Fundamentals of Electric Circuits 7th edition Alexander Solutions Manual

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CHAPTER 1

P.P.1.1 A proton has 1.602 x 10^{-19} C. Hence, 6.667 billion protons have

+1.602 x 10^{-19} x 6.667 x 10^{9} = **1.6021 x 10^{-9} C**

P.P.1.2 $i = dq/dt = d(20–15t–10e^{-3t})/dt = (–15–10(–3)e^{-3t})$ mA

At t = 1.0 sec, $i = –15+30e^{-3} = –15+1.4936 = $ **–13.506 mA**

P.P.1.3 $q = \int i\,dt = \int_0^1 8dt + \int_1^2 8t^2 dt = 8t|_0^1 + \frac{8}{3}t^3\Big|_1^2$

= 8 + 8(8–1)/3 = **26.67 C**

P.P.1.4 (a) $V_{ab} = dw/dq = 100/5 =$ **20 V**

(b) $V_{ab} = dw/dq = 100/–10 =$ **–10 V**

P.P.1.5 (a) $v = 6\,i = 30\cos(60\,\pi\,t)$

$p = v\,i = 150\cos^2(60\,\pi\,t)$

At t = 5 ms, $p = 150\cos^2(60\,\pi\,5x10^{-3}) = 150\cos^2(0.3\,\pi)$

= **51.82 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 ms, $p = 5\cos(0.3\pi)\{6 + (50/(60\,\pi))\sin(0.3\,\pi)\}$

$=5(0.58779)(6+(0.26526)(0.80902))$ = **18.264 watts**

P.P.1.6 $p = v\,i = 115 \times 12 = 1380$ watts; $w = p \times t$

W = 1380x24 = **33.12 k watt-hours**

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

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

$p_3 = 0.12xI(20) = 0.6(25)(20) = \mathbf{60\ w}$

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

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

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

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

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
Total Charge	= \$44.00

Average cost = \$44/[100+160+0] = **16.923 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 = **7.333 A**

P.P.2.2 (a) v = iR = 3 mA[10 kohms] = **30 V**

(b) G = 1/R = 1/10 kohms = **100 μS**

(c) p = vi = 30 volts[3 mA] = **90 mW**

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

or i = **2cos(t) mA**

R = v/i = 15cos(t)V/2cos(t)mA = **7.5 kΩ**

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 which leads to i = 24/6 = 4A

v_1 = 4i = **16 V** and v_2 = –2i = **–8 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 which leads to i = 2 A.

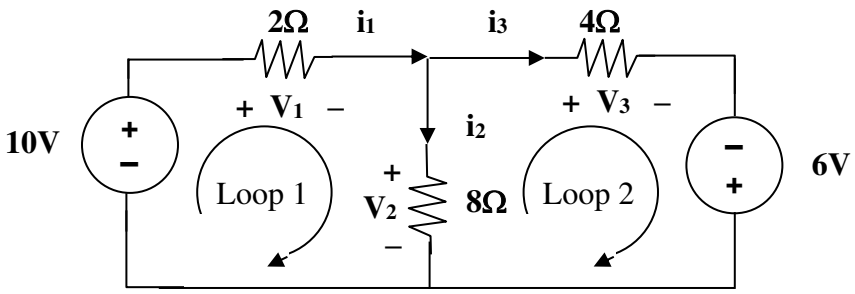
Thus, v_x = **20V** and v_0 = **–10 V**

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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, $v_0 = \mathbf{12\ V}$ and $i_0 = \mathbf{6\ A}$

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

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

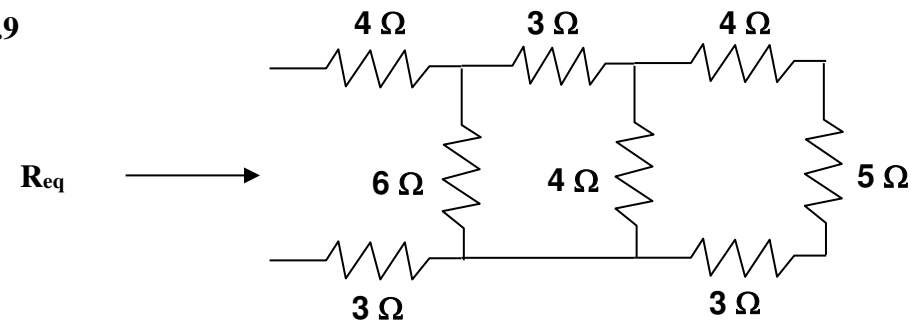
and now using (2) and (3) in the above yields

