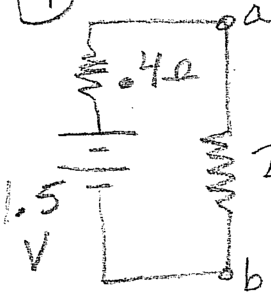
Solutions to Fourth Homework
PHY133

(1)



a) $R_{TOT} = .4 + 2.6 = 3\,\Omega$

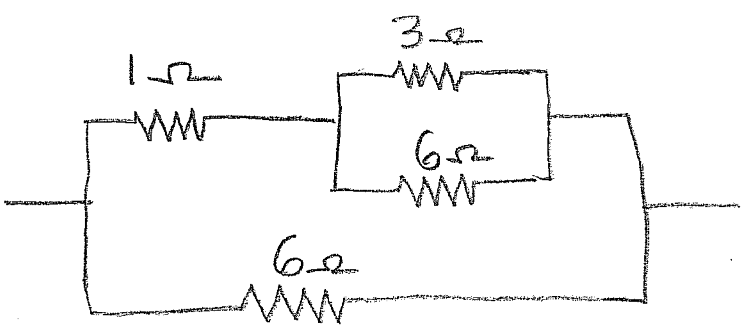
$I = \frac{V}{R} = \frac{1.5}{3} = \boxed{.5\,A}$

b) $V_{ab} = I(2.6\,\Omega) = .5(2.6) = \boxed{1.3V}$

c) $1.4 \text{ amp-hr} = (.5 \text{ Amp})(x \text{ hours})$

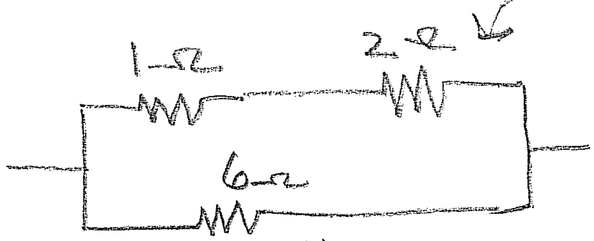
$x = \frac{1.4 \text{ amp-hr}}{.5 \text{ amp}} = \boxed{2.8 \text{ hr}}$

(2)



$\frac{1}{3} + \frac{1}{6} = \frac{1}{2} = \frac{1}{R_{eq}}$

$R_{eq} = 2\,\Omega$



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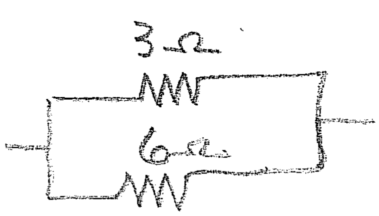


$\frac{1}{3} + \frac{1}{6} = \frac{1}{R_{TOT}}$

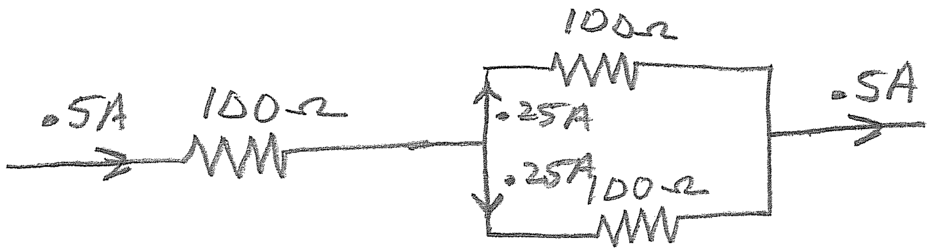
$\frac{1}{2} = \frac{1}{R_{TOT}} \Rightarrow \boxed{R_{TOT} = 2\,\Omega}$

