Finite Mathematics and Applied Calculus 8th edition Waner Solutions Manual

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Section 0.1

1. $2(4+(-1))(2\cdot -4)$
$= 2(3)(-8) = (6)(-8) = -48$

2. $3+([4-2]\cdot 9)$
$= 3+(2\times 9) = 3+18 = 21$

3. $20/(3*4)-1$
$= \frac{20}{12}-1 = \frac{5}{3}-1 = \frac{2}{3}$

4. $2-(3*4)/10$
$= 2-\frac{12}{10} = 2-\frac{6}{5} = \frac{4}{5}$

5. $\dfrac{3+([3+(-5)])}{3-2\times 2}$
$= \dfrac{3+(-2)}{3-4} = \dfrac{1}{-1} = -1$

6. $\dfrac{12-(1-4)}{2(5-1)\cdot 2-1}$
$= \dfrac{12-(-3)}{16-1} = \dfrac{15}{15} = 1$

7. $(2-5*(-1))/1-2*(-1)$
$= \dfrac{2-5\cdot(-1)}{1}-2\cdot(-1)$
$= \dfrac{2+5}{1}+2 = 7+2 = 9$

8. $2-5*(-1)/(1-2*(-1))$
$= 2-\dfrac{5\cdot(-1)}{1-2\cdot(-1)}$
$= 2-\dfrac{-5}{1+2}+2 = 2+\dfrac{5}{3} = \dfrac{11}{5}$

9. $2\cdot(-1)^2/2 = \dfrac{2\times(-1)^2}{2}$
$= \dfrac{2\times 1}{2} = \dfrac{2}{2} = 1$

10. $2+4\cdot 3^2 = 2+4\times 9 = 2+36 = 38$

11. $2\cdot 4^2+1$
$= 2\times 16+1 = 32+1 = 33$

12. $1-3\cdot(-2)^2\times 2$
$= 1-3\times 4\times 2 = 1-24 = -23$

13. `3^2+2^2+1`
$= 3^2+2^2+1 = 9+4+1 = 14$

14. `2^(2^2-2)`
$= 2^{(2^2-2)} = 2^{4-2} = 2^2 = 4$

15. $\dfrac{3-2(-3)^2}{-6(4-1)^2}$
$= \dfrac{3-2\times 9}{-6(3)^2} = \dfrac{3-18}{-6\times 9}$
$= \dfrac{-15}{-54} = \dfrac{5}{18}$

16. $\dfrac{1-2(1-4)^2}{2(5-1)^2\cdot 2}$
$= \dfrac{1-2(-3)^2}{2(4)^2\cdot 2} = \dfrac{1-2\times 9}{2\times 16\times 2}$
$= \dfrac{1-18}{64} = -\dfrac{17}{64}$

17. `10*(1+1/10)^3`
$= 10\left(1+\dfrac{1}{10}\right)^3 = 10(1.1)^3$
$= 10\times 1.331 = 13.31$

18. `121/(1+1/10)^2`
$= \dfrac{121}{\left(1+\frac{1}{10}\right)^2} = \dfrac{121}{1.1^2}$
$= \dfrac{121}{1.21} = 100$

19. $3\left[\frac{-2\cdot 3^2}{-(4-1)^2}\right]$
$= 3\left[\frac{-2\times 9}{-3^2}\right] = 3\left[\frac{-18}{-9}\right]$
$= 3\times 2 = 6$

20. $-\left[\frac{8(1-4)^2}{-9(5-1)^2}\right]$
$= -\left[\frac{8\times 9}{-9\times 16}\right] = -\left(\frac{72}{-144}\right)$
$= -\left(-\frac{1}{2}\right) = \frac{1}{2}$

21. $3\left[1-\left(-\frac{1}{2}\right)^2\right]^2+1$
$= 3\left[1-\frac{1}{4}\right]^2+1$
$= 3\left[\frac{3}{4}\right]^2+1 = 3\left[\frac{9}{16}\right]+1$
$= \frac{27}{16}+1 = \frac{43}{16}$

22. $3\left[\frac{1}{9}-\left(\frac{2}{3}\right)^2\right]^2+1$
$= 3\left[\frac{1}{9}-\frac{4}{9}\right]^2+1$
$= 3\left[\frac{-3}{9}\right]^2+1 = 3\left[\frac{-1}{3}\right]^2+1$
$= 3\,\frac{1}{9}+1 = \frac{3}{9}+1 = \frac{4}{3}$

23. `(1/2)^2-1/2^2`
$= \left[\frac{1}{2}\right]^2 - \frac{1}{2^2} = \frac{1}{4}-\frac{1}{4} = 0$

24. `2/(1^2)-(2/1)^2`
$= \frac{2}{1^2} - \left[\frac{2}{1}\right]^2 = \frac{2}{1}-\frac{4}{1} = -2$

25. $3\times(2-5) =$ `3*(2-5)`

26. $4+\frac{5}{9} =$ `4+5/9` or `4+(5/9)`

27. $\frac{3}{2-5} =$ `3/(2-5)`

28. $\frac{4-1}{3} =$ `(4-1)/3`

29. $\frac{3-1}{8+6} =$ `(3-1)/(8+6)`
Note `3-1/8-6` is wrong, as it corresponds to $3-\frac{1}{8}-6$.

30. $3+\frac{3}{2-9} =$ `3+3/(2-9)`

31. $3-\frac{4+7}{8} =$ `3-(4+7)/8`

32. $\frac{4\times 2}{\left(\frac{2}{3}\right)} =$ `4*2/(2/3)` or `(4*2)/(2/3)`

33. $\frac{2}{3+x}-xy^2 =$ `2/(3+x)-x*y^2`

34. $3+\frac{3+x}{xy} =$ `3+(3+x)/(x*y)`

35. $3.1x^3-4x^{-2}-\frac{60}{x^2-1}$
$=$ `3.1x^3-4x^(-2)-60/(x^2-1)`

36. $2.1x^{-3}-x^{-1}+\frac{x^2-3}{2}$
$=$ `2.1x^(-3)-x^(-1)+(x^2-3)/2`

37. $\dfrac{\left(\frac{2}{3}\right)}{5}$
= `(2/3)/5`

38. $\dfrac{2}{\left(\frac{3}{5}\right)}$
= `2/(3/5)`

39. $3^{4-5} \times 6$
= `3^(4-5)*6`
Note that the entire exponent is in parentheses.

40. $\frac{2}{3+5^{7-9}}$
= `2/(3+5^(7-9))`
Note that the entire exponent is in parentheses.

41. $3\left(1+\dfrac{4}{100}\right)^{-3}$
= `3*(1+4/100)^(-3)`

42. $3\left(\dfrac{1+4}{100}\right)^{-3}$
= `3((1+4)/100)^(-3)`

43. $3^{2x-1}+4^x-1$
= `3^(2*x-1)+4^x-1`

44. $2^{x^2}-(2^{2x})^2$
= `2^(x^2)-(2^(2*x))^2`

45. 2^{2x^2-x+1}
= `2^(2x^2-x+1)`
Note that the entire exponent is in parentheses.

46. $2^{2x^2-x}+1$
= `2^(2x^2-x)+1`
Note that the entire exponent is in parentheses.

47. $\dfrac{4e^{-2x}}{2-3e^{-2x}}$
= `4*e^(-2*x)/(2-3e^(-2*x))`
or `4(*e^(-2*x))/(2-3e^(-2*x))`
or `(4*e^(-2*x))/(2-3e^(-2*x))`

48. $\dfrac{e^{2x}+e^{-2x}}{e^{2x}-e^{-2x}}$
= `(e^(2*x)+e^(-2*x))/(e^(2*x)-e^(-2*x))`

49. $3\left(1-\left(-\frac{1}{2}\right)^2\right)^2+1$
= `3(1-(-1/2)^2)^2+1`

50. $3\left(\frac{1}{9}-\left(\frac{2}{3}\right)^2\right)^2+1$
= `3(1/9-(2/3)^2)^2+1`

Section 0.2

1. $3^3 = 27$

2. $(-2)^3 = -8$

3. $-(2 \cdot 3)^2 = -(2^2 \cdot 3^2) = -(4 \cdot 9) = -36$
or
$-(2 \cdot 3)^2 = -6^2 = -36$

4. $(4 \cdot 2)^2 = 4^2 \cdot 2^2 = 16 \cdot 4 = 64$ or
$(4 \cdot 2)^2 = 8^2 = 64$

5. $\left(\frac{-2}{3}\right)^2 = \frac{(-2)^2}{3^2} = \frac{4}{9}$

6. $\left(\frac{3}{2}\right)^3 = \frac{3^3}{2^3} = \frac{27}{8}$

7. $(-2)^{-3} = \frac{1}{(-2)^3} = \frac{1}{-8} = -\frac{1}{8}$

8. $-2^{-3} = -\frac{1}{2^3} = -\frac{1}{8}$

9. $\left(\frac{1}{4}\right)^{-2} = \frac{1}{(1/4)^2} = \frac{1}{1/16} = 16$

10. $\left(\frac{-2}{3}\right)^{-2} = \frac{1}{(-2/3)^2} = \frac{1}{4/9} = \frac{9}{4}$

11. $2 \cdot 3^0 = 2 \cdot 1 = 2$

12. $3 \cdot (-2)^0 = 3 \cdot 1 = 3$

13. $2^3 2^2 = 2^{3+2} = 2^5 = 32$
or
$2^3 2^2 = 8 \cdot 4 = 32$

14. $3^2 3 = 3^2 3^1 = 3^{2+1} = 3^3 = 27$or
$3^2 3 = 9 \cdot 3 = 27$

15. $2^2 2^{-1} 2^4 2^{-4} = 2^{2-1+4-4} = 2^1 = 2$

16. $5^2 5^{-3} 5^2 5^{-2} = 5^{2-3+2-2} = 5^{-1} = \frac{1}{5}$

17. $x^3 x^2 = x^{3+2} = x^5$

18. $x^4 x^{-1} = x^{4-1} = x^3$

19. $-x^2 x^{-3} y = -x^{2-3} y = -x^{-1} y = -\frac{y}{x}$

20. $-xy^{-1}x^{-1} = -x^{1-1}y^{-1} = -x^0 y^{-1}$
$= -\frac{1}{y}$

21. $\frac{x^3}{x^4} = x^{3-4} = x^{-1} = \frac{1}{x}$

22. $\frac{y^5}{y^3} = y^{5-3} = y^2$

23. $\frac{x^2 y^2}{x^{-1} y} = x^{2-(-1)} y^{2-1} = x^3 y$

24. $\frac{x^{-1} y}{x^2 y^2} = x^{-1-2} y^{1-2} = x^{-3} y^{-1} = \frac{1}{x^3 y}$