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

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

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

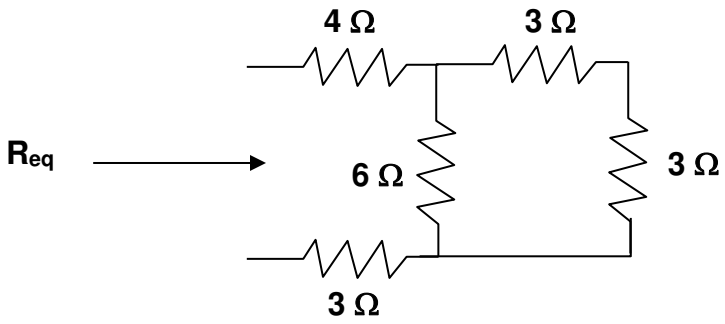
P.P.2.9



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

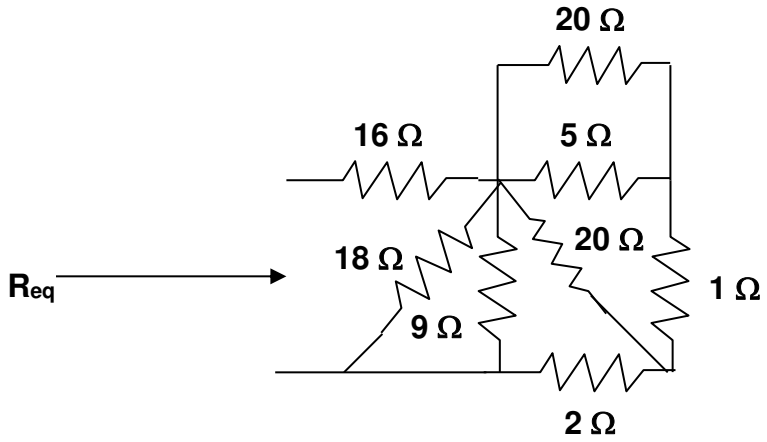
But, 4 in parallel with 12 produces [4x12]/[4+12] = 48/16 = 3ohm.

So that the equivalent circuit is shown below.



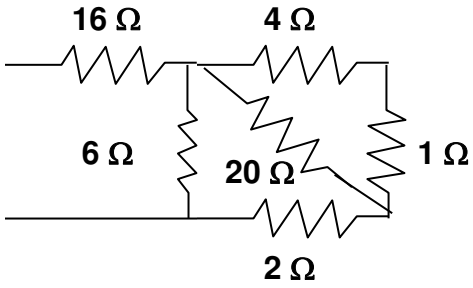
Thus, $\mathbf{R_{eq}}$ = 4 + 3 + [6x6]/[6+6] = **10 Ω**

P.P.2.10

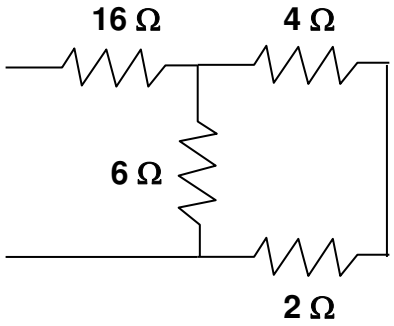


Combining the 9 ohm resistor and the 18 ohm resistor yields [9x18]/[9+18] = 6 ohms.

Combining the 5 ohm and the 20 ohm resistors in parallel produces [5x20/(5+20)] = 4 ohms We now have the following circuit:



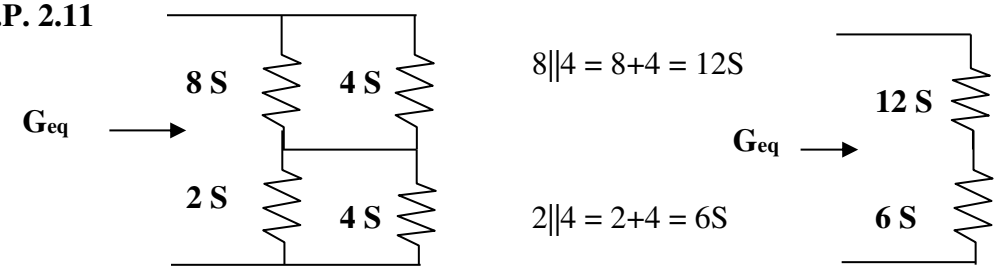
The 4 ohm and 1 ohm resistors can be combined into a 5 ohm resistor in parallel with a 20 ohm resistor. This will result in [5x20/(5+20)] = 4 ohms and the circuit shown below:



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, [6x6/(6+6)] = 3 ohms. We now have a 3 ohm resistor in series with a 16 ohm resistor or 3 + 16 = 19 ohms. Therefore:

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

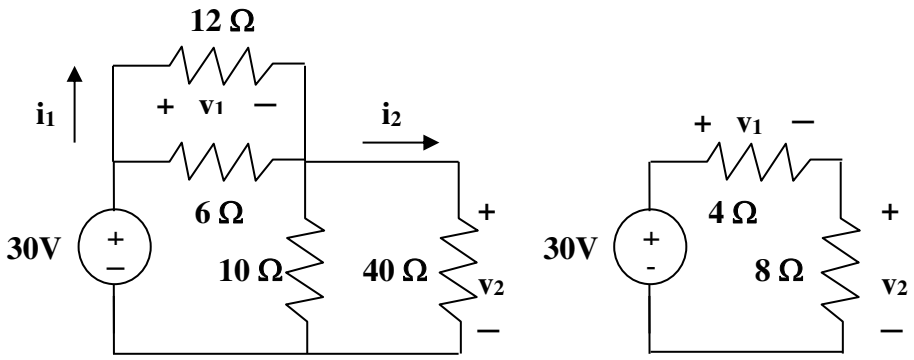
P.P. 2.11



12 S in series with 6 S = {12x6/(12+6)] = 4 or: $\mathbf{G_{eq} = 4 \text{ S}}$

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P.P.2.12



6||12 = [6x12/(6+12)] = 4 ohm and 10||40 = [10x40/(10+40)] = 8 ohm.

