,453,712
Year 4: \$9,453,712(1 + .09) = \$10,304,546
Year 5: \$10,304,546(1 + .09) = \$11,231,955
Year 6: \$11,231,955(1 + .04) = \$11,681,233

We can calculate the terminal value in Year 5 since the cash flows begin a perpetual growth rate. Since we are valuing Arras, we need to use the cost of capital for that company since this rate is based on the risk of Arras. The cost of capital for Schultz is irrelevant in this case. So, the terminal value is:

$TV_5 = CF_6/(WACC - g)$
$TV_5 = \$11,681,233/(.10 - .04)$
$TV_5 = \$194,687,218$

Now we can discount the cash flows for the first 5 years as well as the terminal value back to today. Again, using the cost of capital for Arras, we find the value of the company today is:

$V_0 = \$7,957,000/1.10 + \$8,673,130/1.10^2 + \$9,453,712/1.10^3 + \$10,304,546/1.10^4$
$+ (\$11,231,955 + 194,687,218)/1.10^5$
$V_0 = \$156,401,974$

The market value of the equity is the market value of the company minus the market value of the debt, or:

$S = \$156,401,974 - 30,000,000$
$S = \$126,401,974$

To find the maximum offer price, we divide the market value of equity by the shares outstanding, or:

Share price = \$126,401,974/1,900,000
Share price = \$66.53

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21. *a.* To begin the valuation of Joe's, we will begin by calculating the WACC for Happy Times. Since both companies are in the same industry, it is likely that the WACC for both companies will be the same. The weights of debt and equity are:

X_B = \$95,000,000/(\$95,000,000 + 340,000,000)
X_B = .2184, or 21.84%

X_S = \$340,000,000/(\$95,000,000 + 340,000,000)
X_S = .7816, or 78.16%

The WACC for Happy Times is:

WACC = .2184(.06)(1 – .21) + .7816(.11)
WACC = .0963, or 9.63%

Next, we need to calculate the cash flows for each year. The EBIT will grow at 10 percent per year for 5 years. Net working capital, capital spending, and depreciation are 9 percent, 15 percent, and 8 percent of EBIT, respectively. So, the cash flows for each year over the next 5 years will be:

	Year 1	*Year 2*	*Year 3*	*Year 4*	*Year 5*
EBIT	\$10,300,000	\$11,330,000	\$12,463,000	\$13,709,300	\$15,080,230
Taxes	2,163,000	2,379,300	2,617,230	2,878,953	3,166,848
Net income	\$8,137,000	\$8,950,700	\$9,845,770	\$10,830,347	\$11,913,382
Depreciation	824,000	906,400	997,040	1,096,744	1,206,418
OCF	\$8,961,000	\$9,857,100	\$10,842,810	\$11,927,091	\$13,119,800
– Capital spending	1,545,000	1,699,500	1,869,450	2,056,395	2,262,035
– Change in NWC	927,000	1,019,700	1,121,670	1,233,837	1,357,221
Cash flow from assets	\$6,489,000	\$7,137,900	\$7,851,690	\$8,636,859	\$9,500,545

After Year 5 the cash flows will grow at 3 percent in perpetuity. We can find the terminal value of the company in Year 5 using the cash flow in Year 6, as:

$TV_5 = CF_6/(WACC - g)$
TV_5 = \$9,500,545(1 + .03)/(.0963 – .03)
TV_5 = \$147,531,250

Now we can discount the cash flows and terminal value to today. Doing so, we find:

V_0 = \$6,489,000/1.0963 + \$7,137,900/1.0963^2 + \$7,851,690/1.0963^3
+ \$8,636,859/1.0963^4 + (\$9,500,545 + 147,531,250)/1.0963^5
V_0 = \$122,942,488

The market value of the equity is the market value of the company minus the market value of the debt, or:

S = \$122,942,488 – 26,500,000
S = \$96,442,488

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To find the maximum offer price, we divide the market value of equity by the shares outstanding, or:

Share price = $96,442,488/1,850,000
Share price = $52.13

b. To calculate the terminal value using the EV/EBITDA multiple we need to calculate the Year 5 EBITDA, which is EBIT plus depreciation, or:

EBITDA = $15,080,230 + 1,206,418
EBITDA = $16,286,648

We can now calculate the terminal value of the company using the Year 5 EBITDA, which will be:

TV_5 = $16,286,648(8)
TV_5 = $130,293,187

Note, this is the terminal value in Year 5 since we used the Year 5 EBITDA. We need to calculate the present value of the cash flows for the first 4 years, plus the present value of the Year 5 terminal value. We do not need to include the Year 5 cash flow since it is included in the Year 5 terminal value. So, the value of the company today is:

V_0 = $6,489,000/1.0963 + $7,137,900/1.0963^2 + $7,851,690/1.0963^3
+ $8,636,859/1.0963^4 + $130,293,187/1.0963^5
V_0 = $106,060,064

The market value of the equity is the market value of the company minus the market value of the debt, or:

S = $106,060,064 – 26,500,000
S = $79,560,064

To find the maximum offer price, we divide the market value of equity by the shares outstanding, or:

Share price = $79,560,064/1,850,000
Share price = $43.01

Challenge

22. We can use the debt-equity ratio to calculate the weights of equity and debt. The debt of the company has a weight for long-term debt and a weight for accounts payable. We can use the target given for accounts payable to calculate the weight of accounts payable and the weight of long-term debt. The weight of each will be:

Accounts payable weight = .20/1.20
Accounts payable weight = .17

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Long-term debt weight = 1/1.20
Long-term debt weight = .83

Since the accounts payable has the same cost as the overall WACC, we can write the equation for the WACC as:

WACC = (1/1.45)(.13) + (.45/1.45)[(.20/1.2)WACC + (1/1.2)(.07)(1 – .21)]

Solving for WACC, we find:

WACC = .0897 + .3103[(.20/1.2)WACC + .0461]
WACC = .0897 + (.0517)WACC + .0143
(.9483)WACC = .1040
WACC = .1096, or 10.96%

We will use the same equation to calculate the weighted average flotation cost, except we will use the flotation cost for each form of financing. Doing so, we get:

Flotation costs = (1/1.45)(.08) + (.45/1.45)[(.20/1.2)(0) + (1/1.2)(.04)]
Flotation costs = .0655, or 6.55%

The total amount we need to raise to fund the new equipment will be:

Amount raised cost = $40,000,000/(1 – .0655)
Amount raised = $42,804,428.04

Since the cash flows go to perpetuity, we can calculate the present value using the equation for the PV of a perpetuity. The NPV is:

NPV = –$42,804,428.04 + $5,400,000/.1096
NPV = $6,453,387.70

23. We can use the debt-equity ratio to calculate the weights of equity and debt. The weight of debt in the capital structure is:

X_B = .65/1.65
X_B = .3939, or 39.39%

And the weight of equity is:

X_S = 1 – .3939
X_S = .6061, or 60.61%

Now we can calculate the weighted average flotation costs for the various percentages of internally-raised equity. To find the portion of equity flotation costs, we can multiply the equity costs by the percentage of equity raised externally, which is one minus the percentage raised internally. So, if the company raises all equity externally, the flotation costs are:

f_T = (.6061)(.07)(1 – 0) + (.3939)(.025)
f_T = .0523, or 5.23%

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The initial cash outflow for the project needs to be adjusted for the flotation costs. To account for the flotation costs:

Amount raised(1 – .0523) = $145,000,000
Amount raised = $145,000,000/(1 – .0523)
Amount raised = $152,997,602

If the company uses 60 percent internally generated equity, the flotation cost is:

f_T = (.6061)(.07)(1 – .60) + (.3939)(.025)
f_T = .0268, or 2.68%

And the initial cash flow will be:

Amount raised(1 – .0268) = $145,000,000
Amount raised = $145,000,000/(1 – .0268)
Amount raised = $148,995,796

If the company uses 100 percent internally generated equity, the flotation cost is:

f_T = (.6061)(.07)(1 – 1) + (.3939)(.025)
f_T = .0098, or .98%

And the initial cash flow will be:

Amount raised(1 – .0098) = $145,000,000
Amount raised = $145,000,000/(1 – .0098)
Amount raised = $146,442,234

24. The $7.5 million cost of the land 3 years ago is a sunk cost and irrelevant; the $7.1 million appraised value of the land is an opportunity cost and is relevant. The $7.4 million land value in 5 years is a relevant cash flow as well. The fact that the company is keeping the land rather than selling it is unimportant. The land is an opportunity cost in 5 years and is a relevant cash flow for this project. The market value capitalization weights are:

B = 280,000($1,000)(1.03)
B = $288,400,000

S = 9,800,000($73)
S = $715,400,000

P = 450,000($87)
P = $39,150,000

The total market value of the company is:

V = $288,400,000 + 715,400,000 + 39,150,000
V = $1,042,950,000

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The weight of each form of financing in the company's capital structure is:

X_B = \$288,400,000/\$1,042,950,000
X_B = .2765

X_S = \$715,400,000/\$1,042,950,000
X_S = .6859

X_P = \$39,150,000/\$1,042,950,000
X_P = .0375

Next we need to find the cost of funds. We have the information available to calculate the cost of equity using the CAPM, so:

R_S = .032 + 1.20(.075)
R_S = .1220, or 12.20%

The cost of debt is the YTM of the company's outstanding bonds, so:

P_0 = \$1,030 = \$32(PVIFA$_{R\%,50}$) + \$1,000(PVIF$_{R\%,50}$)
R = 3.082%
YTM = 3.082% × 2 = 6.16%

And the aftertax cost of debt is:

R_B = (1 – .24)(.0616)
R_B = .0468, or 4.68%

The cost of preferred stock is:

R_P = \$5.10/\$87
R_P = .0586, or 5.86%

a. The weighted average flotation cost is the sum of the weight of each source of funds in the capital structure of the company times the flotation costs, so:

f_T = .6859(.065) + .2765(.03) + .0375(.045)
f_T = .0546, or 5.46%

The initial cash outflow for the project needs to be adjusted for the flotation costs. To account for the flotation costs:

Amount raised(1 – .0546) = \$45,000,000
Amount raised = \$45,000,000/(1 – .0546)
Amount raised = \$47,597,436

So the cash flow at Time 0 will be:

CF_0 = –\$7,100,000 – 47,597,436 – 1,400,000
CF_0 = –\$56,097,436

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There is an important caveat to this solution. This solution assumes that the increase in net working capital does not require the company to raise outside funds; therefore the flotation costs are not included. However, this is an assumption and the company could need to raise outside funds for the NWC. If this is true, the initial cash outlay includes these flotation costs, so:

Total cost of NWC including flotation costs:

$1,400,000/(1 – .0546) = $1,480,809

This would make the total initial cash flow:

CF_0 = –$7,100,000 – 47,597,436 – 1,480,809
CF_0 = –$56,178,245

b. To find the required return on this project, we first need to calculate the WACC for the company. The company's WACC is:

WACC = .6859(.1220) + .2765(.0468) + .0375(.0586)]
WACC = .0988, or 9.88%

The company wants to use the subjective approach to this project because it is located overseas. The adjustment factor is 2 percent, so the required return on this project is:

Project required return = 9.88% + 2%
Project required return = 11.88%

c. The annual depreciation for the equipment will be:

$45,000,000/8 = $5,625,000

So, the book value of the equipment at the end of five years will be:

BV_5 = $45,000,000 – 5($5,625,000)
BV_5 = $16,875,000

So, the aftertax salvage value will be:

Aftertax salvage value = $8,500,000 + .24($16,875,000 – 8,500,000)
Aftertax salvage value = $10,510,000

d. Using the tax shield approach, the OCF for this project is:

OCF = $[(P - v)Q - \text{FC}](1 - T_C) + T_C D$
OCF = [($12,900 – 11,250)(18,000) – 8,100,000](1 – .24) + .24($45,000,000/8)
OCF = $17,766,000

e. The accounting break-even sales figure for this project is:

$Q_A = (\text{FC} + D)/(P - v)$
Q_A = ($8,100,000 + 5,625,000)/($12,900 – 11,250)
Q_A = 8,318.18 units

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f. We have calculated all cash flows of the project. We just need to make sure that in Year 5 we add back the aftertax salvage value and the recovery of the initial NWC. The cash flows for the project are:

Year	*Flow Cash*
0	–$56,097,436
1	17,766,000
2	17,766,000
3	17,766,000
4	17,766,000
5	37,076,000

Using the required return of 11.88 percent, the NPV of the project is:

$NPV = –\$56,097,436 + \$17,766,000(PVIFA_{11.88\%,4}) + \$37,076,000/1.1188^5$
$NPV = \$19,143,948.95$

And the IRR is:

$NPV = 0 = –\$56,097,436 + \$17,766,000(PVIFA_{IRR\%,4}) + \$37,076,000/(1 + IRR)^5$
$IRR = 23.43\%$

If the initial NWC is assumed to be financed from outside sources, the cash flows are:

Year	*Flow Cash*
0	–$56,178,245
1	17,766,000
2	17,766,000
3	17,766,000
4	17,766,000
5	37,076,000

With this assumption, and the required return of 11.88 percent, the NPV of the project is:

$NPV = –\$56,178,245 + \$17,766,000(PVIFA_{11.88\%,4}) + \$37,076,000/1.1188^5$
$NPV = \$19,063,139.82$

And the IRR is:

$NPV = 0 = –\$56,178,245 + \$17,766,000(PVIFA_{IRR\%,4}) + \$37,076,000/(1 + IRR)^5$
$IRR = 23.37\%$

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CHAPTER 13
EFFICIENT CAPITAL MARKETS AND BEHAVIORAL CHALLENGES

Answers to Concept Questions

1. To create value, firms should accept financing proposals with positive net present values. Firms can create valuable financing opportunities in three ways: 1) Fool investors. A firm can issue a complex security to receive more than the fair market value. Financial managers attempt to package securities to receive the greatest value. 2) Reduce costs or increase subsidies. A firm can package securities to reduce taxes. Such a security will increase the value of the firm. In addition, financing techniques involve many costs, such as those associated with hiring accountants, lawyers, and investment bankers. Packaging securities in a way to reduce these costs will also increase the value of the firm. 3) Create a new security. A previously unsatisfied investor may pay extra for a specialized security catering to his or her needs. Corporations gain from developing unique securities by issuing these securities at premium prices.

2. The three forms of the efficient markets hypothesis are: 1) Weak form. Market prices reflect information contained in historical prices. Investors are unable to earn abnormal returns using historical prices to predict future price movements. 2) Semistrong form. In addition to historical data, market prices reflect all publicly-available information. Investors with insider, or private information, can earn abnormal returns. 3) Strong form. Market prices reflect all information, public or private. Investors are unable to earn abnormal returns using insider information or historical prices to predict future price movements.

3. *a.* False. Market efficiency implies that prices reflect all available information, but it does not imply certain knowledge. Many pieces of information that are available and reflected in prices are fairly uncertain. Efficiency of markets does not eliminate that uncertainty and therefore does not imply perfect forecasting ability.

b. True. Market efficiency exists when prices reflect all available information. To be efficient in the weak form, the market must incorporate all historical data into prices. Under the semistrong form of the hypothesis, the market incorporates all publicly-available information in addition to the historical data. In strong form efficient markets, prices reflect all publicly and privately available information.

c. False. Market efficiency implies that market participants are rational. Rational people will immediately act upon new information and will bid prices up or down to reflect that information.

d. False. In efficient markets, prices reflect all available information. Thus, prices will fluctuate whenever new information becomes available.

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e. True. Competition among investors results in the rapid transmission of new market information. In efficient markets, prices immediately reflect new information as investors bid the stock price up or down.

4. On average, the only return that is earned is the required return—investors buy assets with returns in excess of the required return (positive NPV), bidding up the price and thus causing the return to fall to the required return (zero NPV); investors sell assets with returns less than the required return (negative NPV), driving the price lower and thus causing the return to rise to the required return (zero NPV).

5. The market is not weak form efficient.

6. Yes, historical information is also public information; weak form efficiency is a subset of semistrong form efficiency.

7. Ignoring trading costs, on average, such investors merely earn what the market offers; the trades all have zero NPV. If trading costs exist, then these investors lose by the amount of the costs.

8. Unlike gambling, the stock market is a positive sum game; everybody can win. Also, speculators provide liquidity to markets and thus help to promote efficiency.

9. The EMH only says, within the bounds of increasingly strong assumptions about the information processing of investors, that assets are fairly priced. An implication of this is that, on average, the typical market participant cannot earn excessive profits from a particular trading strategy. However, that does not mean that a few particular investors cannot outperform the market over a particular investment horizon. Certain investors who do well for a period of time get a lot of attention from the financial press, but the scores of investors who do not do well over the same period of time generally get considerably less attention from the financial press.

10. *a.* If the market is not weak form efficient, then this information could be acted on and a profit earned from following the price trend. Under (2), (3), and (4), this information is fully impounded in the current price and no abnormal profit opportunity exists.

b. Under (2), if the market is not semistrong form efficient, then this information could be used to buy the stock "cheap" before the rest of the market discovers the financial statement anomaly. Since (2) is stronger than (1), both imply that a profit opportunity exists; under (3) and (4), this information is fully impounded in the current price and no profit opportunity exists.

c. Under (3), if the market is not strong form efficient, then this information could be used as a profitable trading strategy, by noting the buying activity of the insiders as a signal that the stock is underpriced or that good news is imminent. Since (1) and (2) are weaker than (3), all three imply that a profit opportunity exists. Note that this assumes the individual who sees the insider trading is the only one who sees the trading. If the information about the trades made by company management is public information, it will be discounted in the stock price and no profit opportunity exists. Under (4), this information does not signal any profit opportunity for traders; any pertinent information the manager-insiders may have is fully reflected in the current share price.

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11. A technical analyst would argue that the market is not efficient. Since a technical analyst examines past prices, the market cannot be weak form efficient for technical analysis to work. If the market is not weak form efficient, it cannot be efficient under stronger assumptions about the information available.

12. Investor sentiment captures the mood of the investing public. If investors are bearish in general, it may be that the market is headed down in the future since investors are less likely to invest. If the sentiment is bullish, it would be taken as a positive signal to the market. To use investor sentiment in technical analysis, you would probably want to construct a ratio such as a bulls/bears ratio. To use the ratio, compare the historical ratio to the market to determine if a certain level on the ratio indicates a market upturn or downturn.

13. Taken at face value, this fact suggests that markets have become more efficient. The increasing ease with which information is available over the internet lends strength to this conclusion. On the other hand, during this particular period, large-capitalization growth stocks were the top performers. Value-weighted indexes such as the S&P 500 are naturally concentrated in such stocks, thus making them especially hard to beat during this period. So, it may be that the dismal record compiled by the pros is just a matter of bad luck or benchmark error.

14. It is likely the market has a better estimate of the stock price, assuming it is semistrong form efficient. However, semistrong form efficiency only states that you cannot easily profit from publicly available information. If financial statements are not available, the market can still price stocks based upon the available public information, limited though it may be. Therefore, it may have been as difficult to examine the limited public information and make an extra return.

15. *a.* Aerotech's stock price should rise immediately after the announcement of the positive news.

b. Only scenario (*ii*) indicates market efficiency. In that case, the price of the stock rises immediately to the level that reflects the new information, eliminating all possibility of abnormal returns. In the other two scenarios, there are periods of time during which an investor could trade on the information and earn abnormal returns.

16. False. The stock price would have adjusted before the founder's death only if investors had perfect forecasting ability. The 12.5 percent increase in the stock price after the founder's death indicates that either the market did not anticipate the death or that the market had anticipated it imperfectly. However, the market reacted immediately to the new information, implying efficiency. It is interesting that the stock price rose after the announcement of the founder's death. This price behavior indicates that the market felt he was a liability to the firm.

17. The announcement should not deter investors from buying UPC's stock. If the market is semistrong form efficient, the stock price will have already reflected the present value of the payments that UPC must make. The expected return after the announcement should still be equal to the expected return before the announcement. UPC's current stockholders bear the burden of the loss, since the stock price falls on the announcement. After the announcement, the expected return moves back to its original level.

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18. The market is often considered to be relatively efficient up to the semistrong form. If so, no systematic profit can be made by trading on publicly-available information. Although illegal, the lead engineer of the device can profit from purchasing the firm's stock *before* the news release on the implementation of the new technology. The price should immediately and fully adjust to the new information in the article. Thus, no abnormal return can be expected from purchasing after the publication of the article.

19. Under the semistrong form of market efficiency, the stock price should stay the same. The accounting system changes are publicly available information. Investors would identify no changes in either the firm's current or its future cash flows. Thus, the stock price will not change after the announcement of increased earnings.

20. Because the number of subscribers has increased dramatically, the time it takes for information in the newsletter to be reflected in prices has shortened. With shorter adjustment periods, it becomes impossible to earn abnormal returns with the information provided by Durkin. If Durkin is using only publicly-available information in its newsletter, its ability to pick stocks is inconsistent with the efficient markets hypothesis. Under the semistrong form of market efficiency, all publicly-available information should be reflected in stock prices. The use of private information for trading purposes is illegal.

21. You should not agree with your broker. The performance ratings of the small manufacturing firms were published and became public information. Prices should adjust immediately to the information, thus preventing future abnormal returns.

22. Stock prices should immediately and fully rise to reflect the announcement. Thus, one cannot expect abnormal returns following the announcement.

23. *a.* No. Earnings information is in the public domain and reflected in the current stock price.

b. Possibly. If the rumors were publicly disseminated, the prices would have already adjusted for the possibility of a merger. If the rumor is information that you received from an insider, you could earn excess returns, although trading on that information is illegal.

c. No. The information is already public, and thus, already reflected in the stock price.

24. Serial correlation occurs when the current value of a variable is related to the future value of the variable. If the market is efficient, the information about the serial correlation in the macroeconomic variable and its relationship to net earnings should already be reflected in the stock price. In other words, although there is serial correlation in the variable, there will not be serial correlation in stock returns. Therefore, knowledge of the correlation in the macroeconomic variable will not lead to abnormal returns for investors.

25. The statement is false because every investor has a different risk preference. Although the expected return from every well-diversified portfolio is the same after adjusting for risk, investors still need to choose funds that are consistent with their particular risk level.

26. The share price will decrease immediately to reflect the new information. At the time of the announcement, the price of the stock should immediately decrease to reflect the negative information.

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27. In an efficient market, the cumulative abnormal return (CAR) for Prospectors would rise substantially at the announcement of a new discovery. The CAR falls slightly on any day when no discovery is announced. There is a small positive probability that there will be a discovery on any given day. If there is no discovery on a particular day, the price should fall slightly because the good event did not occur. The substantial price increases on the rare days of discovery should balance the small declines on the other days, leaving CARs that are horizontal over time.

28. Behavioral finance attempts to explain both the 1987 stock market crash and the internet bubble by changes in investor sentiment and psychology. These changes can lead to non-random price behavior.

Solutions to Questions and Problems

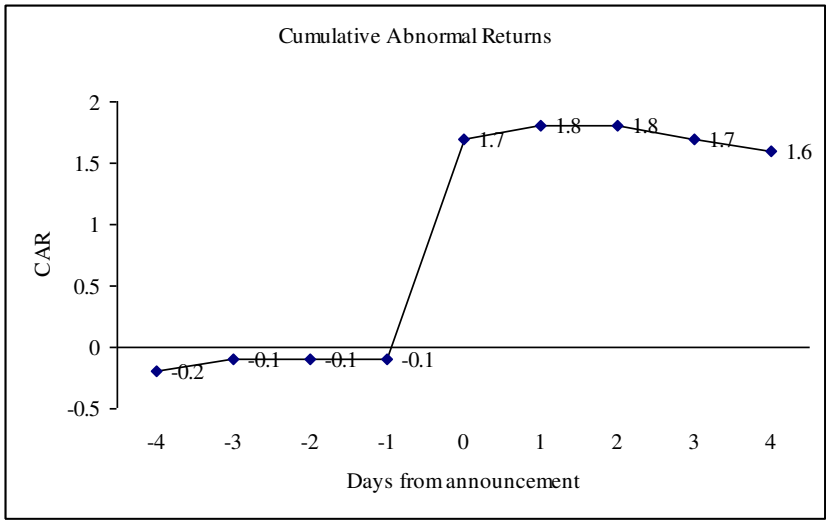
NOTE: All end-of-chapter problems were solved using a spreadsheet. Many problems require multiple steps. Due to space and readability constraints, when these intermediate steps are included in this solutions manual, rounding may appear to have occurred. However, the final answer for each problem is found without rounding during any step in the problem.

Basic

1. To find the cumulative abnormal returns, we chart the abnormal returns for each of the three airlines for the days preceding and following the announcement. The abnormal return is calculated by subtracting the market return from a stock's return on a particular day, $R_i - R_M$. Then, group the returns by the number of days before or after the announcement for each respective airline. Finally, calculate the cumulative average abnormal return by adding each abnormal return to the previous day's abnormal return.

	Abnormal returns ($R_i - R_M$)					
Days from announcement	Delta	United	American	Sum	Average abnormal return	Cumulative average residual
–4	–.2	–.2	–.2	–.6	–.2	–.2
–3	.2	–.1	.2	.3	.1	–.1
–2	.2	–.2	0	0	.0	–.1
–1	.2	.2	–.4	0	.0	–.1
0	3.3	.2	1.9	5.4	1.8	1.7
1	.2	.1	.0	.3	.1	1.8
2	–.1	0	.1	0	0	1.8
3	–.2	.1	–.2	–.3	–.1	1.7
4	–.1	–.1	–.1	–.3	–.1	1.6

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The market reacts favorably to the announcements. Moreover, the market reacts only on the day of the announcement. Before and after the event, the cumulative abnormal returns are relatively flat. This behavior is consistent with market efficiency.

2. The diagram does not support the efficient markets hypothesis. The CAR should remain relatively flat following the announcements. The diagram reveals that the CAR rose in the first month, only to drift down to lower levels during later months. Such movement violates the semistrong form of the efficient markets hypothesis because an investor could earn abnormal profits while the stock price gradually decreased.

3. *a.* Supports. The CAR remained constant after the event at Time 0. This result is consistent with market efficiency, because prices adjust immediately to reflect the new information. Drops in CAR prior to an event can easily occur in an efficient capital market. For example, consider a sample of forced removals of the CEO. Since any CEO is more likely to be fired following bad rather than good stock performance, CARs are likely to be negative prior to removal. Because the firing of the CEO is announced at Time 0, one cannot use this information to trade profitably *before* the announcement. Thus, price drops prior to an event are neither consistent nor inconsistent with the efficient markets hypothesis.

b. Rejects. Because the CAR increases after the event date, one can profit by buying after the event. This possibility is inconsistent with the efficient markets hypothesis.

c. Supports. The CAR does not fluctuate after the announcement at Time 0. While the CAR was rising before the event, insider information would be needed for profitable trading. Thus, the graph is consistent with the semistrong form of efficient markets.

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d. Supports. The diagram indicates that the information announced at Time 0 was of no value. There appears to be a slight drop in the CAR prior to the event day. Similar to part (a), such movement is neither consistent nor inconsistent with the efficient markets hypothesis (EMH). Movements at the event date are neither consistent nor inconsistent with the efficient markets hypothesis.

4. Once the verdict is reached, the diagram shows that the CAR continues to decline after the court decision, allowing investors to earn abnormal returns. The CAR should remain constant on average, even if an appeal is in progress, because no new information about the company is being revealed. Thus, the diagram is not consistent with the efficient markets hypothesis (EMH).

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CHAPTER 14
CAPITAL STRUCTURE: *BASIC CONCEPTS*

Answers to Concept Questions

1. Assumptions of the Modigliani-Miller theory in a world without taxes: 1) Individuals can borrow at the same interest rate at which the firm borrows. Since investors can purchase securities on margin, an individual's effective interest rate is probably no higher than that for a firm. Therefore, this assumption is reasonable when applying MM's theory to the real world. If a firm were able to borrow at a rate lower than the rate at which individuals are able to borrow, the firm's value would increase through corporate leverage. As MM Proposition I states, this is not the case in a world with no taxes. 2) There are no taxes. In the real world, firms do pay taxes. In the presence of corporate taxes, the value of a firm is positively related to its debt level. Since interest payments are deductible, increasing debt reduces taxes and raises the value of the firm. 3) There are no costs of financial distress. In the real world, costs of financial distress can be substantial. Since stockholders eventually bear these costs, there are incentives for a firm to lower the amount of debt in its capital structure. This topic will be discussed in more detail in later chapters.

2. False. A reduction in leverage will decrease both the risk of the stock and its expected return. Modigliani and Miller state that, in the absence of taxes, these two effects exactly cancel each other out and leave the price of the stock and the overall value of the firm unchanged.

3. False. Modigliani-Miller Proposition II (No Taxes) states that the required return on a firm's equity is positively related to the firm's debt-equity ratio [$R_S = R_0 + (B/S)(R_0 - R_B)$]. Therefore, any increase in the amount of debt in a firm's capital structure will increase the required return on the firm's equity.

4. Interest payments are tax deductible, where payments to shareholders (dividends) are not tax deductible.

5. Business risk is the equity risk arising from the nature of the firm's operating activity and is directly related to the systematic risk of the firm's assets. Financial risk is the equity risk that is due entirely to the firm's chosen capital structure. As financial leverage, or the use of debt financing, increases, so does financial risk and, hence, the overall risk of the equity. Thus, Firm B could have a higher cost of equity if it uses greater leverage.

6. No, it doesn't follow. While it is true that the equity and debt costs are rising, the key thing to remember is that the cost of debt is still less than the cost of equity. Since we are using more and more debt, the WACC does not necessarily rise, so the value of the firm does not necessarily fall.

7. Because many relevant factors such as bankruptcy costs, tax asymmetries, and agency costs cannot easily be identified or quantified, it's practically impossible to determine the precise debt-equity ratio that maximizes the value of the firm. However, if the firm's cost of new debt suddenly becomes much more expensive, it's probably true that the firm is too highly leveraged.

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8. It's called leverage (or "gearing" in the UK) because it magnifies gains or losses.

9. Homemade leverage refers to the use of borrowing on the personal level as opposed to the corporate level.

10. The basic goal is to minimize the value of non-marketed claims, which will maximize shareholder wealth.

Solutions to Questions and Problems

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Basic

1. *a.* A table outlining the income statement for the three possible states of the economy is shown below. The EPS is the net income divided by the 5,000 shares outstanding. The last row shows the percentage change in EPS the company will experience in a recession or an expansion economy.

	Recession	Normal	Expansion
EBIT	$21,700	$31,000	$38,750
Interest	0	0	0
NI	$21,700	$31,000	$38,750
EPS	$ 4.34	$ 6.20	$ 7.75
%ΔEPS	–30	–	+25

b. If the company undergoes the proposed recapitalization, it will repurchase:

Share price = Equity/Shares outstanding
Share price = $325,000/5,000
Share price = $65.00

Shares repurchased = Debt issued/Share price
Shares repurchased = $105,000/$65
Shares repurchased = 1,615.38

The interest payment each year under all three scenarios will be:

Interest payment = $105,000(.06)
Interest payment = $6,300

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The last row shows the percentage change in EPS the company will experience in a recession or an expansion economy under the proposed recapitalization.

	Recession	Normal	Expansion
EBIT	$21,700	$31,000	$38,750
Interest	6,300	6,300	6,300
NI	$15,400	$24,700	$32,450
EPS	$ 4.55	$ 7.30	$ 9.59
%ΔEPS	–37.65	—	+31.38

2. *a.* A table outlining the income statement with taxes for the three possible states of the economy is shown below. The share price is still $65, and there are still 5,000 shares outstanding. The last row shows the percentage change in EPS the company will experience in a recession or an expansion economy.

	Recession	Normal	Expansion
EBIT	$21,700	$31,000	$38,750
Interest	0	0	0
Taxes	4,557	6,510	8,138
NI	$17,143	$24,490	$30,613
EPS	$3.43	$4.90	$6.12
%ΔEPS	–30	—	+25

b. A table outlining the income statement with taxes for the three possible states of the economy and assuming the company undertakes the proposed capitalization is shown below. The interest payment and shares repurchased are the same as in part (b) of Problem 1.

	Recession	Normal	Expansion
EBIT	$21,700	$31,000	$38,750
Interest	6,300	6,300	6,300
Taxes	3,234	5,187	6,815
NI	$12,166	$19,513	$25,636
EPS	$3.59	$5.77	$7.57
%ΔEPS	–37.65	—	+31.38

Notice that the percentage change in EPS is the same both with and without taxes.

3. *a.* Since the company has a market-to-book ratio of 1.0, the total equity of the firm is equal to the market value of equity. Using the equation for ROE:

ROE = NI/$325,000

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The ROE for each state of the economy under the current capital structure and no taxes is:

	Recession	Normal	Expansion
ROE	6.68%	9.54%	11.92%
%ΔROE	–30	—	+25

The second row shows the percentage change in ROE from the normal economy.

b. If the company undertakes the proposed recapitalization, the new equity value will be:

Equity = $325,000 – 105,000
Equity = $220,000

So, the ROE for each state of the economy is:

ROE = NI/$220,000

	Recession	Normal	Expansion
ROE	7.00%	11.23%	14.75%
%ΔROE	–37.65	—	+31.38

c. If there are corporate taxes and the company maintains its current capital structure, the ROE is:

ROE	5.27%	7.54%	9.42%
%ΔROE	–30	—	+25

If the company undertakes the proposed recapitalization, and there are corporate taxes, the ROE for each state of the economy is:

ROE	5.53%	8.87%	11.65%
%ΔROE	–37.65	—	+31.38

Notice that the percentage change in ROE is the same as the percentage change in EPS. The percentage change in ROE is also the same with or without taxes.

4. *a.* Under Plan I, the unlevered company, net income is the same as EBIT with no corporate tax. The EPS under this capitalization will be:

EPS = $250,000/125,000 shares
EPS = $2.00

Under Plan II, the levered company, EBIT will be reduced by the interest payment. The interest payment is the amount of debt times the interest rate, so:

NI = $250,000 – .07($1,197,000)
NI = $166,210

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And the EPS will be:

EPS = $166,210/90,000 shares
EPS = $1.85

Plan I has the higher EPS when EBIT is $250,000.

b. Under Plan I, the net income is $350,000 and the EPS is:

EPS = $350,000/125,000 shares
EPS = $2.80

Under Plan II, the net income is:

NI = $350,000 – .07($1,197,000)
NI = $266,210

And the EPS is:

EPS = $266,210/90,000 shares
EPS = $2.96

Plan II has the higher EPS when EBIT is $350,000.

c. To find the break-even EBIT for two different capital structures, we set the equations for EPS equal to each other and solve for EBIT. The break-even EBIT is:

EBIT/125,000 = [EBIT – .07($1,197,000)]/90,000
EBIT = $299,250

5. We can find the price per share by dividing the amount of debt used to repurchase shares by the number of shares repurchased. Doing so, we find the share price is:

Share price = $1,197,000/(125,000 – 90,000)
Share price = $34.20 per share

The value of the company under the all-equity plan is:

V_U = $34.20(125,000 shares)
V_U = $4,275,000

And the value of the company under the levered plan is:

V_L = $34.20(90,000 shares) + $1,197,000 debt
V_L = $4,275,000

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6. *a.* The income statement for each capitalization plan is:

	I	*II*	*All-equity*
EBIT	$8,400	$8,400	$8,400
Interest	718	1,641	0
NI	$7,682	$6,759	$8,400
EPS	$ 1.55	$ 1.50	$ 1.58

The all-equity plan has the highest EPS; Plan II has the lowest EPS.

b. The break-even level of EBIT occurs when the capitalization plans result in the same EPS. The EPS is calculated as:

EPS = (EBIT – $R_D D$)/Shares outstanding

This equation calculates the interest payment ($R_D D$) and subtracts it from the EBIT, which results in the net income. Dividing by the shares outstanding gives us the EPS. For the all-equity capital structure, the interest term is zero. To find the break-even EBIT for two different capital structures, we set the equations equal to each other and solve for EBIT. The break-even EBIT between the all-equity capital structure and Plan I is:

EBIT/5,300 = [EBIT – .07($10,255)]/4,950
EBIT = $10,870

And the break-even EBIT between the all-equity capital structure and Plan II is:

EBIT/5,300 = [EBIT – .07($23,440)]/4,500
EBIT = $10,870

The break-even levels of EBIT are the same because of M&M Proposition I.

c. Setting the equations for EPS from Plan I and Plan II equal to each other and solving for EBIT, we get:

[EBIT – .07($10,255)]/4,950 = [EBIT – .07($23,440)]/4,500
EBIT = $10,870

This break-even level of EBIT is the same as in part (b) again because of M&M Proposition I.

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d. The income statement for each capitalization plan with corporate income taxes is:

	I	*II*	*All-equity*
EBIT	$8,400	$8,400	$8,400
Interest	718	1,641	0
Taxes	1,613	1,419	1,764
NI	$6,069	$5,340	$6,636
EPS	$ 1.23	$ 1.19	$ 1.25

The all-equity plan still has the highest EPS; Plan II still has the lowest EPS.