25. $\dfrac{(xy^{-1}z^3)^2}{x^2yz^2} = \dfrac{x^2(y^{-1})^2(z^3)^2}{x^2yz^2}$
$= \dfrac{x^2y^{-2}z^6}{x^2yz^2} = x^{2-2}y^{-2-1}z^{6-2}$
$= x^0y^{-3}z^4 = \dfrac{z^4}{y^3}$

26. $\dfrac{x^2yz^2}{(xyz^{-1})^{-1}} = \dfrac{x^2yz^2}{x^{-1}y^{-1}(z^{-1})^{-1}}$
$= \dfrac{x^2yz^2}{x^{-1}y^{-1}z} = x^{2-(-1)}y^{1-(-1)}z^{2-1}$
$= x^3y^2z^4$

27. $\left(\dfrac{xy^{-2}z}{x^{-1}z}\right)^3 = \dfrac{(xy^{-2}z)^3}{(x^{-1}z)^3}$
$= \dfrac{x^3y^{-6}z^3}{x^{-3}z^3} = x^{3-(-3)}y^{-6}z^{3-3}$
$= x^6y^{-6}z^0 = \dfrac{x^6}{y^6}$

28. $\left(\dfrac{x^2y^{-1}z^0}{xyz}\right)^2 = \dfrac{(x^2y^{-1}z^0)^2}{(xyz)^2}$
$= \dfrac{x^4y^{-2}}{x^2y^2z^2} = x^{4-2}y^{-2-2}z^{-2}$
$= x^2y^{-4}z^{-2} = \dfrac{x^2}{y^4z^2}$

29. $\left(\dfrac{x^{-1}y^{-2}z^2}{xy}\right)^{-2} = (x^{-1-1}y^{-2-1}z^2)^{-2}$
$= (x^{-2}y^{-3}z^2)^{-2} = x^4y^6z^{-4}$
$= \dfrac{x^4y^6}{z^4}$

30. $\left(\dfrac{xy^{-2}}{x^2y^{-1}z}\right)^{-3} = (x^{1-2}y^{-2+1}z^{-1})^{-3}$
$= (x^{-1}y^{-1}z^{-1})^{-3} = x^3y^3z^3$

31. $\sqrt{4} = 2$

32. $\sqrt{5} \approx 2.236$

33. $\sqrt{\dfrac{1}{4}} = \dfrac{\sqrt{1}}{\sqrt{4}} = \dfrac{1}{2}$

34. $\sqrt{\dfrac{1}{9}} = \dfrac{\sqrt{1}}{\sqrt{9}} = \dfrac{1}{3}$

35. $\sqrt{\dfrac{16}{9}} = \dfrac{\sqrt{16}}{\sqrt{9}} = \dfrac{4}{3}$

36. $\sqrt{\dfrac{9}{4}} = \dfrac{\sqrt{9}}{\sqrt{4}} = \dfrac{3}{2}$

37. $\dfrac{\sqrt{4}}{5} = \dfrac{2}{5}$

38. $\dfrac{6}{\sqrt{25}} = \dfrac{6}{5}$

39. $\sqrt{9} + \sqrt{16} = 3 + 4 = 7$

40. $\sqrt{25} - \sqrt{16} = 5 - 4 = 1$

41. $\sqrt{9+16} = \sqrt{25} = 5$

42. $\sqrt{25-16} = \sqrt{9} = 3$

43. $\sqrt[3]{8-27} = \sqrt[3]{-19} \approx -2.668$

44. $\sqrt[4]{81-16} = \sqrt[4]{65} \approx 2.839$

45. $\sqrt[3]{27/8} = \dfrac{\sqrt[3]{27}}{\sqrt[3]{8}} = \dfrac{3}{2}$

46. $\sqrt[3]{8 \times 64} = \sqrt[3]{8} \cdot \sqrt[3]{64} = 2 \cdot 4 = 8$

47. $\sqrt{(-2)^2} = \sqrt{4} = 2$

48. $\sqrt{(-1)^2} = \sqrt{1} = 1$

49. $\sqrt{\frac{1}{4}(1+15)} = \sqrt{\frac{16}{4}} = \frac{\sqrt{16}}{\sqrt{4}} = \frac{4}{2} = 2$

50. $\sqrt{\frac{1}{9}(3+33)} = \sqrt{\frac{36}{9}} = \frac{\sqrt{36}}{\sqrt{9}} = \frac{6}{3} = 2$

51. $\sqrt{a^2b^2} = \sqrt{a^2}\sqrt{b^2} = ab$

52. $\sqrt{\frac{a^2}{b^2}} = \frac{\sqrt{a^2}}{\sqrt{b^2}} = \frac{a}{b}$

53. $\sqrt{(x+9)^2} = x+9$
($x+9>0$ because x is positive.)

54. $\left(\sqrt{x+9}\right)^2 = x+9$

55. $\sqrt[3]{x^3(a^3+b^3)} = \sqrt[3]{x^3}\,\sqrt[3]{(a^3+b^3)}$
$= x\,\sqrt[3]{(a^3+b^3)}$ (*Not* $x(a+b)$)

56. $\sqrt[4]{\frac{x^4}{a^4b^4}} = \frac{\sqrt[4]{x^4}}{\sqrt[4]{a^4}\,\sqrt[4]{b^4}} = \frac{x}{ab}$

57. $\sqrt{\frac{4xy^3}{x^2y}} = \sqrt{\frac{4y^2}{x}} = \frac{\sqrt{4}\sqrt{y^2}}{\sqrt{x}} = \frac{2y}{\sqrt{x}}$

58. $\sqrt{\frac{4(x^2+y^2)}{c^2}} = \frac{\sqrt{4}\sqrt{x^2+y^2}}{\sqrt{c^2}}$
$= \frac{2\sqrt{x^2+y^2}}{c}$ (*Not* $2(x+y)/c$)

Section 0.3

1. $3x^{-4} = \dfrac{3}{x^4}$

2. $\dfrac{1}{2}x^{-4} = \dfrac{1}{2x^4}$

3. $\dfrac{3}{4}x^{-2/3} = \dfrac{3}{4x^{2/3}}$

4. $\dfrac{4}{5}y^{-3/4} = \dfrac{4}{5y^{3/4}}$

5. $1 - \frac{0.3}{x^{-2}} - \frac{6}{5}x^{-1} = 1 - 0.3x^2 - \frac{6}{5x}$

6. $\dfrac{1}{3x^{-4}} + \dfrac{0.1x^{-2}}{3} = \dfrac{x^4}{3} + \dfrac{0.1}{3x^2}$

7. $2^{2/3} = \sqrt[3]{2^2}$

8. $3^{4/5} = \sqrt[5]{3^4}$

9. $x^{4/3} = \sqrt[3]{x^4} = \sqrt[3]{x^3}\,\sqrt[3]{x} = x\,\sqrt[3]{x}$

10. $y^{7/4} = \sqrt[4]{y^7} = \sqrt[4]{y^4}\,\sqrt[4]{y^3} = |y|\,\sqrt[4]{y^3}$

11. $\left(x^{1/2}y^{1/3}\right)^{1/5} = \sqrt[5]{\sqrt{x}\,\sqrt[3]{y}}$

12. $x^{-1/3}y^{3/2} = \dfrac{y^{3/2}}{x^{1/3}} = \dfrac{\sqrt{y^3}}{\sqrt[3]{x}} = \dfrac{|y|\sqrt{y}}{\sqrt[3]{x}}$

13. $-\dfrac{3}{2}x^{-1/4} = -\dfrac{3}{2x^{1/4}} = -\dfrac{3}{2\sqrt[4]{x}}$

14. $\dfrac{4}{5}x^{3/2} = \dfrac{4\sqrt{x^3}}{5} = \dfrac{4|x|\sqrt{x}}{5}$

15. $0.2x^{-2/3} + \dfrac{3}{7x^{-1/2}} = \dfrac{0.2}{x^{2/3}} + \dfrac{3x^{1/2}}{7}$

$= \dfrac{0.2}{\sqrt[3]{x^2}} + \dfrac{3\sqrt{x}}{7}$

16. $\dfrac{3.1}{x^{-4/3}} - \dfrac{11}{7}x^{-1/7} = 3.1x^{4/3} - \dfrac{11}{7x^{1/7}}$

$= 3.1\,\sqrt[3]{x^4} - \dfrac{11}{7\sqrt[7]{x}} = 3.1x\,\sqrt[3]{x} - \dfrac{11}{7\sqrt[7]{x}}$

17. $\dfrac{3}{4(1-x)^{5/2}} = \dfrac{3}{4\sqrt{(1-x)^5}}$

$= \dfrac{3}{4\sqrt{(1-x)^4}\sqrt{1-x}}$

$= \dfrac{3}{4(1-x)^2\sqrt{1-x}}$

18. $\dfrac{9}{4(1-x)^{-7/3}} = \dfrac{9(1-x)^{7/3}}{4}$

$= \dfrac{9\,\sqrt[3]{(1-x)^7}}{4} = \dfrac{9\,\sqrt[3]{(1-x)^6}\,\sqrt[3]{1-x}}{4}$

$= \dfrac{9(1-x)^2\,\sqrt[3]{1-x}}{4}$

19. $\sqrt{3} = 3^{1/2}$

20. $\sqrt{8} = 8^{1/2}$

21. $\sqrt{x^3} = x^{3/2}$

22. $\sqrt[3]{x^2} = x^{2/3}$

23. $\sqrt[3]{xy^2} = (xy^2)^{1/3}$

24. $\sqrt{x^2y} = (x^2y)^{1/2}$

25. $\dfrac{x^2}{\sqrt{x}} = \dfrac{x^2}{x^{1/2}} = x^{2-1/2} = x^{3/2}$

26. $\dfrac{x}{\sqrt{x}} = \dfrac{x}{x^{1/2}} = x^{1-1/2} = x^{1/2}$

27. $\dfrac{3}{5x^2} = \dfrac{3}{5}x^{-2}$

28. $\dfrac{2}{5x^{-3}} = \dfrac{2}{5}x^3$

29. $\dfrac{3x^{-1.2}}{2} - \dfrac{1}{3x^{2.1}} = \dfrac{3}{2}x^{-1.2} - \dfrac{1}{3}x^{-2.1}$

30. $\dfrac{2}{3x^{-1.2}} - \dfrac{x^{2.1}}{3} = \dfrac{2}{3}x^{1.2} - \dfrac{1}{3}x^{2.1}$

31. $\dfrac{2x}{3} - \dfrac{x^{0.1}}{2} + \dfrac{4}{3x^{1.1}}$
$= \dfrac{2}{3}x - \dfrac{1}{2}x^{0.1} + \dfrac{4}{3}x^{-1.1}$