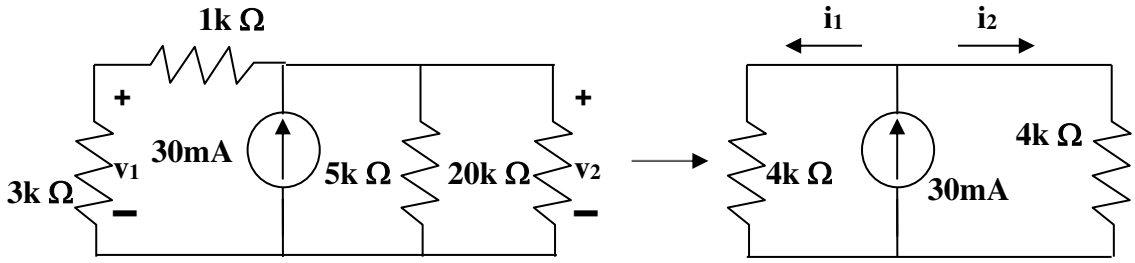
Using voltage division we get:

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

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

$\mathbf{P_1}$ = v_1 i_1 = 10x10/12 = **8.333 watts**, $\mathbf{P_2}$ = v_2 i_2 = 20x0.5 = **10 watts**

P.P.2.13



Using current division, i_1 = i_2 = (30 mA)(4 kohm/(4 kohm + 4 kohm)) = 15mA

(a) $\mathbf{v_1}$ = (3 kohm)(15 mA) = **45 volts**
$\mathbf{v_2}$ = (4 kohm)(15 mA) = **60 volts**

(b) For the 3k ohm resistor, $\mathbf{P_1}$ = v_1 x i_1 = $45x15x10^{-3}$ = **675 mw**
For the 20k ohm resistor, $\mathbf{P_2}$ = $(v_2)^2$ /20k = **180 mw**

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

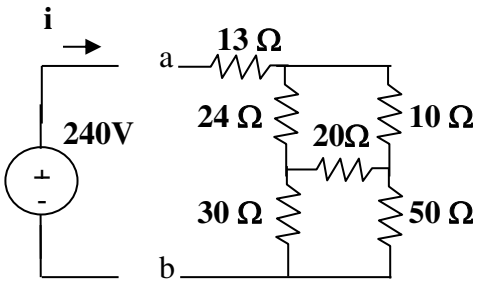
P.P.2.14

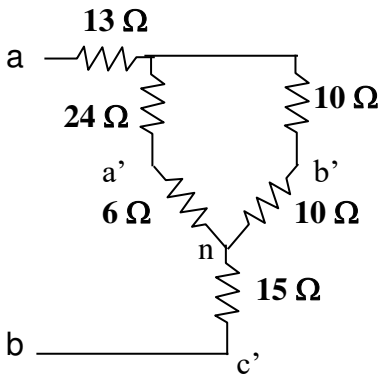
$\mathbf{R_a} = [R_1R_2 + R_2R_3 + R_3R_1]/R_1 = [10\text{x}20 + 20\text{x}40 + 40\text{x}10]/10 = \mathbf{140\ ohms}$

$\mathbf{R_b} = [R_1R_2 + R_2R_3 + R_3R_1]/R_2 = 1400/20 = \mathbf{70\ ohms}$

$\mathbf{R_c} = [R_1R_2 + R_2R_3 + R_3R_1]/R_3 = 1400/40 = \mathbf{35\ ohms}$

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:





$R_{a'n} = 20\text{x}30/[20 + 30 + 50] = 6$ ohms, $R_{b'n} = 20\text{x}50/100 = 10$ ohms
$R_{c'n} = 30\text{x}50/100 = 15$ ohms.

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

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

P.P.2.16 **For the parallel case, $v = v_0 = 110$volts.**
$p = vi \Longrightarrow i = p/v = 40/110 = 364$ mA

For the series case, $v = v_0/N = 110/10 = 11$ volts
$\mathbf{i} = p/v = 40/11 = \mathbf{3.64\ amps}$

P.P.2.17 We use equation (2.61)
(a) $\mathbf{R_1} = 50\text{x}10^{-3}/(1\text{-}10^{-3}) = 0.05/999 = \mathbf{50\ m\Omega\ (shunt)}$

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

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

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