We can calculate the EPS as:

EPS = [(EBIT – $R_D D$)(1 – T_C)]/Shares outstanding

This is similar to the equation we used before, except that now we need to account for taxes. Again, the interest expense term is zero in the all-equity capital structure. So, the break-even EBIT between the all-equity plan and Plan I is:

EBIT(1 – .21)/5,300 = [EBIT – .07($10,255)](1 – .21)/4,950
EBIT = $10,870

The break-even EBIT between the all-equity plan and Plan II is:

EBIT(1 – .21)/5,300 = [EBIT – .07($23,440)](1 – .21)/4,500
EBIT = $10,870

And the break-even between Plan I and Plan II is:

[EBIT – .07($10,255)](1 – .21)/4,950 = [EBIT – .07($23,440)](1 – .21)/4,500
EBIT = $10,870

The break-even levels of EBIT do not change because the addition of taxes reduces the income of all three plans by the same percentage; therefore, they do not change relative to one another.

7. To find the value per share of the stock under each capitalization plan, we can calculate the price as the value of shares repurchased divided by the number of shares repurchased. The dollar value of the shares repurchased is the increase in the value of the debt used to repurchase shares, or:

Shares repurchased = 5,300 – 4,950
Shares repurchased = 350

So, under Plan I, the value per share is:

P = $10,255/350 shares
P = $29.30 per share

And under Plan II, the number of shares repurchased is:

Shares repurchased = 5,300 – 4,500
Shares repurchased = 800

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So, the value per share is:

P = $23,440/800 shares
P = $29.30 per share

This shows that when there are no corporate taxes, the stockholder does not care about the capital structure decision of the firm. This is M&M Proposition I without taxes.

8. *a.* The earnings per share are:

EPS = $36,000/7,100 shares
EPS = $5.07

So, the cash flow for the shareholder is:

Cash flow = $5.07(100 shares)
Cash flow = $507.04

b. To determine the cash flow to the shareholder, we need to determine the EPS of the firm under the proposed capital structure. The market value of the firm is:

V = $55(7,100)
V = $390,500

Under the proposed capital structure, the firm will raise new debt in the amount of:

D = .35($390,500)
D = $136,675

This means the number of shares repurchased will be:

Shares repurchased = $136,675/$55
Shares repurchased = 2,485

Under the new capital structure, the company will have to make an interest payment on the new debt. The net income with the interest payment will be:

NI = $36,000 – .08($136,675)
NI = $25,066

This means the EPS under the new capital structure will be:

EPS = $25,066/(7,100 – 2,485) shares
EPS = $5.43

Since all earnings are paid as dividends, the shareholder will receive:

Shareholder cash flow = $5.43(100 shares)
Shareholder cash flow = $543.14

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c. To replicate the proposed capital structure, the shareholder should sell 35 percent of their shares, or 35 shares, and lend the proceeds at 8 percent. The shareholder will have an interest cash flow of:

Interest cash flow = 35($55)(.08)
Interest cash flow = $154

The shareholder will receive dividend payments on the remaining 65 shares, so the dividends received will be:

Dividends received = $5.43(65 shares)
Dividends received = $353.04

The total cash flow for the shareholder under these assumptions will be:

Total cash flow = $154 + 353.04
Total cash flow = $507.04

This is the same cash flow we calculated in part (a).

d. The capital structure is irrelevant because shareholders can create their own leverage or unlever the stock to create the payoff they desire, regardless of the capital structure the firm actually chooses.

9. *a.* The rate of return earned will be the dividend yield. The company has debt, so it must make an interest payment. The net income for the company is:

NI = $60,000 – .08($275,000)
NI = $38,000

The investor will receive dividends in proportion to the percentage of the company's share they own. The total dividends received by the shareholder will be:

Dividends received = $38,000($20,000/$275,000)
Dividends received = $2,764

So the return the shareholder expects is:

R = $2,764/$20,000
R = .1382, or 13.82%

b. To generate exactly the same cash flows in the other company, the shareholder needs to match the capital structure of ABC. The shareholder should sell all shares in XYZ. This will net $20,000. The shareholder should then borrow $20,000. This will create an interest cash flow of:

Interest cash flow = .08($20,000)
Interest cash flow = $1,600

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The investor should then use the proceeds of the stock sale and the loan to buy shares in ABC. The investor will receive dividends in proportion to the percentage of the company's shares they own. The total dividends received by the shareholder will be:

Dividends received = \$60,000(\$40,000/\$550,000)
Dividends received = \$4,364

The total cash flow for the shareholder will be:

Total cash flow = \$4,364 – 1,600
Total cash flow = \$2,764

The shareholder's return in this case will be:

R = \$2,764/\$20,000
R = .1382, or 13.82%

c. ABC is an all equity company, so:

$R_S = R_0$ = \$60,000/\$550,000
R_S = .1091, or 10.91%

To find the cost of equity for XYZ, we need to use M&M Proposition II, so:

$R_S = R_0 + (R_0 - R_D)(D/S)(1 - T_C)$
R_S = .1091 + (.1091 – .08)(1)(1)
R_S = .1382, or 13.82%

d. To find the WACC for each company, we need to use the WACC equation:

$\text{WACC} = (S/V)R_S + (D/V)R_D(1 - T_C)$

So, for ABC, the WACC is:

WACC = (1)(.1091) + (0)(.08)
WACC = .1091, or 10.91%

And for XYZ, the WACC is:

WACC = (1/2)(.1382) + (1/2)(.08)
WACC = .1091, or 10.91%

When there are no corporate taxes, the cost of capital for the firm is unaffected by the capital structure; this is M&M Proposition I without taxes.

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10. With no taxes, the value of an unlevered firm is the interest rate divided by the unlevered cost of equity, so:

V = EBIT/WACC
$47,800,000 = EBIT/.089
EBIT = .089($47,800,000)
EBIT = $4,254,200

11. If there are corporate taxes, the value of an unlevered firm is:

$V_U = \text{EBIT}(1 - T_C)/R_0$

Using this relationship, we can find EBIT as:

$47,800,000 = EBIT(1 – .23)/.089
EBIT = $5,524,935.06

The WACC remains at 8.9 percent. Due to taxes, EBIT for an all-equity firm would have to be higher for the firm to still be worth $47.8 million.

12. *a.* With the information provided, we can use the equation for calculating WACC to find the cost of equity. The equation for WACC is:

$\text{WACC} = (S/V)R_S + (B/V)R_B(1 - T_C)$

The company has a debt-equity ratio of 1.4, which implies the weight of debt is 1.4/2.4, and the weight of equity is 1/2.4, so

WACC = .083 = (1/2.4)R_S + (1.4/2.4)(.054)(1 – .24)
R_S = .1417, or 14.17%

b. To find the unlevered cost of equity we need to use M&M Proposition II with taxes, so:

$R_S = R_0 + (R_0 - R_B)(B/S)(1 - T_C)$
.1417 = R_U + (R_0 – .054)(1.4)(1 – .24)
R_U = .0965, or 9.65%

c. To find the cost of equity under different capital structures, we can again use M&M Proposition II with taxes. With a debt-equity ratio of 2, the cost of equity is:

$R_S = R_0 + (R_0 - R_B)(B/S)(1 - T_C)$
R_S = .0965 + (.0965 – .054)(2)(1 – .24)
R_S = .1611, or 16.11%

With a debt-equity ratio of 1, the cost of equity is:

R_S = .0965 + (.0965 – .054)(1)(1 – .24)
R_S = .1288, or 12.88%

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And with a debt-equity ratio of 0, the cost of equity is:

$R_S = .0965 + (.0965 - .054)(0)(1 - .24)$
$R_S = R_0 = .0965$, or 9.65%

13. *a.* For an all-equity financed company:

WACC = $R_0 = R_S = .0890$, or 8.90%

b. To find the cost of equity for the company with leverage, we need to use M&M Proposition II with taxes, so:

$R_S = R_0 + (R_0 - R_B)(B/S)(1 - T_C)$
$R_S = .0890 + (.0890 - .0575)(.25/.75)(1 - .22)$
$R_S = .0972$, or 9.72%

c. Using M&M Proposition II with taxes again, we get:

$R_S = R_0 + (R_0 - R_B)(B/S)(1 - T_C)$
$R_S = .0890 + (.0890 - .0575)(.50/.50)(1 - .22)$
$R_S = .1136$, or 11.36%

d. The WACC with 25 percent debt is:

WACC = $(S/V)R_S + (B/V)R_B(1 - T_C)$
WACC = $.75(.0972) + .25(.0575)(1 - .22)$
WACC = .0841, or 8.41%

And the WACC with 50 percent debt is:

WACC = $(S/V)R_S + (B/V)R_B(1 - T_C)$
WACC = $.50(.1136) + .50(.0575)(1 - .22)$
WACC = .0792, or 7.92%

14. *a.* The value of the unlevered firm is:

$V_U = \text{EBIT}(1 - T_C)/R_0$
$V_U = \$92,600(1 - .22)/.14$
$V_U = \$515,914.29$

b. The value of the levered firm is:

$V_L = V_U + T_C B$
$V_L = \$515,914.29 + .22(\$165,000)$
$V_L = \$552,214.29$

15. We can find the cost of equity using M&M Proposition II with taxes. Doing so, we find:

$R_S = R_0 + (R_0 - R_B)(B/S)(1 - T_C)$
$R_S = .14 + (.14 - .07)[\$165,000/(\$552,214.29 - 165,000)](1 - .22)$
$R_S = .1633$, or 16.33%

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Using this cost of equity, the WACC for the firm after recapitalization is:

WACC = $(S/V)R_S + (B/V)R_B(1 - T_C)$
WACC = .1633[($552,214.29 – 165,000)/$552,214.29] + .07(1 – .22)($165,000/$552,214.29)
WACC = .1308, or 13.08%

When there are corporate taxes, the overall cost of capital for the firm declines the more highly leveraged is the firm's capital structure. This is M&M Proposition I with taxes.

16. Since Unlevered is an all-equity firm, its value is equal to the market value of its outstanding shares. Unlevered has 25,000 shares of common stock outstanding, worth $66 per share. Therefore, the value of Unlevered:

V_U = 23,000($66)
V_U = $1,518,000

Modigliani-Miller Proposition I states that, in the absence of taxes, the value of a levered firm equals the value of an otherwise identical unlevered firm. Since Levered is identical to Unlevered in every way except its capital structure and neither firm pays taxes, the value of the two firms should be equal. Therefore, the market value of Levered, Inc., *should* be $1,518,000 also. Since Levered has 18,000 outstanding shares, worth $64 per share, the market value of Levered's equity is:

S_L = 18,000($64)
S_L = $1,152,000

The market value of Levered's debt is $290,000. The value of a levered firm equals the market value of its debt plus the market value of its equity. Therefore, the current market value of Levered is:

$V_L = B + S$
V_L = $1,152,000 + 290,000
V_L = $1,442,000

The market value of Levered's equity needs to be $1,518,000, $76,000 higher than its current market value of $1,442,000, for MM Proposition I to hold. Since Levered's market value is less than Unlevered's market value, Levered is relatively underpriced and an investor should buy shares of the firm's stock.

Intermediate

17. To find the value of the levered firm, we first need to find the value of an unlevered firm. So, the value of the unlevered firm is:

V_U = EBIT$(1 - T_C)/R_0$
V_U = ($51,600)(1 – .24)/.11
V_U = $356,509.09

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Now we can find the value of the levered firm as:

$V_L = V_U + T_C B$
$V_L = \$356{,}509.09 + .24(\$90{,}000)$
$V_L = \$378{,}109.09$

Applying M&M Proposition I with taxes, the firm has increased its value by issuing debt. As long as M&M Proposition I holds, that is, there are no bankruptcy costs and so forth, then the company should continue to increase its debt-equity ratio to maximize the value of the firm.

18. *a.* With no debt, we are finding the value of an unlevered firm, so:

$V_U = \text{EBIT}(1 - T_C)/R_0$
$V_U = \$28{,}650(1 - .23)/.128$
$V_U = \$172{,}347.66$

b. The general expression for the value of a leveraged firm is:

$V_L = V_U + T_C B$

If debt is 50 percent of V_U, then $B = (.50)V_U$, and we have:

$V_L = V_U + T_C[(.50)V_U]$
$V_L = \$172{,}347.66 + .23(.50)(\$172{,}347.66)$
$V_L = \$192{,}167.64$

And if debt is 50 percent of V_U, then $B = (1.0)V_U$, and we have:

$V_L = V_U + T_C[(1.0)V_U]$
$V_L = \$172{,}347.66 + .23(1.0)(\$172{,}347.66)$
$V_L = \$211{,}987.62$

c. According to M&M Proposition I with taxes:

$V_L = V_U + T_C B$

With debt being 50 percent of the value of the levered firm, B must equal $(.50)V_L$, so:

$V_L = V_U + T_C[(.50)V_L]$
$V_L = \$172{,}347.66 + .23(.50)(V_L)$
$V_L = \$194{,}743.11$

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If the debt is 100 percent of the levered value, B must equal V_L, so:

$V_L = V_U + T_C[(1.0)V_L]$
$V_L = \$172,347.66 + .23(1.0)(V_L)$
$V_L = \$223,828.13$

19. According to M&M Proposition I with taxes, the increase in the value of the company will be the present value of the interest tax shield. Since the loan will be repaid in equal principal installments, we need to find the loan interest and the interest tax shield each year. The loan schedule will be:

Year	Loan Balance	Interest	Tax Shield
0	$525,000		
1	262,500	$36,750	.23($36,750) = $8,453
2	0	18,375	.23($18,375) = $4,226

So, the increase in the value of the company is:

Value increase = $\$8,453/1.07 + \$4,226/1.07^2$
Value increase = $11,590.90

20. *a.* Since Alpha Corporation is an all-equity firm, its value is equal to the market value of its outstanding shares. Alpha has 21,000 shares of common stock outstanding, worth $23 per share, so the value of Alpha Corporation is:

$V_{\text{Alpha}} = 21,000(\$23)$
$V_{\text{Alpha}} = \$483,000$

b. Modigliani-Miller Proposition I states that in the absence of taxes, the value of a levered firm equals the value of an otherwise identical unlevered firm. Since Beta Corporation is identical to Alpha Corporation in every way except its capital structure and neither firm pays taxes, the value of the two firms should be equal. So, the value of Beta Corporation is $483,000 as well.

c. The value of a levered firm equals the market value of its debt plus the market value of its equity. So, the value of Beta's equity is:

$V_L = B + S$
$\$483,000 = \$90,000 + S$
$S = \$393,000$

d. The investor would need to invest 20 percent of the total market value of Alpha's equity, which is:

Amount to invest in Alpha = .20($483,000)
Amount to invest in Alpha = $96,600

Beta has less equity outstanding, so to purchase 20 percent of Beta's equity, the investor would need:

Amount to invest in Beta = .20($393,000)
Amount to invest in Beta = $78,600

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e. Alpha has no interest payments, so the dollar return to an investor who owns 20 percent of the company's equity would be:

Dollar return on Alpha investment = .20($76,000)
Dollar return on Alpha investment = $15,200

Beta Corporation has an interest payment due on its debt in the amount of:

Interest on Beta's debt = .07($90,000)
Interest on Beta's debt = $6,300

So, the investor who owns 20 percent of the company would receive 20 percent of EBIT minus the interest expense, or:

Dollar return on Beta investment = .20($76,000 – 6,300)
Dollar return on Beta investment = $13,940

f. From part (d), we know the initial cost of purchasing 20 percent of Alpha Corporation's equity is $96,600, but the cost to an investor of purchasing 20 percent of Beta Corporation's equity is only $78,600. In order to purchase $96,600 worth of Alpha's equity using only $78,600 of his own money, the investor must borrow $18,000 to cover the difference. The investor will receive the same dollar return from the Alpha investment, but will pay interest on the amount borrowed, so the net dollar return to the investment is:

Net dollar return = $15,200 – .07($18,000)
Net dollar return = $13,940

Notice that this amount exactly matches the dollar return to an investor who purchases 20 percent of Beta's equity.

g. The equity of Beta Corporation is riskier. Beta must pay off its debt holders before its equity holders receive any of the firm's earnings. If the firm does not do particularly well, all of the firm's earnings may be needed to repay its debt holders, and equity holders will receive nothing.

21. *a.* A firm's debt-equity ratio is the market value of the firm's debt divided by the market value of a firm's equity. So, the debt-equity ratio of the company is:

Debt-equity ratio = MV of debt/MV of equity
Debt-equity ratio = $2,600,000/$6,400,000
Debt-equity ratio = .4063

b. We first need to calculate the cost of equity. To do this, we can use the CAPM, which gives us:

$R_S = R_f + \beta[E(R_M) - R_f]$
$R_S = .04 + 1.10(.11 - .04)$
$R_S = .1170$, or 11.70%

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In the absence of taxes, a firm's weighted average cost of capital is equal to:

WACC = $[B/(B + S)]R_B + [S/(B + S)]R_S$
WACC = ($2,600,000/$9,000,000)(.075) + ($6,400,000/$9,000,000)(.1170)
WACC = .1049, or 10.49%

c. According to Modigliani-Miller Proposition II with no taxes:

$R_S = R_0 + (B/S)(R_0 - R_B)$
$.1170 = R_0 + (.4063)(R_0 - .075)$
$R_0 = .1049$, or 10.49%

This is consistent with Modigliani-Miller's proposition that, in the absence of taxes, the cost of capital for an all-equity firm is equal to the weighted average cost of capital of an otherwise identical levered firm.

22. *a.* To purchase 5 percent of Knight's equity, the investor would need:

Knight investment = .05($1,650,000)
Knight investment = $82,500

And to purchase 5 percent of Veblen without borrowing would require:

Veblen investment = .05($2,850,000)
Veblen investment = $142,500

In order to compare dollar returns, the initial net cost of both positions should be the same. Therefore, the investor will need to borrow the difference between the two amounts, or:

Amount to borrow = $142,500 – 82,500
Amount to borrow = $60,000

An investor who owns 5 percent of Knight's equity will be entitled to 5 percent of the firm's earnings available to common stockholders at the end of each year. While Knight's expected operating income is $425,000, it must pay $99,000 to debtholders before distributing any of its earnings to stockholders. So, the amount available to this shareholder will be:

Cash flow from Knight to shareholder = .05($425,000 – 99,000)
Cash flow from Knight to shareholder = $16,300

Veblen will distribute all of its earnings to shareholders, so the shareholder will receive:

Cash flow from Veblen to shareholder = .05($425,000)
Cash flow from Veblen to shareholder = $21,250

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However, to have the same initial cost, the investor has borrowed $60,000 to invest in Veblen, so interest must be paid on the borrowings. The net cash flow from the investment in Veblen will be:

Net cash flow from Veblen investment = $21,250 – .06($60,000)
Net cash flow from Veblen investment = $17,650

For the same initial cost, the investment in Veblen produces a higher dollar return.

b. Both strategies have the same initial cost. Since the dollar return to the investment in Veblen is higher, all investors will choose to invest in Veblen over Knight. The process of investors purchasing Veblen's equity rather than Knight's will cause the market value of Veblen's equity to rise and the market value of Knight's equity to fall. Any differences in the dollar returns to the two strategies will be eliminated, and the process will cease when the total market values of the two firms are equal.

23. *a.* Before the announcement of the stock repurchase plan, the market value of the outstanding debt is $4,150,000. Using the debt-equity ratio, we can find that the value of the outstanding equity must be:

Debt-equity ratio = B/S
.20 = $4,150,000/$S$
S = $20,750,000

The value of a levered firm is equal to the sum of the market value of the firm's debt and the market value of the firm's equity, so:

$V_L = B + S$
V_L = $4,150,000 + 20,750,000
V_L = $24,900,000

According to MM Proposition I without taxes, changes in a firm's capital structure have no effect on the overall value of the firm. Therefore, the value of the firm will not change after the announcement of the stock repurchase plan

b. The expected return on a firm's equity is the ratio of annual earnings to the market value of the firm's equity or return on equity. Before the restructuring, the company was expected to pay interest in the amount of:

Interest payment = .07($4,150,000)
Interest payment = $290,500

The return on equity, which is equal to R_S, will be:

ROE = R_S = ($2,730,000 – 290,500)/$20,750,000
R_S = .1176, or 11.76%

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c. According to Modigliani-Miller Proposition II with no taxes:

$R_S = R_0 + (B/S)(R_0 - R_B)$
$.1176 = R_0 + (.20)(R_0 - .07)$
$R_0 = .1096$, or 10.96%

This problem can also be solved in the following way:

R_0 = Earnings before interest/V_U

According to Modigliani-Miller Proposition I, in a world with no taxes, the value of a levered firm equals the value of an otherwise-identical unlevered firm. Since the value of the company as a levered firm is $24,900,000 and since the firm pays no taxes, the value of the company as an unlevered firm is also $24,900,000. So:

$R_0 = \$2,730,000/\$24,900,000$
$R_0 = .1096$, or 10.96%

d. In part (c), we calculated the cost of an all-equity firm. We can use Modigliani-Miller Proposition II with no taxes again to find the cost of equity for the firm with the new leverage ratio. The cost of equity under the stock repurchase plan will be:

$R_S = R_0 + (B/S)(R_0 - R_B)$
$R_S = .1096 + (.35)(.1096 - .07)$
$R_S = .1235$, or 12.35%

24. *a.* The expected return on a firm's equity is the ratio of annual aftertax earnings to the market value of the firm's equity. The amount the firm must pay each year in taxes will be:

Taxes = .24($1,860,000)
Taxes = $446,400

So, the return on the unlevered equity will be:

$R_0 = (\$1,860,000 - 446,400)/\$8,100,000$
$R_0 = .1745$, or 17.45%
Notice that perpetual annual earnings of $1,413,600 (= $1,860,000 – 446,400), discounted at 17.45 percent, yields the market value of the firm's equity

b. The company's market value balance sheet before the announcement of the debt issue is:

		Debt	0
Assets	$8,100,000	Equity	$8,100,000
Total assets	$8,100,000	Total D&E	$8,100,000

The price per share is the total market value of the stock divided by the shares outstanding, or:

Price per share = $8,100,000/250,000
Price per share = $32.40

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c. Modigliani-Miller Proposition I states that in a world with corporate taxes:

$V_L = V_U + T_C B$

When the company announces the debt issue, the value of the firm will increase by the present value of the tax shield on the debt. The present value of the tax shield is:

PV(Tax Shield) = $T_C B$
PV(Tax Shield) = .24($1,900,000)
PV(Tax Shield) = $456,000

Therefore, the value of the company will increase by $456,000 as a result of the debt issue. The value of the company after the repurchase announcement is:

$V_L = V_U + T_C B$
V_L = $8,100,000 + .24($1,900,000)
V_L = $8,556,000

Since the firm has not yet issued any debt, the company's equity is also worth $8,556,000.

The company's market value balance sheet after the announcement of the debt issue is:

Old assets	$8,100,000	Debt	0
PV(tax shield)	456,000	Equity	$8,556,000
Total assets	$8,556,000	Total D&E	$8,556,000

d. The share price immediately after the announcement of the debt issue will be:

New share price = $8,556,000/250,000
New share price = $34.22

e. The number of shares repurchased will be the amount of the debt issue divided by the new share price, or:

Shares repurchased = $1,900,000/$34.22
Shares repurchased = 55,516.60

The number of shares outstanding will be the current number of shares minus the number of shares repurchased, or:

New shares outstanding = 250,000 – 55,516.60
New shares outstanding = 194,483.40

f. The share price will remain the same after restructuring takes place. The total market value of the outstanding equity in the company will be:

Market value of equity = $34.22(194,483.40)
Market value of equity = $6,656,000

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The market-value balance sheet after the restructuring is:

Old assets	$8,100,000	Debt	$1,900,000
PV(tax shield)	456,000	Equity	6,656,000
Total assets	$8,556,000	Total D&E	$8,556,000

g. According to Modigliani-Miller Proposition II with corporate taxes

$R_S = R_0 + (B/S)(R_0 - R_B)(1 - T_C)$
$R_S = .1745 + (\$1,900,000/\$6,656,000)(.1745 - .06)(1 - .24)$
$R_S = .1994$, or 19.94%

25. *a.* In a world with corporate taxes, a firm's weighted average cost of capital is equal to:

$\text{WACC} = [B/(B + S)](1 - T_C)R_B + [S/(B + S)]R_S$

We do not have the company's debt-to-value ratio or the equity-to-value ratio, but we can calculate either from the debt-to-equity ratio. With the given debt-equity ratio, we know the company has 1.8 dollars of debt for every dollar of equity. Since we only need the ratio of debt-to-value and equity-to-value, we can say:

$B/(B + S) = 1.8/(1.8 + 1) = .6429$
$S/(B + S) = 1/(1.8 + 1) = .3571$

We can now use the weighted average cost of capital equation to find the cost of equity, which is:

$.091 = (.6429)(1 - .21)(.056) + (.3571)(R_S)$
$R_S = .1752$, or 17.52%

b. We can use Modigliani-Miller Proposition II with corporate taxes to find the unlevered cost of equity. Doing so, we find:

$R_S = R_0 + (B/S)(R_0 - R_B)(1 - T_C)$
$.1752 = R_0 + (1.8)(R_0 - .056)(1 - .21)$
$R_0 = .1052$, or 10.52%

c. We first need to find the debt-to-value ratio and the equity-to-value ratio. We can then use the cost of levered equity equation with taxes, and finally the weighted average cost of capital equation. So:

If debt-equity = .60

$B/(B + S) = .60/(.60 + 1) = .3750$
$S/(B + S) = 1/(.60 + 1) = .6250$

The cost of levered equity will be:

$R_S = R_0 + (B/S)(R_0 - R_B)(1 - T_C)$
$R_S = .1052 + (.60)(.1052 - .056)(1 - .21)$
$R_S = .1285$, or 12.85%

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And the weighted average cost of capital will be:

$WACC = [B/(B + S)](1 - T_C)R_B + [S/(B + S)]R_S$
$WACC = (.3750)(1 - .21)(.056) + (.6250)(.1285)$
$WACC = .0969$, or 9.69%

If debt-equity =1.25

$B/(B + S) = 1.25/(1.25 + 1) = .5556$
$S/(B + S) = 1/(1.25 + 1) = .4444$

The cost of levered equity will be:

$R_S = R_0 + (B/S)(R_0 - R_B)(1 - R_C)$
$R_S = .1052 + (1.25)(.1052 - .056)(1 - .21)$
$R_S = .1538$, or 15.38%

And the weighted average cost of capital will be:

$WACC = [B/(B + S)](1 - T_C)R_B + [S/(B + S)]R_S$
$WACC = (.5556)(1 - .21)(.056) + (.4444)(.1538)$
$WACC = .0929$, or 9.29%

26. *a.* A table outlining the income statement with taxes for the three possible states of the economy is shown below. The share price is still \$65 and there are still 5,000 shares outstanding. Since there is no debt, the value of the company is the unlevered value, which is given. The last row shows the percentage change in EPS the company will experience in a recession or an expansion economy. Notice, this is identical to the solution from Problem 2.

	Recession	Normal	Expansion
EBIT	\$21,700	\$31,000	\$38,750
Interest	0	0	0
Taxes	4,557	6,510	8,138
NI	\$17,143	\$24,490	\$30,613
EPS	\$3.43	\$4.90	\$6.12
%ΔEPS	–30	—	+25

b. The value of the levered company will increase by the interest tax shield, so it will become:

$V_L = V_U + T_C B$
$V_L = \$325,000 + .21(\$105,000)$
$V_L = \$347,050$

So, the value of equity will become:

$V = S + B$
$\$347,050 = S + \$105,000$
$S = \$242,050$

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The new share price will be:

Share price = $347,050/5,000
Share price = $69.41

The number of shares the company will repurchase will be:

Shares repurchased = $105,000/$69.41
Shares repurchased = 1,512.75

And the new shares outstanding will be:

New shares outstanding = 5,000 – 1,512.75
New shares outstanding = 3,487.25

A table outlining the income statement with taxes for the three possible states of the economy and assuming the company undertakes the proposed capitalization is shown below. The interest payment and shares repurchased are the same as in part (b) of Problem 1.

	Recession	Normal	Expansion
EBIT	$21,700	$31,000	$38,750
Interest	6,300	6,300	6,300
Taxes	3,234	5,187	6,815
NI	$12,166	$19,513	$25,636
EPS	$3.49	$5.60	$7.35
%ΔEPS	–37.65	—	+31.38

Notice that the percentage change in EPS is the same both with and without taxes.

Challenge

27. M&M Proposition II states:

$R_S = R_0 + (R_0 - R_B)(B/S)(1 - T_C)$

And the equation for WACC is:

$\text{WACC} = (S/V)R_S + (B/V)R_B(1 - T_C)$

Substituting the M&M Proposition II equation into the equation for WACC, we get:

$\text{WACC} = (S/V)[R_0 + (R_0 - R_B)(B/S)(1 - T_C)] + (B/V)R_B(1 - T_C)$

Rearranging and reducing this equation, we get:

$\text{WACC} = R_0[(S/V) + (S/V)(B/S)(1 - T_C)] + R_B(1 - T_C)[(B/V) - (S/V)(B/S)]$
$\text{WACC} = R_0[(S/V) + (B/V)(1 - T_C)]$
$\text{WACC} = R_0[\{(S+B)/V\} - T_C(B/V)]$
$\text{WACC} = R_0[1 - T_C(B/V)]$

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28. The return on equity is net income divided by equity. Net income can be expressed as:

$NI = (EBIT - R_B B)(1 - T_C)$

So, ROE is:

$R_S = (EBIT - R_B B)(1 - T_C)/E$

Now we can rearrange and substitute as follows to arrive at M&M Proposition II with taxes:

$R_S = [EBIT(1 - T_C)/S] - [R_B(B/S)(1 - T_C)]$
$R_S = R_A V_U/S - [R_B(B/S)(1 - T_C)]$
$R_S = R_A(V_L - T_C B)/S - [R_B(B/S)(1 - T_C)]$
$R_S = R_A(S + B - T_C B)/S - [R_B(B/S)(1 - T_C)]$
$R_S = R_A + (R_A - R_B)(B/S)(1 - T_C)$

29. M&M Proposition II, with no taxes is:

$R_S = R_A + (R_A - R_f)(B/S)$

Note that we use the risk-free rate as the return on debt. This is an important assumption of M&M Proposition II. The CAPM to calculate the cost of equity is expressed as:

$R_S = \beta_E(R_M - R_f) + R_f$

We can rewrite the CAPM to express the return on an unlevered company as:

$R_A = \beta_A(R_M - R_f) + R_f$

We can now substitute the CAPM for an unlevered company into M&M Proposition II. Doing so and rearranging the terms we get:

$R_S = \beta_A(R_M - R_f) + R_f + [\beta_A(R_M - R_f) + R_f - R_f](B/S)$
$R_S = \beta_A(R_M - R_f) + R_f + [\beta_A(R_M - R_f)](B/S)$
$R_S = (1 + B/S)\beta_A(R_M - R_f) + R_f$

Now we set this equation equal to the CAPM equation to calculate the cost of equity and reduce:

$\beta_E(R_M - R_f) + R_f = (1 + B/S)\beta_A(R_M - R_f) + R_f$
$\beta_E(R_M - R_f) = (1 + B/S)\beta_A(R_M - R_f)$
$\beta_E = \beta_A(1 + B/S)$

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30. Using the equation we derived in Problem 28:

$\beta_S = \beta_A(1 + B/S)$

The equity beta for the respective asset betas is:

Debt-equity ratio	Equity beta
0	1(1 + 0) = 1
1	1(1 + 1) = 2
5	1(1 + 5) = 6
20	1(1 + 20) = 21

The equity risk to the shareholder is composed of both business and financial risk. Even if the assets of the firm are not very risky, the risk to the shareholder can still be large if the financial leverage is high. These higher levels of risk will be reflected in the shareholder's required rate of return, R_S, which will increase with higher debt-equity ratios.

31. We first need to set the cost of capital equation equal to the cost of capital for an all-equity firm, so:

$$\frac{B}{B+S}R_B + \frac{S}{B+S}R_S = R_0$$

Multiplying both sides by $(B + S)/S$ yields:

$$\frac{B}{S}R_B + R_S = \frac{B+S}{S}R_0$$

We can rewrite the right-hand side as:

$$\frac{B}{S}R_B + R_S = \frac{B}{S}R_0 + R_0$$

Moving $(B/S)R_0$ to the right-hand side and rearranging gives us:

$$R_S = R_0 + \frac{B}{S}(R_0 - R_B)$$

CHAPTER 15
CAPITAL STRUCTURE: *LIMITS TO THE USE OF DEBT*

Answers to Concept Questions

1. Direct costs are potential legal and administrative costs. These are the costs associated with the litigation arising from a liquidation or bankruptcy. These costs include lawyers' fees, courtroom costs, and expert witness fees. Indirect costs include the following: 1) Impaired ability to conduct business. Firms may suffer a loss of sales due to a decrease in consumer confidence and loss of reliable supplies due to a lack of confidence by suppliers. 2) Incentive to take large risks. When faced with projects of different risk levels, managers acting in the stockholders' interest have an incentive to undertake high-risk projects. Imagine a firm with only one project, which pays $100 in an expansion and $60 in a recession. If debt payments are $60, the stockholders receive $40 (= $100 – 60) in the expansion but nothing in the recession. The bondholders receive $60 for certain. Alternatively, imagine that the project pays $110 in an expansion but $50 in a recession. Here, the stockholders receive $50 (= $110 – 60) in the expansion but nothing in the recession. The bondholders receive only $50 in the recession because there is no more money in the firm. That is, the firm declares bankruptcy, leaving the bondholders "holding the bag." Thus, an increase in risk can benefit the stockholders. The key here is that the bondholders are hurt by risk, since the stockholders have limited liability. If the firm declares bankruptcy, the stockholders are not responsible for the bondholders' shortfall. 3) Incentive to under-invest. If a company is near bankruptcy, stockholders may well be hurt if they contribute equity to a new project, even if the project has a positive NPV. The reason is that some (or all) of the cash flows will go to the bondholders. Suppose a real estate developer owns a building that is likely to go bankrupt, with the bondholders receiving the property and the developer receiving nothing. Should the developer take $1 million out of his own pocket to add a new wing to a building? Perhaps not, even if the new wing will generate cash flows with a present value greater than $1 million. Since the bondholders are likely to end up with the property anyway, why would the developer pay the additional $1 million and likely end up with nothing to show for it? 4) Milking the property. In the event of bankruptcy, bondholders have the first claim to the assets of the firm. When faced with a possible bankruptcy, the stockholders have strong incentives to vote for increased dividends or other distributions. This will ensure them of getting some of the assets of the firm before the bondholders can lay claim to them.

2. The statement is incorrect. If a firm has debt, it might be advantageous to stockholders for the firm to undertake risky projects, even those with negative net present values. This incentive results from the fact that most of the risk of failure is borne by bondholders. Therefore, value is transferred from the bondholders to the shareholders by undertaking risky projects, even if the projects have negative NPVs. This incentive is even stronger when the probability and costs of bankruptcy are high.

3. The firm should issue equity in order to finance the project. The tax-loss carry-forwards make the firm's effective tax rate zero. Therefore, the company will not benefit from the tax shield that debt provides. Moreover, since the firm already has a moderate amount of debt in its capital structure, additional debt will likely increase the probability that the firm will face financial distress or bankruptcy. As long as there are bankruptcy costs, the firm should issue equity in order to finance the project.

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4. Stockholders can undertake the following measures in order to minimize the costs of debt: 1) Use protective covenants. Firms can enter into agreements with the bondholders that are designed to decrease the cost of debt. There are two types of protective covenants. Negative covenants prohibit the company from taking actions that would expose the bondholders to potential losses. An example would be prohibiting the payment of dividends in excess of earnings. Positive covenants specify an action that the company agrees to take or a condition the company must abide by. An example would be agreeing to maintain its working capital at a minimum level. 2) Repurchase debt. A firm can eliminate the costs of bankruptcy by eliminating debt from its capital structure. 3) Consolidate debt. If a firm decreases the number of debt holders, it may be able to decrease the direct costs of bankruptcy should the firm become insolvent.

5. Modigliani and Miller's theory with corporate taxes indicates that, since there is a positive tax advantage of debt, the firm should maximize the amount of debt in its capital structure. In reality, however, no firm adopts an all-debt financing strategy. MM's theory ignores both the financial distress and agency costs of debt. The marginal costs of debt continue to increase with the amount of debt in the firm's capital structure so that, at some point, the marginal costs of additional debt will outweigh the marginal tax benefits. Therefore, there is an optimal level of debt for every firm at the point where the marginal tax benefits of the debt equal the marginal increase in financial distress and agency costs.

6. There are two major sources of the agency costs of equity: 1) Shirking. Managers with small equity holdings have a tendency to reduce their work effort, thereby hurting both the debt holders and outside equity holders. 2) Perquisites. Since management receives all the benefits of increased perquisites but only shoulder a fraction of the cost, managers have an incentive to overspend on luxury items at the expense of debt holders and outside equity holders.

7. The more capital-intensive industries, such as airlines, building construction, hotels, and utilities, tend to use greater financial leverage. Also, industries with less predictable future earnings, such as computers or drugs, tend to use less financial leverage. Such industries also have a higher concentration of growth and startup firms. Overall, the general tendency is for firms with identifiable, tangible assets and relatively more predictable future earnings to use more debt financing. These are typically the firms with the greatest need for external financing and the greatest likelihood of benefiting from the interest tax shelter.