32. $\dfrac{4x^2}{3} + \dfrac{x^{3/2}}{6} - \dfrac{2}{3x^2}$
$= \dfrac{4}{3}x^2 + \dfrac{1}{6}x^{3/2} - \dfrac{2}{3}x^{-2}$

33. $\dfrac{3\sqrt{x}}{4} - \dfrac{5}{3\sqrt{x}} + \dfrac{4}{3x\sqrt{x}}$
$= \dfrac{3x^{1/2}}{4} - \dfrac{5}{3x^{1/2}} + \dfrac{4}{3x \cdot x^{1/2}}$
$= \dfrac{3}{4}x^{1/2} - \dfrac{5}{3}x^{-1/2} + \dfrac{4}{3}x^{-3/2}$

34. $\dfrac{3}{5\sqrt{x}} - \dfrac{5\sqrt{x}}{8} + \dfrac{7}{2\sqrt[3]{x}}$
$= \dfrac{3}{5x^{1/2}} - \dfrac{5x^{1/2}}{8} + \dfrac{7}{2x^{1/3}}$
$= \dfrac{3}{5}x^{-1/2} - \dfrac{5}{8}x^{1/2} + \dfrac{7}{2}x^{-1/3}$

35. $\dfrac{3\sqrt[5]{x^2}}{4} - \dfrac{7}{2\sqrt{x^3}} = \dfrac{3x^{2/5}}{4} - \dfrac{7}{2x^{3/2}}$
$= \dfrac{3}{4}x^{2/5} - \dfrac{7}{2}x^{-3/2}$

36. $\dfrac{1}{8x\sqrt{x}} - \dfrac{2}{3\sqrt[5]{x^3}} = \dfrac{1}{8x^{3/2}} - \dfrac{2}{3x^{3/5}}$
$= \dfrac{1}{8}x^{-3/2} - \dfrac{2}{3}x^{-3/5}$

37. $\dfrac{1}{(x^2+1)^3} - \dfrac{3}{4\sqrt[3]{x^2+1}}$
$= \dfrac{1}{(x^2+1)^3} - \dfrac{3}{(x^2+1)^{1/3}}$
$= (x^2+1)^{-3} - \dfrac{3}{4}(x^2+1)^{-1/3}$

38. $\dfrac{2}{3(x^2+1)^{-3}} - \dfrac{3\sqrt[3]{(x^2+1)^7}}{4}$
$= \dfrac{2}{3}(x^2+1)^3 - \dfrac{3}{4}(x^2+1)^{7/3}$

39. $4^{-1/2}4^{7/2} = 4^{-1/2+7/2} = 4^{6/2} = 4^3 = 64$

40. $\dfrac{2^{1/a}}{2^{2/a}} = 2^{1/a-2/a} = 2^{-1/a} = \dfrac{1}{2^{1/a}}$

41. $3^{2/3}3^{-1/6} = 3^{2/3-1/6} = 3^{1/2} = \sqrt{3}$

42. $2^{1/3}2^{-1}2^{2/3}2^{-1/3} = 2^{1/3-1+2/3-1/3}$
$= 2^{-1/3} = \dfrac{1}{2^{1/3}}$

43. $\dfrac{x^{3/2}}{x^{5/2}} = x^{3/2-5/2} = x^{-1} = \dfrac{1}{x}$

44. $\dfrac{y^{5/4}}{y^{3/4}} = y^{5/4-3/4} = y^{1/2} = \sqrt{y}$

45. $\dfrac{x^{1/2}y^2}{x^{-1/2}y} = x^{1/2-(-1/2)}y^{2-1} = xy$

46. $\dfrac{x^{-1/2}y}{x^2y^{3/2}} = x^{-1/2-2}y^{1-3/2} = x^{-5/2}y^{-1/2}$

47. $\left(\dfrac{x}{y}\right)^{1/3}\left(\dfrac{y}{x}\right)^{2/3} = \dfrac{x^{1/3}}{y^{1/3}} \cdot \dfrac{y^{2/3}}{x^{2/3}}$
$= x^{1/3-2/3}y^{-1/3+2/3}$
$= x^{-1/3}y^{1/3}$ or $\left(\frac{y}{x}\right)^{1/3}$

48. $\left(\dfrac{x}{y}\right)^{-1/3}\left(\dfrac{y}{x}\right)^{1/3} = \dfrac{x^{-1/3}}{y^{-1/3}} \cdot \dfrac{y^{1/3}}{x^{1/3}}$
$x^{-1/3-1/3}y^{1/3+1/3}$
$= x^{-2/3}y^{2/3}$ or $\left(\frac{y}{x}\right)^{2/3}$

49. $x^2 - 16 = 0 \Rightarrow x^2 = 16$
$\Rightarrow x = \pm\sqrt{16} \Rightarrow x = \pm 4$

50. $x^2 - 1 = 0 \Rightarrow x^2 = 1$
$\Rightarrow x = \pm\sqrt{1} \Rightarrow x = \pm 1$

51. $x^2 - \dfrac{4}{9} = 0 \Rightarrow x^2 = \dfrac{4}{9}$
$\Rightarrow x = \pm\sqrt{\dfrac{4}{9}} \Rightarrow x = \pm\dfrac{2}{3}$

52. $x^2 - \dfrac{1}{10} = 0 \Rightarrow x^2 = \dfrac{1}{10}$
$\Rightarrow x = \pm\sqrt{\dfrac{1}{10}} \Rightarrow x = \pm\dfrac{1}{\sqrt{10}}$

53. $x^2 - (1+2x)^2 = 0 \Rightarrow x^2 = (1+2x)^2$
$\Rightarrow x = \pm 1 + 2x$
If $x = 1 + 2x$, then $-x = 1 \Rightarrow x = -1$.
If $x = -(1+2x)$, then $= -1 \Rightarrow x = -\dfrac{1}{3}$.
So, $x = 1$ or $-\dfrac{1}{3}$.

54. $x^2 - (2-3x)^2 = 0 \Rightarrow x^2 = (2-3x)^2$
$\Rightarrow x = \pm 2 - 3x$
If $x = 2 - 3x$, then $4x = 2 \Rightarrow x = \dfrac{1}{2}$.
If $x = -(2-3x)$, then $-2x = -2 \Rightarrow x = 1$.
So, $x = 1$ or $\dfrac{1}{2}$.

55. $x^5 + 32 = 0 \Rightarrow x^5 = -32$
$\Rightarrow x = \sqrt[5]{-32} = -2$

56. $x^4 - 81 = 0 \Rightarrow x^4 = 81$
$\Rightarrow x = \pm\sqrt[4]{81} = \pm 3$

57. $x^{1/2} - 4 = 0 \Rightarrow x^{1/2} = 4$
$\Rightarrow x = 4^2 = 16$

58. $x^{1/3} - 2 = 0 \Rightarrow x^{1/3} = 2$
$\Rightarrow x = 2^3 = 8$

59. $1 - \dfrac{1}{x^2} = 0 \Rightarrow 1 = \dfrac{1}{x^2}$
$\Rightarrow x^2 = 1 \Rightarrow x = \pm\sqrt{1} = \pm 1$

60. $\dfrac{2}{x^3} - \dfrac{6}{x^4} = 0 \Rightarrow \dfrac{2}{x^3} = \dfrac{6}{x^4}$
$\Rightarrow 2x^4 = 6x^3 \Rightarrow 2x = 6 \Rightarrow x = 3$

61. $(x-4)^{-1/3} = 2 \Rightarrow x - 4 = 2^{-3} = \dfrac{1}{8}$
$\Rightarrow x = 4 + \dfrac{1}{8} = \dfrac{33}{8}$

62. $(x-4)^{2/3} + 1 = 5 \Rightarrow (x-4)^{2/3} = 4$
$\Rightarrow x - 4 = \pm 4^{3/2} = \pm 8$
$\Rightarrow x = 4 \pm 8 = -4$ or 12

Section 0.4

1. $x(4x+6) = 4x^2 + 6x$

2. $(4y-2)y = 4y^2 - 2y$

3. $(2x-y)y = 2xy - y^2$

4. $x(3x+y) = 3x^2 + xy$

5. $(x+1)(x-3) = x^2 + x - 3x - 3$
$= x^2 - 2x - 3$

6. $(y+3)(y+4) = y^2 + 3y + 4y + 12$
$= y^2 + 7y + 12$

7. $(2y+3)(y+5) = 2y^2 + 3y + 10y + 15$
$= 2y^2 + 13y + 15$

8. $(2x-2)(3x-4) = 6x^2 - 6x - 8x + 8$
$= 6x^2 - 14x + 8$

9. $(2x-3)^2 = 4x^2 - 12x + 9$

10. $(3x+1)^2 = 9x^2 + 6x + 1$

11. $\left(x + \frac{1}{x}\right)^2 = x^2 + 2 + \frac{1}{x^2}$

12. $\left(y - \frac{1}{y}\right)^2 = y^2 - 2 + \frac{1}{y^2}$

13. $(2x-3)(2x+3) = (2x)^2 - 3^2 = 4x^2 - 9$

14. $(4+2x)(4-2x) = 4^2 - (2x)^2 = 16 - 4x^2$

15. $\left(y - \frac{1}{y}\right)\left(y + \frac{1}{y}\right) = y^2 - \left(\frac{1}{y}\right)^2 = y^2 - \frac{1}{y^2}$

16. $(x - x^2)(x + x^2) = x^2 - (x^2)^2 = x^2 - x^4$

17. $(x^2 + x - 1)(2x+4)$
$= x^2(2x+4) + x(2x+4) - 1(2x+4)$
$= 2x^3 + 4x^2 + 2x^2 + 4x - 2x - 4$
$= 2x^3 + 6x^2 + 2x - 4$

18. $(3x+1)(2x^2 - x + 1)$
$= 3x(2x^2 - x + 1) + 1(2x^2 - x + 1)$
$= 6x^3 - 3x^2 + 3x + 2x^2 - x + 1$
$= 6x^3 - x^2 + 2x + 1$

19. $(x^2 - 2x + 1)^2 = (x^2 - 2x + 1)(x^2 - 2x + 1)$
$= x^2(x^2 - 2x + 1) - 2x(x^2 - 2x + 1) + 1(x^2 - 2x + 1)$
$= x^4 - 2x^3 + x^2 - 2x^3 + 4x^2 - 2x + x^2 - 2x + 1$
$= x^4 - 4x^3 + 6x^2 - 4x + 1$

