

***Fundamentals of Electric Circuits 7th edition
Alexander Solutions Manual***

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CHAPTER 1

P.P.1.1 A proton has 1.602×10^{-19} C. Hence, 6.667 billion protons have
 $+1.602 \times 10^{-19} \times 6.667 \times 10^9 = \mathbf{1.6021 \times 10^{-9} \text{ C}}$

P.P.1.2 $i = dq/dt = d(20 - 15t - 10e^{-3t})/dt = (-15 - 10(-3)e^{-3t}) \text{ mA}$
 At $t = 1.0 \text{ sec}$, $i = -15 + 30e^{-3} = -15 + 1.4936 = \mathbf{-13.506 \text{ mA}}$

P.P.1.3 $q = \int i dt = \int_0^1 8 dt + \int_1^2 8t^2 dt = 8t \Big|_0^1 + \frac{8}{3} t^3 \Big|_1^2$
 $= 8 + 8(8-1)/3 = \mathbf{26.67 \text{ C}}$

P.P.1.4 (a) $V_{ab} = dw/dq = 100/5 = \mathbf{20 \text{ V}}$
 (b) $V_{ab} = dw/dq = 100/-10 = \mathbf{-10 \text{ V}}$

P.P.1.5 (a) $v = 6i = 30 \cos(60\pi t)$
 $p = vi = 150 \cos^2(60\pi t)$
 At $t = 5 \text{ ms}$, $p = 150 \cos^2(60\pi \times 5 \times 10^{-3}) = 150 \cos^2(0.3\pi)$
 $= \mathbf{51.82 \text{ watts}}$
 (b) $v = 6 + 10 \int_0^t i dt = 6 + \int_0^t 50 \cos(60\pi t) dt = 6 + \frac{50}{60\pi} \sin(60\pi t)$
 $p = vi = 5 \cos(60\pi t) [6 + (50/(60\pi)) \sin(60\pi t)]$
 At $t = 5 \text{ ms}$, $p = 5 \cos(0.3\pi) \{6 + (50/(60\pi)) \sin(0.3\pi)\}$
 $= 5(0.58779)(6 + (0.26526)(0.80902)) = \mathbf{18.264 \text{ watts}}$

P.P.1.6 $p = vi = 115 \times 12 = 1380 \text{ watts}$; $w = p \times t$
 $W = 1380 \times 24 = \mathbf{33.12 \text{ k watt-hours}}$

P.P.1.7 $p_1 = 5(-45) = -225 \text{ w}$

$$p_2 = 2(45) = 90 \text{ w}$$

$$p_3 = 0.12 \times I(20) = 0.6(25)(20) = 60 \text{ w}$$

$$p_4 = 3(25) = 75 \text{ w}$$

Note that all the absorbed power adds up to zero as expected.

P.P.1.8 $i = dq/dt = e \frac{dn}{dt} = -1.6 \times 10^{-19} \times 10^{13} = -1.6 \times 10^{-6} \text{ A}$

$$p = v_0 i = 25 \times 10^3 \times (1.6 \times 10^{-6}) = 40 \text{ mW}$$

P.P.1.9 Minimum monthly charge = \$12.00

First 100 kWh @ \$0.16/kWh = \$16.00

Next 160 kWh @ \$0.10/kWh = \$16.00

Remaining 0 kWh @ \$0.06/kWh = \$0.00

$$\text{Total Charge} = \$44.00$$

$$\text{Average cost} = \$44/[100+160+0] = 16.923 \text{ cents/kWh}$$

P.P.1.10 This assigned practice problem is to apply the detailed problem solving technique to some of the more difficult problems of Chapter 1.

CHAPTER 2

P.P.2.1 $i = V/R = 110/15 = \mathbf{7.333\text{ A}}$

P.P.2.2 (a) $v = iR = 3\text{ mA}[10\text{ kohms}] = \mathbf{30\text{ V}}$

(b) $G = 1/R = 1/10\text{ kohms} = \mathbf{100\text{ }\mu\text{S}}$

(c) $p = vi = 30\text{ volts}[3\text{ mA}] = \mathbf{90\text{ mW}}$

P.P.2.3 $p = vi$ which leads to $i = p/v = [30\cos^2(t)\text{ mW}]/[15\cos(t)\text{ mA}]$
or $i = \mathbf{2\cos(t)\text{ mA}}$

$R = v/i = 15\cos(t)\text{V}/2\cos(t)\text{mA} = \mathbf{7.5\text{ k}\Omega}$

P.P.2.4 5 branches and 3 nodes. The 1 ohm and 2 ohm resistors are in parallel. The 4 ohm resistor and the 10 volt source are also in parallel.