8. One answer is that the right to file for bankruptcy is a valuable asset, and the financial manager acts in shareholders' best interest by managing this asset in ways that maximize its value. To the extent that a bankruptcy filing prevents "a race to the courthouse steps," it would seem to be a reasonable use of the process.

9. As in the previous question, it could be argued that using bankruptcy laws as a sword may be the best use of the asset. Creditors are aware at the time a loan is made of the possibility of bankruptcy, and the interest charged incorporates it.

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10. One side is that Continental was going to go bankrupt because its costs made it uncompetitive. The bankruptcy filing enabled Continental to restructure and keep flying. The other side is that Continental abused the bankruptcy code. Rather than renegotiate labor agreements, Continental abrogated them to the detriment of its employees. In this, and the last several, questions, an important thing to keep in mind is that the bankruptcy code is a creation of law, not economics. A strong argument can always be made that making the best use of the bankruptcy code is no different from, for example, minimizing taxes by making best use of the tax code. Indeed, a strong case can be made that it is the financial manager's duty to do so. As the case of Continental illustrates, the code can be changed if socially undesirable outcomes are a problem.

Solutions to Questions and Problems

NOTE: All end-of-chapter problems were solved using a spreadsheet. Many problems require multiple steps. Due to space and readability constraints, when these intermediate steps are included in this solutions manual, rounding may appear to have occurred. However, the final answer for each problem is found without rounding during any step in the problem.

Basic

1. *a.* Using M&M Proposition I with taxes, the value of a levered firm is:

$V_L = [\text{EBIT}(1 - T_C)/R_0] + T_C B$
$V_L = [\$535{,}000(1 - .21)/.132] + .21(\$950{,}000)$
$V_L = \$3{,}401{,}393.94$

b. The CFO may be correct. The value calculated in part (a) does not include the costs of any non-marketed claims, such as bankruptcy or agency costs.

2. *a.* *Debt issue:*

The company needs a cash infusion of $1.6 million. If the company issues debt, the annual interest payments will be:

Interest = $1,600,000(.08)
Interest = $128,000

The cash flow to the owner will be the EBIT minus the interest payments, or:

40-hour week cash flow = $415,000 – 128,000
40-hour week cash flow = $287,000

50-hour week cash flow = $560,000 – 128,000
50-hour week cash flow = $432,000

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Equity issue:

If the company issues equity, the company value will increase by the amount of the issue. So, the current owners' equity interest in the company will decrease to:

Tom's ownership percentage = $2,900,000/($2,900,000 + 1,600,000)
Tom's ownership percentage = .6444

So, Tom's cash flow under an equity issue will be 64.44 percent of EBIT, or:

40-hour week cash flow = .6444($415,000)
40-hour week cash flow = $267,444

50-hour week cash flow = .6444($560,000)
50-hour week cash flow = $360,889

b. Tom will work harder under the debt issue since his cash flows will be higher. Tom will gain more under this form of financing since the payments to bondholders are fixed. Under an equity issue, new investors share proportionally in his hard work, which will reduce his propensity for this additional work.

c. The direct cost of both issues is the payments made to new investors. The indirect costs to the debt issue include potential bankruptcy and financial distress costs. The indirect costs of an equity issue include shirking and perquisites.

3. *a.* The interest payments each year will be:

Interest payment = .06($340,000)
Interest payment = $20,400

This is exactly equal to the EBIT, so no cash is available for shareholders. Under this scenario, the value of equity will be zero since shareholders will never receive a payment. Since the market value of the company's debt is $340,000, and there is no probability of default, the total value of the company is the market value of debt. This implies the debt-to-value ratio is 1 (one).

b. At growth rate of 2 percent, the earnings next year will be:

Earnings next year = $20,400(1.02)
Earnings next year = $20,808

So, the cash available for shareholders is:

Payment to shareholders = $20,808 – 20,400
Payment to shareholders = $408

Since there is no risk, the required return for shareholders is the same as the required return on the company's debt. The payments to stockholders will increase at the growth rate of 2 percent (a growing perpetuity), so the value of these payments today is:

Value of equity = $408/(.06 – .02)
Value of equity = $10,200

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And the debt-to-value ratio now is:

Debt/Value ratio = $340,000/($340,000 + 10,200)
Debt/Value ratio = .971

c. At a growth rate of 4 percent, the earnings next year will be:

Earnings next year = $20,400(1.04)
Earnings next year = $21,216

So, the cash available for shareholders is:

Payment to shareholders = $21,216 – 20,400
Payment to shareholders = $816

Since there is no risk, the required return for shareholders is the same as the required return on the company's debt. The payments to stockholders will increase at the growth rate of 6 percent (a growing perpetuity), so the value of these payments today is:

Value of equity = $816/(.06 – .04)
Value of equity = $40,800

And the debt-to-value ratio now is:

Debt/Value ratio = $340,000/($340,000 + 40,800)
Debt/Value ratio = .893

4. According to M&M Proposition I with taxes, the value of the levered firm is:

$V_L = V_U + T_C B$
V_L = $11,400,000 + .21($2,150,000)
V_L = $11,851,500

We can also calculate the market value of the firm by adding the market value of the debt and equity. Using this procedure, the total market value of the firm is:

$V = B + S$
V = $2,150,000 + 195,000($47)
V = $11,315,000

In the absence of nonmarketed claims, such as bankruptcy costs, we would expect the two values to be the same. The difference is the value of the nonmarketed claims, which are:

$V_T = V_M + V_N$
$11,851,500 = $11,315,000 + V_N
V_N = $536,500

5. The president may be correct, but he may also be incorrect. It is true the interest tax shield is valuable and adding debt can possibly increase the value of the company. However, if the company's debt is increased beyond some level, the value of the interest tax shield becomes less than the additional costs from financial distress.

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Intermediate

6. *a.* The total value of a firm's equity is the discounted expected cash flow to the firm's stockholders. If the expansion continues, each firm will generate earnings before interest and taxes of $2.6 million. If there is a recession, each firm will generate earnings before interest and taxes of only $725,000. Since Steinberg owes its bondholders $640,000 at the end of the year, its stockholders will receive $1,960,000 (= $2,600,000 – 640,000) if the expansion continues. If there is a recession, its stockholders will only receive $85,000 (= $725,000 – 640,000). So, assuming a discount rate of 12 percent, the market value of Steinberg's equity is:

$S_{\text{Steinberg}}$ = [.80($1,960,000) + .20($85,000)]/1.12
$S_{\text{Steinberg}}$ = $1,415,179

Steinberg's bondholders will receive $640,000 whether there is a recession or a continuation of the expansion. So, the market value of Steinberg's debt is:

$B_{\text{Steinberg}}$ = [.80($640,000) + .20($640,000)]/1.12
$B_{\text{Steinberg}}$ = $571,429

Since Dietrich owes its bondholders $1.1 million at the end of the year, its stockholders will receive $1.5 million (= $2,600,000 – 1,100,000) if the expansion continues. If there is a recession, its stockholders will receive nothing since the firm's bondholders have a more senior claim on all $725,000 of the firm's earnings. So, the market value of Dietrich's equity is:

S_{Dietrich} = [.80($1,500,000) + .20($0)]/1.12
S_{Dietrich} = $1,071,429

Dietrich's bondholders will receive $1.1 million if the expansion continues and $725,000 if there is a recession. So, the market value of Dietrich's debt is:

B_{Dietrich} = [.80($1,100,000) + .20($725,000)]/1.12
B_{Dietrich} = $915,179

b. The value of company is the sum of the value of the firm's debt and equity. So, the value of Steinberg is:

$V_{\text{Steinberg}} = B + S$
$V_{\text{Steinberg}}$ = $1,415,179 + 571,429
$V_{\text{Steinberg}}$ = $1,986,607

And value of Dietrich is:

$V_{\text{Dietrich}} = B + S$
V_{Dietrich} = $1,071,429 + 915,179
V_{Dietrich} = $1,986,607

You should disagree with the CEO's statement. The risk of bankruptcy *per se* does not affect a firm's value. It is the actual costs of bankruptcy that decrease the value of a firm. Note that this problem assumes that there are no bankruptcy costs.

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7. *a.* The expected value of each project is the sum of the probability of each state of the economy times the value in that state of the economy. Since this is the only project for the company, the company value will be the same as the project value, so:

Low-volatility project value = .50($12,000) + .50($12,800)
Low-volatility project value = $12,400

High-volatility project value = .50($11,400) + .50($13,300)
High-volatility project value = $12,350

The low-volatility project maximizes the expected value of the firm.

b. The value of the equity is the residual value of the company after the bondholders are paid off. If the low-volatility project is undertaken, the firm's equity will be worth $0 if the economy is bad and $800 if the economy is good. Since each of these two scenarios is equally probable, the expected value of the firm's equity is

Expected value of equity with low-volatility project = .50($0) + .50($800)
Expected value of equity with low-volatility project = $400

And the value of the company if the high-volatility project is undertaken will be:

Expected value of equity with high-volatility project = .50($0) + .50($1,300)
Expected value of equity with high-volatility project = $650

c. Risk-neutral investors prefer the strategy with the highest expected value. Thus, the company's stockholders prefer the high-volatility project since it maximizes the expected value of the company's equity.

d. In order to make stockholders indifferent between the low-volatility project and the high-volatility project, the bondholders will need to raise their required debt payment so that the expected value of equity if the high-volatility project is undertaken is equal to the expected value of equity if the low-volatility project is undertaken. As shown in part (b), the expected value of equity if the low-volatility project is undertaken is $400. If the high-volatility project is undertaken, the value of the firm will be $11,400 if the economy is bad and $13,300 if the economy is good. If the economy is bad, the entire $11,400 will go to the bondholders and stockholders will receive nothing. If the economy is good, stockholders will receive the difference between $13,300, the total value of the firm, and the required debt payment. Let X be the debt payment that bondholders will require if the high-volatility project is undertaken. For stockholders to be indifferent between the two projects, the expected value of equity if the high-volatility project is undertaken must be equal to $400, so:

Expected value of equity = $400 = .50($0) + .50($13,300 – X)
X = $12,500

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8. *a.* The expected payoff to bondholders is the face value of debt or the value of the company, whichever is less. Since the value of the company in a recession is $31 million and the required debt payment in one year is $39 million, bondholders will receive the lesser amount, or $31 million.

b. The promised return on debt is:

Promised return = Face value of debt/Market value of debt – 1
Promised return = $39,000,000/$34,000,000 – 1
Promised return = .1471, or 14.71%

c. In part (a), we determined bondholders will receive $31 million in a recession. In a boom, the bondholders will receive the entire $39 million promised payment since the market value of the company is greater than the payment. So, the expected value of debt is:

Expected payment to bondholders = .60($39,000,000) + .40($31,000,000)
Expected payment to bondholders = $35,800,000

So, the expected return on debt is:

Expected return = Expected value of debt/Market value of debt – 1
Expected return = $35,800,000/$34,000,000 – 1
Expected return = .0529, or 5.29%

Challenge

9. *a.* In their no tax model, MM assume that T_C, T_B, and $C(B)$ are all zero. Under these assumptions, $V_L = V_U$, signifying that the capital structure of a firm has no effect on its value. There is no optimal debt-equity ratio.

b. In their model with corporate taxes, MM assume that $T_C > 0$ and both T_B and $C(B)$ are equal to zero. Under these assumptions, $V_L = V_U + T_C B$, implying that raising the amount of debt in a firm's capital structure will increase the overall value of the firm. This model implies that the debt-equity ratio of every firm should be infinite.

c. If the costs of financial distress are zero, the value of a levered firm equals:

$$V_L = V_U + \{1 - [(1 - T_C)/(1 - T_B)\}] \times B$$

Therefore, the change in the value of this all-equity firm that issues debt and uses the proceeds to repurchase equity is:

Change in value = $\{1 - [(1 - T_C)/(1 - T_B)\}] \times B$
Change in value = $\{1 - [(1 - .25)/(1 - .20)]\} \times \$1,200,000$
Change in value = $75,000

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d. If the costs of financial distress are zero, the value of a levered firm equals:

$V_L = V_U + \{1 - [(1 - T_C)/(1 - T_B)]\} \times B$

Therefore, the change in the value of an all-equity firm that issues $1 of perpetual debt instead of $1 of perpetual equity is:

Change in value = $\{1 - [(1 - T_C)/(1 - T_B)]\} \times \$1$

If the firm is not able to benefit from interest deductions, the firm's taxable income will remain the same regardless of the amount of debt in its capital structure, and no tax shield will be created by issuing debt. Therefore, the firm will receive no tax benefit as a result of issuing debt in place of equity. In other words, the effective corporate tax rate when we consider the change in the value of the firm is zero. Debt will have no effect on the value of the firm since interest payments will not be tax deductible. Since this firm is able to deduct interest payments, the change in value is:

Change in value = $\{1 - [(1 - 0)/(1 - .20)]\} \times \$1$
Change in value = –$.25

The value of the firm will decrease by $.25 if it adds $1 of perpetual debt rather than $1 of equity.

10. *a.* If the company decides to retire all its debt, it will become an unlevered firm. The value of an all-equity firm is the present value of the aftertax cash flow to equity holders, which will be:

$V_U = \text{EBIT}(1 - T_C)/R_0$
$V_U = \$795{,}000(1 - .24)/.14$
$V_U = \$4{,}315{,}714.29$

b. Since there are no bankruptcy costs, the value of the company as a levered firm is:

$V_L = V_U + \{1 - [(1 - T_C)/(1 - T_B)\}] \times B$
$V_L = \$4{,}315{,}714.29 + \{1 - [(1 - .24)/(1 - .25)]\} \times \$1{,}700{,}000$
$V_L = \$4{,}293{,}047.62$

c. The bankruptcy costs would not affect the value of the unlevered firm since it could never be forced into bankruptcy. So, the value of the levered firm with bankruptcy would be:

$V_L = V_U + \{1 - [(1 - T_C)/(1 - T_B)\}] \times B - C(B)$
$V_L = (\$4{,}315{,}714.29 + \{1 - [(1 - .24)/(1 - .25)]\} \times \$1{,}700{,}000) - \$425{,}000$
$V_L = \$3{,}868{,}047.62$

The company should choose the all-equity plan with this bankruptcy cost.

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CHAPTER 16
DIVIDENDS AND OTHER PAYOUTS

Answers to Concept Questions

1. Dividend policy deals with the timing of dividend payments, not the amounts ultimately paid. Dividend policy is irrelevant when the timing of dividend payments doesn't affect the present value of all future dividends.

2. A stock repurchase reduces equity while leaving debt unchanged. The debt ratio rises. A firm could, if desired, use excess cash to reduce debt instead. This is a capital structure decision.

3. The chief drawback to a strict dividend policy is the variability in dividend payments. This is a problem because investors tend to want a somewhat predictable cash flow. Also, if there is information content to dividend announcements, then the firm may be inadvertently telling the market that it is expecting a downturn in earnings prospects when it cuts a dividend, when in reality its prospects are very good. In a compromise policy, the firm maintains a relatively constant dividend. It increases dividends only when it expects earnings to remain at a sufficiently high level to pay the larger dividends, and it lowers the dividend only if it absolutely must.

4. Friday, December 29 is the ex-dividend day. Remember not to count January 1 because it is a holiday, and the exchanges are closed. Anyone who buys the stock before December 29 is entitled to the dividend, assuming they do not sell it again before December 29.

5. No, because the money could be better invested in stocks that pay dividends in cash which benefit the fundholders directly.

6. The change in price is due to the change in dividends, not due to the change in dividend *policy*. Dividend policy can still be irrelevant without a contradiction.

7. The stock price dropped because of an expected drop in future dividends. Since the stock price is the present value of all future dividend payments, if the expected future dividend payments decrease, then the stock price will decline.

8. The plan will probably have little affect on shareholder wealth. The shareholders can reinvest on their own, and the shareholders must pay the taxes on the dividends either way. However, the shareholders who take the option may benefit at the expense of the ones who don't (because of the discount). Also as a result of the plan, the firm will be able to raise equity by paying a 10% flotation cost (the discount), which may be a smaller discount than the market flotation costs of a new issue for some companies.

9. If these firms just went public, they probably did so because they were growing and needed the additional capital. Growth firms typically pay very small cash dividends, if they pay a dividend at all. This is because they have numerous projects available, and they reinvest the earnings in the firm instead of paying cash dividends.

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10. It would not be irrational to find low-dividend, high-growth stocks. The trust should be indifferent between receiving dividends or capital gains since it does not pay taxes on either one (ignoring possible restrictions on invasion of principal, etc.). It would be irrational, however, to hold municipal bonds. Since the trust does not pay taxes on the interest income it receives, it does not need the tax break associated with the municipal bonds. Therefore, it should prefer to hold higher yield, taxable bonds.

11. The stock price drop on the ex-dividend date should be lower. With taxes, stock prices should drop by the amount of the dividend, less the taxes investors must pay on the dividends. A lower tax rate lowers the investors' tax liability.

12. With a high tax on dividends and a low tax on capital gains, investors, in general, will prefer capital gains, which implies stock repurchases are favored. If the dividend tax rate declines, the attractiveness of dividends increases.

13. Knowing that share price can be expressed as the present value of expected future dividends does not make dividend policy relevant. Under the growing perpetuity model, if overall corporate cash flows are unchanged, then a change in dividend policy only changes the timing of the dividends. The PV of those dividends is the same. This is true because, given that future earnings are held constant, dividend policy represents a transfer between current and future stockholders.

In a more realistic context and assuming a finite holding period, the value of the shares should represent the future stock price as well as the dividends. Any cash flow not paid as a dividend will be reflected in the future stock price. As such the PV of the flows will not change with shifts in dividend policy; dividend policy is still irrelevant.

14. The bird-in-the-hand argument is based upon the erroneous assumption that increased dividends make a firm less risky. If capital spending and investment spending are unchanged, the firm's overall cash flows are not affected by the dividend policy.

15. This argument is theoretically correct. In the real world, with transaction costs of security trading, home-made dividends can be more expensive than dividends directly paid out by the firms. However, the existence of financial intermediaries, such as mutual funds, reduces the transaction costs for individuals greatly. Thus, as a whole, the desire for current income shouldn't be a major factor favoring high-current-dividend policy.

16. *a.* Cap's past behavior suggests a preference for capital gains, while Widow Jones exhibits a preference for current income.

b. Cap could show the Widow how to construct homemade dividends through the sale of stock. Of course, Cap will also have to convince her that she lives in an MM world. Remember that homemade dividends can only be constructed under the MM assumptions.

c. Widow Jones may still not invest in Neotech because of the transaction costs involved in constructing homemade dividends. Also, the Widow may desire the uncertainty resolution which comes with high dividend stocks.

17. To minimize her tax burden, your aunt should divest herself of high dividend yield stocks and invest in low dividend yield stock. Or, if possible, she should keep her high dividend stocks, borrow an equivalent amount of money and invest that money in a tax-deferred account.

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18. The capital investment needs of small, growing companies are very high. Therefore, payment of dividends could curtail their investment opportunities. Their other option is to issue stock to pay the dividend, thereby incurring issuance costs. In either case, the companies and thus their investors are better off with a zero dividend policy during the firms' rapid growth phases. This fact makes these firms attractive only to low dividend clienteles.

This example demonstrates that dividend policy is relevant when there are issuance costs. Indeed, it may be relevant whenever the assumptions behind the MM model are not met.

19. As a company begins operations, cash is generally at a premium. The cash flows created by young companies are needed for new, potentially profitable investments. These companies are reluctant to raise outside funds because of flotation costs. As the company grows, internally generated cash flows are higher than the cash necessary to fund new investments. Keeping the excess cash can result in agency costs as company management may be tempted to spend this excess cash. Consistent with what we observe, older, more mature companies make dividend payments. These companies are trading off the agency costs of excess cash with the potential costs of raising external equity in the future.

20. Dividends can be used to "signal" their potential growth and positive NPV prospects to the stock market. Once a company begins making dividend payments, investors treat the stock poorly if dividends are decreased or omitted. A dividend payment also signals to the market that the company will not be hording cash, and thus, alleviates the agency problem of excess cash. A fixed repurchase strategy is not the same as a dividend since a company can announce a repurchase and then fail to make the repurchase. If there were a better monitoring mechanism to ensure that announced repurchased were in fact made, a fixed repurchase would become more similar to a regular dividend payment. Additionally, since managers often have information that investors do not have, it may force managers to buy back stock when it is overvalued because the market is not aware of inside information. In effect, this is a negative NPV investment.

Solutions to Questions and Problems

NOTE: All end-of-chapter problems were solved using a spreadsheet. Many problems require multiple steps. Due to space and readability constraints, when these intermediate steps are included in this solutions manual, rounding may appear to have occurred. However, the final answer for each problem is found without rounding during any step in the problem.

Basic

1. The aftertax dividend is the pretax dividend times one minus the tax rate, so:

Aftertax dividend = $5.60(1 – .25)
Aftertax dividend = $4.20

The stock price should drop by the aftertax dividend amount, or:

Ex-dividend price = $81 – 4.20
Ex-dividend price = $76.80

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2. *a.* The shares outstanding increases by 10 percent, so:

New shares outstanding = 22,000(1.10)
New shares outstanding = 24,200

New shares issued = 2,200

Since the par value of the new shares is $1, the capital surplus per share is $32. The total capital surplus is therefore:

Capital surplus on new shares = 2,200($32)
Capital surplus on new shares = $70,400

Common stock ($1 par value)	$ 24,200
Capital surplus	165,400
Retained earnings	560,200
	$749,800

b. The shares outstanding increases by 25 percent, so:

New shares outstanding = 22,000(1.25)
New shares outstanding = 27,500

New shares issued = 5,500

Since the par value of the new shares is $1, the capital surplus per share is $32. The total capital surplus is therefore:

Capital surplus on new shares = 5,500($32)
Capital surplus on new shares = $176,000

Common stock ($1 par value)	$ 27,500
Capital surplus	271,000
Retained earnings	451,300
	$749,800

3. *a.* To find the new shares outstanding, we multiply the current shares outstanding times the ratio of new shares to old shares, so:

New shares outstanding = 22,000(4/1)
New shares outstanding = 88,000

The equity accounts are unchanged except that the par value of the stock is changed by the ratio of new shares to old shares, so the new par value is:

New par value = $1(1/4)
New par value = $.25 per share

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b. To find the new shares outstanding, we multiply the current shares outstanding times the ratio of new shares to old shares, so:

New shares outstanding = 22,000(1/5)
New shares outstanding = 4,400

The equity accounts are unchanged except that the par value of the stock is changed by the ratio of new shares to old shares, so the new par value is:

New par value = $1(5/1)
New par value = $5.00 per share

4. To find the new stock price, we multiply the current stock price by the ratio of old shares to new shares, so:

a. $87(3/5) = $52.20

b. $87(1/1.15) = $75.65

c. $87(1/1.425) = $61.05

d. $87(7/4) = $152.25

e. To find the new shares outstanding, we multiply the current shares outstanding times the ratio of new shares to old shares, so:

a: 365,000(5/3) = 608,333

b: 365,000(1.15) = 419,750

c: 365,000(1.425) = 520,125

d: 365,000(4/7) = 208,571

5. The stock price is the total market value of equity divided by the shares outstanding, so:

P_0 = $251,000 equity/6,400 shares
P_0 = $39.22 per share

Ignoring tax effects, the stock price will drop by the amount of the dividend, so:

P_X = $39.22 – 1.90
P_X = $37.32

The total dividends paid will be:

$1.90 per share(6,400 shares) = $12,160

The equity and cash accounts will both decline by $12,160.

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6. Repurchasing the shares will reduce shareholders' equity by $12,160. The shares repurchased will be the total purchase amount divided by the stock price, so:

Shares bought = $12,160/$39.22
Shares bought = 310

And the new shares outstanding will be:

New shares outstanding = 6,400 – 310
New shares outstanding = 6,090

After repurchase, the new stock price is:

Share price = ($251,000 – 12,160)/6,090 shares
Share price = $39.22

The repurchase is effectively the same as the cash dividend because you either hold a share worth $39.22 or a share worth $37.32 and $1.90 in cash. Therefore, you participate in the repurchase according to the dividend payout percentage; you are unaffected.

7. The stock price is the total market value of equity divided by the shares outstanding, so:

P_0 = $629,000 equity/19,000 shares
P_0 = $33.11 per share

The shares outstanding will increase by 25 percent, so:

New shares outstanding = 19,000(1.25)
New shares outstanding = 23,750

The new stock price is the market value of equity divided by the new shares outstanding, so:

P_X = $629,000/23,750 shares
P_X = $26.48

8. With a stock dividend, the shares outstanding will increase by one plus the dividend amount, so:

New shares outstanding = 120,000(1.12)
New shares outstanding = 134,400

The capital surplus is the capital paid in excess of par value, which is $1, so:

Capital surplus for new shares = 14,400($72)
Capital surplus for new shares = $1,036,800

The new capital surplus will be the old capital surplus plus the additional capital surplus for the new shares, so:

Capital surplus = $912,300 + 1,036,800
Capital surplus = $1,949,100

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The new equity portion of the balance sheet will look like this:

Common stock ($1 par value)	$ 134,400
Capital surplus	1,949,100
Retained earnings	1,296,000
	$3,379,500

9. The only equity account that will be affected is the par value of the stock. The par value will change by the ratio of old shares to new shares, so:

New par value = $1(1/5)
New par value = $.20 per share

The total dividends paid this year will be the dividend amount times the number of shares outstanding. The company had 120,000 shares outstanding before the split. We must remember to adjust the shares outstanding for the stock split, so:

Total dividends paid this year = $.74(120,000 shares)(5/1 split)
Total dividends paid this year = $444,000

The dividends increased by 10 percent, so the total dividends paid last year were:

Last year's dividends = $444,000/1.10
Last year's dividends = $406,636.36

And to find the dividends per share, we divide this amount by the shares outstanding last year. Doing so, we get:

Dividends per share last year = $406,636.36/120,000 shares
Dividends per share last year = $3.36

10. *a.* If the dividend is declared, the price of the stock will drop on the ex-dividend date by the value of the dividend, $9. It will then trade for $78.

b. If it is not declared, the price will remain at $87.

c. The outflows for investments are $1,800,000 and occur immediately. One year from now, the firm will realize $1,050,000 in net income and it will pay $585,000 (= $9 × 65,000) in dividends, but the need for financing is immediate. The company must finance $1,800,000 through the sale of shares worth $87. It must sell $1,800,000/$87 = 20,690 shares.

d. The MM model is not realistic since it does not account for taxes, brokerage fees, uncertainty over future cash flows, investors' preferences, signaling effects, and agency costs.

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Intermediate

11. The price of the stock today is the present value of the dividends, so:

$P_0 = \$2.34/1.14 + \$74/1.14^2$
$P_0 = \$58.99$

To find the equal two-year dividends with the same present value as the price of the stock, we set up the following equation and solve for the dividend (Note: The dividend is a two-year annuity, so we could solve with the annuity factor as well):

$\$58.99 = D/1.14 + D/1.14^2$
$D = \$35.83$

We now know the cash flow per share we want each of the next two years. We can find the price of stock in one year, which will be:

$P_1 = \$74/1.14$
$P_1 = \$64.91$

Since you own 1,000 shares, in one year you want:

Cash flow in Year 1 = 1,000($35.83)
Cash flow in Year 1 = $35,825.98

But you'll only get:

Dividends received in Year 1 = 1,000($2.34)
Dividends received in Year 1 = $2,340

Thus, in one year you will need to sell additional shares in order to increase your cash flow. The number of shares to sell in year one is:

Shares to sell at Year 1 = ($35,825.98 – 2,340)/$64.91
Shares to sell at Year 1 = 515.87 shares

At Year 2, your cash flow will be the dividend payment times the number of shares you still own, so the Year 2 cash flow is:

Year 2 cash flow = $74(1,000 – 515.87)
Year 2 cash flow = $35,825.98

12. If you only want $200 in Year 1, you will buy:

Shares to buy at Year 1 = ($2,340 – 200)/$64.91
Shares to buy at Year 1 = 32.97 shares

Your dividend payment in Year 2 will be:

Year 2 dividend = (1,000 + 32.97)($74)
Year 2 dividend = $76,439.60

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Note that the present value of each cash flow stream is the same. Below we show this by finding the present values as:

PV = \$200/1.14 + \$76,439.60/1.14^2 = \$58,993.23

PV = 1,000(\$2.34)/1.14 + 1,000(\$74)/1.14^2 = \$58,993.23

13. *a.* If the company makes a dividend payment, we can calculate the wealth of a shareholder as:

Dividend per share = \$11,008/4,300 shares
Dividend per share = \$2.56

The stock price after the dividend payment will be:

P_X = \$89 – 2.56
P_X = \$86.44 per share

The shareholder will have a stock worth \$86.44 and a \$2.56 dividend for a total wealth of \$89. If the company makes a repurchase, the company will repurchase:

Shares repurchased = \$11,008/\$89
Shares repurchased = 123.69 shares

If the shareholder lets their shares be repurchased, they will have \$89 in cash. If the shareholder keeps their shares, they're still worth \$89.

b. If the company pays dividends, the current EPS is \$4.50, and the PE ratio is:

PE = \$86.44/\$4.50
PE = 19.21

If the company repurchases stock, the number of shares will decrease. The total net income is the EPS times the current number of shares outstanding. Dividing net income by the new number of shares outstanding, we find the EPS under the repurchase is:

EPS = \$4.50(4,300)/(4,300 – 123.69)
EPS = \$4.63

The stock price will remain at \$89 per share, so the PE ratio is:

PE = \$89/\$4.63
PE = 19.21

A share repurchase would seem to be the preferred course of action. Only those shareholders who wish to sell will do so, giving the shareholder a tax timing option that he or she doesn't get with a dividend payment.

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14. *a.* Since the firm has a 100 percent payout policy, the entire net income, $130,000 will be paid as a dividend. The current value of the firm is the discounted value one year from now, plus the current income, which is:

Value = $130,000 + $2,430,000/1.11
Value = $2,319,189.19

b. The current stock price is the value of the firm, divided by the shares outstanding, which is:

Stock price = $2,319,189.19/30,000
Stock price = $77.31

Since the company has a 100 percent payout policy, the current dividend per share will be the company's net income, divided by the shares outstanding, or:

Current dividend = $130,000/30,000
Current dividend = $4.33

The stock price will fall by the value of the dividend to:

Ex-dividend stock price = $77.31 – 4.33
Ex-dividend stock price = $72.97

c. *i.* According to MM, it cannot be true that the low dividend is depressing the price. Since dividend policy is irrelevant, the level of the dividend should not matter. Any funds not distributed as dividends add to the value of the firm, hence the stock price. These directors merely want to change the timing of the dividends (more now, less in the future). As the calculations below indicate, the value of the firm is unchanged by their proposal. Therefore, share price will be unchanged.

To show this, consider what would happen if the dividend was increased to $5.40. Since only the existing shareholders will get the dividend, the required dollar amount to pay the dividends is:

Total dividends = $5.40(30,000)
Total dividends = $162,000

To fund this dividend payment, the company must raise:

Dollars raised = Required funds – Net income
Dollars raised = $162,000 – 130,000
Dollars raised = $32,000

This money can only be raised with the sale of new equity to maintain the all-equity financing. Since those new shareholders must also earn 11 percent, their share of the firm one year from now is:

New shareholder value in one year = $32,000(1.11)
New shareholder value in one year = $35,520

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This means that the old shareholders' interest falls to:

Old shareholder value in one year = $2,430,000 – 35,520
Old shareholder value in one year = $2,394,480

Under this scenario, the current value of the firm is:

Value = $162,000 + $2,394,480/1.11
Value = $2,319,189.19

Since the firm value is the same as in part (a), the change in dividend policy had no effect.

ii. The new shareholders are not entitled to receive the current dividend. They will receive only the value of the equity one year hence. The present value of those flows is:

Present value = $2,394,480/1.11
Present value = $2,157,189.19

And the current share price will be:

Current share price = $2,157,189.19/30,000
Current share price = $71.91

So, the number of new shares the company must sell will be:

Shares sold = $32,000/$71.91
Shares sold = 445.02 shares

15. *a.* The current price is the current cash flow of the company plus the present value of the expected cash flows, divided by the number of shares outstanding. So, the current stock price is:

Stock price = ($1,350,000 + 17,800,000)/315,000
Stock price = $60.79

b. To achieve a zero dividend payout policy, he can invest the dividends back into the company's stock. The dividends per share will be:

Dividends per share = [($1,350,000)(.50)]/315,000
Dividends per share = $2.14

And the stockholder in question will receive:

Dividends paid to shareholder = $2.14(1,000)
Dividends paid to shareholder = $2,142.86

The new stock price after the dividends are paid will be:

Ex-dividend stock price = $60.79 – 2.14
Ex-dividend stock price = $58.65

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So, the number of shares the investor will buy is:

Number of shares to buy = $2,142.86/$58.65
Number of shares to buy = 36.54

16. *a.* Using the formula from the text proposed by Lintner:

$D_1 = D_0 + s(t \text{ EPS}_1 - D_0)$
$D_1 = \$2.34 + .3[(.5)(\$6.10) - \$2.34]$
$D_1 = \$2.55$

b. Now we use an adjustment rate of .60, so the dividend next year will be:

$D_1 = D_0 + s(t \text{ EPS}_1 - D_0)$
$D_1 = \$2.34 + .6[(.5)(\$6.10) - \$2.34]$
$D_1 = \$2.77$

c. The lower adjustment factor in part (a) is more conservative. The lower adjustment factor will always result in a lower future dividend.

Challenge

17. Assuming no capital gains tax, the aftertax return for the Gordon Company is the capital gains growth rate, plus the dividend yield times one minus the tax rate. Using the constant growth dividend model, we get:

Aftertax return = $g + D(1 - t) = .14$

Solving for g, we get:

$.14 = g + .025(1 - .25)$
$g = .1213$

The equivalent pretax return for Gordon Company, which pays no dividend, is:

Pretax return = $g + D$
Pretax return = .1213 + .025
Pretax return = .1463, or 14.63%

18. Using the equation for the decline in the stock price ex dividend for each of the tax rate policies, we get:

$(P_0 - P_X)/D = (1 - T_P)/(1 - T_G)$

a. $P_0 - P_X = D(1 - 0)/(1 - 0)$
$P_0 - P_X = D$

b. $P_0 - P_X = D(1 - .15)/(1 - 0)$
$P_0 - P_X = .85D$

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c. $P_0 - P_X = D(1 - .15)/(1 - .20)$
$P_0 - P_X = 1.0625D$

d. With this tax policy, we need to multiply the personal tax rate times one minus the dividend exemption percentage, so:

$P_0 - P_X = D[1 - (.21)(.50)]/(1 - .21)$
$P_0 - P_X = 1.1329D$

e. Since different investors have widely varying tax rates on ordinary income and capital gains, dividend payments have different aftertax implications for different investors. This differential taxation among investors is one aspect of what we have called the clientele effect.

19. Since the $2,600,000 cash is after corporate tax, the full amount will be invested. So, the value of each alternative is:

Alternative 1:
The firm invests in T-bills or in preferred stock, and then pays out as a special dividend in three years.

If the firm invests in T-Bills:

If the firm invests in T-bills, the aftertax yield of the T-bills will be:

Aftertax corporate yield = .016(1 – .21)
Aftertax corporate yield = .0126, or 1.26%

So, the future value of the corporate investment in T-bills will be:

FV of investment in T-bills = $2,600,000(1 + .0126)^3$
FV of investment in T-bills = $2,699,843.45

Since the future value will be paid to shareholders as a dividend, the aftertax cash flow will be:

Aftertax cash flow to shareholders = $2,699,843.45(1 – .15)
Aftertax cash flow to shareholders = $2,294,866.94

If the firm invests in preferred stock:

If the firm invests in preferred stock, the assumption would be that the dividends received will be reinvested in the same preferred stock. The preferred stock will pay a dividend of:

Preferred dividend = .043($2,600,000)
Preferred dividend = $111,800

Since 70 percent of the dividends are excluded from tax:

Taxable preferred dividends = (1 – .50)($111,800)
Taxable preferred dividends = $55,900

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And the taxes the company must pay on the preferred dividends will be:

Taxes on preferred dividends = .21($55,900)
Taxes on preferred dividends = $11,739

So, the aftertax dividend for the corporation will be:

Aftertax corporate dividend = $111,800 – 11,739
Aftertax corporate dividend = $100,061

This means the aftertax corporate dividend yield is:

Aftertax corporate dividend yield = $100,061/$2,600,000
Aftertax corporate dividend yield = .0385, or 3.85%

The future value of the company's investment in preferred stock will be:

FV of investment in preferred stock = $2,600,000(1 + .0385)^3
FV of investment in preferred stock = $2,911,883.74

Since the future value will be paid to shareholders as a dividend, the aftertax cash flow will be:

Aftertax cash flow to shareholders = $2,911,883.74(1 – .15)
Aftertax cash flow to shareholders = $2,475,101.18

Alternative 2:

The firm pays out a dividend now, and individuals invest on their own. The aftertax cash received by shareholders now will be:

Aftertax cash received today = $2,600,000(1 – .15)
Aftertax cash received today = $2,210,000

The individuals invest in Treasury bills:

If the shareholders invest the current aftertax dividends in Treasury bills, the aftertax individual yield will be:

Aftertax individual yield on T-bills = .016(1 – .35)
Aftertax individual yield on T-bills = .0104, or 1.04%

So, the future value of the individual investment in Treasury bills will be:

FV of investment in T-bills = $2,210,000(1 + .0104)^3
FV of investment in T-bills = $2,279,671.59

The individuals invest in preferred stock:

If the individual invests in preferred stock, the assumption would be that the dividends received will be reinvested in the same preferred stock. The preferred stock will pay a dividend of:

Preferred dividend = .043($2,210,000)
Preferred dividend = $95,030

And the taxes on the preferred dividends will be:

Taxes on preferred dividends = .35($95,030)
Taxes on preferred dividends = $33,260.50

So, the aftertax preferred dividend will be:

Aftertax preferred dividend = $95,030 – 33,260.50
Aftertax preferred dividend = $61,769.50

This means the aftertax individual dividend yield is:

Aftertax corporate dividend yield = $61,769.50/$2,210,000
Aftertax corporate dividend yield = .0280, or 2.80%

The future value of the individual investment in preferred stock will be:

FV of investment in preferred stock = $2,210,000(1 + .0280)^3
FV of investment in preferred stock = $2,400,536.13

The aftertax cash flow for the shareholders is maximized when the firm invests the cash in the preferred stocks and pays a special dividend later.