20. $(x + y - xy)^2 = (x + y - xy)(x + y - xy)$
$= x(x + y - xy) + y(x + y - xy) - xy(x + y - xy)$
$= x^2 + xy - x^2y + xy + y^2 - xy^2 - x^2y - xy^2 + x^2y^2$
$= x^2 + 2xy + y^2 - 2x^2y - 2xy^2 + x^2y^2$

21. $(y^3 + 2y^2 + y)(y^2 + 2y - 1)$
$= y^3(y^2 + 2y - 1) + 2y^2(y^2 + 2y - 1) + y(y^2 + 2y - 1)$
$= y^5 + 2y^4 - y^3 + 2y^4 + 4y^3 - 2y^2 + y^3 + 2y^2 - y$
$= y^5 + 4y^4 + 4y^3 - y$

22. $(x^3 - 2x^2 + 4)(3x^2 - x + 2)$
$= x^3(3x^2 - x + 2) - 2x^2(3x^2 - x + 2) + 4(3x^2 - x + 2)$
$= 3x^5 - x^4 + 2x^3 - 6x^4 + 2x^3 - 4x^2 + 12x^2 - 4x + 8$
$= 3x^5 - 7x^4 + 4x^3 + 8x^2 - 4x + 8$

23. $(x + 1)(x + 2) + (x + 1)(x + 3)$
$= (x + 1)(x + 2 + x + 3)$
$= (x + 1)(2x + 5)$

24. $(x + 1)(x + 2)^2 + (x + 1)^2(x + 2)$
$= (x + 1)(x + 2)(x + 2 + x + 1)$
$= (x + 1)(x + 2)(2x + 3)$

25. $(x^2 + 1)^5(x + 3)^4 + (x^2 + 1)^6(x + 3)^3$
$= (x^2 + 1)^5(x + 3)^3(x + 3 + x^2 + 1)$
$= (x^2 + 1)^5(x + 3)^3(x^2 + x + 4)$

26. $10x(x^2 + 1)^4(x^3 + 1)^5 + 15x^2(x^2 + 1)^5(x^3 + 1)^4$
$= 5x(x^2 + 1)^4(x^3 + 1)^4[2(x^3 + 1) + 3x(x^2 + 1)]$
$= 5x(x^2 + 1)^4(x^3 + 1)^4(5x^3 + 3x + 2)$

27. $(x^3 + 1)\sqrt{x + 1} - (x^3 + 1)^2\sqrt{x + 1}$
$= (x^3 + 1)\sqrt{x + 1} \cdot [1 - (x^3 + 1)]$
$= -x^3(x^3 + 1)\sqrt{x + 1}$

28. $(x^2 + 1)\sqrt{x + 1} - \sqrt{(x + 1)^3}$
$= \sqrt{x + 1} \cdot [x^2 + 1 - \sqrt{(x + 1)^2}]$
$= \sqrt{x + 1} \cdot [x^2 + 1 - (x + 1)]$
$= (x^2 - x)\sqrt{x + 1}$
$= x(x - 1)\sqrt{x + 1}$

29. $\sqrt{(x + 1)^3} + \sqrt{(x + 1)^5}$
$= \sqrt{(x + 1)^3} \cdot [1 + \sqrt{(x + 1)^2}]$
$= \sqrt{(x + 1)^3} \cdot (1 + x + 1)$
$= (x + 2)\sqrt{(x + 1)^3}$

30. $(x^2 + 1)\sqrt[3]{(x + 1)^4} - \sqrt[3]{(x + 1)^7}$
$= \sqrt[3]{(x + 1)^4} \cdot [x^2 + 1 - \sqrt[3]{(x + 1)^3}]$
$= \sqrt[3]{(x + 1)^4} \cdot [x^2 + 1 - (x + 1)]$
$= (x^2 - x)\sqrt[3]{(x + 1)^4}$
$= x(x - 1)\sqrt[3]{(x + 1)^4}$

31. $a = 2, b = 6, c = 5$, so that the discriminant is
$b^2 - 4ac = 6^2 - 4(2)(5) = 36 - 40 = -4$
As the discriminant is negative, the expression does not factor at all.

32. $a = 4, b = -6, c = 2$, so that the discriminant is
$b^2 - 4ac = (-6)^2 - 4(4)(2) = 36 - 32 = 4 = 2^2$
As the discriminant is a perfect square, the expression factors over the integers.

33. $a = -3, b = -2, c = 3$, so that the discriminant is
$b^2 - 4ac = (-2)^2 - 4(-3)(3) = 4 + 36 = 40$
As the discriminant is positive but not a perfect square, the expression factors, but not over the integers.

34. $a = 1, b = -4, c = -7$, so that the discriminant is
$b^2 - 4ac = (-4)^2 - 4(1)(-7) = 16 + 28 = 44$
As the discriminant is positive but not a perfect square, the expression factors, but not over the integers.

35. $a = 8, b = 12, c = 4$, so that the discriminant is
$b^2 - 4ac = 12^2 - 4(8)(4) = 144 - 128 = 16 = 4^2$
As the discriminant is a perfect square, the expression factors over the integers.

36. $a = 1, b = 2, c = 19$, so that the discriminant is
$b^2 - 4ac = 2^2 - 4(1)(19) = 4 - 76 = -72$
As the discriminant is negative, the expression does not factor at all.

37. $a = 40, b = -64, c = 24$, so that the discriminant is
$b^2 - 4ac = (-64)^2 - 4(40)(24) = 4{,}096 - 3{,}840 = 256 = 16^2$
As the discriminant is a perfect square, the expression factors over the integers.

38. $a = -10, b = -32, c = -32$, so that the discriminant is
$b^2 - 4ac = (-32)^2 - 4(-10)(-32) = 1{,}024 - 1{,}280 = -256$
As the discriminant is negative, the expression does not factor at all.

39. $a = 6, b = -22, c = 16$, so that the discriminant is
$b^2 - 4ac = (-22)^2 - 4(6)(16) = 484 - 384 = 100 = 10^2$
As the discriminant is a perfect square, the expression factors over the integers.

40. $a = 48, b = 32, c = 4$, so that the discriminant is
$b^2 - 4ac = 32^2 - 4(48)(4) = 1{,}024 - 768 = 256 = 16^2$
As the discriminant is a perfect square, the expression factors over the integers.

41. a. $2x + 3x^2 = x(2 + 3x)$
b. $x(2 + 3x) = 0$
$x = 0$ or $2 + 3x = 0$
$x = 0$ or $-2/3$

42. a. $y^2 - 4y = y(y - 4)$
b. $y(y - 4) = 0$
$y = 0$ or $y - 4 = 0$
$y = 0$ or 4

43. a. $6x^3 - 2x^2 = 2x^2(3x - 1)$
b. $2x^2(3x - 1) = 0$
$x^2 = 0$ or $3x - 1 = 0$
$x = 0$ or $1/3$

44. a. $3y^3 - 9y^2 = 3y^2(y - 3)$
b. $3y^2(y - 3) = 0$
$y^2 = 0$ or $y - 3 = 0$
$y = 0$ or 3

45. a. $x^2 - 8x + 7 = (x - 1)(x - 7)$
b. $(x - 1)(x - 7) = 0$
$x - 1 = 0$ or $x - 7 = 0$
$x = 1$ or 7

46. a. $y^2 + 6y + 8 = (y + 2)(y + 4)$
b. $(y + 2)(y + 4) = 0$
$y + 2 = 0$ or $y + 4 = 0$
$y = -2$ or -4

47. a. $x^2 + x - 12 = (x - 3)(x + 4)$
b. $(x - 3)(x + 4) = 0$
$x - 3 = 0$ or $x + 4 = 0$
$x = 3$ or -4

48. a. $y^2 + y - 6 = (y - 2)(y + 3)$
b. $(y - 2)(y + 3) = 0$
$y - 2 = 0$ or $y + 3 = 0$
$y = 2$ or -3

49. a. $2x^2 - 3x - 2 = (2x + 1)(x - 2)$
b. $(2x + 1)(x - 2) = 0$
$2x + 1 = 0$ or $x - 2 = 0$
$x = -1/2$ or 2

50. a. $3y^2 - 8y - 3 = (3y + 1)(y - 3)$
b. $(3y + 1)(y - 3) = 0$
$3y + 1 = 0$ or $y - 3 = 0$
$y = -1/3$ or 3

51. a. $6x^2 + 13x + 6 = (2x + 3)(3x + 2)$
b. $(2x + 3)(3x + 2) = 0$
$2x + 3 = 0$ or $3x + 2 = 0$
$x = -3/2$ or $-2/3$

52. a. $6y^2 + 17y + 12 = (3y + 4)(2y + 3)$
b. $(3y + 4)(2y + 3) = 0$
$3y + 4 = 0$ or $2y + 3 = 0$
$y = -4/3$ or $-3/2$

53. a. $12x^2 + x - 6 = (3x - 2)(4x + 3)$
b. $(3x - 2)(4x + 3) = 0$
$3x - 2 = 0$ or $4x + 3 = 0$
$x = 2/3$ or $-3/4$

54. a. $20y^2 + 7y - 3 = (4y - 1)(5y + 3)$
b. $(4y - 1)(5y + 3) = 0$
$4y - 1 = 0$ or $5y + 3 = 0$
$y = 1/4$ or $-3/5$

55. a. $x^2 + 4xy + 4y^2 = (x + 2y)^2$
b. $(x + 2y)^2 = 0$
$x + 2y = 0$
$x = -2y$

56. a. $4y^2 - 4xy + x^2 = (2y - x)^2$
b. $(2y - x)^2 = 0$
$2y - x = 0$
$y = x/2$

57. a. $x^4 - 5x^2 + 4 = (x^2 - 1)(x^2 - 4)$
$= (x + 1)(x - 1)(x + 2)(x - 2)$
b. $(x + 1)(x - 1)(x + 2)(x - 2) = 0$
$x + 1 = 0$ or $x - 1 = 0$ or
$x + 2 = 0$ or $x - 2 = 0$
$x = \pm 1$ or ± 2

58. a. $y^4 + 2y^2 - 3 = (y^2 - 1)(y^2 + 3)$
$= (y + 1)(y - 1)(y^2 + 3)$
b. $(y + 1)(y - 1)(y^2 + 3) = 0$
$y + 1 = 0$ or $y - 1 = 0$ or $y^2 + 3 = 0$
$y = \pm 1$
(Notice that $y^2 + 3 = 0$ has no real solutions.)