P.P.2.5 Applying KVL to the loop we get:

$$-32 + 4i - (-8) + 2i = 0 \text{ which leads to } i = 24/6 = 4\text{A}$$

$$v_1 = 4i = \mathbf{16\text{ V}} \quad \text{and} \quad v_2 = -2i = \mathbf{-8\text{ V}}$$

P.P.2.6 Applying KVL to the loop we get:

$$-70 + 10i + 2v_x + 5i = 0$$

But, $v_x = 10i$ and $v_0 = -5i$. Hence,

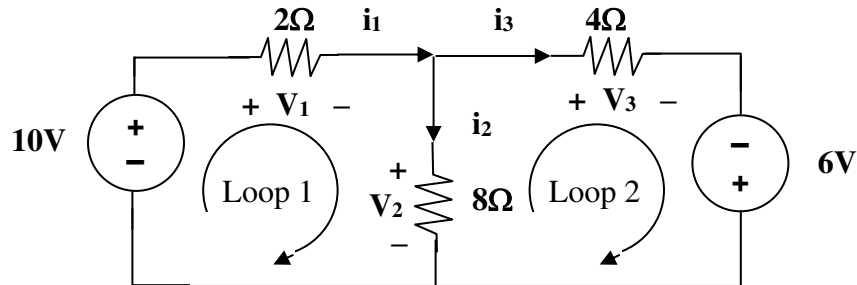
$$-70 + 10i + 20i + 5i = 0 \text{ which leads to } i = 2\text{ A.}$$

$$\text{Thus, } v_x = \mathbf{20\text{ V}} \quad \text{and} \quad v_0 = \mathbf{-10\text{ V}}$$

P.P.2.7 Applying KCL, $0 = -9 + i_0 + [i_0/4] + [v_0/8]$, but $i_0 = v_0/2$

Which leads to: $9 = (v_0/2) + (v_0/8) + (v_0/8)$ thus, $v_0 = 12 \text{ V}$ and $i_0 = 6 \text{ A}$

P.P.2.8



At the top node, $0 = -i_1 + i_2 + i_3$ or $i_1 = i_2 + i_3$ (1)

For loop 1 $-10 + V_1 + V_2 = 0$
or $V_1 = 10 - V_2$ (2)

For loop 2 $-V_2 + V_3 - 6 = 0$
or $V_3 = V_2 + 6$ (3)

Using (1) and Ohm's law, we get

$$(V_1/2) = (V_2/8) + (V_3/4)$$

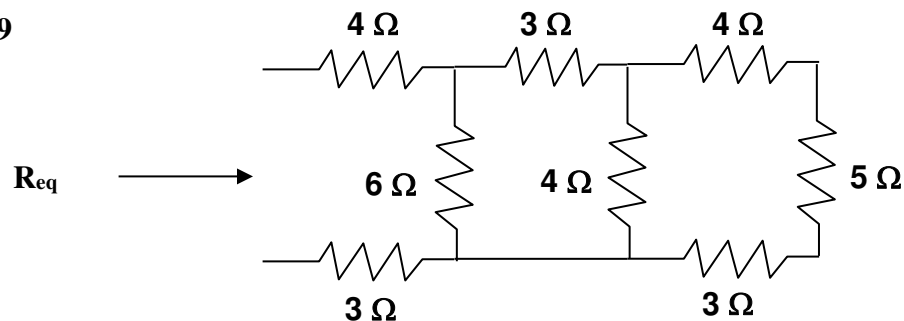
and now using (2) and (3) in the above yields

$$[(10 - V_2)/2] = (V_2/8) + (V_2 + 6)/4$$

or $[7/8]V_2 = 14/4$ or $V_2 = 4 \text{ V}$

$V_1 = 10 - V_2 = 6 \text{ V}$, $V_3 = 4 + 6 = 10 \text{ V}$, $i_1 = (10 - 4)/2 = 3 \text{ A}$,
 $i_2 = 4/8 = 500 \text{ mA}$, $i_3 = 2.5 \text{ A}$