20. *a.* Let x be the ordinary income tax rate. The individual receives an aftertax dividend of:

Aftertax dividend = $1,000(1 – x)

which she invests in Treasury bonds. The Treasury bond will generate aftertax cash flows to the investor of:

Aftertax cash flow from Treasury bonds = $1,000(1 – x)[1 + .035(1 – x)]

If the firm invests the money, its proceeds are:

Firm proceeds = $1,000[1 + .035(1 – .21)]

And the proceeds to the investor when the firm pays a dividend will be:

Proceeds if firm invests first = (1 – x){$1,000[1 + .035(1 – .21)]}

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To be indifferent, the investor's proceeds must be the same whether she invests the aftertax dividend or receives the proceeds from the firm's investment and pays taxes on that amount. To find the rate at which the investor would be indifferent, we can set the two equations equal, and solve for x. Doing so, we find:

$\$1{,}000(1 - x)[1 + .035(1 - x)] = (1 - x)\{\$1{,}000[1 + .035(1 - .21)]\}$
$1 + .035(1 - x) = 1 + .035(1 - .21)$
$x = .21$, or 21%

Note that this argument does not depend upon the length of time the investment is held.

b. Yes, this is a reasonable answer. She is only indifferent if the aftertax proceeds from the $1,000 investment in identical securities are identical. That occurs only when the tax rates are identical.

c. Since both investors will receive the same pre-tax return, you would expect the same answer as in part (a). Yet, because Carlson enjoys a tax benefit from investing in stock (50 percent of income from stock is exempt from corporate taxes), the tax rate on ordinary income which induces indifference, is much lower. Again, set the two equations equal and solve for x:

$\$1{,}000(1 - x)[1 + .062(1 - x)] = (1 - x)(\$1{,}000\{1 + .062[.50 + (1 - .50)(1 - .21)]\})$
$1 + .062(1 - x) = 1 + .062[.50 + (1 - .50)(1 - .21)]$
$x = .1050$, or 10.50%

d. It is a compelling argument, but there are legal constraints, which deter firms from investing large sums in stock of other companies.

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CHAPTER 17
OPTIONS AND CORPORATE FINANCE

Answers to Concept Questions

1. A call option confers the right, without the obligation, to buy an asset at a given price on or before a given date. A put option confers the right, without the obligation, to sell an asset at a given price on or before a given date. You would buy a call option if you expect the price of the asset to increase. You would buy a put option if you expect the price of the asset to decrease. A call option has unlimited potential profit, while a put option has limited potential profit; the underlying asset's price cannot be less than zero.

2. *a.* The buyer of a call option pays money for the right to buy....
b. The buyer of a put option pays money for the right to sell....
c. The seller of a call option receives money for the obligation to sell....
d. The seller of a put option receives money for the obligation to buy....

3. An American option can be exercised on any date up to and including the expiration date. A European option can only be exercised on the expiration date. Since an American option gives its owner the right to exercise on any date up to and including the expiration date, it must be worth at least as much as a European option, if not more.

4. The intrinsic value of a call is Max[$S - E$, 0]. The intrinsic value of a put is Max[$E - S$, 0]. The intrinsic value of an option is the value at expiration.

5. The call is selling for less than its intrinsic value; an arbitrage opportunity exists. Buy the call for $10, exercise the call by paying $35 in return for a share of stock, and sell the stock for $50. You've made a riskless $5 profit.

6. The prices of both the call and the put option should increase. The higher level of downside risk still results in an option price of zero, but the upside potential is greater since there is a higher probability that the asset will finish in the money.

7. False. The value of a call option depends on the total variance of the underlying asset, not just the systematic variance.

8. The call option will sell for more since it provides an unlimited profit opportunity, while the potential profit from the put is limited (the stock price cannot fall below zero).

9. The value of a call option will increase, and the value of a put option will decrease.

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10. The reason they don't show up is that the U.S. government uses cash accounting; i.e., only actual cash inflows and outflows are counted, not contingent cash flows. From a political perspective, they would make the deficit larger, so that is another reason not to count them! Whether they should be included depends on whether we feel cash accounting is appropriate or not, but these contingent liabilities should be measured and reported. They currently are not, at least not in a systematic fashion.

11. Increasing the time to expiration increases the value of an option. The reason is that the option gives the holder the right to buy or sell. The longer the holder has that right, the more time there is for the option to increase (or decrease in the case of a put) in value. For example, imagine an out-of-the-money option that is about to expire. Because the option is essentially worthless, increasing the time to expiration would obviously increase its value.

12. An increase in volatility acts to increase both call and put values because the greater volatility increases the possibility of favorable in-the-money payoffs.

13. A put option is insurance since it guarantees the policyholder will be able to sell the asset for a specific price. Consider homeowners insurance. If a house burns down, it is essentially worthless. In essence, the homeowner is selling the worthless house to the insurance company for the amount of insurance.

14. The equityholders of a firm financed partially with debt can be thought as holding a call option on the assets of the firm with a strike price equal to the debt's face value and a time to expiration equal to the debt's time to maturity. If the value of the firm exceeds the face value of the debt when it matures, the firm will pay off the debtholders in full, leaving the equityholders with the firm's remaining assets. However, if the value of the firm is less than the face value of debt when it matures, the firm must liquidate all its assets in order to pay off the debtholders, and the equityholders receive nothing. Consider the following:

Let V_L = the value of a firm financed with both debt and equity
FV(debt) = the face value of the firm's outstanding debt at maturity

	If $V_L <$ FV(debt)	If $V_L >$ FV(debt)
Payoff to debtholders	V_L	FV(debt)
Payoff to equityholders	0	V_L – FV(debt)
	V_L	V_L

Notice that the payoff to equityholders is identical to a call option of the form Max(0, $S_T - K$), where the stock price at expiration (S_T) is equal to the value of the firm at the time of the debt's maturity and the strike price (K) is equal to the face value of outstanding debt.

15. Since you have a large number of stock options in the company, you have an incentive to accept the second project, which will increase the overall risk of the company and reduce the value of the firm's debt. However, accepting the risky project will increase your wealth, as the options are more valuable when the risk of the firm increases.

16. Rearranging the put-call parity formula, we get: $S - \text{PV}(E) = C - P$. Since we know that the stock price and exercise price are the same, assuming a positive interest rate, the left-hand side of the equation must be greater than zero. This implies the price of the call must be higher than the price of the put in this situation.

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17. Rearranging the put-call parity formula, we get: $S - PV(E) = C - P$. If the call and the put have the same price, we know $C - P = 0$. This must mean the stock price is equal to the present value of the exercise price, so the put is in the money.

18. A stock can be replicated using a long call (to capture the upside gains), a short put (to reflect the downside losses) and a T-bill (to reflect the time value component – the "wait" factor).

Solutions to Questions and Problems

NOTE: All end-of-chapter problems were solved using a spreadsheet. Many problems require multiple steps. Due to space and readability constraints, when these intermediate steps are included in this solutions manual, rounding may appear to have occurred. However, the final answer for each problem is found without rounding during any step in the problem.

Basic

1. *a.* The calls are in the money. The intrinsic value of the calls is $2.

b. The puts are out of the money. The intrinsic value of the puts is $0.

c. The Mar call and the Oct put are mispriced. The call is mispriced because it is selling for less than its intrinsic value. If the option expired today, the arbitrage strategy would be to buy the call for $1.90, exercise it and pay $75 for a share of stock, and sell the stock for $77. A riskless profit of $.10 results. The October put is mispriced because it sells for less than the July put. To take advantage of this, sell the July put for $3.90 and buy the October put for $3.65, for a cash inflow of $.25. The exposure of the short position is completely covered by the long position in the October put, with a positive cash inflow today.

2. *a.* Each contract is for 100 shares, so the total cost is:

Cost = 10(100 shares/contract)($2.85)
Cost = $2,850

b. If the stock price at expiration is $105, the payoff is:

Payoff = 10(100)($96 – 90)
Payoff = $6,000

If the stock price at expiration is $107, the payoff is:

Payoff = 10(100)($107 – 90)
Payoff = $17,000

c. Remembering that each contract is for 100 shares of stock, the cost is:

Cost = 10(100)($9.12)
Cost = $9,120

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The maximum gain on the put option would occur if the stock price goes to $0. We also need to subtract the initial cost, so:

Maximum gain = 10(100)($90) – $9,120
Maximum gain = $80,880

If the stock price at expiration is $83, the position will have a value of:

Value = 10(100)($90 – 83)
Value = $7,000

So, the net gain to your position is the value at expiration minus the cost of the position, or:

Net gain = $7,000 – 9,120
Net gain = –$2,120

d. At a stock price of $88 the put is in the money. As the writer, you will make:

Net profit = $9,120 – 10(100)($90 – 88)
Net profit = $7,120

At a stock price of $98 the put is out of the money, so the writer will make the initial cost:

Net gain = $9,120

At the break-even, you would recover the initial cost of $9,120, so:

$9,120 = 10(100)($90 – S_T)
S_T = $80.88

For terminal stock prices above $80.88, the writer of the put option makes a net profit (ignoring transaction costs and the effects of the time value of money).

3. Using put-call parity and solving for the put price, we get:

$\$51 + P = \$55e^{-(.039)(3/12)} + \$2.79$
$P = \$6.26$

4. Using put-call parity and solving for the call price we get:

$\$57 + 3.19 = \$60e^{-(.041)(5/12)} + C$
$C = \$1.21$

5. Using put-call parity and solving for the stock price we get:

$S + \$3.87 = \$50e^{-(.027)(3/12)} + \$4.89$
$S = \$50.68$

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6. Using put-call parity, we can solve for the risk-free rate as follows:

$\$84.17 + 7.05 = \$80e^{-R(4/12)} + 11.74$
$\$79.48 = \$80e^{-R(4/12)}$
$.9935 = e^{-R(4/12)}$
$\ln(.9935) = \ln(e^{-R(4/12)})$
$-.00652 = -R(4/12)$
$R_f = .0196$, or 1.96%

7. Using the Black-Scholes option pricing model to find the price of the call option, we find:

$d_1 = [\ln(\$79/\$75) + (.04 + .47^2/2) \times (3/12)]/(.47 \times \sqrt{3/12}) = .3812$

$d_2 = .3812 - (.47 \times \sqrt{3/12}) = .1462$

$N(d_1) = .6485$

$N(d_2) = .5581$

Putting these values into the Black-Scholes model, we find the call price is:

$C = \$79(.6485) - (\$75e^{-.04(.25)})(.5581)$
$C = \$9.79$

Using put-call parity, the put price is:

$P = \$75e^{-.04(.25)} + \$9.79 - 79$
$P = \$5.04$

8. Using the Black-Scholes option pricing model to find the price of the call option, we find:

$d_1 = [\ln(\$87/\$90) + (.03 + .49^2/2) \times (2/12)]/(.49 \times \sqrt{2/12}) = -.0461$

$d_2 = -.0461 - (.49 \times \sqrt{2/12}) = -.2462$

$N(d_1) = .4816$

$N(d_2) = .4028$

Putting these values into the Black-Scholes model, we find the call price is:

$C = \$87(.4816) - (\$90e^{-.03(2/12)})(.4028)$
$C = \$5.82$

Using put-call parity, the put price is:

$P = \$90e^{-.03(2/12)} + \$5.82 - 87$
$P = \$8.40$

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9. The delta of a call option is N(d_1), so:

$d_1 = [\ln(\$68/\$60) + (.05 + .43^2/2) \times (9/12)]/(.43 \times \sqrt{(9/12)}) = .6230$

N(d_1) = .7334

For a call option the delta is .7334. For a put option, the delta is:

Put delta = .7334 – 1
Put delta = –.2666

The delta tells us the change in the price of an option for a $1 change in the price of the underlying asset.

10. Using the Black-Scholes option pricing model, with a 'stock' price of $1,100,000 and an exercise price of $1,300,000, the price you should receive is:

$d_1 = [\ln(\$1{,}100{,}000/\$1{,}300{,}000) + (.05 + .25^2/2) \times (12/12)]/(.25 \times \sqrt{12/12}) = -.3432$

$d_2 = -.3432 - (.25 \times \sqrt{12/12}) = -.5932$

N(d_1) = .3657

N(d_2) = .2765

Putting these values into the Black-Scholes model, we find the call price is:

$C = \$1{,}100{,}000(.3657) - (\$1{,}300{,}000e^{-.05(1)})(.2765)$
$C = \$60{,}347.73$

11. Using the call price we found in the previous problem and put-call parity, you would need to pay:

$P = \$1{,}300{,}000e^{-.05(1)} + \$60{,}347.73 - 1{,}100{,}000$
$P = \$196{,}945.98$

You would have to pay $196,945.98 in order to guarantee the right to sell the land for $1,300,000.

12. Using the Black-Scholes option pricing model to find the price of the call option, we find:

$d_1 = [\ln(\$68/\$70) + (.04 + .54^2/2) \times (6/12)]/(.54 \times \sqrt{(6/12)}) = .1674$

$d_2 = .1674 - (.54 \times \sqrt{6/12}) = -.2145$

N(d_1) = .5665

N(d_2) = .4151

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Putting these values into the Black-Scholes model, we find the call price is:

$C = \$68(.5665) - (\$70e^{-.04(.50)})(.4151)$
$C = \$10.04$

Using put–call parity, we find the put price is:

$P = \$70e^{-.04(.50)} + \$10.04 - 68$
$P = \$10.65$

a. The intrinsic value of each option is:

Call intrinsic value = Max[$S - E$, 0] = \$0

Put intrinsic value = Max[$E - S$, 0] = \$2

b. Option value consists of time value and intrinsic value, so:

Call option value = Intrinsic value + Time value
\$10.04 = \$0 + Time value
Time value = \$10.04

Put option value = Intrinsic value + Time value
\$10.65 = \$2 + Time value
Time value = \$8.65

c. The time premium (theta) is more important for a call option than a put option; therefore, the time premium is, in general, larger for a call option.

13. The stock price can either increase 13 percent or decrease 13 percent. The stock price at expiration will either be:

Stock price increase = \$66(1 + .13) = \$74.58

Stock price decrease = \$66(1 – .13) = \$57.42

The payoff in either state will be the maximum stock price minus the exercise price, or zero, which is:

Payoff if stock price increases = Max[\$74.58 – 60, 0] = \$14.58

Payoff if stock price decreases = Max[\$57.42 – 60, 0] = \$0

To get a return of 13 percent, we can use the following expression to determine the risk-neutral probability of a rise in the price of the stock:

Risk-free rate = (Probability$_{Rise}$)(Return$_{Rise}$) + (Probability$_{Fall}$)(Return$_{Fall}$)
.06 = (Probability$_{Rise}$)(.13) + (1 – Probability$_{Rise}$)(–.13)
Probability$_{Rise}$ = .7308

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And the probability of a stock price decrease is:

$\text{Probability}_{\text{Fall}} = 1 - .7308 = .2692$

So, the risk neutral value of a call option will be:

Call value = [(.7308 × $14.58) + (.2692 × $0)]/(1 + .06)
Call value = $10.05

14. The stock price increase, decrease, and option payoffs will remain unchanged since the stock price change is the same. The new risk neutral probability of a stock price increase is:

$\text{Risk-free rate} = (\text{Probability}_{\text{Rise}})(\text{Return}_{\text{Rise}}) + (\text{Probability}_{\text{Fall}})(\text{Return}_{\text{Fall}})$
$.04 = (\text{Probability}_{\text{Rise}})(.13) + (1 - \text{Probability}_{\text{Rise}})(-.13)$
$\text{Probability}_{\text{Rise}} = .6538$

And the probability of a stock price decrease is:

$\text{Probability}_{\text{Fall}} = 1 - .6538 = .3462$

So, the risk neutral value of a call option will be:

Call value = [(.6538 × $14.58) + (.3462 × $0)]/(1 + .04)
Call value = $9.17

Intermediate

15. If the exercise price is equal to zero, the call price will equal the stock price, which is $75.

16. If the standard deviation is zero, d_1 and d_2 go to $+\infty$, so $N(d_1)$ and $N(d_2)$ go to 1, which gives us:

$C = SN(d_1) - EN(d_2)e^{-Rt}$
$C = \$74(1) - \$70(1)e^{-.04(6/12)}$
$C = \$5.39$

17. If the standard deviation is infinite, d_1 goes to positive infinity so $N(d_1)$ goes to 1, and d_2 goes to negative infinity so $N(d_2)$ goes to 0. In this case, the call price is equal to the stock price, which is $35.

18. We can use the Black-Scholes model to value the equity of a firm. Using the asset value of $13,800 as the stock price, and the face value of debt of $12,000 as the exercise price, the value of the firm's equity is:

$d_1 = [\ln(\$13{,}800/\$12{,}000) + (.06 + .32^2/2) \times 1]/(.32 \times \sqrt{1}) = .7843$

$d_2 = .7843 - (.32 \times \sqrt{1}) = .4643$

$N(d_1) = .7836$

$N(d_2) = .6788$

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Putting these values into the Black-Scholes model, we find the equity value is:

Equity = \$13,800(.7836) – (\$12,000$e^{-.06(1)}$)(.6788)
Equity = \$3,142.19

The value of the debt is the firm value minus the value of the equity, so:

Debt = \$13,800 – 3,142.19
Debt = \$10,657.81

19. *a.* We can use the Black-Scholes model to value the equity of a firm. Using the asset value of \$14,600 (= \$13,800 + 800) as the stock price, and the face value of debt of \$12,000 as the exercise price, the value of the firm if it accepts Project A is:

d_1 = [ln(\$14,600/\$12,000) + (.06 + $.50^2$/2) × 1]/(.50 × $\sqrt{1}$) = .7622

d_2 = .7622 – (.50 × $\sqrt{1}$) = .2622

N(d_1) = .7770

N(d_2) = .6034

Putting these values into the Black-Scholes model, we find the equity value is:

Equity_A = \$14,600(.7770) – (\$12,000$e^{-.06(1)}$)(.6034)
Equity_A = \$4,525.32

The value of the debt is the firm value minus the value of the equity, so:

Debt_A = \$14,600 – 4,525.32
Debt_A = \$10,074.68

And the value of the firm if it accepts Project B is:

d_1 = [ln(\$15,100/\$12,000) + (.06 + $.23^2$/2) × 1]/(.23 × $\sqrt{1}$) = 1.3749

d_2 = 1.3749 – (.23 × $\sqrt{1}$) = 1.1449

N(d_1) = .9154

N(d_2) = .8739

Putting these values into the Black-Scholes model, we find the equity value is:

Equity_B = \$15,100(.9154) – (\$12,000$e^{-.06(1)}$)(.8739)
Equity_B = \$3,947.01

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The value of the debt is the firm value minus the value of the equity, so:

$\text{Debt}_B = \$15{,}100 - 3{,}947.01$
$\text{Debt}_B = \$11{,}152.99$

b. Although the NPV of Project B is higher, the equity value with Project A is higher. While NPV represents the increase in the value of the assets of the firm, in this case, the increase in the value of the firm's assets resulting from Project B is mostly allocated to the debtholders, resulting in a smaller increase in the value of the equity. Stockholders would, therefore, prefer Project A even though it has a lower NPV.

c. Yes. If the same group of investors have equal stakes in the firm as bondholders and stockholders, then total firm value matters and Project B should be chosen, since it increases the value of the firm to \$15,100 instead of \$14,600.

d. Stockholders may have an incentive to take on riskier, less profitable projects if the firm is leveraged; the higher the firm's debt load, all else the same, the greater is this incentive.

20. We can use the Black-Scholes model to value the equity of a firm. Using the asset value of \$21,900 as the stock price, and the face value of debt of \$20,000 as the exercise price, the value of the firm's equity is:

$d_1 = [\ln(\$21{,}900/\$20{,}000) + (.06 + .34^2/2) \times 1]/(.34 \times \sqrt{1}) = .6134$

$d_2 = .6134 - (.34 \times \sqrt{1}) = .2734$

$N(d_1) = .7302$

$N(d_2) = .6077$

Putting these values into the Black-Scholes model, we find the equity value is:

$\text{Equity} = \$21{,}900(.7302) - (\$20{,}000e^{-.06(1)})(.6077)$
$\text{Equity} = \$4{,}544.53$

The value of the debt is the firm value minus the value of the equity, so:

$\text{Debt} = \$21{,}900 - 4{,}544.53$
$\text{Debt} = \$17{,}355.47$

The return on the company's debt is:

$\$17{,}355.47 = \$20{,}000e^{-R(1)}$
$.86777 = e^{-R}$
$R_D = -\ln(.86777)$
$R_D = .1418$, or 14.18%

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21. *a.* Using Black-Scholes model to value the equity, we get:

$d_1 = [\ln(\$8{,}800{,}000/\$10{,}000{,}000) + (.06 + .47^2/2) \times 10]/(.47 \times \sqrt{10}) = 1.0608$

$d_2 = 1.0608 - (.47 \times \sqrt{10}) = -.4254$

$N(d_1) = .8556$

$N(d_2) = .3353$

Putting these values into Black-Scholes:

Equity = $\$8{,}800{,}000(.8556) - (\$10{,}000{,}000e^{-.06(10)})(.3353)$
Equity = $\$5{,}689{,}490.69$

b. The value of the debt is the firm value minus the value of the equity, so:

Debt = $\$8{,}800{,}000 - 5{,}689{,}490.69$
Debt = $\$3{,}110{,}509.31$

c. Using the equation for the PV of a continuously compounded lump sum, we get:

$\$3{,}110{,}509.31 = \$10{,}000{,}000e^{-R(10)}$
$.3110 = e^{-R10}$
$R_D = -(1/10)\ln(.3110)$
$R_D = .1168$, or 11.68%

d. Using Black-Scholes model to value the equity, we get:

$d_1 = [\ln(\$9{,}900{,}000/\$10{,}000{,}000) + (.06 + .47^2/2) \times 10]/(.47 \times \sqrt{10}) = 1.1401$

$d_2 = 1.1401 - (.47 \times \sqrt{10}) = -.3462$

$N(d_1) = .8729$

$N(d_2) = .3646$

Putting these values into Black-Scholes:

Equity = $\$9{,}900{,}000(.8729) - (\$10{,}000{,}000e^{-.06(10)})(.3646)$
Equity = $\$6{,}640{,}481.78$

e. The value of the debt is the firm value minus the value of the equity, so:

Debt = $\$9{,}900{,}000 - 6{,}640{,}481.78$
Debt = $\$3{,}259{,}518.22$

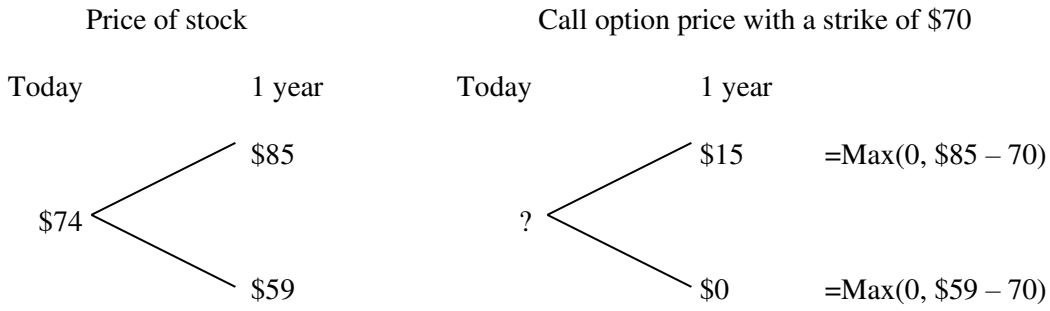
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Using the equation for the PV of a continuously compounded lump sum, we get:

$\$3,259,518.22 = \$10,000,000e^{-R(10)}$
$.3260 = e^{-R10}$
$R_D = -(1/10)\ln(.3260)$
$R_D = .1121$, or 11.21%

When the firm accepts the new project, part of the NPV accrues to bondholders. This increases the present value of the bond, thus reducing the return on the bond. Additionally, the new project makes the firm safer in the sense that it increases the value of assets, thus increasing the probability the call will end in the money and the bondholders will receive their payment.

22. *a.* In order to solve a problem using the two-state option model, we first need to draw a stock price tree containing both the current stock price and the stock's possible values at the time of the option's expiration. Next, we can draw a similar tree for the option, designating what its value will be at expiration given either of the two possible stock price movements.



The stock price today is $74. It will either increase to $85 or decrease to $59 in one year. If the stock price rises to $85, the call will be exercised for $70 and a payoff of $15 will be received at expiration. If the stock price falls to $59, the option will not be exercised, and the payoff at expiration will be zero.

If the stock price rises, its return over the period is 14.86 percent [= ($85/$74) – 1]. If the stock price falls, its return over the period is –20.27 percent [= ($59/$74) –1]. We can use the following expression to determine the risk-neutral probability of a rise in the price of the stock:

Risk-free rate = $(\text{Probability}_{\text{Rise}})(\text{Return}_{\text{Rise}}) + (\text{Probability}_{\text{Fall}})(\text{Return}_{\text{Fall}})$
Risk-free rate = $(\text{Probability}_{\text{Rise}})(\text{Return}_{\text{Rise}}) + (1 - \text{Probability}_{\text{Rise}})(\text{Return}_{\text{Fall}})$
$.055 = (\text{Probability}_{\text{Rise}})(.1486) + (1 - \text{Probability}_{\text{Rise}})(-.2027)$
$\text{Probability}_{\text{Rise}} = .7335$, or 73.35%

This means the risk neutral probability of a stock price decrease is:

$\text{Probability}_{\text{Fall}} = 1 - \text{Probability}_{\text{Rise}}$
$\text{Probability}_{\text{Fall}} = 1 - .7335$
$\text{Probability}_{\text{Fall}} = .2665$, or 26.65%

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Using these risk-neutral probabilities, we can now determine the expected payoff of the call option at expiration. The expected payoff at expiration is:

Expected payoff at expiration = .7335($15) + .2665($0)
Expected payoff at expiration = $11.00

Since this payoff occurs one year from now, we must discount it back to the value today. Since we are using risk-neutral probabilities, we can use the risk-free rate, so:

PV(Expected payoff at expiration) = $11.00/1.055
PV(Expected payoff at expiration) = $10.43

Therefore, given the information about the stock price movements over the next year, a European call option with a strike price of $70 and one year until expiration is worth $10.43 today.

b. Yes, there is a way to create a synthetic call option with identical payoffs to the call option described above. In order to do this, we will need to buy shares of stock and borrow at the risk-free rate. The number of shares to buy is based on the delta of the option, where delta is defined as:

Delta = (Swing of option)/(Swing of stock)

Since the call option will be worth $15 if the stock price rises and $0 if it falls, the swing of the option is $15 (= $15 – 0). Since the stock price will either be $85 or $59 at the time of the option's expiration, the swing of the stock is $26 (= $85 – 59). With this information, the delta of the option is:

Delta = $15/$26
Delta = .5769

Therefore, the first step in creating a synthetic call option is to buy .5769 shares of the stock. Since the stock is currently trading at $74 per share, this will cost $42.69 [= .5769($74)]. In order to determine the amount that we should borrow, compare the payoff of the actual call option to the payoff of delta shares at expiration.

<u>Call Option</u>
If the stock price rises to $85: Payoff = $15
If the stock price falls to $59: Payoff = $0

<u>Delta Shares</u>
If the stock price rises to $85: Payoff = (.5769)($85) = $49.04
If the stock price falls to $59: Payoff = (.5769)($59) = $34.04

The payoff of his synthetic call position should be identical to the payoff of an actual call option. However, owning .5769 shares leaves us exactly $15 above the payoff at expiration, regardless of whether the stock price rises or falls. In order to reduce the payoff at expiration by $34.04, we should borrow the present value of $34.04 now. In one year, the obligation to pay $34.04 will reduce the payoffs so that they exactly match those of an actual call option. So, purchase .5769 shares of stock and borrow $32.26 (= $34.04/1.055) in order to create a synthetic call option with a strike price of $70 and one year until expiration.

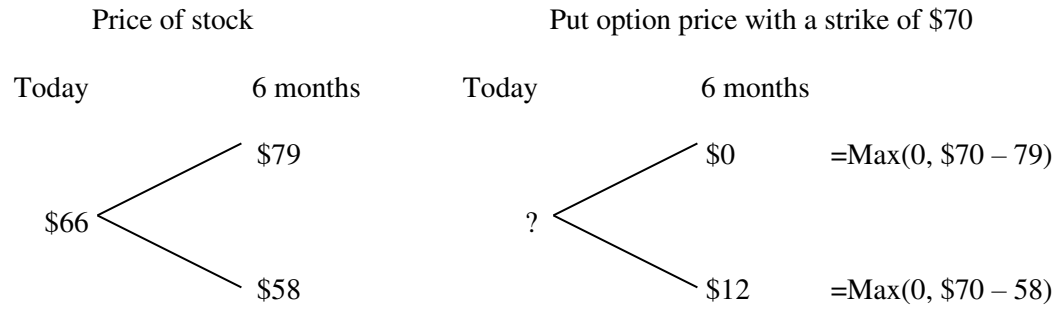
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c. Since the cost of the stock purchase is $42.69 to purchase .5769 shares and $32.26 is borrowed, the total cost of the synthetic call option is:

Cost of synthetic option = $42.69 – 32.26
Cost of synthetic option = $10.43

This is exactly the same price as an actual call option. Since an actual call option and a synthetic call option provide identical payoff structures, we should not expect to pay more for one than for the other.

23. *a.* In order to solve a problem using the two-state option model, we first draw a stock price tree containing both the current stock price and the stock's possible values at the time of the option's expiration. Next, we can draw a similar tree for the option, designating what its value will be at expiration given either of the two possible stock price movements.



The stock price today is $66. It will either decrease to $58 or increase to $79 in six months. If the stock price falls to $58, the put will be exercised and the payoff will be $12. If the stock price rises to $79, the put will not be exercised, so the payoff will be zero.

If the stock price rises, its return over the period is 19.70 percent [= ($79/$66) – 1]. If the stock price falls, its return over the period is –12.12 percent [= ($58/$66) –1]. Use the following expression to determine the risk-neutral probability of a rise in the price of the stock:

Risk-free rate = $(\text{Probability}_{\text{Rise}})(\text{Return}_{\text{Rise}}) + (\text{Probability}_{\text{Fall}})(\text{Return}_{\text{Fall}})$
Risk-free rate = $(\text{Probability}_{\text{Rise}})(\text{Return}_{\text{Rise}}) + (1 - \text{Probability}_{\text{Rise}})(\text{Return}_{\text{Fall}})$

The risk-free rate over the next six months must be used in order to match the timing of the expected stock price change. Since the risk-free rate per annum is 4.3 percent, the risk-free rate over the next six months is 2.13 percent [= $(1.043)^{1/2} - 1$], so:

Risk-free rate = $(\text{Probability}_{\text{Rise}})(\text{Return}_{\text{Rise}}) + (\text{Probability}_{\text{Fall}})(\text{Return}_{\text{Fall}})$
.0213 = $(\text{Probability}_{\text{Rise}})(.1970) + (1 - \text{Probability}_{\text{Rise}})(-.1212)$
$\text{Probability}_{\text{Rise}}$ = .4478, or 44.78%

Which means the risk-neutral probability of a decrease in the stock price is:

$\text{Probability}_{\text{Fall}} = 1 - \text{Probability}_{\text{Rise}}$
$\text{Probability}_{\text{Fall}} = 1 - .4478$
$\text{Probability}_{\text{Fall}} = .5522$, or 55.22%

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Using these risk-neutral probabilities, we can determine the expected payoff to the put option at expiration as:

Expected payoff at expiration = .4478($0) + .5522($12)
Expected payoff at expiration = $6.63

Since this payoff occurs six months from now, we must discount it at the risk-free rate in order to find its present value, which is:

PV(Expected payoff at expiration) = $6.63/$(1.043)^{1/2}$
PV(Expected payoff at expiration) = $6.49

Therefore, given the information about the stock price movements over the next six months, a European put option with a strike price of $70 and six months until expiration is worth $6.49 today.

b. Yes, there is a way to create a synthetic put option with identical payoffs to the put option described above. In order to do this, we need to short shares of the stock and lend at the risk-free rate. The number of shares that should be shorted is based on the delta of the option, where delta is defined as:

Delta = (Swing of option)/(Swing of stock)

Since the put option will be worth $0 if the stock price rises and $12 if it falls, the swing of the call option is –$12 (= $0 – 12). Since the stock price will either be $79 or $58 at the time of the option's expiration, the swing of the stock is $21 (= $79 – 58). Given this information, the delta of the put option is:

Delta = (Swing of option)/(Swing of stock)
Delta = (–$12/$21)
Delta = –.5714

Therefore, the first step in creating a synthetic put option is to short .5714 shares of stock. Since the stock is currently trading at $66 per share, the amount received will be $37.71 (= .5714 × $66) as a result of the short sale. In order to determine the amount to lend, compare the payoff of the actual put option to the payoff of delta shares at expiration.

<u>Put option</u>
If the stock price rises to $79: Payoff = $0
If the stock price falls to $58: Payoff = $12

<u>Delta shares</u>
If the stock price rises to $79: Payoff = (–.5714)($79) = –$45.14
If the stock price falls to $58: Payoff = (–.5714)($58) = –$33.14

The payoff of the synthetic put position should be identical to the payoff of an actual put option. However, shorting .5714 of a share leaves us exactly $45.14 below the payoff at expiration, whether the stock price rises or falls. In order to increase the payoff at expiration by $45.14, we should lend the present value of $45.14 now. In six months, we will receive $45.14, which will increase the payoffs so that they exactly match those of an actual put option. So, the amount to lend is:

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Amount to lend = $45.14/1.043^{1/2}$
Amount to lend = $44.20

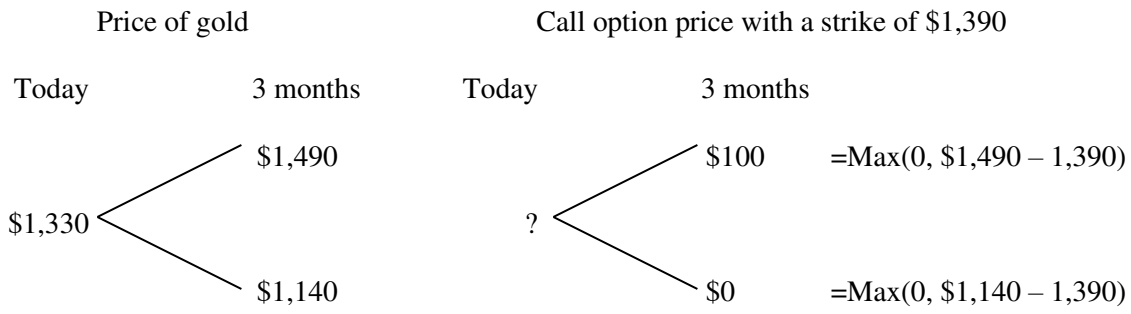
c. Since the short sale results in a positive cash flow of $37.71 and we will lend $44.20, the total cost of the synthetic put option is:

Cost of synthetic put = $44.20 – 37.71
Cost of synthetic put = $6.49

This is exactly the same price as an actual put option. Since an actual put option and a synthetic put option provide identical payoff structures, we should not expect to pay more for one than for the other.

24. *a.* The company would be interested in purchasing a call option on the price of gold with a strike price of $1,390 per ounce and 3 months until expiration. This option will compensate the company for any increases in the price of gold above the strike price and places a cap on the amount the firm must pay for gold at $1,390 per ounce.

b. In order to solve a problem using the two-state option model, first draw a price tree containing both the current price of the underlying asset and the underlying asset's possible values at the time of the option's expiration. Next, draw a similar tree for the option, designating what its value will be at expiration given either of the two possible gold price movements.