59. a. $x^2 - 3 = (x - \sqrt{3})(x + \sqrt{3})$
b. $(x - \sqrt{3})(x + \sqrt{3}) = 0$
$x - \sqrt{3} = 0$ or $x + \sqrt{3} = 0$
$x = \pm\sqrt{3}$

60. a. $y^2 - 7 = (y - \sqrt{7})(y + \sqrt{7})$
b. $(y - \sqrt{7})(y + \sqrt{7}) = 0$
$y - \sqrt{7} = 0$ or $y + \sqrt{7} = 0$
$y = \pm\sqrt{7}$

Section 0.5

1. $\dfrac{x-4}{x+1}\cdot\dfrac{2x+1}{x-1}=\dfrac{(x-4)(2x+1)}{(x+1)(x-1)}=\dfrac{2x^2-7x-4}{x^2-1}$

2. $\dfrac{2x-3}{x-2}\cdot\dfrac{x+3}{x+1}=\dfrac{(2x-3)(x+3)}{(x-2)(x+1)}=\dfrac{2x^2+3x-9}{x^2-x-2}$

3. $\dfrac{x-4}{x+1}+\dfrac{2x+1}{x-1}=\dfrac{(x-4)(x-1)+(x+1)(2x+1)}{(x+1)(x-1)}=\dfrac{3x^2-2x+5}{x^2-1}$

4. $\dfrac{2x-3}{x-2}+\dfrac{x+3}{x+1}=\dfrac{(2x-3)(x+1)+(x-2)(x+3)}{(x-2)(x+1)}=\dfrac{3x^2-9}{x^2-x-2}$

5. $\dfrac{x^2}{x+1}-\dfrac{x-1}{x+1}=\dfrac{x^2-(x-1)}{x+1}=\dfrac{x^2-x+1}{x+1}$

6. $\dfrac{x^2-1}{x-2}-\dfrac{1}{x-1}=\dfrac{(x^2-1)(x-1)-(x-2)}{(x-2)(x-1)}=\dfrac{x^3-x^2-2x+3}{x^2-3x+2}$

7. $\dfrac{1}{\left(\frac{x}{x-1}\right)}+x-1=\dfrac{x-1}{x}+x-1=\dfrac{x-1+x(x-1)}{x}=\dfrac{x^2-1}{x}$

8. $\dfrac{2}{\left(\frac{x-2}{x^2}\right)}-\dfrac{1}{x-2}=\dfrac{2x^2}{x-2}-\dfrac{1}{x-2}=\dfrac{2x^2-1}{x-2}$

9. $\dfrac{1}{x}\left[\dfrac{x-3}{xy}+\dfrac{1}{y}\right]=\dfrac{1}{x}\left[\dfrac{x-3+x}{xy}\right]=\dfrac{2x-3}{x^2y}$

10. $\dfrac{y^2}{x}\left[\dfrac{2x-3}{y}+\dfrac{x}{y}\right]=\dfrac{y^2}{x}\left[\dfrac{2x-3+x}{xy}\right]=\dfrac{y^2(3x-3)}{xy}=\dfrac{y(3x-3)}{x}=\dfrac{3xy-3y}{x}$

11. $\dfrac{(x+1)^2(x+2)^3-(x+1)^3(x+2)^2}{(x+2)^6}=\dfrac{(x+1)^2(x+2)^2[(x+2)-(x+1)]}{(x+2)^6}=\dfrac{(x+1)^2}{(x+2)^4}$

12. $\dfrac{6x(x^2+1)^2(x^3+2)^3-9x^2(x^2+1)^3(x^3+2)^2}{(x^3+2)^6}$

$=\dfrac{3x(x^2+1)^2(x^3+2)^2[2(x^3+2)-3x(x^2+1)]}{(x^3+2)^6}=\dfrac{3x(x^2+1)^2(-x^3-3x+4)}{(x^3+2)^4}$

13. $\dfrac{(x^2-1)\sqrt{x^2+1}-\frac{x^4}{\sqrt{x^2+1}}}{x^2+1}=\dfrac{(x^2-1)(x^2+1)-x^4}{(x^2+1)\sqrt{x^2+1}}=\dfrac{-1}{\sqrt{(x^2+1)^3}}$

14. $\dfrac{x\sqrt{x^3-1}-\frac{3x^4}{\sqrt{x^3-1}}}{x^3-1}=\dfrac{x(x^3-1)-3x^4}{(x^3-1)\sqrt{x^3-1}}=\dfrac{-2x^4-x}{\sqrt{(x^3-1)^3}}=\dfrac{-x(2x^3+1)}{\sqrt{(x^3-1)^3}}$

15. $\dfrac{\frac{1}{(x+y)^2}-\frac{1}{x^2}}{y}=\dfrac{x^2-(x+y)^2}{yx^2(x+y)^2}=\dfrac{x^2-x^2-2xy-y^2}{yx^2(x+y)^2}=\dfrac{-y(2x+y)}{yx^2(x+y)^2}=\dfrac{-(2x+y)}{x^2(x+y)^2}$

16. $\dfrac{\frac{1}{(x+y)^3}-\frac{1}{x^3}}{y}=\dfrac{x^2-(x+y)^2}{yx^2(x+y)^2}=\dfrac{x^3-x^3-3x^2y-3xy^2-y^3}{yx^3(x+y)^3}$

$=\dfrac{-y(3x^2+3xy+y^2)}{yx^3(x+y)^3}=\dfrac{-(3x^2+3xy+y^2)}{x^3(x+y)^3}$

Section 0.6

1. $x+1=0 \Rightarrow x=0-1 \Rightarrow x=-1$

2. $x-3=1 \Rightarrow x=1+3 \Rightarrow x=4$

3. $-x+5=0 \Rightarrow -x=-5 \Rightarrow x=5$

4. $2x+4=1 \Rightarrow 2x=-3 \Rightarrow x=-\frac{3}{2}$

5. $4x-5=8 \Rightarrow 4x=13 \Rightarrow x=\frac{13}{4}$

6. $\frac{3}{4}x+1=0 \Rightarrow \frac{3}{4}x=-1 \Rightarrow x=-\frac{4}{3}$

7. $7x+55=98 \Rightarrow 7x=43 \Rightarrow x=-\frac{43}{7}$

8. $3x+1=x \Rightarrow 2x=-1 \Rightarrow x=-\frac{1}{2}$

9. $x+1=2x+2 \Rightarrow -x=1 \Rightarrow x=-1$

10. $x+1=3x+1 \Rightarrow -2x=0 \Rightarrow x=0$

11. $ax+b=c \Rightarrow ax=c-b \Rightarrow x=\frac{c-b}{a}$

12. $x-1=cx+d \Rightarrow (1-c)x=d+1 \Rightarrow x=\frac{d+1}{1-c}$

13. $2x^2+7x-4=0 \Rightarrow (2x-1)(x+4)=0 \Rightarrow x=-4, \frac{1}{2}$

14. $x^2+x+1=0 \Rightarrow \Delta=b^2-4ac=-3<0$, so this equation has no real solutions.

15. $x^2-x+1=0 \Rightarrow \Delta=b^2-4ac=-3<0$, so this equation has no real solutions.

16. $2x^2-4x+3 \Rightarrow \Delta=b^2-4ac=-8<0$, so this equation has no real solutions.

17. $2x^2-5=0 \Rightarrow x^2=\frac{5}{2} \Rightarrow x=\pm\sqrt{\frac{5}{2}}$

18. $3x^2-1=0 \Rightarrow x^2=\frac{1}{3} \Rightarrow x=\pm\frac{1}{\sqrt{3}}$

19. $-x^2-2x-1=0 \Rightarrow -(x+1)^2=0 \Rightarrow x=-1$

20. $2x^2-x-3=0 \Rightarrow (2x-3)(x+1)=0 \Rightarrow x=\frac{3}{2}, -1$

21. $\frac{1}{2}x^2-x-\frac{3}{2}=0 \Rightarrow x^2-2x-3=0 \Rightarrow (x+1)(x-3)=0 \Rightarrow x=-1, 3$

22. $-\frac{1}{2}x^2-\frac{1}{2}x+1=0 \Rightarrow x^2+x-2=0 \Rightarrow (x+2)(x-1)=0 \Rightarrow x=-2, 1$

23. $x^2 - x = 1 \Rightarrow x^2 - x - 1 = 0 \Rightarrow x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a} = \dfrac{1 \pm \sqrt{5}}{2}$

24. $16x^2 = -24x - 9 \Rightarrow 16x^2 + 24x + 9 = 0(4x + 3)^2 = 0 \Rightarrow x = -\dfrac{3}{4}$

25. $x = 2 - \dfrac{1}{x} \Rightarrow x^2 = 2x - 1 \Rightarrow x^2 - 2x + 1 = 0 \Rightarrow (x - 1)^2 = 0 \Rightarrow x = 1$

26. $x + 4 = \dfrac{1}{x - 2} \Rightarrow (x + 4)(x - 2) = 1 \Rightarrow x^2 + 2x - 8 = 1 \Rightarrow x^2 + 2x - 9 - 0$

$\Rightarrow x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a} = \dfrac{-2 \pm \sqrt{40}}{2} = -1 \pm \sqrt{10}$

27. $x^4 - 10x^2 + 9 = 0 \Rightarrow (x^2 - 1)(x^2 - 9) = 0 \Rightarrow x^2 = 1$ or $x^2 = 0 \Rightarrow x = \pm 1, \pm 3$

28. $x^4 - 2x^2 + 1 = 0 \Rightarrow (x^2 - 1)^2 = 0$

$\Rightarrow x = \pm 1$

29. $x^4 + x^2 - 1 = 0 \Rightarrow x^2 = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a} \Rightarrow x^2 = \dfrac{-1 \pm \sqrt{5}}{2} \Rightarrow x = \pm\sqrt{\dfrac{-1 \pm \sqrt{5}}{2}}$

30. $x^3 + 2x^2 + x = 0 \Rightarrow x(x^2 + 2x + 1) = 0 \Rightarrow x(x + 1)^2 = 0 \Rightarrow x = 0, -1$

31. $x^3 + 16x^2 + 11x + 6 = 0 \Rightarrow (x + 1)(x + 2)(x + 3) = 0 \Rightarrow x = -1, -2, -3$

32. $x^3 - 6x^2 + 12x - 8 = 0 \Rightarrow (x - 2)^3 = 0 \Rightarrow x = 2$

33. $x^3 + 4x^2 + 4x + 3 = 0 \Rightarrow (x + 3)(x^2 + x + 1) = 0 \Rightarrow x = -3$
(For $x^2 + x + 1 = 0,\ \Delta = b^2 - 4ac = -3 < 0$, so there are no real solutions to this quadratic equation.)