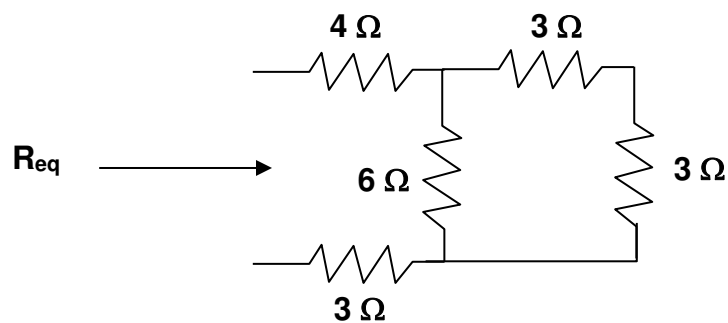
P.P.2.9



Combining the 4 ohm, 5 ohm, and 3ohm resistors in series gives $4+3+5 = 12$.

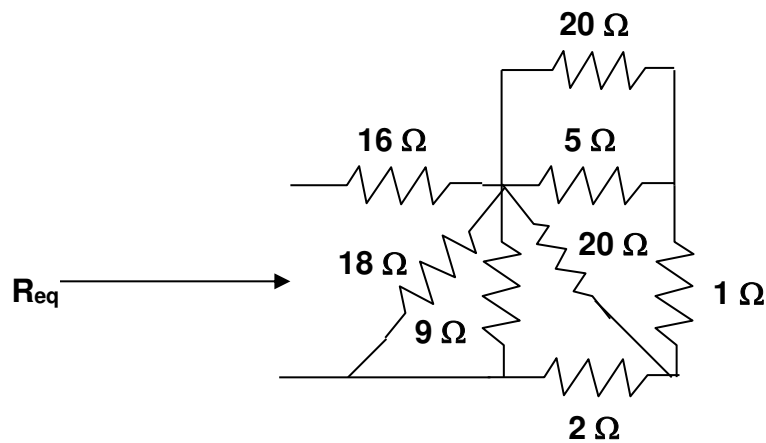
But, 4 in parallel with 12 produces $[4 \times 12] / [4 + 12] = 48 / 16 = 3 \text{ohm}$.

So that the equivalent circuit is shown below.



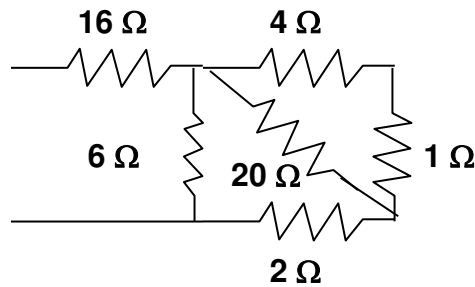
Thus, $R_{eq} = 4 + 3 + [6 \times 6] / [6 + 6] = 10 \Omega$

P.P.2.10

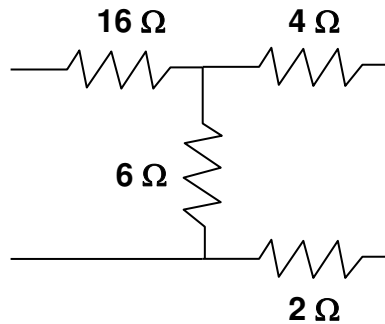


Combining the 9 ohm resistor and the 18 ohm resistor yields $[9 \times 18] / [9 + 18] = 6 \text{ ohms}$.

Combining the 5 ohm and the 20 ohm resistors in parallel produces $[5 \times 20 / (5 + 20)] = 4$ ohms. We now have the following circuit:



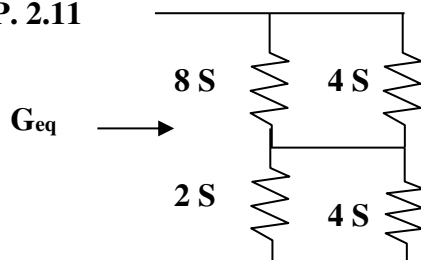
The 4 ohm and 1 ohm resistors can be combined into a 5 ohm resistor in parallel with a 20 ohm resistor. This will result in $[5 \times 20 / (5 + 20)] = 4$ ohms and the circuit shown below:



The 4 ohm and 2 ohm resistors are in series and can be replaced by a 6 ohm resistor. This gives a 6 ohm resistor in parallel with a 6 ohm resistor, $[6 \times 6 / (6 + 6)] = 3$ ohms. We now have a 3 ohm resistor in series with a 16 ohm resistor or $3 + 16 = 19$ ohms. Therefore:

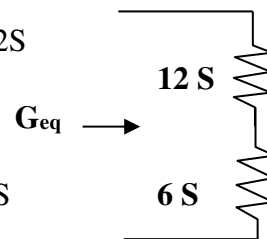
$$R_{eq} = 19 \text{ ohms}$$

P.P. 2.11



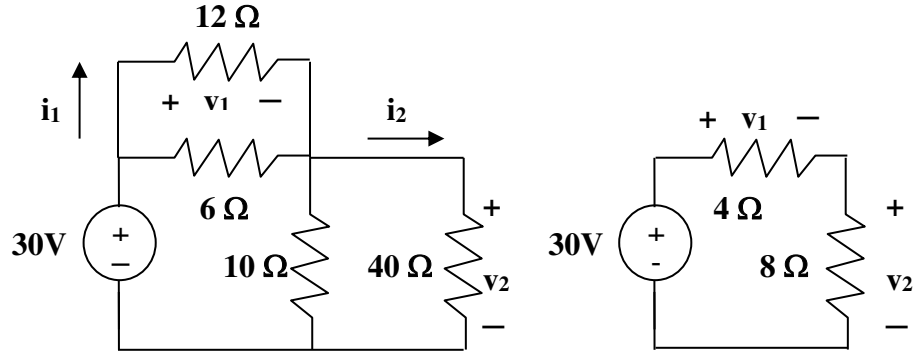
$$8 \parallel 4 = 8 + 4 = 12 \text{ S}$$

$$2 \parallel 4 = 2 + 4 = 6 \text{ S}$$



$$12 \text{ S in series with } 6 \text{ S} = \{12 \times 6 / (12 + 6)\} = 4 \text{ or: } G_{eq} = 4 \text{ S}$$

P.P.2.12



$6 \parallel 12 = [6 \times 12 / (6 + 12)] = 4 \text{ ohm}$ and $10 \parallel 40 = [10 \times 40 / (10 + 40)] = 8 \text{ ohm}$.

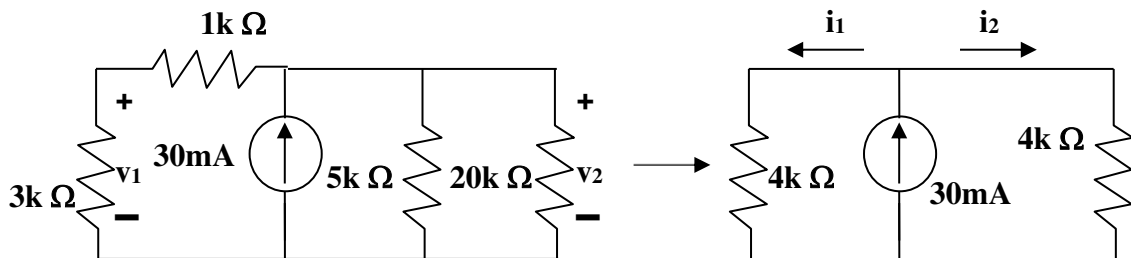
Using voltage division we get:

$$v_1 = [4 / (4 + 8)] (30) = \underline{\underline{10 \text{ volts}}}, v_2 = [8 / 12] (30) = \underline{\underline{20 \text{ volts}}}$$

$$i_1 = v_1 / 12 = 10 / 12 = \underline{\underline{833.3 \text{ mA}}}, i_2 = v_2 / 40 = 20 / 40 = \underline{\underline{500 \text{ mA}}}$$

$$P_1 = v_1 i_1 = 10 \times 10 / 12 = \underline{\underline{8.333 \text{ watts}}}, P_2 = v_2 i_2 = 20 \times 0.5 = \underline{\underline{10 \text{ watts}}}$$