The price of gold is $1,330 per ounce today. If the price rises to $1,490, the company will exercise its call option for $1,390 and receive a payoff of $100 at expiration. If the price of gold falls to $1,140, the company will not exercise its call option, and the firm will receive no payoff at expiration. If the price of gold rises, its return over the period is 12.03 percent [= ($1,490/$1,330) – 1]. If the price of gold falls, its return over the period is –14.29 percent [= ($1,140/$1,330) – 1]. Use the following expression to determine the risk-neutral probability of a rise in the price of gold:

Risk-free rate = $(\text{Probability}_{\text{Rise}})(\text{Return}_{\text{Rise}}) + (\text{Probability}_{\text{Fall}})(\text{Return}_{\text{Fall}})$
Risk-free rate = $(\text{Probability}_{\text{Rise}})(\text{Return}_{\text{Rise}}) + (1 - \text{Probability}_{\text{Rise}})(\text{Return}_{\text{Fall}})$

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The risk-free rate over the next three months must be used in the order to match the timing of the expected price change. Since the risk-free rate per annum is 4 percent, the risk-free rate over the next three months is .99 percent [= $(1.04)^{1/4} - 1$], so:

$.0099 = (\text{Probability}_{\text{Rise}})(.1203) + (1 - \text{Probability}_{\text{Rise}})(-.1429)$
$\text{Probability}_{\text{Rise}} = .5803$, or 58.03%

And the risk-neutral probability of a price decline is:

$\text{Probability}_{\text{Fall}} = 1 - \text{Probability}_{\text{Rise}}$
$\text{Probability}_{\text{Fall}} = 1 - .5803$
$\text{Probability}_{\text{Fall}} = .4197$, or 41.97%

Using these risk-neutral probabilities, we can determine the expected payoff of the call option at expiration, which will be.

Expected payoff at expiration = .5803($100) + .4197($0)
Expected payoff at expiration = $58.03

Since this payoff occurs three months from now, it must be discounted at the risk-free rate in order to find its present value. Doing so, we find:

PV(Expected payoff at expiration) = $58.03/$(1.04)^{1/4}$
PV(Expected payoff at expiration) = $57.46

Therefore, given the information about gold's price movements over the next three months, a European call option with a strike price of $1,390 and three months until expiration is worth $57.46 today.

c. Yes, there is a way to create a synthetic call option with identical payoffs to the call option described above. In order to do this, the company will need to buy gold and borrow at the risk-free rate. The amount of gold to buy is based on the delta of the option, where delta is defined as:

Delta = (Swing of option)/(Swing of price of gold)

Since the call option will be worth $100 if the price of gold rises and $0 if it falls, the swing of the call option is $100 (= $100 – 0). Since the price of gold will either be $1,490 or $1,140 at the time of the option's expiration, the swing of the price of gold is $350 (= $1,490 – 1,140). Given this information the delta of the call option is:

Delta = Swing of option/Swing of price of gold
Delta = $100/$350
Delta = .2857

Therefore, the first step in creating a synthetic call option is to buy .2857 of an ounce of gold. Since gold currently sells for $1,330 per ounce, the company will pay $380.00 (= .2857 × $1,330) to purchase .2857 of an ounce of gold. In order to determine the amount that should be borrowed, compare the payoff of the actual call option to the payoff of delta shares at expiration.

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Call Option
If the price of gold rises to $1,490: Payoff = $100
If the price of gold falls to $1,140: Payoff = $0

Delta Shares
If the price of gold rises to $1,490: Payoff = .2857($1,490) = $425.71
If the price of gold falls to $1,140: Payoff = .2857($1,140) = $325.71

The payoff of this synthetic call position should be identical to the payoff of an actual call option. However, buying .2857 of an ounce of gold leaves us exactly $325.71 above the payoff at expiration, whether the price of gold rises or falls. In order to decrease the company's payoff at expiration by $325.71, it should borrow the present value of $325.71 now. In three months, the company must pay $325.71, which will decrease its payoffs so that they exactly match those of an actual call option. So, the amount to borrow today is:

Amount to borrow today = $325.71/1.04$^{1/4}$
Amount to borrow today = $322.54

d. Since the company pays $380.00 in order to purchase gold and borrows $322.54, the total cost of the synthetic call option is $57.46 (= $380.00 – 322.54). This is exactly the same price for an actual call option. Since an actual call option and a synthetic call option provide identical payoff structures, the company should not expect to pay more for one than for the other.

25. To construct the collar, the investor must purchase the stock, sell a call option with a high strike price, and buy a put option with a low strike price. So, to find the cost of the collar, we need to find the price of the call option and the price of the put option. We can use Black-Scholes to find the price of the call option, which will be:

Price of call option with $65 strike price:

$d_1 = [\ln(\$59/\$65) + (.047 + .45^2/2) \times (6/12)]/(.45 \times \sqrt{(6/12)}) = -.0714$

$d_2 = -.0714 - (.45 \times \sqrt{6/12}) = -.3896$

$N(d_1) = .4715$

$N(d_2) = .3484$

Putting these values into the Black-Scholes model, we find the call price is:

$C = \$59(.4715) - (\$65e^{-.047(6/12)})(.3484)$
$C = \$5.70$

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Now we can use Black-Scholes and put-call parity to find the price of the put option with a strike price of $55. Doing so, we find:

Price of put option with $55 strike price:

$d_1 = [\ln(\$59/\$55) + (.047 + .45^2/2) \times (6/12)]/(.45 \times \sqrt{(6/12)}) = .4536$

$d_2 = .4536 - (.45 \times \sqrt{6/12}) = .1354$

$N(d_1) = .6749$

$N(d_2) = .5538$

Putting these values into the Black-Scholes model, we find the call price is:

$C = \$59(.6749) - (\$55e^{-.047(6/12)})(.5538)$
$C = \$10.07$

Rearranging the put-call parity equation, we get:

$P = C - S + Ee^{-Rt}$
$P = \$10.07 - 59 + 55e^{-.047(6/12)}$
$P = \$4.79$

So, the investor will buy the stock, sell the call option, and buy the put option, so the total cost is:

Total cost of collar = $59 – 5.70 + 4.79
Total cost of collar = $58.09

Challenge

26. *a.* The combined value of equity and debt of the two firms is:

Equity = $3,142.19 + 4,544.53 = $7,686.72

Debt = $10,657.81+ 17,355.47 = $28,013.28

b. For the new firm, the combined market value of assets is $35,700, and the combined face value of debt is $32,000. Using Black-Scholes to find the value of equity for the new firm, we find:

$d_1 = [\ln(\$35{,}700/\$32{,}000) + (.06 + .16^2/2) \times 1]/(.16 \times \sqrt{1}) = 1.1388$

$d_2 = 1.1388 - (.16 \times \sqrt{1}) = .9788$

$N(d_1) = .8726$

$N(d_2) = .8362$

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Putting these values into the Black-Scholes model, we find the equity value is:

Equity = \$35,700(.8726) – (\$32,000$e^{-.06(1)}$)(.8362)
Equity = \$5,953.13

The value of the debt is the firm value minus the value of the equity, so:

Debt = \$35,700 – 5,953.13
Debt = \$29,746.87

c. The change in the value of the firm's equity is:

Equity value change = \$5,953.13 – 7,686.72
Equity value change = –\$1,733.58

The change in the value of the firm's debt is:

Debt value change = \$29,746.87 – 28,013.28
Debt value change = \$1,733.58

d. In a purely financial merger, when the standard deviation of the assets declines, the value of the equity declines as well. The shareholders will lose exactly the amount the bondholders gain. The bondholders gain as a result of the coinsurance effect. That is, it is less likely that the new company will default on the debt.

27. *a.* Using the equation for the PV of a continuously compounded lump sum, we get:

PV = \$100,000 × $e^{-.05(2)}$ = \$90,483.74

b. Using the Black-Scholes model to value the equity, we get:

d_1 = [ln(\$81,000/\$100,000) + (.05 + $.60^2$/2) × 2]/(.60 × $\sqrt{2}$) = .2938

d_2 = .2938 – (.60 × $\sqrt{2}$) = –.5548

N(d_1) = .6155

N(d_2) = .2895

Putting these values into Black-Scholes:

Equity = \$81,000(.6155) – (\$100,000$e^{-.05(2)}$)(.2895)
Equity = \$23,660.42

And using put-call parity, the price of the put option is:

Put = \$100,000$e^{-.05(2)}$ + \$23,660.42 – 81,000
Put = \$33,144.17

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c. The value of a risky bond is the value of a risk-free bond minus the value of a put option on the firm's equity, so:

Value of risky bond = $90,483.74 – 33,144.17
Value of risky bond = $57,339.58

Using the equation for the PV of a continuously compounded lump sum to find the return on debt, we get:

$57,339.58 = $100,000$e^{-R(2)}$
.5734 = e^{-R2}
R_D = –(1/2)ln(.5734)
R_D = .2781, or 27.81%

d. The value of the debt with five years to maturity at the risk-free rate is:

PV = $100,000 × $e^{-.05(5)}$ = $77,880.08

Using the Black-Scholes model to value the equity, we get:

d_1 = [ln($81,000/$100,000) + (.05 + .60^2/2) × 5]/(.60 × $\sqrt{5}$) = .7001

d_2 = .7001 – (.60 × $\sqrt{5}$) = –.6415

N(d_1) = .7581

N(d_2) = .2606

Putting these values into Black-Scholes:

Equity = $81,000(.7581) – ($100,000$e^{-.05(5)}$)(.2606)
Equity = $41,109.04

And using put-call parity, the price of the put option is:

Put = $100,000$e^{-.05(5)}$ + $41,109.04 – $81,000
Put = $37,989.12

The value of a risky bond is the value of a risk-free bond minus the value of a put option on the firm's equity, so:

Value of risky bond = $77,880.08 – 37,989.12
Value of risky bond = $39,890.96

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Using the equation for the PV of a continuously compounded lump sum to find the return on debt, we get:

$\$39,890.96 = \$100,000e^{-R(5)}$
$.3989 = e^{-R5}$
$R_D = -(1/5)\ln(.3989)$
$R_D = .1838$, or 18.38%

The value of the debt declines because of the time value of money, i.e., it will be longer until shareholders receive their payment. However, the required return on the debt declines. Under the current situation, it is not likely the company will have the assets to pay off bondholders. Under the new plan where the company operates for five more years, the probability of increasing the value of assets to meet or exceed the face value of debt is higher than if the company only operates for two more years.

28. *a.* Using the equation for the PV of a continuously compounded lump sum, we get:

$PV = \$85,000 \times e^{-.06(5)} = \$62,969.55$

b. Using Black-Scholes model to value the equity, we get:

$d_1 = [\ln(\$69,000/\$85,000) + (.06 + .50^2/2) \times 5]/(.50 \times \sqrt{5}) = .6408$

$d_2 = .6408 - (.50 \times \sqrt{5}) = -.4772$

$N(d_1) = .7392$

$N(d_2) = .3166$

Putting these values into Black-Scholes:

$\text{Equity} = \$69,000(.7392) - (\$85,000e^{-.06(5)})(.3166)$
$\text{Equity} = \$31,066.97$

And using put-call parity, the price of the put option is:

$\text{Put} = \$85,000e^{-.06(5)} + \$31,066.97 - 69,000$
$\text{Put} = \$25,036.52$

c. The value of a risky bond is the value of a risk-free bond minus the value of a put option on the firm's equity, so:

Value of risky bond = $62,969.55 – 25,036.52
Value of risky bond = $37,933.03

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Using the equation for the PV of a continuously compounded lump sum to find the return on debt, we get:

Return on debt:
$\$37,933.03 = \$85,000e^{-R(5)}$
$.4463 = e^{-R(5)}$
$R_D = -(1/5)\ln(.4463)$
$R_D = .1614$, or 16.14%

d. Using the equation for the PV of a continuously compounded lump sum, we get:

$PV = \$85,000 \times e^{-.06(5)} = \$62,969.55$

Using the Black-Scholes model to value the equity, we get:

$d_1 = [\ln(\$69,000/\$85,000) + (.06 + .60^2/2) \times 5]/(.60 \times \sqrt{5}) = .7390$

$d_2 = .7390 - (.60 \times \sqrt{5}) = -.6027$

$N(d_1) = .7700$

$N(d_2) = .2734$

Putting these values into Black-Scholes:

$\text{Equity} = \$69,000(.7700) - (\$85,000e^{-.06(5)})(.2734)$
Equity = $35,918.98

And using put-call parity, the price of the put option is:

$\text{Put} = \$85,000e^{-.06(5)} + \$35,918.98 - 69,000$
Put = $29,888.53

The value of a risky bond is the value of a risk-free bond minus the value of a put option on the firm's equity, so:

Value of risky bond = $62,969.55 – 29,888.53
Value of risky bond = $33,081.02

Using the equation for the PV of a continuously compounded lump sum to find the return on debt, we get:

$\$33,081.02 = \$85,000e^{-R(5)}$
$.3892 = e^{-R(5)}$
$R_D = -(1/5)\ln(.3892)$
$R_D = .1887$, or 18.87%

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The value of the debt declines. Since the standard deviation of the company's assets increases, the value of the put option on the face value of the bond increases, which decreases the bond's current value.

e. From (c) and (d), bondholders lose: $33,081.02 – 37,933.03 = –$4,852.01
From (c) and (d), stockholders gain: $35,918.98 – 31,066.97 = $4,852.01

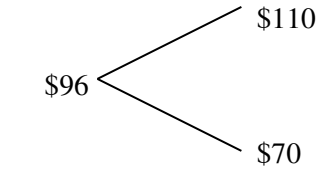
This is an agency problem for bondholders. Management, acting to increase shareholder wealth in this manner, will reduce bondholder wealth by the exact amount by which shareholder wealth is increased.

29. *a.* Since the equityholders of a firm financed partially with debt can be thought of as holding a call option on the assets of the firm with a strike price equal to the debt's face value and a time to expiration equal to the debt's time to maturity, the value of the company's equity equals a call option with a strike price of $89 million and 1 year until expiration.

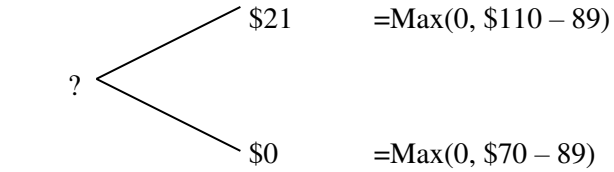
In order to value this option using the two-state option model, first draw a tree containing both the current value of the firm and the firm's possible values at the time of the option's expiration. Next, draw a similar tree for the option, designating what its value will be at expiration given either of the two possible changes in the firm's value.

The value of the company today is $96 million. It will either increase to $110 million or decrease to $70 million in one year as a result of its new project. If the firm's value increases to $110 million, the equityholders will exercise their call option, and they will receive a payoff of $21 million at expiration. However, if the firm's value decreases to $70 million, the equityholders will not exercise their call option, and they will receive no payoff at expiration.

Value of company (in millions)



Equityholders' call option price with a strike of $89 (in millions)



If the project is successful and the company's value rises, the percentage increase in value over the period is 14.58 percent [= ($110/$96) – 1]. If the project is unsuccessful and the company's value falls, the percentage decrease in value over the period is –27.08 percent [= ($70/$96) – 1]. We can determine the risk-neutral probability of an increase in the value of the company as:

$$\text{Risk-free rate} = (\text{Probability}_{\text{Rise}})(\text{Return}_{\text{Rise}}) + (\text{Probability}_{\text{Fall}})(\text{Return}_{\text{Fall}})$$
$$\text{Risk-free rate} = (\text{Probability}_{\text{Rise}})(\text{Return}_{\text{Rise}}) + (1 - \text{Probability}_{\text{Rise}})(\text{Return}_{\text{Fall}})$$
$$.07 = (\text{Probability}_{\text{Rise}})(.1458) + (1 - \text{Probability}_{\text{Rise}})(-.2708)$$
$$\text{Probability}_{\text{Rise}} = .8180, \text{ or } 81.80\%$$

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And the risk-neutral probability of a decline in the company value is:

$\text{Probability}_{\text{Fall}} = 1 - \text{Probability}_{\text{Rise}}$
$\text{Probability}_{\text{Fall}} = 1 - .8180$
$\text{Probability}_{\text{Fall}} = .1820$, or 18.20%

Using these risk-neutral probabilities, we can determine the expected payoff to the equityholders' call option at expiration, which will be:

Expected payoff at expiration = (.8180)($21,000,000) + (.1820)($0)
Expected payoff at expiration = $17,178,000

Since this payoff occurs 1 year from now, we must discount it at the risk-free rate in order to find its present value. So:

PV(Expected payoff at expiration) = $17,178,000/1.07
PV(Expected payoff at expiration) = $16,054,205.61

Therefore, the current value of the company's equity is $16,054,205.61. The current value of the company is equal to the value of its equity plus the value of its debt. In order to find the value of company's debt, subtract the value of the company's equity from the total value of the company:

V_L = Debt + Equity
$96,000,000 = Debt + $16,054,205.61
Debt = $79,945,794.39

b. To find the price per share, we can divide the total value of the equity by the number of shares outstanding. So, the price per share is:

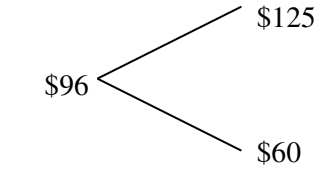
Price per share = Total equity value/Shares outstanding
Price per share = $16,054,205.61/300,000
Price per share = $53.51

c. The market value of the firm's debt is $79,945,794.39. The present value of the same face amount of riskless debt is $83,177,570.09 (= $89,000,000/1.07). The firm's debt is worth less than the present value of riskless debt since there is a risk that it will not be repaid in full. In other words, the market value of the debt takes into account the risk of default. Since there is a chance that the company might not repay its debtholders in full, the debt is worth less than $83,177,570.09.

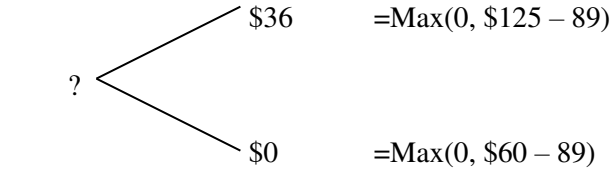
d. The value of the company today is $96 million. It will either increase to $125 million or decrease to $60 million in one year as a result of the new project. If the firm's value increases to $125 million, the equityholders will exercise their call option, and they will receive a payoff of $36 million at expiration. However, if the firm's value decreases to $60 million, the equityholders will not exercise their call option, and they will receive no payoff at expiration.

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Value of company (in millions)



Equityholders' call option price with a strike of $89 (in millions)



If the project is successful and the company's value rises, the increase in the value of the company over the period is 30.21 percent [= ($125/$96) – 1]. If the project is unsuccessful and the company's value falls, the decrease in the value of the company over the period is –37.50 percent [= ($60/$96) – 1]. We can use the following expression to determine the risk-neutral probability of an increase in the value of the company:

Risk-free rate = $(\text{Probability}_{\text{Rise}})(\text{Return}_{\text{Rise}}) + (\text{Probability}_{\text{Fall}})(\text{Return}_{\text{Fall}})$
Risk-free rate = $(\text{Probability}_{\text{Rise}})(\text{Return}_{\text{Rise}}) + (1 - \text{Probability}_{\text{Rise}})(\text{Return}_{\text{Fall}})$
.07 = $(\text{Probability}_{\text{Rise}})(.3021) + (1 – \text{Probability}_{\text{Rise}})(–.3750)$
$\text{Probability}_{\text{Rise}}$ = .6572, or 65.72%

So the risk-neutral probability of a decrease in the company value is:

$\text{Probability}_{\text{Fall}} = 1 – \text{Probability}_{\text{Rise}}$
$\text{Probability}_{\text{Fall}} = 1 – .6572$
$\text{Probability}_{\text{Fall}} = .3428$, or 34.28%

Using these risk-neutral probabilities, we can determine the expected payoff to the equityholders' call option at expiration, which is:

Expected payoff at expiration = .6572($36,000,000) + .3428($0)
Expected payoff at expiration = $23,660,307.69

Since this payoff occurs 1 year from now, we must discount it at the risk-free rate in order to find its present value. So:

PV(Expected payoff at expiration) = ($23,660,307.69/1.07)
PV(Expected payoff at expiration) = $22,112,437.10

Therefore, the current value of the firm's equity is $22,112,437.10.

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The current value of the company is equal to the value of its equity plus the value of its debt. In order to find the value of the company's debt, we can subtract the value of the company's equity from the total value of the company, which yields:

V_L = Debt + Equity
\$96,000,000 = Debt + \$22,112,437.10
Debt = \$73,887,562.90

And the new share price is:

Share price = Total equity/Shares
Share price = \$22,112,437.10/300,000
Share price = \$73.71

The riskier project increases the value of the company's equity and decreases the value of the company's debt. If the company takes on the riskier project, the company is less likely to be able to pay off its bondholders. Since the risk of default increases if the new project is undertaken, the value of the company's debt decreases. Bondholders would prefer the company to undertake the more conservative project.

30. *a.* Going back to the chapter on dividends, the price of the stock will decline by the amount of the dividend (less any tax effects). Therefore, we would expect the price of the stock to drop when a dividend is paid, reducing the upside potential of the call by the amount of the dividend. The price of a call option will decrease when the dividend yield increases.

b. Using the Black-Scholes model with dividends, we get:

$d_1 = [\ln(\$96/\$95) + (.05 - .02 + .50^2/2) \times (4/12)]/(.50 \times \sqrt{4/12}) = .2153$

$d_2 = .2153 - (.50 \times \sqrt{4/12}) = -.0734$

$N(d_1) = .5852$

$N(d_2) = .4707$

$C = \$96e^{-(.02)(4/12)}(.5852) - (\$95^{-.05(4/12)})(.4707)$
$C = \$11.83$

31. *a.* Going back to the chapter on dividends, the price of the stock will decline by the amount of the dividend (less any tax effects). Therefore, we would expect the price of the stock to drop when a dividend is paid. The price of a put option will increase when the dividend yield increases.

b. Using put-call parity to find the price of the put option, we get:

$\$96e^{-.02(4/12)} + P = \$95e^{-.05(4/12)} + 11.83$
$P = \$9.89$

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32. $N(d_1)$ is the probability that "z" is less than or equal to $N(d_1)$, so $1 - N(d_1)$ is the probability that "z" is greater than $N(d_1)$. Because of the symmetry of the normal distribution, this is the same thing as the probability that "z" is less than $N(-d_1)$. So:

$N(d_1) - 1 = N(-d_1)$.

33. From put-call parity:

$$P = E \times e^{-Rt} + C - S$$

Substituting the Black-Scholes call option formula for C and using the result in the previous question produces the put option formula:

$$P = E \times e^{-Rt} + C - S$$
$$P = E \times e^{-Rt} + S \times N(d_1) - E \times e^{-Rt} \times N(d_2) - S$$
$$P = S \times (N(d_1) - 1) + E \times e^{-Rt} \times (1 - N(d_2))$$
$$P = E \times e^{-Rt} \times N(-d_2) - S \times N(-d_1)$$

34. Based on Black-Scholes, the call option is worth \$50! The reason is that present value of the exercise price is zero, so the second term disappears. Also, d_1 is infinite, so $N(d_1)$ is equal to one. The problem is that the call option is European with an infinite expiration, so why would you pay anything for it since you can *never* exercise it? The paradox can be resolved by examining the price of the stock. Remember that the call option formula only applies to a non-dividend paying stock. If the stock will never pay a dividend, it (and a call option to buy it at any price) must be worthless.

35. The delta of the call option is $N(d_1)$ and the delta of the put option is $N(d_1) - 1$. Since you are selling a put option, the delta of the portfolio is $N(d_1) - [N(d_1) - 1]$. This leaves the overall delta of your position as 1. This position will change dollar for dollar in value with the underlying asset. This position replicates the dollar "action" on the underlying asset.

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CHAPTER 18
SHORT-TERM FINANCE AND PLANNING

Answers to Concept Questions

1. These are firms with relatively long inventory periods and/or relatively long receivables periods. Thus, such firms tend to keep inventory on hand, and they allow customers to purchase on credit and take a relatively long time to pay.

2. These are firms that have a relatively long time between the time that purchased inventory is paid for and the time that inventory is sold and payment received. Thus, these are firms that have relatively short payables periods and/or relatively long receivable cycles.

3. *a.* Use: The cash balance declined by $200 to pay the dividend.

b. Source: The cash balance increased by $500, assuming the goods bought on payables credit were sold for cash.

c. Use: The cash balance declined by $900 to pay for the fixed assets.

d. Use: The cash balance declined by $625 to pay for the higher level of inventory.

e. Use: The cash balance declined by $1,200 to pay for the redemption of debt.

4. Carrying costs will decrease because they are not holding goods in inventory. Shortage costs will probably increase depending on how close the suppliers are and how well they can estimate need. The operating cycle will decrease because the inventory period is decreased.

5. Since the cash cycle equals the operating cycle minus the accounts payable period, it is not possible for the cash cycle to be longer than the operating cycle if the accounts payable period is positive. Moreover, it is unlikely that the accounts payable period would ever be negative since that implies the firm pays its bills before they are incurred

6. Shortage costs are those costs incurred by a firm when its investment in current assets is low. There are two basic types of shortage costs. 1) Trading or order costs. Order costs are the costs of placing an order for more cash or more inventory. 2) Costs related to safety reserves. These costs include lost sales, lost customer goodwill and disruption of production schedules.

7. A long-term growth trend in sales will require some permanent investment in current assets. Thus, in the real world, net working capital is not zero. Also, the variation across time for assets means that net working capital is unlikely to be zero at any point in time. This is a liquidity reason.

8. It lengthened its payables period, thereby shortening its cash cycle. It would not affect the operating cycle.

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9. Their receivables period increased, thereby increasing their operating and cash cycles.

10. It is sometimes argued that large firms "take advantage of" smaller firms by threatening to take their business elsewhere. However, considering a move to another supplier to get better terms is the nature of competitive free enterprise.

11. They would like to! The payables period is a subject of much negotiation, and it is one aspect of the price a firm pays its suppliers. A firm will generally negotiate the best possible combination of payables period and price. Typically, suppliers provide strong financial incentives for rapid payment.

12. BlueSky will need less financing because it is essentially borrowing more from its suppliers. Among other things, BlueSky will likely need less short-term borrowing from other sources, so it will save on interest expense.

Solutions to Questions and Problems

NOTE: All end-of-chapter problems were solved using a spreadsheet. Many problems require multiple steps. Due to space and readability constraints, when these intermediate steps are included in this solutions manual, rounding may appear to have occurred. However, the final answer for each problem is found without rounding during any step in the problem.

Basic

1. *a.* No change. A dividend paid for by the sale of debt will not change cash since the cash raised from the debt offer goes immediately to shareholders.

b. No change. The real estate is paid for by the cash raised from the debt, so this will not change the cash balance.

c. No change. Inventory and accounts payable will increase, but neither will impact the cash account.

d. Decrease. The short-term bank loan is repaid with cash, which will reduce the cash balance.

e. Decrease. The payment of taxes is a cash transaction.

f. Decrease. The preferred stock will be repurchased with cash.

g. No change. Accounts receivable will increase, but cash will not increase until the sales are paid off.

h. Decrease. The interest is paid with cash, which will reduce the cash balance.

i. Increase. When payments for previous sales, or accounts receivable, are paid off, the cash balance increases since the payment must be made in cash.

j. Decrease. The accounts payable are reduced through cash payments to suppliers.

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k. Decrease. Here the dividend payments are made with cash, which is generally the case. This is different from part (a), where debt was raised to make the dividend payment.

l. No change. The short-term note will not change the cash balance.

m. Decrease. The utility bills must be paid in cash.

n. Decrease. A cash payment will reduce cash.

o. Increase. If marketable securities are sold, the company will receive cash from the sale.

2. The total liabilities and equity of the company are the book value of equity, plus current liabilities and long-term debt, so:

Total liabilities and equity = $12,490 + 2,160 + 7,230
Total liabilities and equity = $21,880

We have NWC other than cash. Since NWC is current assets minus current liabilities, NWC other than cash is:

NWC other than cash = Accounts receivable + Inventory – Current liabilities
$3,155 = Accounts receivable + Inventory – $2,160
Accounts receivable + Inventory = $3,155 + 2,160
Accounts receivable + Inventory = $5,315

Since total assets must equal total liabilities and equity, we can solve for cash as:

Cash = Total assets – Fixed assets – (Accounts receivable + Inventory)
Cash = $21,880 – 15,120 – 5,315
Cash = $1,445

So, the current assets are:

Current assets = $1,445 + 5,315
Current assets = $6,760

3. *a.* Increase. If receivables go up, the time to collect the receivables would increase, which increases the operating cycle.

b. Increase. If credit repayment times are increased, customers will take longer to pay their bills, which will lead to an increase in the operating cycle.

c. Decrease. If the inventory turnover increases, the inventory period decreases.

d. No change. The accounts payable period is part of the cash cycle, not the operating cycle.

e. Decrease. If the receivables turnover increases, the receivables period decreases.

f. No change. Payments to suppliers affect the accounts payable period, which is part of the cash cycle, not the operating cycle.

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4. *a.* Increase; Increase. If the terms of the cash discount are made less favorable to customers, the accounts receivable period will lengthen. This will increase both the cash cycle and the operating cycle.

b. Increase; No change. This will shorten the accounts payable period, which will increase the cash cycle. It will have no effect on the operating cycle since the accounts payable period is not part of the operating cycle.

c. Decrease; Decrease. If more customers pay in cash, the accounts receivable period will decrease. This will decrease both the cash cycle and the operating cycle.

d. Decrease; Decrease. Assume the accounts payable period and inventory period do not change. Fewer raw materials purchased will reduce the inventory period, which will decrease both the cash cycle and the operating cycle.

e. Decrease; No change. If more raw materials are purchased on credit, the accounts payable period will tend to increase, which would decrease the cash cycle. We should say that this may not be the case. The accounts payable period is a decision made by the company's management. The company could increase the accounts payable account and still make the payments in the same number of days. This would leave the accounts payable period unchanged, which would leave the cash cycle unchanged. The change in credit purchases made on credit will not affect the inventory period or the accounts payable period, so the operating cycle will not change.

f. Increase; Increase. If more goods are produced for inventory, the inventory period will increase. This will increase both the cash cycle and operating cycle.

5. *a.* A 45-day collection period implies all receivables outstanding from the previous quarter are collected in the current quarter, and:

(90 – 45)/90 = 1/2 of current sales are collected. So:

	Q1	*Q2*	*Q3*	*Q4*
Beginning receivables	$325.00	$370.00	$415.00	$440.00
Sales	740.00	830.00	880.00	960.00
Cash collections	–695.00	–785.00	–855.00	–920.00
Ending receivables	$370.00	$415.00	$440.00	$480.00

b. A 60-day collection period implies all receivables outstanding from the previous quarter are collected in the current quarter, and:

(90 – 60)/90 = 1/3 of current sales are collected. So:

	Q1	*Q2*	*Q3*	*Q4*
Beginning receivables	$325.00	$493.33	$553.33	$586.67
Sales	740.00	830.00	880.00	960.00
Cash collections	–571.67	–770.00	–846.67	–906.67
Ending receivables	$493.33	$553.33	$586.67	$640.00

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c. A 30-day collection period implies all receivables outstanding from the previous quarter are collected in the current quarter, and:

(90 – 30)/90 = 2/3 of current sales are collected. So:

	Q1	*Q2*	*Q3*	*Q4*
Beginning receivables	$325.00	$246.67	$276.67	$293.33
Sales	740.00	830.00	880.00	960.00
Cash collections	–818.33	–800.00	–863.33	–933.33
Ending receivables	$246.67	$276.67	$293.33	$320.00

6. The operating cycle is the inventory period plus the receivables period. The inventory turnover and inventory period are:

Inventory turnover = COGS/Average inventory
Inventory turnover = $234,912/[($17,453 + 19,281)/2]
Inventory turnover = 12.7899 times

Inventory period = 365 days/Inventory turnover
Inventory period = 365 days/12.7899
Inventory period = 28.54 days

And the receivables turnover and receivables period are:

Receivables turnover = Credit sales/Average receivables
Receivables turnover = $418,276/[($14,087 + 15,314)/2]
Receivables turnover = 28.4532 times

Receivables period = 365 days/Receivables turnover
Receivables period = 365 days/28.4532
Receivables period = 12.83 days

So, the operating cycle is:

Operating cycle = 28.54 days + 12.83 days
Operating cycle = 41.37 days

The cash cycle is the operating cycle minus the payables period. The payables turnover and payables period are:

Payables turnover = COGS/Average payables
Payables turnover = $234,912/[($15,387 + 16,822)/2]
Payables turnover = 14.5867 times

Payables period = 365 days/Payables turnover
Payables period = 365 days/14.5867
Payables period = 25.02 days

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So, the cash cycle is:

Cash cycle = 41.37 days – 25.02 days
Cash cycle = 16.34 days

The firm is receiving cash on average 16.34 days after it pays its bills.

7. If we factor immediately, we receive cash on an average of 34 days sooner. The number of periods in a year are:

Number of periods = 365/34
Number of periods = 10.7353

The EAR of this arrangement is:

EAR = (1 + Periodic rate)^m – 1
EAR = (1 + 1.2/98.8)$^{10.7353}$ – 1
EAR = .1384, or 13.84%

8. *a.* The payables period is zero since the company pays immediately. Sales in the year following this one are projected to be 15 percent greater in each quarter. Therefore, Q1 sales for the next year will be $1,260(1.15) = $1,449. The payment in each period is 30 percent of next period's sales, so:

	Q1	*Q2*	*Q3*	*Q4*
Payment of accounts	$411.00	$372.00	$453.00	$434.70

b. Since the payables period is 90 days, the payment in each period is 30 percent of the current period sales, so:

	Q1	*Q2*	*Q3*	*Q4*
Payment of accounts	$378.00	$411.00	$372.00	$453.00

c. Since the payables period is 60 days, the payment in each period is 2/3 of last quarter's orders, plus 1/3 of this quarter's orders, or:

Quarterly payments = 2/3(.30) times current sales + 1/3(.30) next period sales.

	Q1	*Q2*	*Q3*	*Q4*
Payment of accounts	$389.00	$398.00	$399.00	$446.90

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9. Since the payables period is 60 days, the payables in each period will be:

Payables each period = 2/3 of last quarter's orders + 1/3 of this quarter's orders
Payables each period = 2/3(.75) times current sales + 1/3(.75) next period sales

	Q1	*Q2*	*Q3*	*Q4*
Payment of accounts	$1,412.50	$1,507.50	$1,635.00	$1,682.50
Wages, taxes, other expenses	368.00	394.00	418.00	472.00
Long-term financing expenses	170.00	170.00	170.00	170.00
Total	$1,950.50	$2,071.50	$2,223.00	$2,324.50

10. *a.* The November sales must have been the total uncollected sales minus the uncollected sales from December, divided by the collection rate two months after the sale, so:

November sales = ($208,000 – 143,000)/.15
November sales = $433,333.33

b. The December sales are the uncollected sales from December divided by the collection rate of the previous months' sales, so:

December sales = $143,000/.35
December sales = $408,571.43

c. The collections each month for this company are:

Collections = .15(Sales from 2 months ago) + .20(Last month's sales) + .65(Current sales)

January collections = .15($433,333.33) + .20($408,571.43) + .65($337,000)
January collections = $365,764.29

February collections = .15($408,571.43) + .20($337,000) + .65($398,000)
February collections = $387,385.71

March collections = .15($337,000) + .20($398,000) + .65($431,000)
March collections = $410,300.00

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11. The sales collections each month will be:

Sales collections = .35(current month sales) + .60(previous month sales)

Given this collection, the cash budget will be:

	April	May	June
Beginning cash balance	$265,000	$236,650	$199,900
Cash receipts			
Cash collections from credit sales	424,450	470,950	530,875
Total cash available	$689,450	$707,600	$730,775
Cash disbursements			
Purchases	$234,200	$230,600	$315,200
Wages, taxes, and expenses	68,300	84,600	101,200
Interest	18,900	18,900	18,900
Equipment purchases	131,400	173,600	0
Total cash disbursements	452,800	507,700	435,300
Ending cash balance	$236,650	$199,900	$295,475

12.