34. $y^3 + 64 = 0 \Rightarrow y^3 = -64 \Rightarrow y = \sqrt[3]{-64} = -4$

35. $x^3 - 1 = 0 \Rightarrow x^3 = 1 \Rightarrow x = \sqrt[3]{1} = 1$

36. $x^3 - 27 = 0$

$\Rightarrow x^3 = 27 \Rightarrow x = \sqrt[3]{27} = 3$

37. $y^3 + 3y^2 + 3y + 2 = 0 \Rightarrow (y + 2)(y^2 + y + 1) = 0 \Rightarrow y = -2$
(For $y^2 + y + 1 = 0,\ \Delta = b^2 - 4ac = -3 < 0$, so there are no real solutions to this quadratic equation.)

38. $y^3 - 2y^2 - 2y - 3 = 0 \Rightarrow (y - 3)(y^2 + y + 1) = 0 \Rightarrow y = 3$
(For $y^2 + y + 1 = 0,\ \Delta = b^2 - 4ac = -3 < 0$, so there are no real solutions to this quadratic equation.)

39. $x^3 - x^2 - 5x + 5 = 0 \Rightarrow (x - 1)(x^2 - 5) = 0 \Rightarrow x = 1,\ \pm\sqrt{5}$

40. $x^3 - x^2 - 3x + 3 = 0 \Rightarrow (x - 1)(x^2 - 3) = 0 \Rightarrow x = 1,\ \pm\sqrt{3}$

41. $2x^6 - x^4 - 2x^2 + 1 = 0 \Rightarrow (2x^2 - 1)(x^4 - 1) = 0 \Rightarrow (2x^2 - 1)(x^2 - 1)(x^2 + 1) = 0$
(Think of the cubic you get by substituting y for x^2)

$$\Rightarrow x = \pm 1, \ \pm \frac{1}{\sqrt{2}}$$

42. $3x^6 - x^4 - 12x^2 + 4 = 0 \Rightarrow (3x^2 - 1)(x^4 - 4) = 0$

$$\Rightarrow (3x^2 - 1)(x^2 - 2)(x^2 + 2) = 0$$

(Think of the cubic you get by substituting y for x^2)

$$\Rightarrow x = \pm\sqrt{2}, \ \pm \frac{1}{\sqrt{3}}$$

43. $(x^2 + 3x + 2)(x^2 - 5x + 6) = 0 \Rightarrow (x + 2)(x + 1)(x - 2)(x - 3) = 0$

$$\Rightarrow x = -2, -1, 2, 3$$

44. $(x^2 - 4x + 4)^2(x^2 + 6x + 5)^3 = 0 \Rightarrow (x - 2)^4(x + 1)^3(x + 5)^3 = 0$

$$\Rightarrow x = -5, -1, 2$$

Section 0.7

1. $x^4 - 3x^3 = 0$, $x^3(x-3) = 0$, $x = 0, 3$

2. $x^6 - 9x^4 = 0$, $x^4(x^2-9) = 0$, $x = 0, \pm 3$

3. $x^4 - 4x^2 = -4$, $x^4 - 4x^2 + 4 = 0$, $(x^2-2)^2 = 0$, $x = \pm\sqrt{2}$

4. $x^4 - x^2 = 6$, $x^4 - x^2 - 6 = 0$, $(x^2-3)(x^2+2) = 0$, $x = \pm\sqrt{3}$

5. $(x+1)(x+2) + (x+1)(x+3) = 0$, $(x+1)(x+2+x+3) = 0$,
$(x+1)(2x+5) = 0$, $x = -1, -5/2$

6. $(x+1)(x+2)^2 + (x+1)^2(x+2) = 0$, $(x+1)(x+2)(x+2+x+1) = 0$,
$(x+1)(x+2)(2x+3) = 0$, $x = -1, -2, -3/2$

7. $(x^2+1)^5(x+3)^4 + (x^2+1)^6(x+3)^3 = 0$,
$(x^2+1)^5(x+3)^3(x+3+x^2+1) = 0$,
$(x^2+1)^5(x+3)^3(x^2+x+4) = 0$, $x = -3$
(Neither $x^2+1 = 0$ nor $x^2+x+4 = 0$ has a real solution.)

8. $10x(x^2+1)^4(x^3+1)^5 - 10x^2(x^2+1)^5(x^3+1)^4 = 0$,
$10x(x^2+1)^4(x^3+1)^4[x^3+1-x(x^2+1)] = 0$,
$10x(x^2+1)^4(x^3+1)^4(1-x) = 0$, $x = -1, 0, 1$

9. $(x^3+1)\sqrt{x+1} - (x^3+1)^2\sqrt{x+1} = 0$,
$(x^3+1)\sqrt{x+1}\,[1-(x^3+1)] = 0$,
$-x^3(x^3+1)\sqrt{x+1} = 0$, $x = 0, -1$

10. $(x^2+1)\sqrt{x+1} - \sqrt{(x+1)^3} = 0$,
$\sqrt{x+1}\,[x^2+1-(x+1)] = 0$,
$(x^2-x)\sqrt{x+1} = 0$, $x(x-1)\sqrt{x+1} = 0$, $x = -1, 0, 1$

11. $\sqrt{(x+1)^3} + \sqrt{(x+1)^5} = 0$,
$\sqrt{(x+1)^3}\,(1+x+1) = 0$,
$(x+2)\sqrt{(x+1)^3} = 0$, $x = -1$
($x = -2$ is not a solution because $\sqrt{(x+1)^3}$ is not defined for $x = -2$.)

12. $(x^2+1)\sqrt[3]{(x+1)^4} - \sqrt[3]{(x+1)^7} = 0$,
$\sqrt[3]{(x+1)^4}\,[x^2+1-(x+1)] = 0$,
$(x^2-x)\sqrt[3]{(x+1)^4} = 0$, $x(x-1)\sqrt[3]{(x+1)^4} = 0$,
$x = -1, 0, 1$

13. $(x+1)^2(2x+3) - (x+1)(2x+3)^2 = 0$,
$(x+1)(2x+3)(x+1-2x-3) = 0$,
$(x+1)(2x+3)(-x-2) = 0$,
$x = -2, -3/2, -1$

14. $(x^2-1)^2(x+2)^3-(x^2-1)^3(x+2)^2=0,$
$(x^2-1)^2(x+2)^2(x+2-x^2+1)=0,$
$-(x^2-1)^2(x+2)^2(x^2-x-3)=0,$
$x=-2,-1,1,(1\pm\sqrt{13})/2$

15. $\dfrac{(x+1)^2(x+2)^3-(x+1)^3(x+2)^2}{(x+2)^6}=0,$
$\dfrac{(x+1)^2(x+2)^2[(x+2)-(x+1)]}{(x+2)^6}=0,$
$\dfrac{(x+1)^2}{(x+2)^4}=0,\ (x+1)^2=0,\ x=-1$

16. $\dfrac{6x(x^2+1)^2(x^2+2)^4-8x(x^2+1)^3(x^2+2)^3}{(x^2+2)^8}=0,$
$\dfrac{2x(x^2+1)^2(x^2+2)^3[3(x^2+2)-4(x^2+1)]}{(x^2+2)^8}=0,$
$\dfrac{-2x(x^2+1)^2(x^2-2)}{(x^2+2)^5}=0,$
$-2x(x^2+1)^2(x^2-2)=0,\ x=0,\pm\sqrt{2}$

17. $\dfrac{2(x^2-1)\sqrt{x^2+1}-\frac{x^4}{\sqrt{x^2+1}}}{x^2+1}=0,\ \dfrac{2(x^2-1)(x^2+1)-x^4}{(x^2+1)\sqrt{x^2+1}}=0,$
$\dfrac{x^4-2}{(x^2+1)\sqrt{x^2+1}}=0,\ x^4-2=0,\ x=\pm\sqrt[4]{2}$

18. $\dfrac{4x\sqrt{x^3-1}-\frac{3x^4}{\sqrt{x^3-1}}}{x^3-1}=0,\ \dfrac{4x(x^3-1)-3x^4}{(x^3-1)\sqrt{x^3-1}}=0,$
$\dfrac{x^4-4x}{(x^3-1)\sqrt{x^3-1}}=0,\ x^4-4x=0,\ x(x^3-4)=0,\ x=0,\pm\sqrt[3]{4}$

19. $x-\dfrac{1}{x}=0,\ x^2-1=0,\ x=\pm1$

20. $1-\dfrac{4}{x^2}=0,\ x^2-4=0,\ x=\pm2$

21. $\dfrac{1}{x}-\dfrac{9}{x^3}=0,\ x^2-9=0,\ x=\pm3$

22. $\dfrac{1}{x^2}-\dfrac{1}{x+1}=0,\ x+1-x^2=0,\ x^2-x-1=0,\ x=(1\pm\sqrt{5})/2$

23. $\dfrac{x-4}{x+1}-\dfrac{x}{x-1}=0,\ \dfrac{(x-4)(x-1)-x(x+1)}{(x+1)(x-1)}=0,$
$\dfrac{-6x+4}{(x+1)(x-1)}=0,\ -6x+4=0,\ x=2/3$

24. $\dfrac{2x-3}{x-1} - \dfrac{2x+3}{x+1} = 0$, $\dfrac{(2x-3)(x+1)-(2x+3)(x-1)}{(x-1)(x+1)} = 0$,

$\dfrac{-2x}{(x-1)(x+1)} = 0$, $-2x = 0$, $x = 0$

25. $\dfrac{x+4}{x+1} + \dfrac{x+4}{3x} = 0$, $\dfrac{3x(x+4)+(x+1)(x+4)}{3x(x+1)} = 0$,

$\dfrac{(x+4)(3x+x+1)}{3x(x+1)} = 0$, $\dfrac{(x+4)(4x+1)}{3x(x+1)} = 0$,

$(x+4)(4x+1) = 0$, $x = -4, -1/4$

26. $\dfrac{2x-3}{x} - \dfrac{2x-3}{x+1} = 0$, $\dfrac{(2x-3)(x+1)-x(2x-3)}{x(x+1)} = 0$,

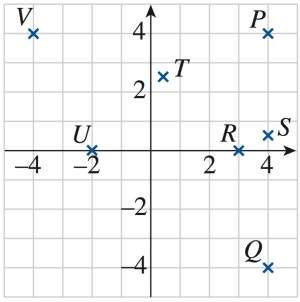
$\dfrac{(2x-3)(x+1-x)}{x(x+1)} = 0$, $\dfrac{(2x-3)}{x(x+1)} = 0$, $2x-3 = 0$, $x = 3/2$

Section 0.8

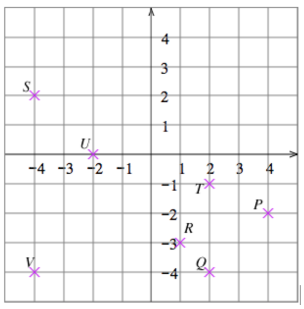
1. $P(0,2), Q(4,-2), R(-2,3), S(-3.5,-1.5), T(-2.5,0), U(2,2.5)$

2. $P(-2,2), Q(3.5,2), R(0,-3), S(-3.5,-1.5), T(2.5,0), U(-2,2.5)$

3.