P.P.2.13



Using current division, $i_1 = i_2 = (30 \text{ mA})(4 \text{ kohm} / (4 \text{ kohm} + 4 \text{ kohm})) = 15 \text{ mA}$

$$(a) \quad v_1 = (3 \text{ kohm})(15 \text{ mA}) = \underline{\underline{45 \text{ volts}}}$$

$$v_2 = (4 \text{ kohm})(15 \text{ mA}) = \underline{\underline{60 \text{ volts}}}$$

$$(b) \quad \text{For the } 3 \text{ k ohm resistor, } P_1 = v_1 \times i_1 = 45 \times 15 \times 10^{-3} = \underline{\underline{675 \text{ mw}}}$$

$$\text{For the } 20 \text{ k ohm resistor, } P_2 = (v_2)^2 / 20 \text{ k} = \underline{\underline{180 \text{ mw}}}$$

- (c) The total power supplied by the current source is equal to:
 $P = v_2 \times 10 \text{ mA} = 60 \times 30 \times 10^{-3} = \mathbf{1.8 \text{ W}}$

P.P.2.14

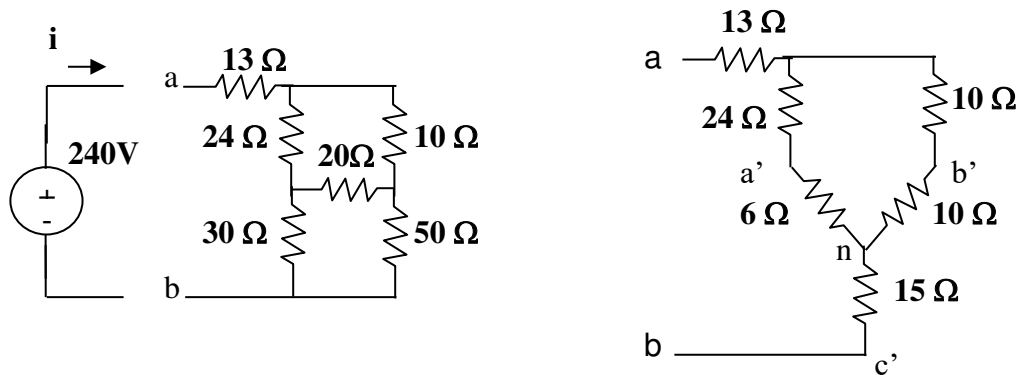
$$R_a = [R_1 R_2 + R_2 R_3 + R_3 R_1] / R_1 = [10 \times 20 + 20 \times 40 + 40 \times 10] / 10 = \mathbf{140 \text{ ohms}}$$

$$R_b = [R_1 R_2 + R_2 R_3 + R_3 R_1] / R_2 = 1400 / 20 = \mathbf{70 \text{ ohms}}$$

$$R_c = [R_1 R_2 + R_2 R_3 + R_3 R_1] / R_3 = 1400 / 40 = \mathbf{35 \text{ ohms}}$$

P.P.2.15

We first find the equivalent resistance, R . We convert the delta sub-network to a wye connected form as shown below:



$$R_{a'n} = 20 \times 30 / [20 + 30 + 50] = 6 \text{ ohms}, R_{b'n} = 20 \times 50 / 100 = 10 \text{ ohms}$$

$$R_{c'n} = 30 \times 50 / 100 = 15 \text{ ohms.}$$

$$\text{Thus, } R_{ab} = 13 + [(24 + 6) \parallel (10 + 10)] + 15 = 28 + 30 \times 20 / (30 + 20) = \mathbf{40 \text{ ohms.}}$$

$$i = 240 / R_{ab} = 240 / 40 = \mathbf{6 \text{ amps}}$$

P.P.2.16

For the parallel case, $v = v_0 = 110 \text{ volts.}$

$$p = vi \implies i = p/v = 40/110 = \mathbf{364 \text{ mA}}$$

For the series case, $v = v_0/N = 110/10 = 11 \text{ volts}$

$$i = p/v = 40/11 = \mathbf{3.64 \text{ amps}}$$

P.P.2.17

We use equation (2.61)

(a) $R_1 = 50 \times 10^{-3} / (1 - 10^{-3}) = 0.05/999 = \mathbf{50 \text{ m}\Omega \text{ (shunt)}}$

(b) $R_2 = 50 \times 10^{-3} / (100 \times 10^{-3} - 10^{-3}) = 50/99 = \mathbf{505 \text{ m}\Omega \text{ (shunt)}}$

(c) $R_3 = 50 \times 10^{-3} / (10 \times 10^{-3} - 10^{-3}) = 50/9 = \mathbf{5.556 \text{ }\Omega \text{ (shunt)}}$