Item	Source/Use	Amount
Cash	Use	–$8,814
Accounts receivable	Source	$1,663
Inventories	Use	–$17,192
Property, plant, and equipment	Use	–$65,390
Accounts payable	Source	$2,854
Accrued expenses	Source	$1,938
Long-term debt	Use	–$3,436
Common stock	Source	$7,470
Accumulated retained earnings	Source	$50,372

13. *a.* There are 30 days until the account is overdue. If you take the full period, you must remit:

Remittance = 425($108)
Remittance = $45,900

b. There is a 1 percent discount offered, with a 10-day discount period. If you take the discount, you will only have to remit:

Remittance = (1 – .01)($45,900)
Remittance = $45,441

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c. The implicit interest is the difference between the two remittance amounts, or:

Implicit interest = $45,900 – 45,441
Implicit interest = $459

The number of days' credit offered is:

Days' credit = 30 – 10
Days' credit = 20 days

14. The interest rate for the term of the discount is:

Interest rate = .01/.99
Interest rate = .0101, or 1.01%

And the interest is for:

30 – 10 = 20 days

So, using the EAR equation, the effective annual interest rate is:

EAR = (1 + Periodic rate)^{m} – 1
EAR = $(1.0101)^{365/20}$ – 1
EAR = .2013, or 20.13%

a. The periodic interest rate is:

Interest rate = .03/.97
Interest rate = .0309, or 3.09%

And the EAR is:

EAR = $(1.0309)^{365/20}$ – 1
EAR = .7435, or 74.35%

b. The EAR is:

EAR = $(1.0101)^{365/35}$ – 1
EAR = .1105, or 11.05%

c. The EAR is:

EAR = $(1.0101)^{365/15}$ – 1
EAR = .2771, or 27.71%

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15. The total sales of the firm are equal to the total credit sales since all sales are on credit, so:

Total credit sales = 4,100($435)
Total credit sales = $1,783,500

The average collection period is the percentage of accounts taking the discount times the discount period, plus the percentage of accounts not taking the discount times the days' until full payment is required, so:

Average collection period = .65(10) + .35(40)
Average collection period = 20.50 days

The receivables turnover is 365 divided by the average collection period, so:

Receivables turnover = 365/20.50
Receivables turnover = 17.805 times

And the average receivables are the credit sales divided by the receivables turnover, so:

Average receivables = $1,783,500/17.805
Average receivables = $100,169.18

If the firm increases the cash discount, more people will pay sooner, thus lowering the average collection period. If the ACP declines, the receivables turnover increases, which will lead to a decrease in the average receivables.

16. The receivables turnover is:

Receivables turnover = 365/Average collection period
Receivables turnover = 365/34
Receivables turnover = 10.7353 times

And the annual credit sales are:

Annual credit sales = Receivables turnover × Average daily receivables
Annual credit sales = 10.7353($109,000)
Annual credit sales = $1,170,147.06

Intermediate

17. *a.* If you borrow $65,000,000 for one month, you will pay interest of:

Interest = $65,000,000(.0053)
Interest = $344,500

However, with the compensating balance, you will only get the use of:

Amount received = $65,000,000 – 65,000,000(.04)
Amount received = $62,400,000

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This means the periodic interest rate is:

Periodic interest = $344,500/$62,400,000
Periodic interest = .005521, or .5521%

So, the EAR is:

EAR = [1 + ($344,500/$62,400,000)]^{12} – 1
EAR = .0683, or 6.83%

b. To end up with $30,000,000, you must borrow:

Amount to borrow = $30,000,000/(1 – .04)
Amount to borrow = $31,250,000

The total interest you will pay on the loan is:

Total interest paid = $31,250,000(1.0053)^{6} – 31,250,000
Total interest paid = $1,007,010.61

18. *a.* The EAR of your investment account is:

EAR = 1.0081^{4} – 1
EAR = .0328, or 3.28%

b. To calculate the EAR of the loan, we can divide the interest on the loan by the amount of the loan. The interest on the loan includes the opportunity cost of the compensating balance. The opportunity cost is the amount of the compensating balance times the potential interest rate you could have earned. The compensating balance is only on the unused portion of the credit line, so:

Opportunity cost = .05($50,000,000 – 35,000,000)(1.0081)^{4}
– .05($50,000,000 – 35,000,000)
Opportunity cost = $24,596.84

And the interest you will pay to the bank on the loan is:

Interest cost = $35,000,000(1.0171)^{4} – 35,000,000
Interest cost = $2,456,109.12

So, the EAR of the loan in the amount of $35 million is:

EAR = ($2,456,109.12 + 24,596.84)/$35,000,000
EAR = .0709, or 7.09%

c. The compensating balance is only applied to the unused portion of the credit line, so the EAR of a loan on the full credit line is:

EAR = 1.0171^{4} – 1
EAR = .0702, or 7.02%

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19. *a.* A 45-day collection period means sales collections each quarter are:

Collections = 1/2 current sales + 1/2 old sales

A 36-day payables period means payables each quarter are:

Payables = 3/5 current orders + 2/5 old orders

So, the cash inflows each quarter are:

Q1 = \$69 + 1/2(\$176) – 2/5(.45)(\$176) – 3/5(.45)(\$159) – .30(\$176) – \$16
Q1 = \$13.59

Q2 = 1/2(\$176) + 1/2(\$159) – 2/5(.45)(\$159) – 3/5(.45)(\$209) – .30(\$159) – \$16 – 55
Q2 = –\$36.25

Q3 = 1/2(\$159) + 1/2(\$209) – 2/5(.45)(\$209) – 3/5(.45)(\$242) – .30(\$209) – \$16
Q3 = \$2.34

Q4 = 1/2(\$209) + 1/2(\$242) – 2/5(.45)(\$242) – 3/5(.45)(\$193) – .30(\$242) – \$16
Q4 = \$41.23

The company's cash budget will be:

WILDCAT, INC.
Cash Budget
(in millions)

	Q1	*Q2*	*Q3*	*Q4*
Beginning cash balance	\$40.00	\$53.59	\$17.34	\$19.68
Net cash inflow	13.59	–36.25	2.34	41.23
Ending cash balance	\$53.59	\$17.34	\$19.68	\$60.91
Minimum cash balance	–20.00	–20.00	–20.00	–20.00
Cumulative surplus (deficit)	\$33.59	–\$2.66	–\$.32	\$40.91

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With a $20,000,000 minimum cash balance, the short-term financial plan will be:

WILDCAT, INC.
Short-Term Financial Plan
(in millions)

b.

	Q1	*Q2*	*Q3*	*Q4*
Minimum cash balance	$20.00	$20.00	$20.00	$20.00
Net cash inflow	13.59	–36.25	2.34	41.23
New short-term investments	–13.99	0	–.71	–41.24
Income on short-term investments	.40	.68	0	.01
Short-term investments sold	0	33.99	0	0
New short-term borrowing	0	1.58	0	0
Interest on short-term borrowing	0	0	–.05	0
Short-term borrowing repaid	0	0	–1.58	0
Ending cash balance	$20.00	$20.00	$20.00	$20.00
Minimum cash balance	–20.00	–20.00	–20.00	–20.00
Cumulative surplus (deficit)	$0	$0	$0	$0
Beginning short-term investments	$20.00	$33.99	$0	$.71
Ending short-term investments	33.99	0	.71	41.96
Beginning short-term debt	0	0	1.58	0
Ending short-term debt	0	1.58	0	0

Below you will find the interest paid (or received) for each quarter:

Q1: excess funds of $20 invested for 1 quarter earns .02($20) = $.40 income

Q2: excess funds of $33.99 invested for 1 quarter earns .02($33.99) = $.68 in income

Q3: shortage of funds of $1.58 invested for 1 quarter costs .03($1.58) = $.05 in interest

Q4: excess funds of $.71 invested for 1 quarter earns .02($.71) = $.01 in income

Net cash cost = $.40 + .68 – .05 + .01 = $1.05

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20. *a.* With a minimum cash balance of $30,000,000, the short-term financial plan will be:

WILDCAT, INC.
Short-Term Financial Plan
(in millions)

	Q1	*Q2*	*Q3*	*Q4*
Minimum cash balance	$30.00	$30.00	$30.00	$30.00
Net cash inflow	13.59	–36.25	2.34	41.23
New short-term investments	–13.79	0	0	–30.93
Income on short-term investments	.20	.48	0	0
Short-term investments sold	0	23.79	0	0
New short-term borrowing	0	11.98	0	0
Interest on short-term borrowing	0	0	–.36	–.30
Short-term borrowing repaid	0	0	–1.98	–10.00
Ending cash balance	$30.00	$30.00	$30.00	$30.00
Minimum cash balance	–30.00	–30.00	–30.00	–30.00
Cumulative surplus (deficit)	$0	$0	$0	$0
Beginning short-term investments	$10.00	$23.79	$0	$0
Ending short-term investments	23.79	0	0	30.93
Beginning short-term debt	0	0	11.98	10.00
Ending short-term debt	0	11.98	10.00	0

Below you will find the interest paid (or received) for each quarter:

Q1: excess funds of $10 invested for 1 quarter earns .02($10) = $.20 income

Q2: excess funds of $23.79 invested for 1 quarter earns .02($23.79) = $.48 in income

Q3: shortage of funds of $11.98 borrowed for 1 quarter costs .03($11.98) = $.36 in interest

Q4: shortage of funds of $10 borrowed for 1 quarter costs .03($10) = $.30 in interest

Net cash cost = $.20 + .48 – .36 – .30 = $.02

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b. And with a minimum cash balance of $10,000,000, the short-term financial plan will be:

WILDCAT, INC.
Short-Term Financial Plan
(in millions)

	Q1	*Q2*	*Q3*	*Q4*
Minimum cash balance	$10.00	$10.00	$10.00	$10.00
Net cash inflow	13.59	–36.25	2.34	41.23
New short-term investments	–14.19	0	–2.52	–41.46
Income on short-term investments	.60	.88	.18	.23
Short-term investments sold	0	35.37	0	0
New short-term borrowing	0	0	0	0
Interest on short-term borrowing	0	0	0	0
Short-term borrowing repaid	0	0	0	0
Ending cash balance	$10.00	$10.00	$10.00	$10.00
Minimum cash balance	–10.00	–10.00	–10.00	–10.00
Cumulative surplus (deficit)	$0	$0	$0	$0
Beginning short-term investments	$30.00	$44.19	$8.82	$11.34
Ending short-term investments	44.19	8.82	11.34	52.80
Beginning short-term debt	0	0	0	0
Ending short-term debt	0	0	0	0

Below you will find the interest paid (or received) for each quarter:

Q1: excess funds of $30 invested for 1 quarter earns .02($30) = $.60 income

Q2: excess funds of $44.19 invested for 1 quarter earns .02($44.19) = $.88 in income

Q3: excess funds of $8.82 invested for 1 quarter earns .02($8.82) = $.18 in income

Q4: excess funds of $11.34 invested for 1 quarter earns .02($11.34) = $.23 in income

Net cash cost = $.60 + .88 + .18 + .23 = $1.89

Since cash has an opportunity cost, the firm can boost its profit if it keeps its minimum cash balance low and invests the cash instead. However, the tradeoff is that in the event of unforeseen circumstances, the firm may not be able to meet its short-run obligations if enough cash is not available.

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Challenge

21. *a.* For every dollar borrowed, you pay interest of:

Interest = $1(.0195) = $.0195

You also must maintain a compensating balance of 5 percent of the funds borrowed, so for each dollar borrowed, you will only receive:

Amount received = $1(1 – .05) = $.95

We can adjust the EAR equation we have been using to account for the compensating balance by dividing the EAR by one minus the compensating balance, so:

EAR = [$(1.0195^4 – 1]/(1 – .05)$
EAR = .08454, or 8.454%

Another way to calculate the EAR is using the FVIF (or PVIF). For each dollar borrowed, we must repay:

Amount owed = $1(1.0195)^4$
Amount owed = $1.08031

At the end of the year the compensating will be returned, so your net cash flow at the end of the year will be:

End of year cash flow = $1.08031 – .05
End of year cash flow = $1.03031

The present value of the end of year cash flow is the amount you receive at the beginning of the year, so the EAR is:

$FV = PV(1 + R)$
$1.03031 = $.95(1 + R)$
$R = $1.03031/$.95 – 1$
EAR = .08454, or 8.454%

b. The EAR is the amount of interest paid on the loan divided by the amount received when the loan is originated. The amount of interest you will pay on the loan is the amount of the loan times the effective annual interest rate, so:

Interest = $125,000,000[$(1.0195)^4$ – 1]
Interest = $10,038,913.01

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For whatever loan amount you take, you will only receive 95 percent of that amount since you must maintain a compensating balance of 5 percent on the portion of the credit line used. The credit line also has a fee of .195 percent, so you will only get to use:

Amount received = .95($125,000,000) – .00195($300,000,000)
Amount received = $118,165,000

So, the EAR of the loan is:

EAR = $10,038,913.01/$118,165,000
EAR = .08496, or 8.496%

22. You will pay interest of:

Interest = $20,000,000(.091) = $1,820,000

Additionally, the compensating balance on the loan is:

Compensating balance = $20,000,000(.045) = $900,000

Since this is a discount loan, you will receive the loan amount minus the interest payment. You will also not get to use the compensating balance. So, the amount of money you will actually receive on a $20 million loan is:

Cash received = $20,000,000 – 1,820,000 – 900,000 = $17,280,000

The EAR is the interest amount divided by the loan amount, so:

EAR = $1,820,000/$17,280,000
EAR = .1053, or 10.53%

We can also use the FVIF (or PVIF) here to calculate the EAR. Your cash flow at the beginning of the year is $17,280,000. At the end of the year, your cash flow is the loan repayment, but you will also receive your compensating balance back, so:

End of year cash flow = $20,000,000 – 900,000
End of year cash flow = $19,100,000

So, using the time value of money, the EAR is:

$19,100,000 = $17,280,000(1 + *R*)
R = $19,100,000/$17,280,000 – 1
EAR = .1053, or 10.53%

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CHAPTER 19
RAISING CAPITAL

Answers to Concepts Review and Critical Thinking Questions

1. A company's internally generated cash flow provides a source of equity financing. For a profitable company, outside equity may never be needed. Debt issues are larger because large companies have the greatest access to public debt markets (small companies tend to borrow more from private lenders). Equity issuers are frequently small companies going public; such issues are often quite small. Additionally, to maintain a debt-equity ratio, a company must issue new bonds when the current bonds mature.

2. From the previous question, economies of scale are part of the answer. Beyond this, debt issues are easier and less risky to sell from an investment bank's perspective. The two main reasons are that very large amounts of debt securities can be sold to a relatively small number of buyers, particularly large institutional buyers such as pension funds and insurance companies, and debt securities are much easier to price.

3. They are riskier and harder to market from an investment bank's perspective.

4. Yields on comparable bonds can usually be readily observed, so pricing a bond issue accurately is much less difficult.

5. It is clear that the stock was sold too cheaply, so Eventbrite had reason to be unhappy.

6. No, but in fairness, pricing the stock in such a situation is extremely difficult.

7. It's an important factor. Only a small percentage of the shares were underpriced. The rest were, in effect, priced completely correctly.

8. The evidence suggests that a non-underwritten rights offering might be substantially cheaper than a cash offer. However, such offerings are rare, and there may be hidden costs or other factors not yet identified or well understood by researchers.

9. He could have done worse since his access to the oversubscribed and, presumably, underpriced issues was restricted while the bulk of his funds were allocated to stocks from the undersubscribed and, quite possibly, overpriced issues.

10. *a.* The price will probably go up because IPOs are generally underpriced. This is especially true for smaller issues such as this one.

b. It is probably safe to assume that they are having trouble moving the issue, and it is likely that the issue is not substantially underpriced.

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Solutions to Questions and Problems

NOTE: All end of chapter problems were solved using a spreadsheet. Many problems require multiple steps. Due to space and readability constraints, when these intermediate steps are included in this solutions manual, rounding may appear to have occurred. However, the final answer for each problem is found without rounding during any step in the problem.

Basic

1. *a.* The new market value will be the current shares outstanding times the stock price plus the rights offered times the rights price, so:

New market value = 425,000($65) + 90,000($57)
New market value = $32,755,000

b. The number of rights associated with the old shares is the number of shares outstanding divided by the rights offered, so:

Number of rights needed = 425,000 old shares/90,000 new shares
Number of rights needed = 4.72 rights per new share

c. The new price of the stock will be the new market value of the company divided by the total number of shares outstanding after the rights offer, which will be:

P_X = $32,755,000/(425,000 + 90,000)
P_X = $63.60

d. The value of the right is:

Value of a right = $65 – 63.60
Value of a right = $1.40

e. A rights offering usually costs less; it protects the proportionate interests of existing shareholders and also protects against underpricing.

2. *a.* The maximum subscription price is the current stock price, or $37. The minimum price is anything greater than $0.

b. The number of new shares will be the amount raised divided by the subscription price, so:

Number of new shares = $50,000,000/$32
Number of new shares = 1,562,500 shares

And the number of rights needed to buy one share will be the current shares outstanding divided by the number of new shares offered, so:

Number of rights needed = 2,700,000 shares outstanding/1,562,500 new shares
Number of rights needed = 1.73

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c. A shareholder can buy 1.73 rights-on shares for:

1.73($37) = $63.94

The shareholder can exercise these rights for $32, at a total cost of:

$63.94 + 32 = $95.94

The investor will then have:

Ex-rights shares = 1 + 1.73
Ex-rights shares = 2.73

The ex-rights price per share is:

P_X = [1.73($37) + $32]/2.73
P_X = $35.17

So, the value of a right is:

Value of a right = $37 – 35.17
Value of a right = $1.83

d. Before the offer, a shareholder will have the shares owned at the current market price, or:

Portfolio value = (1,000 shares)($37)
Portfolio value = $37,000

After the rights offer, the share price will fall, but the shareholder will also hold the rights, so:

Portfolio value = (1,000 shares)($35.17) + (1,000 rights)($1.83)
Portfolio value = $37,000

3. Using the equation we derived in part (c) of Problem 2 to calculate the price of the stock ex-rights, we can find the number of shares a shareholder will have ex-rights, which is:

P_X = $64.60 = [$N$($67) + $40]/($N$ + 1)
N = 10.25

The number of new shares is the amount raised divided by the per-share subscription price, so:

Number of new shares = $12,000,000/$40
Number of new shares = 300,000

And the number of old shares is the number of new shares times the number of shares ex-rights, so:

Number of old shares = 10.25(300,000)
Number of old shares = 3,075,000

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4. If you receive 1,000 shares of each, the profit is:

Profit = 1,000($7) – 1,000($4)
Profit = $3,000

Since you will only receive one-half of the shares of the oversubscribed issue, your profit will be:

Expected profit = 500($7) – 1,000($4)
Expected profit = –$500

This is an example of the winner's curse.

5. Using *X* to stand for the required sale proceeds, the equation to calculate the total sale proceeds, including flotation costs is:

X(1 – .07) = $60,000,000
X = $64,516,129 required total proceeds from sale.

So the number of shares offered is the total amount raised divided by the offer price, which is:

Number of shares offered = $64,516,129/$29
Number of shares offered = 2,224,694

6. This is basically the same as the previous problem, except we need to include the $1,300,000 of expenses in the amount the company needs to raise, so:

X(1 – .07) = $61,300,000
X = $65,913,978 required total proceeds from sale

Number of shares offered = $65,913,978/$29
Number of shares offered = 2,272,896

7. We need to calculate the net amount raised and the costs associated with the offer. The net amount raised is the number of shares offered times the price received by the company, minus the costs associated with the offer, so:

Net amount raised = (12,000,000 shares)($20.46) – 1,650,000 – 375,000
Net amount raised = $243,495,000

The company received $243,495,000 from the stock offering. Now we can calculate the direct costs. Part of the direct costs are given in the problem, but the company also had to pay the underwriters. The stock was offered at $22 per share, and the company received $20.46 per share. The difference, which is the underwriters spread, is also a direct cost. The total direct costs were:

Total direct costs = $1,650,000 + ($22 – 20.46)(12,000,000 shares)
Total direct costs = $20,130,000

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We are given part of the indirect costs in the problem. Another indirect cost is the immediate price appreciation. The total indirect costs were:

Total indirect costs = $375,000 + ($27.85 – 22)(12,000,000 shares)
Total indirect costs = $70,575,000

This makes the total costs:

Total costs = $20,130,000 + 70,575,000
Total costs = $90,705,000

The flotation cost as a percentage of the amount raised is the total cost divided by the amount raised, so:

Flotation cost percentage = $90,705,000/$243,495,000
Flotation cost percentage = .3725, or 37.25%

8. The number of rights needed per new share is:

Number of rights needed = 125,000 old shares/33,750 new shares
Number of rights needed = 3.70 rights per new share

Using P_{RO} as the rights-on price, and P_S as the subscription price, we can express the price per share of the stock ex-rights as:

$P_X = [NP_{RO} + P_S]/(N + 1)$

a. $P_X = [3.70(\$58) + \$58]/4.70 = \$58.00$; No change.

b. $P_X = [3.70(\$58) + \$55]/4.70 = \$57.36$; Price drops by $.64 per share.

c. $P_X = [3.70(\$58) + \$51]/4.70 = \$56.51$; Price drops by $1.49 per share.

Intermediate

9. *a.* The number of shares outstanding after the stock offer will be the current shares outstanding, plus the amount raised divided by the current stock price, assuming the stock price doesn't change. So:

Number of shares after offering = 6,800,000 + $30,000,000/$65
Number of shares after offering = 7,261,538

Since the book value per share is $20, the old book value of the shares is the current number of shares outstanding times $20. We can see the company will sell 461,538 shares, and these will have a book value of $65 per share. The sum of these two values will give us the total book value of the company. We divide this by the new number of shares outstanding. Doing so, we find the new book value per share will be:

New book value per share = [6,800,000($20) + 461,538($65)]/7,261,538
New book value per share = $22.86

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The current EPS for the company is:

$EPS_0 = NI_0/Shares_0$
$EPS_0 = \$11,500,000/6,800,000 \text{ shares}$
$EPS_0 = \$1.69 \text{ per share}$

And the current PE is:

$PE_0 = \$65/\$1.69$
$PE_0 = 38.43$

If the net income increases by $675,000, the new EPS will be:

$EPS_1 = NI_1/shares_1$
$EPS_1 = \$12,175,000/7,261,538 \text{ shares}$
$EPS_1 = \$1.68 \text{ per share}$

Assuming the PE remains constant, the new share price will be:

$P_1 = PE_0(EPS_1)$
$P_1 = 38.43(\$1.68)$
$P_1 = \$64.44$

The current market-to-book ratio is:

Current market-to-book = $65/$20
Current market-to-book = 3.25

Using the new share price and book value per share, the new market-to-book ratio will be:

New market-to-book = $64.44/$22.86
New market-to-book = 2.8189

Accounting dilution has occurred because new shares were issued when the market-to-book ratio was less than one; market value dilution has occurred because the firm financed a negative NPV project. The cost of the project is given at $30 million. The NPV of the project is the new market value of the firm minus the current market value of the firm, or:

NPV = –$30,000,000 + [7,261,538($64.44) – 6,800,0000($65)]
NPV = –$4,056,522

b. For the price to remain unchanged when the PE ratio is constant, EPS must remain constant. The new net income must be the new number of shares outstanding times the current EPS, which gives:

$NI_1 = (7,261,538 \text{ shares})(\$1.69 \text{ per share})$
$NI_1 = \$12,280,543$

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10. The current ROE of the company is:

$ROE_0 = NI_0/TE_0$
$ROE_0 = \$980,000/(\$9,400,000 – 4,100,000)$
$ROE_0 = .1849$, or 18.49%

The new net income will be the ROE times the new total equity, or:

$NI_1 = (ROE_0)(TE_1)$
$NI_1 = .1849(\$5,300,000 + 1,500,000)$
$NI_1 = \$1,257,358$

The company's current earnings per share are:

$EPS_0 = NI_0/\text{Shares outstanding}_0$
$EPS_0 = \$980,000/65,000$ shares
$EPS_0 = \$15.08$

The number of shares the company will offer is the cost of the investment divided by the current share price, so:

Number of new shares = $\$1,500,000/\$75$
Number of new shares = 20,000

The earnings per share after the stock offer will be:

$EPS_1 = \$1,257,358/(65,000 \text{ shares} + 20,000 \text{ shares})$
$EPS_1 = \$14.79$

The current PE ratio is:

$PE_0 = \$75/\$15.08$
$PE_0 = 4.974$

Assuming the PE remains constant, the new stock price will be:

$P_1 = 4.974(\$14.79)$
$P_1 = \$73.58$

The current book value per share and the new book value per share are:

$BVPS_0 = TE_0/\text{Shares}_0$
$BVPS_0 = \$5,300,000/65,000$ shares
$BVPS_0 = \$81.54$ per share

$BVPS_1 = TE_1/\text{Shares}_1$
$BVPS_1 = (\$5,300,000 + 1,500,000)/85,000$ shares
$BVPS_1 = \$80.00$ per share

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So the current and new market-to-book ratios are:

Market-to-book$_0$ = \$75/\$81.54
Market-to-book$_0$ = .9198

Market-to-book$_1$ = \$73.58/\$80.00
Market-to-book$_1$ = .9198

The NPV of the project is the new market value of the firm minus the current market value of the firm, or:

NPV = –\$1,500,000 + [\$73.58(85,000) – \$75(65,000)]
NPV = –\$120,283

Accounting dilution takes place here because the market-to-book ratio is less than one. Market value dilution has occurred since the firm is investing in a negative NPV project.

11. Using the PE ratio to find the necessary EPS after the stock issue, we get:

P_1 = \$75 = 4.974(EPS$_1$)
EPS$_1$ = \$15.08

The additional net income level must be the EPS times the new shares outstanding, so:

NI = \$15.08(20,000 shares)
NI = \$301,538

And the new ROE is:

ROE$_1$ = \$301,538/\$1,500,000
ROE$_1$ = .2010, or 20.10%

Next, we need to find the NPV of the project. The NPV of the project is the new market value of the firm minus the current market value of the firm, or:

NPV = –\$1,500,000 + [\$75(85,000) – \$75(65,000)]
NPV = \$0

Accounting dilution still takes place, as BVPS still falls from \$81.54 to \$80.00, but no market dilution takes place because the firm is investing in a zero NPV project.

12. *a.* Assume you hold three shares of the company's stock. The value of your holdings before you exercise your rights is:

Value of holdings = 3(\$68)
Value of holdings = \$204

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When you exercise, you must remit the three rights you receive for owning three shares, and $6. You have increased your equity investment by $6. The value of your holdings after surrendering your rights is:

New value of holdings = $204 + 6
New value of holdings = $210

After exercise, you own four shares of stock. Thus, the price per share of your stock is:

Stock price = $210/4
Stock price = $52.50

b. The value of a right is the difference between the rights-on price of the stock and the ex-rights price of the stock:

Value of rights = Rights-on price – Ex-rights price
Value of rights = $68 – 52.50
Value of rights = $15.50

c. The price drop will occur on the ex-rights date, even though the ex-rights date is neither the expiration date nor the date on which the rights are first exercisable. If you purchase the stock before the ex-rights date, you will receive the rights. If you purchase the stock on or after the ex-rights date, you will not receive the rights. Since rights have value, the stockholder receiving the rights must pay for them. The stock price drop on the ex-rights day is similar to the stock price drop on an ex-dividend day.

13. *a.* The number of new shares offered through the rights offering is the existing shares divided by the rights per share, or:

New shares = 1,450,000/2
New shares = 725,000

And the new price per share after the offering will be:

P = (Current market value + Proceeds from offer)/(Old shares + New shares)
P = [1,450,000($31) + 2,800,000]/(1,450,000 + 725,000)
P = $21.95

The subscription price is the amount raised divided by the number of new shares offered, or:

Subscription price = $2,800,000/725,000
Subscription price = $3.86

And the value of a right is:

Value of a right = (Ex-rights price – Subscription price)/Rights needed to buy a share of stock
Value of a right = ($21.95 – 3.86)/2
Value of a right = $9.05

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b. Following the same procedure, the number of new shares offered through the rights offering is:

New shares = 1,450,000/4
New shares = 362,500

And the new price per share after the offering will be:

P = (Current market value + Proceeds from offer)/(Old shares + New shares)
P = [1,450,000($31) + 2,800,000]/(1,450,000 + 362,500)
P = $26.34

The subscription price is the amount raised divided by the number of number of new shares offered, or:

Subscription price = $2,800,000/362,500
Subscription price = $7.72

And the value of a right is:

Value of a right = (Ex-rights price – Subscription price)/Rights needed to buy a share of stock
Value of a right = ($26.34 – 7.72)/4
Value of a right = $4.66

c. Since rights issues are constructed so that existing shareholders' proportionate share will remain unchanged, we know that the stockholders' wealth should be the same between the two arrangements. However, a numerical example makes this clearer. Assume that an investor holds four shares, and will exercise under either (a) or (b). Prior to exercise, the investor's portfolio value is:

Current portfolio value = Number of shares × Stock price
Current portfolio value = 4($31)
Current portfolio value = $124

After exercise, the value of the portfolio will be the new number of shares times the ex-rights price, less the subscription price paid. Under (a), the investor gets two new shares, so the portfolio value will be:

New portfolio value = 6($21.95) – 2($3.86)
New portfolio value = $124

Under *b*, the investor gets one new share, so the portfolio value will be:

New portfolio value = 5($26.34) – 1($7.72)
New portfolio value = $124

So, the shareholder's wealth position is unchanged either by the rights issue itself, or the choice of which rights issue the firm chooses.

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14. The number of new shares is the amount raised divided by the subscription price, so:

Number of new shares = \$45,000,000/P_S

And the ex-rights number of shares (N) is equal to:

N = Old shares outstanding/New shares outstanding
N = 9,200,000/(\$45,000,000/P_S)
N = .2044P_S

We know the equation for the ex-rights stock price is:

$P_X = [NP_{RO} + P_S]/(N + 1)$

We can substitute in the numbers we are given, and then substitute the two previous results. Doing so, and solving for the subscription price, we get:

P_X = \$53 = [N(\$58) + P_S]/(N + 1)
\$53 = [\$58(.2044P_S) + P_S]/(.2044P_S + 1)
\$53 = (11.858P_S + P_S)/(1 + .2044P_S)
P_S = \$26.21

15. Using P_{RO} as the rights-on price, and P_S as the subscription price, we can express the price per share of the stock ex-rights as:

$P_X = (NP_{RO} + P_S)/(N + 1)$

And the equation for the value of a right is:

Value of a right = $P_{RO} - P_X$

Substituting the ex-rights price equation into the equation for the value of a right and rearranging, we get:

Value of a right = $P_{RO} - (NP_{RO} + P_S)/(N + 1)$
Value of a right = $[(N + 1)P_{RO} - NP_{RO} - P_S]/(N + 1)$
Value of a right = $(P_{RO} - P_S)/(N + 1)$

16. Using the equation for valuing a stock ex-rights, we find:

$P_X = (NP_{RO} + P_S)/(N + 1)$
P_X = [4(\$75) + \$40]/5
P_X = \$68

The stock is correctly priced. Calculating the value of a right, we find:

Value of a right = $P_{RO} - P_X$
Value of a right = \$75 – 68
Value of a right = \$7

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So, the rights are underpriced. You can create an immediate profit on the ex-rights day if the stock is selling for $68 and the rights are selling for $6 by executing the following transactions:

Buy four rights in the market for 4($6) = $24. Use these rights to purchase a new share at the subscription price of $40. Immediately sell this share in the market for $68, creating an instant $4 profit.

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CHAPTER 20
INTERNATIONAL CORPORATE FINANCE

Answers to Concept Questions

1. *a.* The dollar is selling at a premium because it is more expensive in the forward market than in the spot market (Fr 1.53 versus Fr 1.50).

b. The franc is expected to depreciate relative to the dollar because it will take more francs to buy one dollar in the future than it does today.

c. Inflation in Switzerland is higher than in the United States, as are nominal interest rates.

2. The exchange rate will increase, as it will take progressively more pesos to purchase a dollar. This is the relative PPP relationship.

3. *a.* The Australian dollar is expected to weaken relative to the dollar, because it will take more A$ in the future to buy one dollar than it does today.

b. The inflation rate in Australia is higher.

c. Nominal interest rates in Australia are higher; relative real rates in the two countries are the same.

4. A Yankee bond is most accurately described by *d*.

5. Neither. For example, if a country's currency strengthens, imports become cheaper (good), but its exports become more expensive for others to buy (bad). The reverse is true for currency depreciation.

6. Additional advantages include being closer to the final consumer and, thereby, saving on transportation, significantly lower wages, and less exposure to exchange rate risk. Disadvantages include political risk and costs of supervising distant operations.

7. One key thing to remember is that dividend payments are made in the home currency. More generally, it may be that the owners of the multinational are primarily domestic and are ultimately concerned about their wealth denominated in their home currency because, unlike a multinational, they are not internationally diversified.

8. *a.* False. If prices are rising faster in Great Britain, it will take more pounds to buy the same amount of goods that one dollar can buy; the pound will depreciate relative to the dollar.

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b. False. The forward market would already reflect the projected deterioration of the euro relative to the dollar. Only if you feel that there might be additional, unanticipated weakening of the euro that isn't reflected in forward rates today, will the forward hedge protect you against additional declines.

c. True. The market would only be correct on average, while you would be correct all the time.

9. *a.* American exporters: their situation in general improves because a sale of the exported goods for a fixed number of euros will be worth more dollars.
American importers: their situation in general worsens because the purchase of the imported goods for a fixed number of euros will cost more in dollars.

b. American exporters: they would generally be better off if the British government's intentions result in a strengthened pound.
American importers: they would generally be worse off if the pound strengthens.

c. American exporters: they would generally be much worse off, because an extreme case of fiscal expansion like this one will make American goods prohibitively expensive to buy, or else Brazilian sales, if fixed in reais, would become worth an unacceptably low number of dollars.
American importers: they would generally be much better off, because Brazilian goods will become much cheaper to purchase in dollars.

10. IRP is the most likely to hold because it presents the easiest and least costly means to exploit any arbitrage opportunities. Relative PPP is least likely to hold since it depends on the absence of market imperfections and frictions in order to hold strictly.

11. It all depends on whether the forward market expects the same appreciation over the period and whether the expectation is accurate. Assuming that the expectation is correct and that other traders do not have the same information, there will be value to hedging the currency exposure.

12. One possible reason investment in the foreign subsidiary might be preferred is if this investment provides direct diversification that shareholders could not attain by investing on their own. Another reason could be if the political climate in the foreign country was more stable than in the home country. Increased political risk can also be a reason you might prefer the home subsidiary investment. Indonesia can serve as a great example of political risk. If it cannot be diversified away, investing in this type of foreign country will increase the systematic risk. As a result, it will raise the cost of the capital, and could actually decrease the NPV of the investment.

13. Yes, the firm should undertake the foreign investment. If, after taking into consideration all risks, a project in a foreign country has a positive NPV, the firm should undertake it. Note that in practice, the stated assumption (that the adjustment to the discount rate has taken into consideration all political and diversification issues) is a huge task. But once that has been addressed, the net present value principle holds for foreign operations, just as for domestic.

14. If the foreign currency depreciates, the U.S. parent will experience an exchange rate loss when the foreign cash flow is remitted to the U.S. This problem could be overcome by selling forward contracts. Another way of overcoming this problem would be to borrow in the country where the project is located.

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15. False. If the financial markets are perfectly competitive, the difference between the Eurodollar rate and the U.S. rate will be due to differences in risk and government regulation. Therefore, speculating in those markets will not be beneficial.

16. The difference between a Eurobond and a foreign bond is that the foreign bond is denominated in the currency of the country of origin of the issuing company. Eurobonds are more popular than foreign bonds because of registration differences. Eurobonds are unregistered securities.

Solutions to Questions and Problems

NOTE: All end-of-chapter problems were solved using a spreadsheet. Many problems require multiple steps. Due to space and readability constraints, when these intermediate steps are included in this solutions manual, rounding may appear to have occurred. However, the final answer for each problem is found without rounding during any step in the problem.

Basic

1. Using the quotes from the table, we get:

a. $100(€.8819/$1) = €88.19

b. $1.1340

c. €5M($1.1340/€) = $5,670,000

d. New Zealand dollar

e. Mexican peso

f. (Ps21.8829/$1)($1.1340/€1) = Ps21.8829/€

This is a cross-rate.

g. The most valuable is the Kuwait dinar. The least valuable is the Vietnam dong.

2. *a.* You would prefer £100, since:

(£100)($1.3178/£1) = $131.78

b. You would still prefer £100. Using the $/£ exchange rate and the Fr/$ exchange rate to find the amount of Swiss francs £100 will buy, we get:

(£100)($1.3178/£1)(Fr.9989) = Fr 75.964

c. Using the quotes in the book to find the Fr/£ cross-rate, we find:

(Fr/$.9989)($1.3179/£1) = Fr 1.3164

The £/Fr exchange rate is the inverse of the Fr/£ exchange rate, so:

£1/Fr1.3164 = £.7596/Fr

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3. *a.* F_{180} = ¥111.90(per $). The yen is selling at a discount because it is less expensive in the forward market than in the spot market ($.0089366 versus $.0089493).

b. F_{90} = $.7623/£. The pound is selling at a discount because it is less expensive in the forward market than in the spot market ($1.3118 versus $1.3178).

c. The value of the dollar will rise relative to the yen, since it will take less dollars to buy one yen in the future than it does today. The value of the dollar will rise relative to the pound, because it will take less dollars to buy one pound in the future than it does today.

4. *a.* The U.S. dollar, since one Canadian dollar will buy:

(Can$1)/(Can$1.29/$1) = $.7752

b. The cost in U.S. dollars is:

(Can$2.49)/(Can$1.29/$1) = $1.93

Among the reasons that absolute PPP doesn't hold are tariffs and other barriers to trade, transactions costs, taxes, and different tastes.

c. The U.S. dollar is selling at a premium, because it is more expensive in the forward market than in the spot market (Can$1.34 versus Can$1.29).

d. The Canadian dollar is expected to depreciate in value relative to the dollar, because it takes more Canadian dollars to buy one U.S. dollar in the future than it does today.

e. Interest rates in Canada are probably higher than they are in the United States.