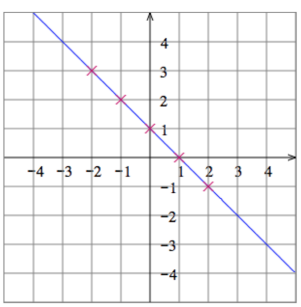
4.



5. Solve the equation $x + y = 1$ for y to get $y = 1 - x$. Then plot some points:

x	-2	-1	0	1	2
$y = 1 - x$	3	2	1	0	-1

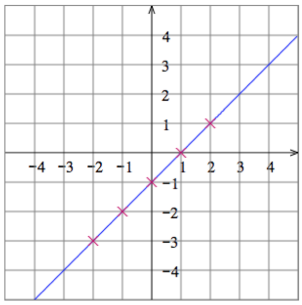
Graph:



6. Solve the equation $y - x = -1$ for y to get $y = -1 + x$. Then plot some points:

x	-2	-1	0	1	2
$y = -1 + x$	-3	-2	-1	0	1

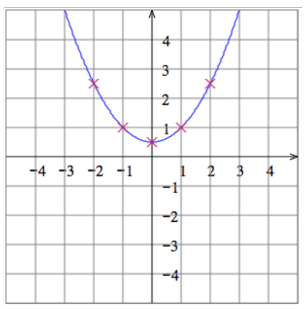
Graph:



7. Solve the equation $2y - x^2 = 1$ for y to get $y = \dfrac{1 + x^2}{2}$. Then plot some points:

x	-2	-1	0	1	2
$y = \dfrac{1 + x^2}{2}$	2.5	1	0.5	1	2.5

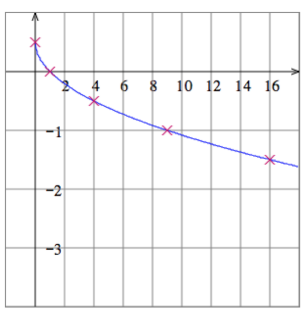
Graph:



8. Solve the equation $2y + \sqrt{x} = 1$ for y to get $y = \dfrac{1 - \sqrt{x}}{2}$. Then plot some points:

x	0	1	4	9	16
$y = \dfrac{1 - \sqrt{x}}{2}$	0.5	0	-0.5	-1	-1.5

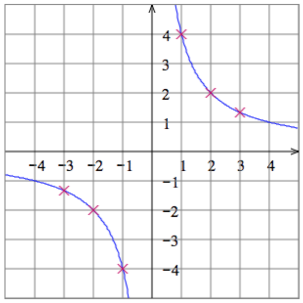
Graph:



9. Solve the equation $xy = 4$ for y to get $y = \frac{4}{x}$. Then plot some points:

x	-3	-2	-1	1	2	3
$y = \frac{4}{x}$	$-\frac{4}{3}$	-2	-4	4	2	$\frac{4}{3}$

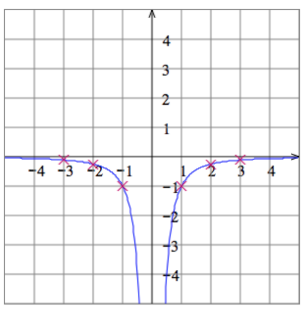
Graph:



10. Solve the equation $x^2y = -1$ for y to get $y = -\frac{1}{x^2}$. Then plot some points:

x	-3	-2	-1	1	2	3
$y = -\frac{1}{x^2}$	$-\frac{1}{9}$	$-\frac{1}{4}$	-1	-1	$-\frac{1}{4}$	$-\frac{1}{9}$

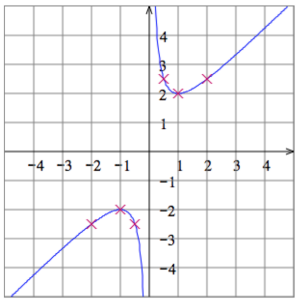
Graph:



11. Solve the equation $xy = x^2 + 1$ for y to get $y = x + \frac{1}{x}$. Then plot some points:

x	-2	-1	$-\frac{1}{2}$	$\frac{1}{2}$	1	2
$y = x + \frac{1}{x}$	$-\frac{5}{2}$	-2	$-\frac{5}{2}$	$\frac{5}{2}$	2	$\frac{5}{2}$

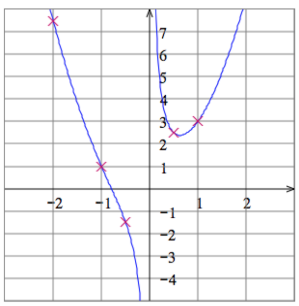
Graph:



12. Solve the equation $xy = 2x^3 + 1$ for y to get $y = 2x^2 + \frac{1}{x}$. Then plot some points:

x	-2	-1	$-\frac{1}{2}$	$\frac{1}{2}$	1	2
$y = 2x^2 + \frac{1}{x}$	$\frac{15}{2}$	1	$-\frac{3}{2}$	$\frac{5}{2}$	3	$\frac{17}{2}$

Graph:



13. $\sqrt{(2-1)^2 + (-2+1)^2} = \sqrt{2}$

14. $\sqrt{(6-1)^2 + (1-0)^2} = \sqrt{26}$

15. $\sqrt{(0-a)^2 + (b-0)^2} = \sqrt{a^2 + b^2}$

16. $\sqrt{(b-a)^2 + (b-0)^2} = \sqrt{2(b-a)^2}$ or $\sqrt{2}|b-a|$

17. Set the two distances equal and solve:

$$\sqrt{(1-0) * 2 + (k-0)^2} = \sqrt{(1-2)^2 + (k-1)^2}$$
$$\Rightarrow \sqrt{1+k^2} = \sqrt{2 - 2k + k^2}$$
$$\Rightarrow 1 + k^2 = 2 - 2k + k^2$$
$$\Rightarrow 2k = 1 \Rightarrow k = \frac{1}{2}$$

18. Set the two distances equal and solve:

$$\sqrt{(k+1) * 2 + (k-0)^2} = \sqrt{(k-0)^2 + (k-2)^2}$$
$$\Rightarrow \sqrt{2k^2 + 2k + 1} = \sqrt{2k^2 - 4k + 4}$$
$$\Rightarrow 2k^2 + 2k + 1 = 2k^2 - 4k + 4$$
$$\Rightarrow 6k = 3 \Rightarrow k = \frac{1}{2}$$

19. Circle with center $(0, 0)$ and radius 3.

20. The single point $(0, 0)$.

Section 0.9

1.

Exponential Form	$10^2 = 100$	$4^3 = 64$	$4^4 = 256$	$0.45^0 = 1$	$8^{1/2} = 2\sqrt{2}$	$4^{-3} = \frac{1}{64}$
Logarithmic Form	$\log_{10} 100 = 2$	$\log_4 64 = 3$	$\log_4 256 = 4$	$\log_{0.45} 1 = 0$	$\log_8 2\sqrt{2} = \frac{1}{2}$	$\log_4\left(\frac{1}{64}\right) = -3$

2.

Exponential Form	$10^1 = 10$	$5^5 = 3{,}125$	$6^3 = 216$
Logarithmic Form	$\log_{10} 10 = 1$	$\log_5 3{,}125 = 5$	$\log_6 216 = 3$
Exponential Form	$0.5^3 = 0.125$	$4^{1/4} = \sqrt{2}$	$3^{-4} = \frac{1}{81}$
Logarithmic Form	$\log_{0.5} 0.125 = 3$	$\log_4 \sqrt{2} = \frac{1}{4}$	$\log_3\left(\frac{1}{81}\right) = -4$

3.

Exponential Form	$0.3^2 = 0.09$	$\left(\frac{1}{2}\right)^0 = 1$	$10^{-3} = 0.001$
Logarithmic Form	$\log_{0.3} 0.09 = 2$	$\log_{1/2} 1 = 0$	$\log_{10} 0.001 = -3$
Exponential Form	$9^{-2} = \frac{1}{81}$	$2^{10} = 1{,}024$	$64^{-1/3} = \frac{1}{4}$
Logarithmic Form	$\log_9 \frac{1}{81} = -2$	$\log_2 1{,}024 = 10$	$\log_{64} \frac{1}{4} = -\frac{1}{3}$

4.

Exponential Form	$2^{-1} = \frac{1}{2}$	$10^5 = 100{,}000$	$10^{-5} = 0.00001$
Logarithmic Form	$\log_2 \frac{1}{2} = -1$	$\log_{10} 100{,}000 = 5$	$\log_{10} 0.00001 = -5$
Exponential Form	$2^{11} = 2{,}048$	$16^{-1/4} = \frac{1}{2}$	$0.25^2 = 0.0625$
Logarithmic Form	$\log_2 2{,}048 = 11$	$\log_{16} \frac{1}{2} = -\frac{1}{4}$	$\log_{0.25} 0.0625 = 2$

5. $\log_4 16$ = the power to which we need to raise 4 in order to get 16. Because $4^{\text{boxed } 2} = 16$, this power is 2, so $\log_4 16 = 2$.

6. $\log_5 125$ = the power to which we need to raise 5 in order to get 125. Because $5^{\text{boxed } 3} = 125$, this power is 3, so $\log_5 125 = 3$.

7. $\log_5 \frac{1}{25}$ = the power to which we need to raise 5 in order to get $\frac{1}{25}$. Because $5^{\text{boxed } -2} = \frac{1}{25}$, this power is -2, so $\log_5 \frac{1}{25} = -2$.

8. $\log_4 \frac{1}{64}$ = the power to which we need to raise 4 in order to get $\frac{1}{64}$. Because $4^{\text{boxed } -3} = \frac{1}{64}$, this power is -3, so $\log_4 \frac{1}{64} = -3$.

Solutions Section 0.9

9. $\log 100{,}000 = \log_{10} 100{,}000$ = the power to which we need to raise 10 in order to get 100,000. Because $10^{\text{boxed } 5} = 100{,}000$, this power is 5, so $\log 100{,}000 = 5$.

10. $\log 1{,}000 = \log_{10} 1{,}000$ = the power to which we need to raise 10 in order to get 1,000. Because $10^{\text{boxed } 3} = 1{,}000$, this power is 3, so $\log 1{,}000 = 3$.

11. $\log_{16} 16$ = the power to which we need to raise 16 in order to get 16. Because $16^{\text{boxed } 1} = 16$, this power is 1, so $\log_{16} 16 = 1$.

12. $\log_{1/2} \frac{1}{2}$ = the power to which we need to raise $\frac{1}{2}$ in order to get $\frac{1}{2}$. Because $\left(\frac{1}{2}\right)^{\text{boxed } 1} = \frac{1}{2}$, this power is 1, so $\log_{1/2} \frac{1}{2} = 1$.

13. $\log_4 \frac{1}{16}$ = the power to which we need to raise 4 in order to get $\frac{1}{16}$. Because $4^{\text{boxed } -2} = \frac{1}{16}$, this power is -2, so $\log_4 \frac{1}{16} = -2$.

14. $\log_2 \frac{1}{8}$ = the power to which we need to raise 2 in order to get $\frac{1}{8}$. Because $2^{\text{boxed } -3} = \frac{1}{8}$, this power is -3, so $\log_2 \frac{1}{8} = -3$.

15. $\log_2 \sqrt{2}$ = the power to which we need to raise 2 in order to get $\sqrt{2}$. Because $2^{\text{boxed } 1/2} = \sqrt{2}$, this power is $\frac{1}{2}$, so $\log_2 \sqrt{2} = \frac{1}{2}$.

16. $\log_4 \sqrt{2}$ = the power to which we need to raise 4 in order to get $\sqrt{2}$. Because $4^{\text{boxed } 1/4} = \sqrt{2}$, this power is $\frac{1}{4}$, so $\log_4 \sqrt{2} = \frac{1}{4}$.

17. By Identity (1), $\log_b 3 + \log_b 4 = \log_b(3 \times 4) = \log_b \text{boxed } 12$.

18. By Identity (2), $\log_b 3 - \log_b 4 = \log_b \text{boxed } \frac{3}{4}$.

19. $\log_b 2 - \log_b 5 - \log_b 4 = \log_b 2 - (\log_b 5 + \log_b 4) = \log_b 2 - (\log_b(5 \times 4))$ (Identity 1)
$= \log_b\left(\frac{2}{5 \times 4}\right)$ (Identity 2) $= \log_b \text{boxed } \frac{1}{10}$

20. $\log_b 3 + \log_b 2 - \log_b 7 = \log_b(3 \times 2) - \log_b 7$ (Identity 1) $= \log_b\left(\frac{3 \times 2}{7}\right)$ (Identity 2) $= \log_b \text{boxed } \frac{6}{7}$

21. $\log_b 3 - 3 \log_b 2 = \log_b 3 - \log_b 2^3$ (Identity 3) $= \log_b\left(\frac{3}{2^3}\right)$ (Identity 2) $= \log_b \text{boxed } \frac{3}{8}$

22. $3 \log_b 2 + 2 \log_b 3 = \log_b 2^3 + \log_b 3^2$ (Identity 3) $= \log_b(2^3 \times 3^2)$ (Identity 1) $= \log_b \text{boxed } 72$

23. $4 \log_b x + 5 \log_b y = \log_b x^4 + \log_b y^5$ (Identity 3) $= \log_b \text{boxed } x^4 y^5$ (Identity 1)

24. $3\log_b p - 2\log_b q = \log_b p^3 - \log_b q^2$ (Identity 3) $= \log_b$ boxed $\dfrac{p^3}{q^2}$ (Identity 2)

25. $2\log_b x + 3\log_b y - 4\log_b z = \log_b x^2 + \log_b y^3 - \log_b z^4$ (Identity 3)
$= \log_b(x^2y^3) - \log_b z^4$ (Identity 1) $= \log_b$ boxed $\dfrac{x^2y^3}{z^4}$ (Identity 2)

26. $4\log_b p - 3\log_b q - 2\log_b r = \log_b p^4 - \log_b q^3 - \log_b r^2$ (Identity 3)
$= \log_b p^4 - (\log_b q^3 + \log_b r^2) = \log_b p^4 - \log_b(q^3r^2)$ (Identity 1) $= \log_b$ boxed $\dfrac{p^4}{q^3r^2}$ (Identity 2)

27. $x\log_b 2 - 2\log_b x = \log_b 2^x - \log_b x^2$ (Identity 3) $= \log_b$ boxed $\dfrac{2^x}{x^2}$ (Identity 2)

28. $p\log_b q + q\log_b p = \log_b q^p + \log_b p^q$ (Identity 3) $= \log_b$ boxed $q^p p^q$ (Identity 1)

29. $\log 21 = \log(3\times 7) = \log 3 + \log 7 = b + c$ (Identity 1)

30. $\log 14 = \log(2\times 7) = \log 2 + \log 7 = a + c$ (Identity 1)

31. $\log 42 = \log(2\times 3\times 7) = \log 2 + \log 3 + \log 7 = a + b + c$ (Identity 1)

32. $\log 28 = \log(2\times 2\times 7) = \log 2 + \log 2 + \log 7 = 2a + c$ (Identity 1)

33. $\log\left(\frac{1}{7}\right) = -\log 7 = -c$ (Identity 5)

34. $\log\left(\frac{1}{3}\right) = -\log 3 = -b$ (Identity 5)

35. $\log\left(\frac{2}{3}\right) = \log 2 - \log 3 = a - b$ (Identity 2)

36. $\log\left(\frac{7}{2}\right) = \log 7 - \log 2 = c - a$ (Identity 2)

37. $\log\left(\frac{4}{7}\right) = \log 4 - \log 7$ (Identity 2) $= \log 2 + \log 2 - \log 7$ (Identity 1) $= 2a - c$

38. $\log\left(\frac{2}{9}\right) = \log 2 - \log 9$ (Identity 2) $= \log 2 - (\log 3 + \log 3)$ (Identity 1) $= a - 2b$

39. $\log 16 = \log 2^4 = 4\log 2 = 4a$ (Identity 3)

40. $\log 81 = \log 3^4 = 4\log 3 = 4b$ (Identity 3)

41. $\log 0.03 = \log\left(\frac{3}{10^2}\right) = \log 3 - \log 10^2 = \log 3 - 2\log 10 = b - 2$

42. $\log 7{,}000 = \log(7\times 10^3) = \log 7 + \log 10^3 = \log 7 + 3\log 10 = c + 3$

43. $\log 5 = \log\left(\frac{10}{2}\right) = \log 10 - \log 2 = 1 - a$ (Identity 2)

44. $\log 25 = \log\left(\frac{100}{4}\right) = \log 100 - \log 4 = \log 10^2 - \log 2^2 = 2\log 10 - 2\log 2 = 2 - 2a$

45. $\log \sqrt{7} = \log(7^{1/2}) = \frac{1}{2}\log 7 = \frac{c}{2}$

46. $\log\left(\frac{2}{\sqrt{3}}\right) = \log(2) - \log\sqrt{3} = \log(2) - \log(3^{1/2}) = \log 2 - \frac{1}{2}\log 3 = a - \frac{b}{2}$

47. $4 = 2^x$ is exactly the equation we solve in order to calculate $\log_2 4$; answer: 2. Alternatively, write the equation $4 = 2^x$ in logarithmic form to get $x = \log_2 4 = 2$.

48. $81 = 3^x$ is exactly the equation we solve in order to calculate $\log_3 81$; answer: 4. Alternatively, write the equation $81 = 3^x$ in logarithmic form to get $x = \log_3 81 = 4$.

49. Take the base 3 logarithm of both sides of the given equation $27 = 3^{2x-1}$ to get

$\log_3 27 = \log_3 3^{2x-1}$

$3 = (2x-1)\log_3 3$ By Identity 3

$3 = 2x - 1$ By Identity 4

$x = \frac{3+1}{2} = 2$ Solve for x.

50. Take the base 4 logarithm of both sides of the given equation $4^{2-3x} = 256$ to get

$\log_4 4^{2-3x} = \log_4 256$

$(2-3x)\log_4 4 = 4$ By Identity 3

$2 - 3x = 4$ By Identity 4

$x = \frac{2-4}{3} = -\frac{2}{3}$ Solve for x.

51. Take the base 5 logarithm of both sides of the given equation $5^{-x+1} = \frac{1}{125}$ to get

$\log_5 5^{-x+1} = \log_5\left(\frac{1}{125}\right)$

$(-x+1)\log_5 5 = -\log_5 125$ By Identities 3 and 5

$-x + 1 = -3$ By Identity 4

$x = 1 + 3 = 4$ Solve for x.

52. Take the base 3 logarithm of both sides of the given equation $3^{x^2-12} = \frac{1}{27}$ to get

$\log_3 3^{x^2-12} = \log_3\left(\frac{1}{27}\right)$

$(x^2-12)\log_3 3 = -\log_3 27$ By Identities 3 and 5

$x^2 - 12 = -3$ By Identity 4

$x = \pm\sqrt{9} = \pm 3$ Solve for x.

53. First divide both sides of the given equation by 50 to get $2.4 = 2^{3t}$. Take the common logarithm of both sides:

$\log 2.4 = \log(2^{3t})$

$\log 2.4 = 3t \log 2$ By Identity 3

$3t = \dfrac{\log 2.4}{\log 2}$ Divide.

$t = \dfrac{\log 2.4}{3 \log 2} \approx 0.4210$ Solve for t.

If instead you take the base-2 logarithm, the answer is represented as $\dfrac{\log_2(2.4)}{3}$.

54. First divide both sides of the given equation by 500 to get $2 = 1.1^{2t}$. Take the common logarithm of both sides:

$\log 2 = \log(1.1^{2t})$

$\log 2 = 2t \log 1.1$ By Identity 3

$2t = \dfrac{\log 2}{\log 1.1}$ Divide.

$t = \dfrac{\log 2}{2 \log 1.1} \approx 3.6363$ Solve for t.

55. First divide both sides of the given equation by 300 to get $\dfrac{10}{3} = 1.3^{4t-1}$. Take the common logarithm of both sides:

$\log\left(\dfrac{10}{3}\right) = \log(1.3^{4t-1})$

$\log 10 - \log 3 = (4t - 1) \log 1.3$ By Identities 2 and 3

$4t - 1 = \dfrac{\log 10 - \log 3}{\log 1.3}$ Divide.

$t = \dfrac{1}{4}\left(\dfrac{\log 10 - \log 3}{\log 1.3} + 1\right) \approx 1.3972$ Solve for t.

56. First divide both sides of the given equation by 700 to get $\dfrac{100}{7} = 1.04^{3t+1}$. Take the common logarithm of both sides:

$\log\left(\dfrac{100}{7}\right) = \log(1.04^{3t+1})$

$\log 100 - \log 7 = (3t + 1) \log 1.04$ By Identities 2 and 3

$3t + 1 = \dfrac{\log 100 - \log 7}{\log 1.04}$ Divide.

$t = \dfrac{1}{3}\left(\dfrac{\log 100 - \log 7}{\log 1.04} - 1\right) \approx 22.2675$ Solve for t.