5. *a.* The cross-rate in ¥/£ terms is:

(¥105/$1)($1.34/£1) = ¥140.70/£1

b. The yen is quoted too low relative to the pound. Take out a loan for $1 and buy ¥105. Use the ¥105 to purchase pounds at the cross-rate, which will give you:

¥105(£1/¥175) = £.7721

Use the pounds to buy back dollars and repay the loan. The cost to repay the loan will be:

£.7721($1.34/£1) = $1.0346

Your arbitrage profit is $.0346 per dollar used.

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6. We can rearrange the interest rate parity condition to answer this question. The equation we will use is:

$R_{FC} = (F_T - S_0)/S_0 + R_{US}$

Using this relationship, we find:

Great Britain: $R_{FC} = (£.7658 - £.7588)/£.7588 + .019 = .0282$, or 2.82%

Japan: $R_{FC} = (¥111.90 - ¥111.74)/¥111.74 + .019 = .0204$, or 2.04%

Switzerland: $R_{FC} = (Fr\ .9818 - Fr\ .9989)/Fr\ .9989 + .019 = .0019$, or .19%

7. If we invest in the U.S. for the next three months, we will have:

$\$30,000,000(1.0039)^3 = \$30,352,370.68$

If we invest in Great Britain, we must exchange the dollars today for pounds, and exchange the pounds for dollars in three months. After making these transactions, the dollar amount we would have in three months would be:

$(\$30,000,000)(£.7347/\$1)(1.0041)^3/(£.7358/\$1) = \$30,325,111.91$

They should invest in the United States.

8. Using the relative purchasing power parity equation:

$E(S_t) = S_0 \times [1 + (h_{FC} - h_{US})]^t$

We find:

$zł\ 3.93 = zł\ 3.74[1 + (h_{FC} - h_{US})]^3$
$h_{FC} - h_{US} = (zł\ 3.93/zł\ 3.74)^{1/3} - 1$
$h_{FC} - h_{US} = .0167$, or 1.67%

Inflation in Poland is expected to exceed that in the U.S. by 1.67% over this period.

9. The profit will be the quantity sold, times the sales price minus the cost of production. The production cost is in Singapore dollars, so we must convert this to U.S. dollars. Doing so, we find that if the exchange rates stay the same, the profit will be:

Profit = 30,000[\$98 – {(S\$124.60)/(S\$1.3545/\$1)}]
Profit = \$180,310.08

If the exchange rate rises, we must adjust the cost by the increased exchange rate, so:

Profit = 30,000[\$98 – {(S\$124.60)/1.1(S\$1.3545/\$1)}]
Profit = \$431,190.98

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If the exchange rate falls, we must adjust the cost by the decreased exchange rate, so:

Profit = 30,000[$98 – {(S$124.60)/.9(S$1.3545/$1)}]
Profit = –$126,322.14

To calculate the break-even change in the exchange rate, we need to find the exchange rate that makes the cost in Singapore dollars equal to the selling price in U.S. dollars, so:

$98 = S$124.60/S_T
S_t = S$1.2714/$1

The percentage change in the exchange rate that results in a break-even profit is computed as:

%Δ = (S$1.2714 − 1.3545)/S$1.3545
%Δ = −.0613, or −6.13%

10. *a.* If IRP holds, then:

F_{180} = (Kr 8.53)[1 + (.044 – .032)]$^{1/2}$
F_{180} = Kr 8.5810

Since given F_{180} is Kr 8.61, an arbitrage opportunity exists; the forward premium is too high. Borrow Kr 1 today at 4.4% interest. Agree to a 180-day forward contract at Kr 8.61. Convert the loan proceeds into dollars:

Kr 1 ($1/Kr 8.53) = $.11723

Invest these dollars at 3.2%, ending up with $.11907. Convert the dollars back into krone as

$.11907(Kr 8.61/$1) = Kr 1.02518

Repay the Kr 1 loan, ending with a profit of:

Kr 1.02518 – Kr 1.02146 = Kr .00372

b. To find the forward rate that eliminates arbitrage, we use the interest rate parity condition, so:

F_{180} = (Kr 8.53)[1 + (.044 – .032)]$^{1/2}$
F_{180} = Kr 8.5810

11. The international Fisher effect states that the real interest rate across countries is equal. We can rearrange the international Fisher effect as follows to answer this question:

$R_{US} - h_{US} = R_{FC} - h_{FC}$
$h_{FC} = R_{FC} + h_{US} - R_{US}$

a. h_{AUS} = .027 + .022 – .034
h_{AUS} = .015, or 1.5%

b. h_{CAN} = .041 + .022 – .034
h_{CAN} = .029, or 2.9%

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c. $h_{TAI} = .057 + .022 - .034$
$h_{TAI} = .045$, or 4.5%

12. *a.* The yen is expected to get stronger, since it will take fewer yen to buy one dollar in the future than it does today.

b. $h_{JAP} - h_{US} \approx (¥114.18 - ¥114.61)/¥114.61$
$h_{JAP} - h_{US} = -.0038$, or –.38%

$(1 - .0038)^4 - 1 = -.0149$, or –1.49%

The approximate inflation differential between the U.S. and Japan is –1.49 percent annually.

13. We need to find the change in the exchange rate over time, so we need to use the interest rate parity relationship:

$F_t = S_0 \times [1 + (R_{FC} - R_{US})]^t$

Using this relationship, we find the exchange rate in one year should be:

$F_1 = 268[1 + (.0219 - .0163)]^1$
$F_1 =$ HUF 269.50

The exchange rate in two years should be:

$F_2 = 268[1 + (.0219 - .0163)]^2$
$F_2 =$ HUF 271.01

And the exchange rate in five years should be:

$F_5 = 268[1 + (.0219 - .0163)]^5$
$F_5 =$ HUF 275.59

Intermediate

14. First, we need to forecast the future spot rate for each of the next three years. From uncovered interest rate parity, the expected exchange rate is:

$E(S_t) = S_0[1 + (R_{FC} - R_{US})]^t$

So:

$E(S_1) = \$.81/€[1 + (.0230 - .0310)]^1 = \$.8035/€$
$E(S_2) = \$.81/€[1 + (.0230 - .0310)]^2 = \$.7971/€$
$E(S_3) = \$.81/€[1 + (.0230 - .0310)]^3 = \$.7907/€$

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Now we can use these future spot rates to find the dollar cash flows. The dollar cash flow each year will be:

Year 0 cash flow = –€10,900,000($.81/€) = –$8,829,000.00
Year 1 cash flow = €2,800,000($.8035/€) = $2,249,856.00
Year 2 cash flow = €2,800,000($.7971/€) = $2,231,857.15
Year 3 cash flow = (€3,100,000 + 8,900,000)($.7907/€) = $9,488,581.26

And the NPV of the project will be:

NPV = –$8,829,000 + $2,249,856.00/1.13 + $2,231,857.15/$1.13^2$ + $9,488,581.26/$1.13^3$
NPV = $1,485,957.32

15. *a.* Implicitly, it is assumed that interest rates won't change over the life of the project, but the exchange rate is projected to increase because the Eurodollar rate is lower than the Swiss franc rate.

b. We can use relative purchasing power parity to calculate the dollar cash flows at each time. The equation is:

$E(S_t) = (\text{Fr } .97)[1 + (.06 - .05)]^t$
$E(S_t) = .97(1.01)^t$

So, the cash flows each year in U.S. dollar terms will be:

t	Fr	$E(S_t)$	US$
0	–19,600,000	.9700	–$20,206,185.57
1	6,100,000	.9797	$6,226,395.84
2	6,100,000	.9895	$6,164,748.35
3	6,100,000	.9994	$6,103,711.24
4	6,100,000	1.0094	$6,043,278.45
5	6,100,000	1.0195	$5,983,444.01

And the NPV is:

NPV = –$20,206,185.57 + $6,226,395.84/1.12 + $6,164,748.35/$1.12^2$ + $6,103,711.24/$1.12^3$ +
$6,043,278.45/$1.12^4$ + $5,983,444.01/$1.12^5$
NPV = $1,847,876.71

c. Rearranging the relative purchasing power parity equation to find the required return in Swiss francs, we get:

$R_{Fr} = 1.12[1 + (.06 - .05)] - 1$
$R_{Fr} = .1312$, or 13.12%

So, the NPV in Swiss francs is:

NPV = –Fr 19,600,000 + Fr 6,100,000($PVIFA_{13.12\%,5}$)
NPV = Fr 1,792,440.40

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Converting the NPV to dollars at the spot rate, we get the NPV in U.S. dollars as:

NPV = (Fr 1,792,440.40)($1/Fr .97)
NPV = $1,847,876.71

16. *a.* To construct the balance sheet in dollars, we need to convert the account balances to dollars. At the current exchange rate, we get:

Assets = solaris 48,000($/solaris 1.20) = $40,000
Debt = solaris 15,000($/solaris 1.20) = $12,500
Equity = solaris 33,000($/solaris 1.20) = $27,500

b. In one year, if the exchange rate is solaris 1.40/$, the accounts will be:

Assets = solaris 48,000($/solaris 1.40) = $34,285.71
Debt = solaris 15,000($/solaris 1.40) = $10,714.29
Equity = solaris 33,000($/solaris 1.40) = $23,571.43

c. If the exchange rate is solaris 1.15/$, the accounts will be:

Assets = solaris 48000($/solaris 1.15) = $41,739.13
Debt = solaris 15,000($/solaris 1.15) = $13,043.48
Equity = solaris 33,000($/solaris 1.15) = $28,695.65

Challenge

17. First, we need to construct the end-of-year balance sheet in solaris. Since the company has retained earnings, the equity account will increase, which necessarily implies the assets will also increase by the same amount. So, the balance sheet at the end of the year in solaris will be:

		Balance Sheet (solaris)	
		Liabilities	15,000.00
		Equity	35,100.00
Assets	50,100.00	Total liabilities & equity	50,100.00

Now we need to convert the balance sheet accounts to dollars, which gives us:

Assets = solaris 50,100($/solaris 1.24) = $40,403.23
Debt = solaris 15,000($/solaris 1.24) = $12,096.77
Equity = solaris 35,100($/solaris 1.24) = $28,306.45

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18. *a.* The domestic Fisher effect is:

$1 + R_{US} = (1 + r_{US})(1 + h_{US})$
$1 + r_{US} = (1 + R_{US})/(1 + h_{US})$

This relationship must hold for any country, that is:

$1 + r_{FC} = (1 + R_{FC})/(1 + h_{FC})$

The international Fisher effect states that real rates are equal across countries, so:

$1 + r_{US} = (1 + R_{US})/(1 + h_{US}) = (1 + R_{FC})/(1 + h_{FC}) = 1 + r_{FC}$

b. The exact form of unbiased interest rate parity is:

$E[S_t] = F_t = S_0[(1 + R_{FC})/(1 + R_{US})]^t$

c. The exact form for relative PPP is:

$E[S_t] = S_0\,[(1 + h_{FC})/(1 + h_{US})]^t$

d. For the home currency approach, we calculate the expected currency spot rate at Time *t* as:

$E[S_t] = (€.5)[1.07/1.05]^t = (€.5)(1.019)^t$

We then convert the euro cash flows using this equation at every time and find the present value. Doing so, we find:

$NPV = –[€2M/€.5] + \{€.9M/[1.019(€.5)]\}/1.1 + \{€.9M/[1.019^2(€.5)]\}/1.1^2 + \{€.9M/[1.019^3(€.5/\$1)]\}/1.1^3$
NPV = $316,230.72

For the foreign currency approach, we first find the return in the euros as:

$R_{FC} = 1.10(1.07/1.05) – 1 = .121$

Next, we find the NPV in euros as:

$NPV = – €2M + €.9M/1.121 + €.9M/1.121^2 + €.9M /1.121^3 = €158,115.36$

And finally, we convert the euros to dollars at the current exchange rate, which is:

NPV ($) = €158,115.36/(€.5/$1) = $316,230.72

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CHAPTER 21
MERGERS AND ACQUISITIONS

Answers to Concepts Review and Critical Thinking Questions

1. In merger accounting, if an acquiring company pays more than the market value for a target company, the amount paid above market value is considered goodwill. If the acquisition does not work as planned, the goodwill is impaired, that is, a reduction is made in the goodwill account in the amount of the loss in value due to the acquisition. Some analysts have argued that the number of goodwill impairment charges is an indication that mergers and acquisitions are bad. However, there is no "unimpairment", or increase in goodwill if the acquisition is widely successful. For example, Google paid $50 million for Android in 2005. This acquisition has resulted in a huge success for Google and obviously been worth more than $50 million, but any original goodwill created when the acquisition was made has never been increased, and, in fact, accounting rules have no such mechanism for rewarding good acquisitions.

2. *a.* False. Although the reasoning seems correct, in general, the new firms do not have monopoly power. This is especially true since many countries have laws limiting mergers when it would create a monopoly.

b. True. When managers act in their own interest, acquisitions are an important control device for shareholders. It appears that some acquisitions and takeovers are the consequence of underlying conflicts between managers and shareholders.

c. False. Even if markets are efficient, the presence of synergy will make the value of the combined firm different from the sum of the values of the separate firms. Incremental cash flows provide the positive NPV of the transaction.

d. False. In an efficient market, traders will value takeovers based on "fundamental factors" regardless of the time horizon. Recall that the evidence as a whole suggests efficiency in the markets. Mergers should be no different.

e. False. The tax effect of an acquisition depends on whether the merger is taxable or non-taxable. In a taxable merger, there are two opposing factors to consider, the capital gains effect and the write-up effect. The net effect is the sum of these two effects.

f. True. Because of the coinsurance effect, wealth might be transferred from the stockholders to the bondholders. Acquisition analysis usually disregards this effect and considers only the total value.

3. Diversification doesn't create value in and of itself because diversification reduces unsystematic, not systematic, risk. As discussed in the chapter on options, there is a subtler issue as well. Reducing unsystematic risk benefits bondholders by making default less likely. However, if a merger is done purely to diversify (i.e., no operating synergy), then the NPV of the merger is zero. If the NPV is zero, and the bondholders are better off, then stockholders must be worse off.

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4. A firm might choose to split up because the newer, smaller firms may be better able to focus on their particular markets. Thus, reverse synergy is a possibility. An added advantage is that performance evaluation becomes much easier once the split is made because the new firm's financial results (and stock prices) are no longer commingled.

5. It depends on how they are used. If they are used to protect management, then they are not good for stockholders. If they are used by management to negotiate the best possible terms of a merger, then they are good for stockholders.

6. One of the primary advantages of a taxable merger is the write-up in the basis of the target firm's assets, while one of the primary disadvantages is the capital gains tax that is payable. The situation is the reverse for a tax-free merger.

The basic determinant of tax status is whether the old stockholders will continue to participate in the new company, which is usually determined by whether they get any shares in the bidding firm. An LBO is usually taxable because the acquiring group pays off the current stockholders in full, usually in cash.

7. Economies of scale occur when average cost declines as output levels increase. A merger in this particular case might make sense because Eastern and Western may need less total capital investment to handle the peak power needs, thereby reducing average generation costs.

8. Among the defensive tactics often employed by management are seeking white knights, threatening to sell the crown jewels, appealing to regulatory agencies and the courts (if possible), and targeted share repurchases. Frequently, anti-takeover charter amendments are available as well, such as poison pills, poison puts, golden parachutes, lockup agreements, and supermajority amendments, but these require shareholder approval, so they can't be immediately used if time is short. While target firm shareholders may benefit from management actively fighting acquisition bids, in that it encourages higher bidding and may solicit bids from other parties as well, there is also the danger that such defensive tactics will discourage potential bidders from seeking the firm in the first place, which harms the shareholders.

9. In a cash offer, it almost surely does not make sense. In a stock offer, management may feel that one suitor is a better long-run investment than the other, but this is only valid if the market is not efficient. In general, the highest offer is the best one.

10. Various reasons include: (1) Anticipated gains may be smaller than thought; (2) Bidding firms are typically much larger, so any gains are spread thinly across shares; (3) Management may not be acting in the shareholders' best interest with many acquisitions; (4) Competition in the market for takeovers may force prices for target firms up to the zero NPV level; and (5) Market participants may have already discounted the gains from the merger before it is announced.

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Solutions to Questions and Problems

NOTE: All end-of-chapter problems were solved using a spreadsheet. Many problems require multiple steps. Due to space and readability constraints, when these intermediate steps are included in this solutions manual, rounding may appear to have occurred. However, the final answer for each problem is found without rounding during any step in the problem.

Basic

1. For the merger to make economic sense, the acquirer must feel the acquisition will increase value by at least the amount of the premium over the market value, so:

Minimum economic value = $275,000,000 – 241,000,000
Minimum economic value = $34,000,000

2. With the purchase method, the assets of the combined firm will be the book value of Firm X, the acquiring company, plus the market value of Firm Y, the target company, so:

Assets from X = 26,000($13) = $338,000 (book value)
Assets from Y = 11,000($16) = $176,000 (market value)

The purchase price of Firm Y is the number of shares outstanding times the sum of the current stock price per share plus the premium per share, so:

Purchase price of Y = 11,000($16 + 6)
Purchase price of Y = $242,000

The goodwill created will be:

Goodwill = $242,000 – 176,000
Goodwill = $66,000

And the total assets of the combined company will be:

Total assets XY = Total equity XY = $338,000 + 176,000 + 66,000
Total assets XY = Total equity XY = $580,000

3. Since the acquisition is funded by long-term debt, the post-merger balance sheet will have long-term debt equal to the original long-term debt of Jurion's balance sheet plus James's long-term debt plus the new long-term debt issue, so:

Post-merger long-term debt = $11,700 + 1,900 + 13,500
Post-merger long-term debt = $27,100

Goodwill will be created since the acquisition price is greater than the market value. The goodwill amount is equal to the purchase price minus the market value of assets plus the market value of debt. Generally, the market value of current assets is equal to the book value, so:

Goodwill = $13,500 – 11,500(market value FA) + 2,800(market value debt)
Goodwill = $4,800

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Current liabilities and equity will remain the same as the pre-merger balance sheet of the acquiring firm. Current assets will be the sum of the two firms' pre-merger balance sheet accounts, and the fixed assets will be the sum of the pre-merger fixed assets of the acquirer and the market value of fixed assets of the target firm. The post-merger balance sheet will be:

Jurion Co., post-merger

Current assets	$17,000	Current liabilities	$ 6,400
Fixed assets	45,900	Long-term debt	27,100
Goodwill	4,800	Equity	34,200
Total	$67,700	Total	$67,700

4. *a.* The cash cost is the amount of cash offered, so the cash cost is $42 million.

To calculate the cost of the stock offer, we first need to calculate the value of the target to the acquirer. The value of the target firm to the acquiring firm will be the market value of the target plus the PV of the incremental cash flows generated by the target firm. The cash flows are a perpetuity, so

$V^* = \$28,000,000 + \$1,700,000/.10$
$V^* = \$45,000,000$

The cost of the stock offer is the percentage of the acquiring firm given up times the sum of the market value of the acquiring firm and the value of the target firm to the acquiring firm. So, the equity cost will be:

Equity cost = .35($73,000,000 + 45,000,000)
Equity cost = $41,300,000

b. The NPV of each offer is the value of the target firm to the acquiring firm minus the cost of acquisition, so:

NPV cash = $45,000,000 – 42,000,000
NPV cash = $3,000,000

NPV stock = $45,000,000 – 41,300,000
NPV stock = $3,700,000

c. Since the NPV is greater with the stock offer, the acquisition should be in stock.

5. *a.* The EPS of the combined company will be the sum of the earnings of both companies divided by the shares in the combined company. Since the stock offer is one share of the acquiring firm for three shares of the target firm, new shares in the acquiring firm will be one-third of Flannery's shares outstanding. So, the new EPS will be:

EPS = ($160,000 + 720,000)/[168,000 + (1/3)(72,000)]
EPS = $4.583

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The market price of Stultz will remain unchanged if it is a zero NPV acquisition. Using the PE ratio, we find the current market price of Stultz stock, which is:

$P = 21(\$720,000)/168,000$
$P = \$90.00$

If the acquisition has a zero NPV, the stock price should remain unchanged. Therefore, the new PE will be:

PE = \$90.00/\$4.583
PE = 19.64

b. The value of Flannery to Stultz must be the market value of the company since the NPV of the acquisition is zero. Therefore, the value is:

$V^* = \$160,000(13.5)$
$V^* = \$2,160,000$

The cost of the acquisition is the number of shares offered times the share price, so the cost is:

Cost = (1/3)(72,000)(\$90.00)
Cost = \$2,160,000

So, the NPV of the acquisition is:

$NPV = 0 = V^* + \Delta V - \text{Cost} = \$2,160,000 + \Delta V - 2,160,000$
$\Delta V = \$0$

Although there is no economic value to the takeover, it is possible that Stultz is motivated to purchase Flannery for other than financial reasons.

6. The decision hinges upon the risk of surviving. That is, consider the wealth transfer from bondholders to stockholders when risky projects are undertaken. High-risk projects will reduce the expected value of the bondholders' claims on the firm. The telecommunications business is riskier than the utilities business.

If the total value of the firm does not change, the increase in risk should favor the stockholder. Hence, management should approve this transaction.

If the total value of the firm drops because of the transaction, and the wealth effect is lower than the reduction in total value, management should reject the project.

7. *a.* The NPV of the merger is the market value of the target firm, plus the value of the synergy, minus the acquisition costs, so:

NPV = 2,100(\$29) + \$18,400 – 2,100(\$31)
NPV = \$14,200

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b. Since the NPV goes directly to stockholders, the share price of the merged firm will be the market value of the acquiring firm plus the NPV of the acquisition, divided by the number of shares outstanding, so:

Share price = [8,500($75) + $14,200]/8,500
Share price = $76.67

c. The merger premium is the premium per share times the number of shares of the target firm outstanding, so the merger premium is:

Merger premium = 2,100($31 – 29)
Merger premium = $4,200

d. The number of new shares will be the number of shares of the target times the exchange ratio, so:

New shares created = 2,100(1/2)
New shares created = 1,050 new shares

The value of the merged firm will be the market value of the acquirer plus the market value of the target plus the synergy benefits, so:

V_{BT} = 8,500($75) + 2,100($29) + 18,400
V_{BT} = $716,800

The price per share of the merged firm will be the value of the merged firm divided by the total shares of the new firm, which is:

P = $716,800/(8,500 + 1,050)
P = $75.06

e. The NPV of the acquisition using a share exchange is the market value of the target firm plus synergy benefits, minus the cost. The cost is the value per share of the merged firm times the number of shares offered to the target firm shareholders, so:

NPV = 2,100($29) + $18,400 – 1,050($75.06)
NPV = $489.53

Intermediate

8. The share offer is better for the target firm shareholders since they receive only $31 per share in the cash offer. In the share offer, the target firm's shareholders will receive:

Equity offer value = (1/2)($75.06)
Equity offer value = $37.53 per share

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From Problem 7, we know the value of the merged firm's assets will be $716,800. The number of shares in the new firm will be:

Shares in new firm = 8,500 + 2,100x

That is, the number of shares outstanding in the bidding firm, plus the number of shares outstanding in the target firm, times the exchange ratio. This means the post-merger share price will be:

P = $716,800/(8,500 + 2,100$x$)

To make the target firm's shareholders indifferent, they must receive the same wealth, so:

2,100(x)P = 2,100($31)

This equation shows that the new offer is the shares outstanding in the target company times the exchange ratio times the new stock price. The value under the cash offer is the shares outstanding times the cash offer price. Solving this equation for P, we find:

P = $31/$x$

Combining the two equations, we find:

$716,800/(8,500 + 2,100x) = $31/$x$
x = .4043

There is a simpler solution that requires an economic understanding of the merger terms. If the target firm's shareholders are indifferent, the bidding firm's shareholders are indifferent as well. That is, the offer is a zero sum game. Using the new stock price produced by the cash deal, we find:

Exchange ratio = $31/$76.67
Exchange ratio = .4043

9. The cost of the acquisition is:

Cost = 600($43)
Cost = $25,800

Since the stock price of the acquiring firm is $38, the firm will have to give up:

Shares offered = $25,800/$38
Shares offered = 678.95 shares

a. The EPS of the merged firm will be the combined EPS of the existing firms divided by the new shares outstanding, so:

EPS = ($3,300 + 1,300)/(1,500 + 678.95)
EPS = $2.11

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b. The PE of the acquiring firm is:

Original PE = $38/($3,300/1,500)
Original PE = 17.27 times

Assuming the PE ratio does not change, the new stock price will be:

New price = $2.11(17.27)
New price = $36.46

c. If the market correctly analyzes the earnings, the stock price will remain unchanged since this is a zero NPV acquisition, so:

New PE = $38/$2.11
New PE = 18.00 times

d. The new share price will be the combined market value of the two existing companies divided by the number of shares outstanding in the merged company. So:

P = [(1,500)($38) + 600($41)]/(1,500 + 678.95)
P = $37.45

And the PE ratio of the merged company will be:

PE = $37.45/$2.11
PE = 17.74 times

At the proposed bid price, this is a negative NPV acquisition for A since the share price declines. They should revise their bid downward until the NPV is zero.

10. Beginning with the fact that the NPV of a merger is the value of the target minus the cost, we get:

$$\begin{aligned} \text{NPV} &= V_B^* - \text{Cost} \\ \text{NPV} &= \Delta V + V_B - \text{Cost} \\ \text{NPV} &= \Delta V - (\text{Cost} - V_B) \\ \text{NPV} &= \Delta V - \text{Merger premium} \end{aligned}$$

11. *a.* The synergy will be the present value of the incremental cash flows of the proposed purchase. Since the cash flows are perpetual, the synergy value is:

Synergy value = $415,000/.08
Synergy value = $5,187,500

b. The value of Flash-in-the-Pan to Fly-by-Night is the synergy plus the current market value of Flash-in-the-Pan, which is:

Value = $5,187,500 + 13,400,000
Value = $18,587,500

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c. The value of the cash option is the amount of cash paid, or $16 million. The value of the stock acquisition is the percentage of ownership in the merged company, times the value of the merged company, so:

Stock acquisition value = .35($18,587,500 + 28,700,000)
Stock acquisition value = $16,550,625

d. The NPV is the value of the acquisition minus the cost, so the NPV of each alternative is:

NPV of cash offer = $18,587,500 – 16,000,000
NPV of cash offer = $2,587,500

NPV of stock offer = $18,587,500 – 16,550,625
NPV of stock offer = $2,036,875

e. The acquirer should make the cash offer since the NPV is greater.

12. *a.* The number of shares after the acquisition will be the current number of shares outstanding for the acquiring firm, plus the number of new shares created for the acquisition, which is:

Number of shares after acquisition = 5,000,000 + 1,200,000
Number of shares after acquisition = 6,200,000

And the share price will be the value of the combined company divided by the shares outstanding, which will be:

New stock price = £147,000,000/6,200,000
New stock price = £23.71

b. Let α equal the fraction of ownership for the target shareholders in the new firm. We can set the percentage of ownership in the new firm equal to the value of the cash offer, so:

α(£147,000,000) = £36,200,000
α = .2463, or 24.63%

So, the shareholders of the target firm would be equally as well off if they received 24.63 percent of the stock in the new company as if they received the cash offer. The ownership percentage of the target firm shareholders in the new firm can be expressed as:

Ownership = New shares issued/(New shares issued + Current shares of acquiring firm)
.2463 = New shares issued/(New shares issued + 5,000,000)
New shares issued = 1,633,574

To find the exchange ratio, we divide the new shares issued to the shareholders of the target firm by the existing number of shares in the target firm, so:

Exchange ratio = New shares/Existing shares in target firm
Exchange ratio = 1,633,574/2,000,000
Exchange ratio = .8168

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An exchange ratio of .8168 shares of the merged company for each share of the target company owned would make the value of the stock offer equivalent to the value of the cash offer.

13. *a.* The value of each company is the sum of the probability of each state of the economy times the value of the company in that state of the economy, so:

$\text{Value}_{\text{Bentley}} = .70(\$410{,}000) + .30(\$170{,}000)$
$\text{Value}_{\text{Bentley}} = \$338{,}000$

$\text{Value}_{\text{Rolls}} = .70(\$360{,}000) + .30(\$130{,}000)$
$\text{Value}_{\text{Rolls}} = \$291{,}000$

b. The value of each company's equity is sum of the probability of each state of the economy times the value of the equity in that state of the economy. The value of equity in each state of the economy is the maximum of total company value minus the value of debt, or zero. Since Rolls is an all equity company, the value of its equity is the total value of the firm, or $291,000. The value of Bentley's equity in a boom is $220,000 ($410,000 company value minus $190,000 debt value), and the value of Bentley's equity in a recession is zero since the value of its debt is greater than the value of the company in that state of the economy. So, the value of Bentley's equity is:

$\text{Equity}_{\text{Bentley}} = .70(\$220{,}000) + .30(\$0)$
$\text{Equity}_{\text{Bentley}} = \$154{,}000$

The value of Bentley's debt in a boom is the full face value of $190,000. In a recession, the value of the company's debt is $170,000 since the value of the debt cannot exceed the value of the company. So, the value of Bentley's debt today is:

$\text{Debt}_{\text{Bentley}} = .70(\$190{,}000) + .30(\$170{,}000)$
$\text{Debt}_{\text{Bentley}} = \$184{,}000$

Note, this is also the value of the company minus the value of the equity, or:

$\text{Debt}_{\text{Bentley}} = \$338{,}000 - 154{,}000$
$\text{Debt}_{\text{Bentley}} = \$184{,}000$

c. The combined value of the companies, the combined equity value, and combined debt value is:

Combined value = $338,000 + 291,000
Combined value = $629,000

Combined equity value = $154,000 + 291,000
Combined equity value = $445,000

Combined debt value = $184,000

d. To find the value of the merged company, we need to find the value of the merged company in each state of the economy, which is:

Boom merged value = $410,000 + 360,000
Boom merged value = $770,000

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Recession merged value = $170,000 + 130,000
Recession merged value = $300,000

So, the value of the merged company today is:

Merged company value = .70($770,000) + .30($300,000)
Merged company value = $629,000

Since the merged company will still have $190,000 in debt, the value of the equity in a boom is $580,000, and the value of equity in a recession is $110,000. So, the value of the merged company's equity is:

Merged equity value = .70($580,000) + .30($110,000)
Merged equity value = $439,000

The merged company will have a value greater than the face value of debt in both states of the economy, so the value of the company's debt is $190,000.

e. There is a wealth transfer in this case. The combined equity value before the merger was $445,000, but the value of the equity in the merged company is only $439,000, a loss of $6,000 for stockholders. The value of the debt in the combined companies was only $184,000, but the value of debt in the merged company is $190,000 since there is no chance of default. The bondholders gained $6,000, exactly the amount the stockholders lost.

f. If the value of Bentley's debt before the merger is less than the lowest firm value, there is no coinsurance effect. Since there is no possibility of default before the merger, bondholders do not gain after the merger.

Challenge

14. *a.* To find the value of the target to the acquirer, we need to find the share price with the new growth rate. We begin by finding the required return for shareholders of the target firm. The earnings per share of the target are:

EPS_T = $705,000/195,000
EPS_T = $3.62 per share

The price per share is:

$P_T = 9.2(\$3.62)$
P_T = $33.26

And the dividends per share are:

DPS_T = $375,000/195,000
DPS_T = $1.92

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The current required return for the target company's shareholders, which incorporates the risk of the company, is:

R_E = [\$1.92(1.05)/\$33.26] + .05
R_E = .1107, or 11.07%

The price per share of the target company with the new growth rate is:

P_T = \$1.92(1.07)/(.1107 – .07)
P_T = \$50.55

The value of the target firm to the acquiring firm is the number of shares outstanding times the price per share under the new growth rate assumptions, so:

V_T^* = 195,000(\$50.55)
V_T^* = \$9,856,862.86

b. The gain to the acquiring firm will be the value of the target firm to the acquiring firm minus the market value of the target, so:

Gain = \$9,856,862.86 – 195,000(\$33.26)
Gain = \$3,370,862.86

c. The NPV of the acquisition is the value of the target firm to the acquiring firm minus the cost of the acquisition, so:

NPV = \$9,856,862.86 – 195,000(\$38)
NPV = \$2,446,862.86

d. The most the acquiring firm should be willing to pay per share is the offer price per share plus the NPV per share, so:

Maximum bid price = \$38 + (\$2,446,862.86/195,000)
Maximum bid price = \$50.55

Notice, this is the same value we calculated earlier in part (a) as the value of the target to the acquirer.

e. The market value of the acquiring firm is the earnings per share times the price-earnings ratio times the number of shares outstanding, so:

EPS_A = \$4,300,000/1,400,000
EPS_A = \$3.07

P_A = 14.5(\$3.07)
P_A = \$44.54

V_A = 1,400,000(\$44.54)
V_A = \$62,350,000

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The price of the stock in the merged firm would be the market value of the acquiring firm plus the value of the target to the acquirer, divided by the number of shares in the merged firm, so:

P_{BT} = ($62,350,000 + 9,856,862.86)/(1,400,000 + 205,000)
P_{BT} = $44.99

The NPV of the stock offer is the value of the target to the acquirer minus the value offered to the target shareholders. The value offered to the target shareholders is the stock price of the merged firm times the number of shares offered, so:

NPV = $9,856,862.86 – 205,000($44.99)
NPV = $634,179.44

f. Yes, the acquisition should go forward, and Plant should offer cash since the NPV is higher.

g. Using the new growth rate in the dividend growth model, along with the dividend and required return we calculated earlier, the price of the target under these assumptions is:

P_T = $1.92(1.06)/(.1107 – .06)
P_T = $40.20

And the value of the target firm to the acquiring firm is:

V_T^* = 195,000($40.20)
V_T^* = $7,839,049.53

The gain to the acquiring firm will be:

Gain = $7,839,049.53 – 195,000($33.26)
Gain = $1,353,049.53

The NPV of the cash offer is now:

NPV cash = $7,839,049.53 – 195,000($38)
NPV cash = $429,049.53

And the new price per share of the merged firm with the stock offer will be:

P_{BT} = [$62,350,000 + 7,839,049.53]/(1,400,000 + 205,000)
P_{BT} = $43.73

And the NPV of the stock offer under the new assumption will be:

NPV stock = $7,839,049.53 – 205,000($43.73)
NPV stock = –$1,125,906.95

With the lower projected growth rate, only the cash offer has a positive NPV, although it is significantly lower. Plant should still purchase Palmer with the cash offer.

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15. *a.* To find the distribution of joint values, we first must find the joint probabilities. To do this, we need to find the joint probabilities for each possible combination of weather in the two towns. The weather conditions are independent; therefore, the joint probabilities are the products of the individual probabilities.

Possible states	Joint probability
Rain-Rain	.1(.1) = .01
Rain-Warm	.1(.4) = .04
Rain-Hot	.1(.5) = .05
Warm-Rain	.4(.1) = .04
Warm-Warm	.4(.4) = .16
Warm-Hot	.4(.5) = .20
Hot-Rain	.5(.1) = .05
Hot-Warm	.5(.4) = .20
Hot-Hot	.5(.5) = .25

Next, note that the revenue when rainy is the same regardless of which town. So, since the state "Rain-Warm" has the same outcome (revenue) as "Warm-Rain", their probabilities can be added. The same is true of "Rain-Hot"/"Hot-Rain" and "Warm-Hot"/"Hot-Warm". Thus, the joint probabilities are:

Possible states	Joint probability
Rain-Rain	.01
Rain-Warm	.08
Rain-Hot	.10
Warm-Warm	.16
Warm-Hot	.40
Hot-Hot	.25

Finally, the joint values are the sums of the values of the two companies for the particular state.

Possible states		Joint value
Rain-Rain	$250,000 + 250,000 =	$500,000
Rain-Warm	$250,000 + 425,000 =	675,000
Rain-Hot	$250,000 + 875,000 =	1,125,000
Warm-Warm	$425,000 + 425,000 =	850,000
Warm-Hot	$425,000 + 875,000 =	1,300,000
Hot-Hot	$875,000 + 875,000 =	1,750,000

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b. Recall that if a firm cannot service its debt, the bondholders receive the value of the assets. Thus, the value of the debt is reduced to the value of the company if the face value of the debt is greater than the value of the company. If the value of the company is greater than the value of the debt, the value of the debt is its face value. Here, the value of the common stock is always the residual value of the firm over the value of the debt. So, the value of the debt and the value of the stock in each state is:

Possible states	Joint Prob.	Joint Value	Debt Value	Stock Value
Rain-Rain	.01	$500,000	$500,000	$0
Rain-Warm	.08	675,000	675,000	0
Rain-Hot	.10	1,125,000	850,000	275,000
Warm-Warm	.16	850,000	850,000	0
Warm-Hot	.40	1,300,000	850,000	450,000
Hot-Hot	.25	1,750,000	850,000	900,000

c. The bondholders are better off if the value of the debt after the merger is greater than the value of the debt before the merger. The value of the debt is the smaller of the debt value or the company value. So, the value of the debt of each individual company before the merger in each state is:

Possible states	Probability	Debt Value
Rain	.10	$250,000
Warm	.40	425,000
Hot	.50	425,000

Individual debt value = .1($250,000) + .4($425,000) + .5($425,000)
Individual debt value = $407,500

This means the total value of the debt for both companies pre-merger must be:

Total debt value pre-merger = 2($407,500)
Total debt value pre-merger = $815,000

To get the expected debt value, post-merger, we can use the joint probabilities for each possible state and the debt values corresponding to each state we found in part (c). Using this information to find the value of the debt in the post-merger firm, we get:

Total debt value post-merger = .01($500,000) + .08($675,000) + .10($850,000)
+ .16($850,000) + .40($850,000) + .25($850,000)
Total debt value post-merger = $832,500

The bondholders are better off by $17,500. Since we have already shown that the total value of the combined company is the same as the sum of the values of the individual companies, the implication is that the stockholders are worse off by $17,500.

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End of Chapter Solutions
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CHAPTER 1
INTRODUCTION TO CORPORATE FINANCE

Answers to Concept Questions

1. The three basic forms are sole proprietorships, partnerships, and corporations. Some disadvantages of sole proprietorships and partnerships are: unlimited liability, limited life, difficulty in transferring ownership, and hard to raise capital funds. Some advantages are: simplicity, less regulation, the owners are also the managers, and sometimes personal tax rates are better than corporate tax rates. The primary disadvantage of the corporate form is the double taxation to shareholders on distributed earnings and dividends. Some advantages include: limited liability, ease of transferability, ability to raise capital, and unlimited life. When a business is started, most take the form of a sole proprietorship or partnership because of the relative simplicity of starting these forms of businesses.

2. To maximize the current market value (share price) of the equity of the firm (whether it's publicly traded or not).

3. In the corporate form of ownership, the shareholders are the owners of the firm. The shareholders elect the directors of the corporation, who in turn appoint the firm's management. This separation of ownership from control in the corporate form of organization is what causes agency problems to exist. Management may act in its own or someone else's best interests, rather than those of the shareholders. If such events occur, they may contradict the goal of maximizing the share price of the equity of the firm.

4. Such organizations frequently pursue social or political missions, so many different goals are conceivable. One goal that is often cited is revenue minimization; i.e., provide whatever goods and services are offered at the lowest possible cost to society. A better approach might be to observe that even a not-for-profit business has equity. Thus, one answer is that the appropriate goal is to maximize the value of the equity.

5. Presumably, the current stock value reflects the risk, timing, and magnitude of all future cash flows, both short-term *and* long-term. If this is correct, then the statement is false.

6. An argument can be made either way. At the one extreme, we could argue that in a market economy, all these things are priced. Thus, there is an optimal level of, for example, unethical and/or illegal behavior, and the framework of stock valuation explicitly includes these. At the other extreme, we could argue that these are non-economic phenomena and are best handled through the political process. A classic (and highly relevant) thought question that illustrates this debate goes something like this: "A firm has estimated that the cost of improving the safety of one of its products is $30 million. However, the firm believes that improving the safety of the product will only save $20 million in product liability claims. What should the firm do?"

7. The goal will be the same, but the best course of action toward that goal may be different because of differing social, political, and economic institutions.

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8. The goal of management should be to maximize the share price for the current shareholders. If management believes that it can improve the profitability of the firm so that the share price will exceed $35, then they should fight the offer from the outside company. If management believes that this bidder or other unidentified bidders will actually pay more than $35 per share to acquire the company, then they should still fight the offer. However, if the current management cannot increase the value of the firm beyond the bid price, and no other higher bids come in, then management is not acting in the interests of the shareholders by fighting the offer. Since current managers often lose their jobs when the corporation is acquired, poorly monitored managers have an incentive to fight corporate takeovers in situations such as this.

9. We would expect agency problems to be less severe in other countries, primarily due to the relatively small percentage of individual ownership. Fewer individual owners should reduce the number of diverse opinions concerning corporate goals. The high percentage of institutional ownership might lead to a higher degree of agreement between owners and managers on decisions concerning risky projects. In addition, institutions may be better able to implement effective monitoring mechanisms on managers than can individual owners, based on the institutions' deeper resources and experiences with their own management. The increase in institutional ownership of stock in the United States and the growing activism of these large shareholder groups may lead to a reduction in agency problems for U.S. corporations and a more efficient market for corporate control.

10. How much is too much? Who is worth more, Larry Ellison or Tiger Woods? The simplest answer is that there is a market for executives just as there is for all types of labor. Executive compensation is the price that clears the market. The same is true for athletes and performers. Having said that, one aspect of executive compensation deserves comment. A primary reason that executive compensation has grown so dramatically is that companies have increasingly moved to stock-based compensation. Such movement is obviously consistent with the attempt to better align stockholder and management interests. When stock prices soar, management cleans up. It is sometimes argued that much of this reward is due to rising stock prices in general, not managerial performance. Perhaps in the future, executive compensation will be designed to reward only differential performance, i.e., stock price increases in excess of general market increases.

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CHAPTER 2
FINANCIAL STATEMENTS AND CASH FLOW

Answers to Concept Questions

1. Liquidity measures how quickly and easily an asset can be converted to cash without significant loss in value. It's desirable for firms to have high liquidity so that they have a large factor of safety in meeting short-term creditor demands. However, since liquidity also has an opportunity cost associated with it, namely that higher returns can generally be found by investing the cash into productive assets, low liquidity levels are also desirable to the firm. It's up to the firm's financial management staff to find a reasonable compromise between these opposing needs

2. The recognition and matching principles in financial accounting call for revenues, and the costs associated with producing those revenues, to be "booked" when the revenue process is essentially complete, not necessarily when the cash is collected or bills are paid. Note that this way is not necessarily correct; it's the way accountants have chosen to do it.

3. The bottom-line number shows the change in the cash balance on the balance sheet. As such, it is not a useful number for analyzing a company.

4. The major difference is the treatment of interest expense. The accounting statement of cash flows treats interest as an operating cash flow, while the financial statement of cash flows treats interest as a financing cash flow. The logic of the accounting statement of cash flows is that since interest appears on the income statement, which shows the operations for the period, it is an operating cash flow. In reality, interest is a financing expense, which results from the company's choice of debt/equity. We will have more to say about this in a later chapter. When comparing the two cash flow statements, the financial statement of cash flows is a more appropriate measure of the company's operating performance because of its treatment of interest.

5. Market values can never be negative. Imagine a share of stock selling for –$20. This would mean that if you placed an order for 100 shares, you would get the stock along with a check for $2,000. How many shares do you want to buy? More generally, because of corporate and individual bankruptcy laws, net worth for a person or a corporation cannot be negative, implying that liabilities cannot exceed assets in market value.

6. For a successful company that is rapidly expanding, for example, capital outlays will be large, possibly leading to negative cash flow from assets. In general, what matters is whether the money is spent productively, not whether cash flow from assets is positive or negative.

7. It's probably not a good sign for an established company, but it would be fairly ordinary for a start-up, so it depends.

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8. For example, if a company were to become more efficient in inventory management, the amount of inventory needed would decline. The same might be true if it becomes better at collecting its receivables. In general, anything that leads to a decline in ending NWC relative to beginning NWC would have this effect. Negative net capital spending would mean more long-lived assets were liquidated than purchased.

9. If a company raises more money from selling stock than it pays in dividends in a particular period, its cash flow to stockholders will be negative. If a company borrows more than it pays in interest and principal, its cash flow to creditors will be negative.

10. The adjustments were purely accounting changes; they had no cash flow or market value consequences.

Solutions to Questions and Problems

NOTE: All end-of-chapter problems were solved using a spreadsheet. Many problems require multiple steps. Due to space and readability constraints, when these intermediate steps are included in this solutions manual, rounding may appear to have occurred. However, the final answer for each problem is found without rounding during any step in the problem.

Basic

1. To find owners' equity, we must construct a balance sheet as follows:

Balance Sheet			
CA	$6,400	CL	$5,100
NFA	29,300	LTD	11,800
		OE	??
TA	$35,700	TL & OE	$35,700

We know that total liabilities and owners' equity (TL & OE) must equal total assets of $35,700. We also know that TL & OE is equal to current liabilities plus long-term debt plus owners' equity, so owners' equity is:

Owners' equity = $35,700 – 11,800 – 5,100 = $18,800

NWC = CA – CL = $6,400 – 5,100 = $1,300

2. The income statement for the company is:

Income Statement	
Sales	$517,400
Costs	296,300
Depreciation	42,300
EBIT	$178,800
Interest	20,400
EBT	$158,400
Taxes (21%)	33,264
Net income	$125,136

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One equation for net income is:

Net income = Dividends + Addition to retained earnings

Rearranging, we get:

Addition to retained earnings = Net income – Dividends
Addition to retained earnings = $125,136 – 27,000
Addition to retained earnings = $98,136

3. To find the book value of current assets, we use the NWC equation, that is:

NWC = CA – CL

Rearranging to solve for current assets, we get:

CA = NWC + CL
CA = $340,000 + 1,125,000
CA = $1,465,000

So, the book value balance sheet will be:

Book Value Balance Sheet	
Current assets	$1,465,000
Fixed assets	3,900,000
Total assets	$5,365,000

The market value of current assets is given, so the market value balance sheet is:

Market Value Balance Sheet	
NWC	$ 380,000
Fixed assets	5,600,000
Total assets	$5,980,000

4. Taxes = .10($9,700) + .12($39,475 – 9,700) + .22($84,200 – 39,475) + .24($160,725 – 84,200)
+ .32($189,000 – 160,725)
Taxes = $41,796.50

The average tax rate is the total tax paid divided by taxable income, so:

Average tax rate = $41,796.50/$189,000
Average tax rate = .2211, or 22.11%

The marginal tax rate is the tax rate on the next $1 of earnings, so the marginal tax rate is 32 percent.

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5. To calculate OCF, we first need the income statement:

Income Statement	
Sales	$32,400
Costs	14,300
Depreciation expense	2,200
EBIT	$15,900
Interest expense	1,160
EBT	$14,740
Taxes (23%)	3,390
Net income	$11,350

Using the equation for OCF, we get:

OCF = EBIT + Depreciation – Taxes
OCF = $15,900 + 2,200 – 3,390
OCF = $14,709.80

6. The net capital spending is the increase in fixed assets, plus depreciation, so:

Net capital spending = $NFA_{end} - NFA_{beg}$ + Depreciation
Net capital spending = $4,630,000 – 3,820,000 + 405,000
Net capital spending = $1,215,000

7. The long-term debt account will increase by $7.6 million, the amount of the new long-term debt issue. Since the company sold 3.2 million new shares of stock with a $1 par value, the common stock account will increase by $3.2 million. The capital surplus account will increase by $17.6 million, the value of the new stock sold above its par value. Since the company had a net income of $12.24 million, and paid $2.48 million in dividends, the addition to retained earnings was $9.76 million, which will increase the accumulated retained earnings account. So, the new long-term debt and stockholders' equity portion of the balance sheet will be:

Long-term debt	$ 37,200,000
Total long-term debt	$ 37,200,000
Shareholders' equity	
Preferred stock	$ 1,680,000
Common stock ($1 par value)	10,320,000
Capital surplus	50,400,000
Accumulated retained earnings	69,960,000
Total equity	$ 132,360,000

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8. The cash flow to creditors is the interest paid minus the change in long-term debt, so:

Cash flow to creditors = Interest paid – Net new borrowing
Cash flow to creditors = \$168,000 – (LTD_{end} – LTD_{beg})
Cash flow to creditors = \$168,000 – (\$2,280,000 – 2,160,000)
Cash flow to creditors = \$48,000

9. The cash flow to stockholders is the dividends paid minus any new equity purchased by shareholders, so:

Cash flow to stockholders = Dividends paid – Net new equity
Cash flow to stockholders = \$245,000 – [($Common_{end}$ + $APIS_{end}$) – ($Common_{beg}$ + $APIS_{beg}$)]
Cash flow to stockholders = \$245,000 – [(\$536,000 + 5,560,000) – (\$486,000 + 5,040,000)]
Cash flow to stockholders = –\$325,000

Note: APIS is the additional paid-in surplus.

10. We know that the cash flow from assets must be equal to the cash flow to creditors plus the cash flow to stockholders, so:

Cash flow from assets = Cash flow to creditors + Cash flow to stockholders
Cash flow from assets = \$48,000 – 325,000
Cash flow from assets = –\$277,000

Now, we can use the relationship between the cash flow from assets and the operating cash flow, change in net working capital, and capital spending to find the operating cash flow. Doing so, we find:

Cash flow from assets	= OCF – Change in NWC – Net capital spending
–\$277,000	= OCF – (–\$59,000) – 575,000
Operating cash flow	= \$239,000

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Intermediate

11. *a.* The accounting statement of cash flows explains the change in cash during the year. The accounting statement of cash flows will be:

Statement of cash flows	
Operations	
Net income	$191
Depreciation	92
Changes in other current assets	–14
Change in accounts payable	8
Total cash flow from operations	$277
Investing activities	
Acquisition of fixed assets	–$252
Total cash flow from investing activities	–$252
Financing activities	
Proceeds of long-term debt	$48
Dividends	–58
Total cash flow from financing activities	– $10
Change in cash (on balance sheet)	$ 15

b. The change in net working capital is the ending net working capital minus the beginning net working capital, so:

$$\begin{aligned}\text{Change in NWC} &= NWC_{end} - NWC_{beg} \\ &= (CA_{end} - CL_{end}) - (CA_{beg} - CL_{beg}) \\ &= [(\$112 + 318) - 362] - [(\$97 + 304) - 354) \\ &= \$68 - 47 \\ &= \$21\end{aligned}$$

c. To find the cash flow generated by the firm's assets, we need the operating cash flow, and the capital spending. Since there are no interest payments, EBIT is the same as EBT. Calculating each of these, we find:

Operating cash flow	
EBT	$245
Depreciation	92
–Taxes	54
Operating cash flow	$283

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Next, we will calculate the capital spending, which is:

Capital spending	
Ending fixed assets	$988
–Beginning fixed assets	828
Depreciation	92
Capital spending	$252

Now we can calculate the cash flow generated by the firm's assets, which is:

Cash flow from assets	
Operating cash flow	$283
–Capital spending	252
–Change in NWC	21
Cash flow from assets	$10

Notice that the accounting statement of cash flows shows a positive cash flow, but the financial cash flows show a negative cash flow. The financial cash flow is a better number for analyzing the firm's performance.

12. To construct the cash flow identity, we will begin with cash flow from assets. Cash flow from assets is:

Cash flow from assets = OCF – Change in NWC – Net capital spending

So, the operating cash flow is:

OCF = EBIT + Depreciation – Taxes
OCF = $138,393 + 59,862 – 24,310
OCF = $173,945

Next, we will calculate the change in net working capital which is:

Change in NWC = $NWC_{end} - NWC_{beg}$
Change in NWC = $(CA_{end} - CL_{end}) - (CA_{beg} - CL_{beg})$
Change in NWC = ($59,656 – 33,831) – ($51,323 – 26,408)
Change in NWC = $910

Now, we can calculate the capital spending. The capital spending is:

Net capital spending = $NFA_{end} - NFA_{beg}$ + Depreciation
Net capital spending = $448,481 – 373,760 + 59,862
Net capital spending = $134,583

Now, we have the cash flow from assets, which is:

Cash flow from assets = OCF – Change in NWC – Net capital spending
Cash flow from assets = $173,945 – 910 – 134,583
Cash flow from assets = $38,452

The company generated $38,452 from its assets. The cash flow from operations was $173,945, and the company spent $910 on net working capital and $134,583 on fixed assets.

The cash flow to creditors is:

Cash flow to creditors = Interest paid – New long-term debt
Cash flow to creditors = Interest paid – (Long-term $debt_{end}$ – Long-term $debt_{beg}$)
Cash flow to creditors = $20,952 – ($152,400 – 148,700)
Cash flow to creditors = $17,252

The cash flow to stockholders is a little trickier in this problem. First, we need to calculate the new equity sold. The equity balance increased during the year. The only way to increase the equity balance is through addition to retained earnings or selling equity. To calculate the new equity sold, we can use the following equation:

New equity = Ending equity – Beginning equity – Addition to retained earnings
New equity = $321,906 – 249,975 – 67,931
New equity = $4,000

What happened was the equity account increased by $71,931. Of this increase, $67,931 came from addition to retained earnings, so the remainder must have been the sale of new equity. Now we can calculate the cash flow to stockholders as:

Cash flow to stockholders = Dividends paid – Net new equity
Cash flow to stockholders = $25,200 – 4,000
Cash flow to stockholders = $21,200

The company paid $17,252 to creditors and $21,200 to its stockholders.

Finally, the cash flow identity is:

Cash flow from assets = Cash flow to creditors + Cash flow to stockholders
$38,452 = $17,252 + $21,200

The cash flow identity balances, which is what we expect.

13. With the information given, we have the capital spending, change in NWC, and cash flow to stockholders. The cash flow to creditors is:

Cash flow to creditors = Interest paid – New long-term debt
Cash flow to creditors = $2,460 – 19,800
Cash flow to creditors = –$17,340

Now we can use the cash flow identity to calculate the OCF:

OCF – Change in NWC – Net capital spending = Cash flow to creditors + Cash flow to stockholders
OCF – $3,380 – $23,100 = –$17,340 + $8,520
OCF = –$17,340 + 8,520 + 3,380 + 23,100
OCF = $17,660

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14. *a.* The interest expense for the company is the amount of debt times the interest rate on the debt. So, the income statement for the company is:

Income Statement	
Sales	$529,900
Cost of goods sold	174,800
Selling expenses	102,200
Depreciation expense	60,900
EBIT	$192,000
Interest expense	28,800
EBT	$163,200
Taxes	39,168
Net income	$124,032

b. And the operating cash flow is:

OCF = EBIT + Depreciation – Taxes
OCF = $192,000 + 60,900 – 39,168
OCF = $213,732

15. To find the OCF, we first calculate net income.

Income Statement	
Sales	$315,000
Costs	208,600
Other expenses	8,600
Depreciation expense	21,400
EBIT	$76,400
Interest expense	15,700
EBT	$60,700
Taxes	12,747
Net income	$47,953
Dividends	$13,600
Addition to retained earnings	34,353

a. The operating cash flow was:

OCF = EBIT + Depreciation – Taxes
OCF = $76,400 + 21,400 – 12,747
OCF = $85,053

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b. The cash flow to creditors is the interest paid minus any net new long-term debt, so:

CFC = Interest – Net new LTD
CFC = $15,700 – (–$11,900)
CFC = $27,600

Note that the net new long-term debt is negative because the company repaid part of its long-term debt.

c. The cash flow to stockholders is the dividends paid minus any net new equity, or:

CFS = Dividends – Net new equity
CFS = $13,600 – 8,400
CFS = $5,200

d. We know that CFA = CFC + CFS, so:

CFA = $27,600 + 5,200
CFA = $32,800

CFA is also equal to (OCF – Net capital spending – Change in NWC). We already know OCF. Net capital spending is equal to:

Net capital spending = Increase in NFA + Depreciation
Net capital spending = $28,600 + 21,400
Net capital spending = $50,000

Now we can use:

CFA = OCF – Net capital spending – Change in NWC
$32,800 = $85,053 – 50,000 – Change in NWC

Solving for the change in NWC yields $2,253, meaning the company increased its NWC by $2,253.

16. The solution to this question works the income statement backwards. Starting at the bottom:

Net income = Dividends + Addition to retained earnings
Net income = $6,240 + 9,420
Net income = $15,660

Now, looking at the income statement:

EBT – (EBT × Tax rate) = Net income

Recognize that EBT × Tax rate is the calculation for taxes. Solving this for EBT yields:

EBT = NI/(1 – Tax rate)
EBT = $15,660/(1 – .21)
EBT = $19,823

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Now we can calculate:

EBIT = EBT + Interest
EBIT = $19,823 + 2,460
EBIT = $22,283

The last step is to use:

EBIT = Sales – Costs – Depreciation
$22,283 = $69,480 – 34,320 – Depreciation
Depreciation = $12,877

17. The balance sheet for the company looks like this:

Balance Sheet

Cash	$117,600	Accounts payable	$300,300
Accounts receivable	165,900	Notes payable	118,000
Inventory	269,500	Current liabilities	$418,300
Current assets	$553,000	Long-term debt	1,389,500
		Total liabilities	$1,807,800
Tangible net fixed assets	$2,387,000		
Intangible net fixed assets	579,000	Common stock	??
		Accumulated ret. earnings	1,458,800
Total assets	$3,519,000	Total liab. & owners' equity	$3,519,000

Total liabilities and owners' equity is:

TL & OE = CL + LTD + Common stock

Solving this equation for equity gives us:

Common stock = $3,519,000 – 1,807,800 – 1,458,800
Common stock = $252,400

18. The market value of shareholders' equity cannot be negative. A negative market value in this case would imply that the company would pay you to own the stock. The market value of shareholders' equity can be stated as: Shareholders' equity = Max[(TA – TL), 0]. So, if TA is $14,900, equity is equal to $1,400, and if TA is $10,700, equity is equal to $0. We should note here that the book value of shareholders' equity can be negative.

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19. *a.* The income statement for the company is:

Income Statement	
Sales	$890,000
Costs	604,000
Administrative and selling expenses	151,000
Depreciation expense	93,000
EBIT	$ 42,000
Interest expense	74,000
EBT	–$32,000
Taxes	0
Net income	–$32,000

b. OCF = EBIT + Depreciation – Taxes
OCF = $42,000 + 93,000 – 0
OCF = $135,000

c. Net income was negative because of the tax deductibility of depreciation and interest expense. However, the actual cash flow from operations was positive because depreciation is a non-cash expense and interest is a financing expense, not an operating expense.

20. A firm can still pay out dividends if net income is negative; it just has to be sure there is sufficient cash flow to make the dividend payments.

Change in NWC = Net capital spending = Net new equity = 0 (Given)

Cash flow from assets = OCF – Change in NWC – Net capital spending
Cash flow from assets = $135,000 – 0 – 0 = $135,000

Cash flow to stockholders = Dividends – Net new equity
Cash flow to stockholders = $95,000 – 0 = $95,000

Cash flow to creditors = Cash flow from assets – Cash flow to stockholders
Cash flow to creditors = $135,000 – 95,000
Cash flow to creditors = $40,000

Cash flow to creditors is also:

Cash flow to creditors = Interest – Net new LTD

So:

Net new LTD = Interest – Cash flow to creditors
Net new LTD = $74,000 – 40,000
Net new LTD = $34,000

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21. *a.* The income statement is:

Income Statement	
Sales	$53,520
Cost of goods sold	36,800
Depreciation	5,560
EBIT	$11,160
Interest	1,260
Taxable income	$ 9,900
Taxes	2,475
Net income	$ 7,425

b. OCF = EBIT + Depreciation – Taxes
OCF = $11,160 + 5,560 – 2,475
OCF = $14,245

c. Change in NWC $= NWC_{end} - NWC_{beg}$
$= (CA_{end} - CL_{end}) - (CA_{beg} - CL_{beg})$
= ($9,260 – 5,780) – ($8,210 – 5,490)
= $760

Net capital spending $= NFA_{end} - NFA_{beg}$ + Depreciation
= $42,730 – 33,020 + 5,560
= $15,270

CFA = OCF – Change in NWC – Net capital spending
= $14,245 – 760 – 15,270
= –$1,785

The cash flow from assets can be positive or negative, since it represents whether the firm raised funds or distributed funds on a net basis. In this problem, even though net income and OCF are positive, the firm invested heavily in both fixed assets and net working capital; it had to raise a net $1,785 in funds from its stockholders and creditors to make these investments.

d. Cash flow to creditors = Interest – Net new LTD
= $1,260 – 0
= $1,260

Cash flow to stockholders = Cash flow from assets – Cash flow to creditors
= –$1,785 – 1,260
= –$3,045

We can also calculate the cash flow to stockholders as:

Cash flow to stockholders = Dividends – Net new equity

Solving for net new equity, we get:

Net new equity = $2,730 – (–3,045)
= $5,775

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The firm had positive earnings in an accounting sense (NI > 0) and had positive cash flow from operations. The firm invested $760 in new net working capital and $15,270 in new fixed assets. The firm had to raise $1,785 from its stakeholders to support this new investment. It accomplished this by raising $5,775 in the form of new equity. After paying out $2,730 of this in the form of dividends to shareholders and $1,260 in the form of interest to creditors, $1,785 was left to meet the firm's cash flow needs for investment.

22. *a.* Total assets 2019 = $1,173 + 5,702 = $6,875
Total liabilities 2019 = $523 + 3,168 = $3,691
Owners' equity 2019 = $6,875 – 3,691 = $3,184

Total assets 2020 = $1,260 + 6,019 = $7,279
Total liabilities 2020 = $570 + 3,399 = $3,969
Owners' equity 2020 = $7,279 – 3,969 = $3,310

b. NWC 2019 = $CA_{2019} - CL_{2019}$ = $1,173 – 523 = $650
NWC 2020 = $CA_{2020} - CL_{2020}$ = $1,260 – 570 = $690
Change in NWC = $NWC_{2020} - NWC_{2019}$ = $690 – 650 = $40

c. We can calculate net capital spending as:

Net capital spending = Net fixed assets 2020 – Net fixed assets 2019 + Depreciation
Net capital spending = $6,019 – 5,702 + 1,472
Net capital spending = $1,789

So, the company had a net capital spending cash flow of $1,789. We also know that net capital spending is:

Net capital spending = Fixed assets bought – Fixed assets sold
$1,789 = $3,050 – Fixed assets sold
Fixed assets sold = $3,050 – 1,789
Fixed assets sold = $1,261

To calculate the cash flow from assets, we must first calculate the operating cash flow. The operating cash flow is calculated as follows (you can also prepare a traditional income statement):

EBIT = Sales – Costs – Depreciation
EBIT = $17,259 – 5,113 – 1,472
EBIT = $10,674

EBT = EBIT – Interest
EBT = $10,674 – 618
EBT = $10,674

Taxes = EBT × .25
Taxes = $10,674 × .25
Taxes = $2,514

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OCF = EBIT + Depreciation – Taxes
OCF = $10,674 + 1,472 – 2,514
OCF = $9,632

Cash flow from assets = OCF – Change in NWC – Net capital spending
Cash flow from assets = $9,632 – 40 – 1,789
Cash flow from assets = $7,803

d. Net new borrowing = $LTD_{2020} - LTD_{2019}$
Net new borrowing = $3,399 – 3,168
Net new borrowing = $231

Net new borrowing = $231 = Debt issued – Debt retired
Debt retired = $618 – 231
Debt retired = $466

Cash flow to creditors = Interest – Net new LTD
Cash flow to creditors = $618 – 231
Cash flow to creditors = $387

23.

	Balance sheet as of Dec. 31, 2019		
Cash	$25,636	Accounts payable	$32,819
Accounts receivable	33,940		
Inventory	60,344	Long-term debt	85,860
Current assets	$119,920		
Net fixed assets	$215,940	Owners' equity	217,181
Total assets	$335,860	Total liab. & equity	$335,860

	Balance sheet as of Dec. 31, 2020		
Cash	$26,227	Accounts payable	$30,767
Accounts receivable	38,327		
Inventory	62,015	Long-term debt	100,171
Current assets	$126,479		
Net fixed assets	$220,130	Owners' equity	215,671
Total assets	$346,609	Total liab. & equity	$346,609

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2019 Income Statement	
Sales	$48,892
COGS	20,628
Other expenses	3,986
Depreciation	7,024
EBIT	$17,254
Interest	2,518
EBT	$14,736
Taxes	3,684
Net income	$11,052
Dividends	$5,900
Additions to RE	5,152

2020 Income Statement	
Sales	$51,932
COGS	23,277
Other expenses	3,331
Depreciation	7,030
EBIT	$18,294
Interest	3,770
EBT	$14,524
Taxes	3,631
Net income	$10,893
Dividends	$8,600
Additions to RE	2,293

24. OCF = EBIT + Depreciation – Taxes
OCF = $18,294 + 7,030 – 3,631
OCF = $21,693

Change in NWC = $NWC_{end} - NWC_{beg} = (CA - CL)_{end} - (CA - CL)_{beg}$
Change in NWC = ($126,479 – 30,767) – (119,920 – 32,819)
Change in NWC = $8,611

Net capital spending = $NFA_{end} - NFA_{beg}$ + Depreciation
Net capital spending = $220,130 – 215,940 + 7,030
Net capital spending = $11,220

Cash flow from assets = OCF – Change in NWC – Net capital spending
Cash flow from assets = $21,693 – 8,611 – 11,220
Cash flow from assets = $1,862

Cash flow to creditors = Interest – Net new LTD
Net new LTD = $LTD_{end} - LTD_{beg}$
Cash flow to creditors = $3,770 – ($100,171 – 85,860)
Cash flow to creditors = –$10,541

Net new equity = Common $stock_{end}$ – Common $stock_{beg}$
Common stock + Retained earnings = Total owners' equity
Net new equity = $(OE - RE)_{end} - (OE - RE)_{beg}$
Net new equity = $OE_{end} - OE_{beg} + RE_{beg} - RE_{end}$
$RE_{end} = RE_{beg}$ + Additions to RE
Net new equity = $OE_{end} - OE_{beg} + RE_{beg} - (RE_{beg}$ + Additions to $RE_{2020})$
Net new equity = $OE_{end} - OE_{beg}$ – Additions to RE_{2020}
Net new equity = $215,671 – 217,181 – 2,293
Net new equity = –$3,803

Cash flow to stockholders = Dividends – Net new equity
Cash flow to stockholders = $8,600 – (–$3,803)
Cash flow to stockholders = $12,403

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As a check, cash flow from assets is $1,862.

Cash flow from assets = Cash flow to creditors + Cash flow to stockholders
Cash flow from assets = –$10,541 + 12,403
Cash flow from assets = $1,862

Challenge

25. We will begin by calculating the operating cash flow. First, we need the EBIT, which can be calculated as:

EBIT = Net income + Current taxes + Deferred taxes + Interest
EBIT = $321 + 185 + 34 + 96
EBIT = $636

Now we can calculate the operating cash flow as:

Operating cash flow	
Earnings before interest and taxes	$636
Depreciation	177
– Current taxes	–185
Operating cash flow	$628

The net capital spending is found in the investing activities portion of the accounting statement of cash flows, so:

Net capital spending	
Acquisition of fixed assets	$332
– Sale of fixed assets	–42
Capital spending	$290

The net working capital cash flows are all found in the operations cash flow section of the accounting statement of cash flows. However, instead of calculating the net working capital cash flows as the change in net working capital, we must calculate each item individually. Doing so, we find:

Net working capital cash flow	
Cash	$27
Accounts receivable	52
Inventories	–41
Accounts payable	–33
Accrued expenses	17
Other	–4
NWC cash flow	$18

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Except for the interest expense and notes payable, the cash flow to creditors is found in the financing activities of the accounting statement of cash flows. The interest expense from the income statement is given, so:

Cash flow to creditors	
Interest	$96
Retirement of debt	195
Debt service	$291
– Proceeds from sale of long-term debt	–105
Total	$186

And we can find the cash flow to stockholders in the financing section of the accounting statement of cash flows. The cash flow to stockholders was:

Cash flow to stockholders	
Dividends	$158
Repurchase of stock	26
Cash to stockholders	$184
– Proceeds from new stock issue	–50
Total	$134

26. Net capital spending $= NFA_{end} - NFA_{beg} + \text{Depreciation}$

$= (NFA_{end} - NFA_{beg}) + (\text{Depreciation} + AD_{beg}) - AD_{beg}$

$= (NFA_{end} - NFA_{beg}) + AD_{end} - AD_{beg}$

$= (NFA_{end} + AD_{end}) - (NFA_{beg} + AD_{beg}) = FA_{end} - FA_{beg}$

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Corporate Finance

Capital Markets

Sean just started his first professional job two weeks ago and his parents have already started nagging him to start investing. Since he already has a small account open at Vanguard, he reluctantly decides to give them a call to discuss his options. Help answer Sean's questions about the markets and talk him through different scenarios.

Materials

Ticker	Description	Allocation	Historic Return	Expense Ratio	Standard Deviation
VFIAX	S&P 500 Fund	50%	13.62%	0.04%	18%
VSMAX	Small Cap Fund	30%	11.62%	0.05%	23%
VBTLX	US Bond Fund	20%	3.62%	0.05%	4%

Year	Return
1	11.60%
2	-26.20%
3	17.90%
4	7.30%

Year	Sell - Return	Sell - Value
0		$1,000
1	-50%	
2	3%	
3	3%	
4	3%	
5	3%	
6	3%	

Question 1:

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Ok, looks like you currently have a few thousand dollars invested in several mutual funds.

Could you explain what those are? I'm not familiar.

Solution:

Collections of stocks, bonds, or other securities.

Question 2:

What are some characteristics of investing in individual stocks and mutual funds?

Hint:

Not quite. Stocks and mutual funds should each have 3 characteristics.

Solution:

Individual stocks	Mutual Funds
Allow you to invest in specific companies easier	Less risk
Trades are typically $5 - $10, no expense ratios	Trades are typically free, expense ratios of 0.1% - 2.0%
More risk	Allow you to invest in specific companies more easily

Question 3:

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Say that VFIAX is trading at $50 at the beginning of the year. What is the range in which we can expect it to finish the year?

Hint:

Remember that the standard deviation indicates the range (+/-) a fund is expected to deviate.

Solution:

$41.19 - $58.81

Question 4:

Why would I want to invest in small caps? They have a lower historic return and higher risk.

Solution:

- [x] Past returns do not guarantee future returns. ✓
- [ ] Investing in small caps would not be advised in this situation. ✓
- [x] It is important to represent many different parts of the market to be truly diversified. ✓
- [ ] Only invest in small caps once the historic return passes that of the S&P 500 fund. ✓

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Question 5:

What annual returns can Sean expect with your recommended portfolio? (what is the weighted average return?)

Hint:

Hint: Take the weighted average of each of the three historic returns.

Solution:

That was the third incorrect attempt.
Sean can expect a return of 11.02%.

$$\begin{aligned}&(VFIAX\ Return \times VFIAX\ weight)\\&+(VSMAX\ Return \times VSMAX\ weight)\\&+(VBTLX\ Return \times VBTLX\ weight)\\&=(13.62\% \times 50\%)+(11.62\% \times 30\%)\\&+(3.62\% \times 20\%)=11.02\%\end{aligned}$$

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Question 6:

Assume you see the returns on the right over the next 4 years. What is the geometric average return? (Enter as a percentage rounded to 1 decimal.)

Materials:

Year	**Return**
1	11.60%
2	-26.20%
3	17.90%
4	7.30%

Hint:

Hint: The geometric average return is different than taking the averages of each percentage change.

Solution:

That was the third incorrect attempt.
The geometric average return would be 4.192%.

$$(1 + Return1) \times (1 + Return2) \times (1 + Return3) \times (1 + Return4) = 1.116 \times 0.738 \times 1.179 \times 1.073 = 4.192\%$$

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Question 7:

Why is it important not to suddenly change your investment strategy?

Hint:

Is that the only reason?

Solution:

All of these

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Question 8:

Let me show you an example (right of screen). Let's say you invest $1,000 today. Over the next year, the market drops 50 percent. In Scenario 1, you panic and sell all of your stock, locking in your loss. You go and buy Treasury bills, which give you a safe, guaranteed 3 percent annual return.

How much is Sean's portfolio worth at the end of Year 6 in this scenario? (Round to the nearest dollar.)

Materials:

Year	Sell - Return	Sell - Value
0		$1,000
1	-50%	
2	3%	
3	3%	
4	3%	
5	3%	
6	3%	

Hint:

Hint: Start at $1,000 and multiply each year's return to get to the portfolio value in year 6.

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Solution:

That was the third incorrect attempt.
Sean's portfolio would be worth $579.63 at the end of Year 6.
Please see table to the right for annual returns and portfolio values.

Year	Sell - Return	Sell - Value
0		$1,000
1	-50%	$500
2	3%	$515
3	3%	$530
4	3%	$546
5	3%	$563
6	3%	$580

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Question 9:

Scenario 2 is you stay calm and don't sell or change anything.

How much is Sean's portfolio worth at the end of year 6 in scenario 2? (Round to the nearest dollar).

Materials:

Year	Sell - Return	Sell - Value		Stay Invested - Return
0		$1,000		
1	-50%	$500		-50%
2	3%	$515		13%
3	3%	$530		30%
4	3%	$546		5%
5	3%	$563		23%
6	3%	$580		31%

Hint:

Hint: Start at $1,000 and multiply each year's return to get to the portfolio value in year 6.

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Solution:

That was the third incorrect attempt.
Sean's portfolio would be worth $1,241.47 after year 6 in this scenario.
Please see table to the right for annual returns and portfolio values.

Year	Sell - Return	Sell - Value		Stay Invested - Return	Stay Invested - Value
0		$1,000			$1,000
1	-50%	$500		-50%	$500
2	3%	$515		13%	$566
3	3%	$530		30%	$736
4	3%	$546		5%	$774
5	3%	$563		23%	$951
6	3%	$580		31%	$1,241

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