(3) For 25 watts, the maximum current is

$$P = I^2 R$$

$$25 = I^2 (100\Omega) \Rightarrow I = \sqrt{\frac{25}{100}} = \underline{.5A}$$

So we must have



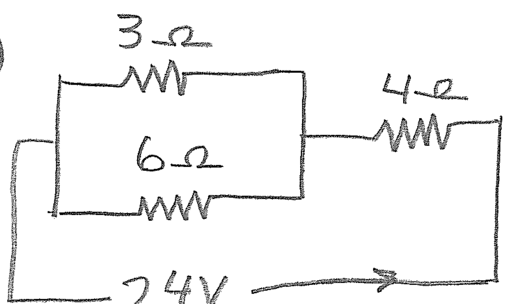
a) So the maximum voltage is

$$.5(100) + .25(100) = \boxed{75V}$$

b) TOTAL Power $= (.5)^2(100) + (.25)^2(100) + (.25)^2(100)$

$$= 25 + 6.25 + 6.25 = \boxed{37.5W}$$

(4)



$$R_{TOT} = \frac{1}{\frac{1}{3} + \frac{1}{6}} + 4$$

$$R_{TOT} = 2 + 4 = 6\Omega$$

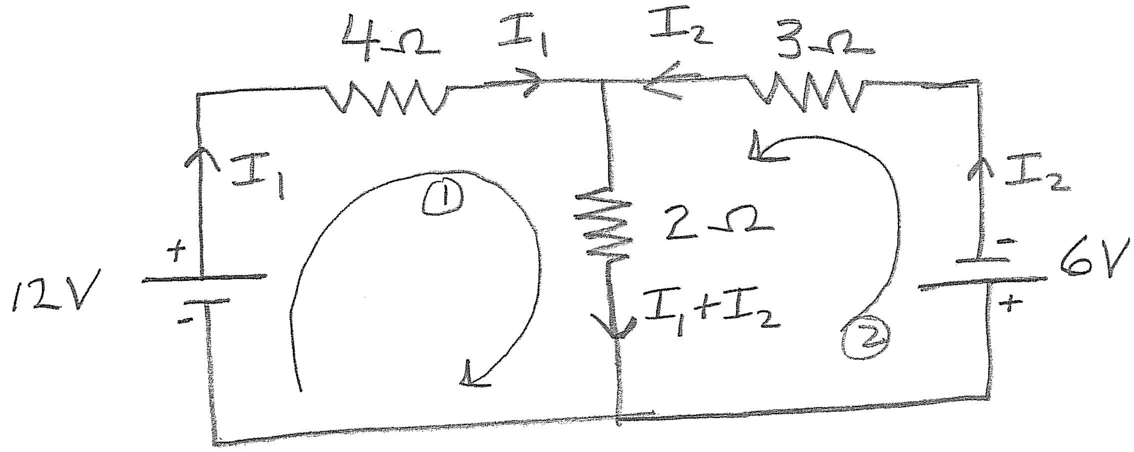
So $I = \frac{24}{6} = \boxed{4A}$ through the 4Ω resistor.

$V = 4(4) = \boxed{16 \text{ Volts}}$ across the 4Ω resistor

V across the 3Ω and 6Ω resistors $= 24 - 16 = \boxed{8V}$

$I_{\text{through } 3\Omega} = \frac{8V}{3\Omega} = \boxed{2\frac{2}{3}A}$ $\quad I_{\text{through } 6\Omega} = \frac{8V}{6\Omega} = \boxed{1\frac{1}{3}A}$

(5)



Loop 1:

$$+12 - 4I_1 - 2(I_1+I_2) = 0$$

$$12 = 6I_1 + 2I_2$$

① $\boxed{6 = 3I_1 + I_2}$

Loop 2:

$$-6 - 3I_2 - 2(I_1+I_2) = 0$$

② $\boxed{-6 = +2I_1 + 5I_2}$

Solving these equations:

$5① - ② \Rightarrow \quad 5(6) - (-6) = 5(3I_1) - 2I_1$

$$36 = 13I_1$$

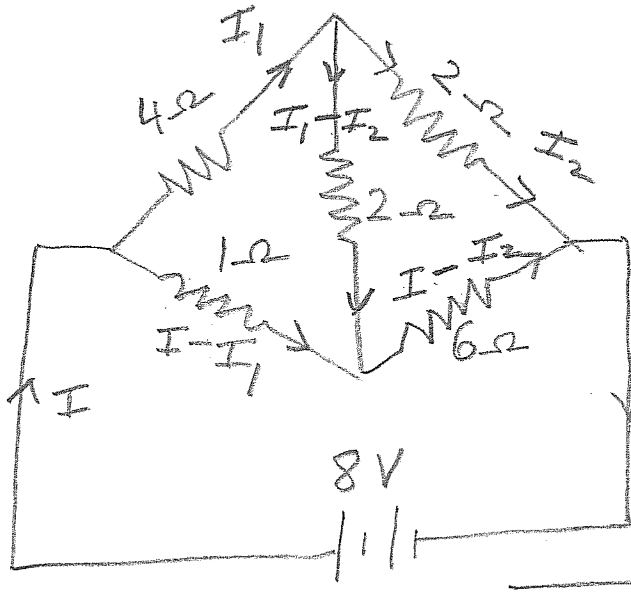
$$\boxed{I_1 = \frac{36}{13} \text{ Amps}}$$

$$6 = 3\left(\frac{36}{13}\right) + I_2$$

$$I_2 = 6 - 3\left(\frac{36}{13}\right) = \boxed{-\frac{30}{13} \text{ Amps}}$$

Through the 2 Ω resistor flows $I_1 + I_2 = \boxed{\frac{6}{13} \text{ Amps}}$

(6)



$$8 - 4I_1 - 2I_2 = 0$$
$$8 - (I - I_1) - 6(I - I_2) = 0$$
$$-4I_1 - 2(I_1 - I_2) + (I - I_1) = 0$$

$$4 = 2I_1 + I_2$$
$$8 = 7I - I_1 - 6I_2$$
$$0 = I - 7I_1 + 2I_2$$

(a)

$$I = \frac{\begin{vmatrix} 4 & 2 & 1 \\ 8 & -1 & -6 \\ 0 & -7 & 2 \end{vmatrix}}{\begin{vmatrix} 0 & 2 & 1 \\ 7 & -1 & -6 \\ 1 & -7 & 2 \end{vmatrix}} = \frac{4(-2-42) - 8(4+7)}{-7(4+7) + 1(-12+1)} = \boxed{3\,A}$$

(b)

$$R_{effective} = \frac{V}{I} = \frac{8}{3} = \boxed{2\tfrac{2}{3}\,\Omega}$$

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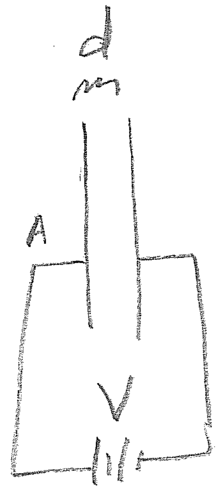
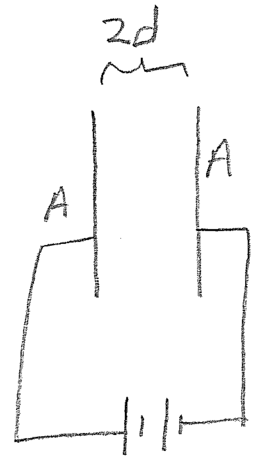
(a)



$C_0 = \frac{\epsilon_0 A}{d}$

$U_0 = \frac{C_0 V^2}{2}$



$C = \frac{\epsilon_0 A}{2d}$

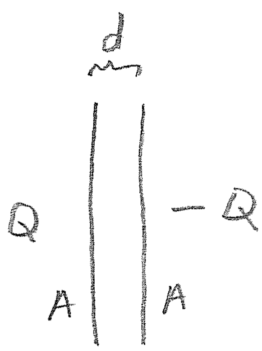
$C = \frac{C_0}{2}$

$U = (C_0/2)\frac{V^2}{2}$

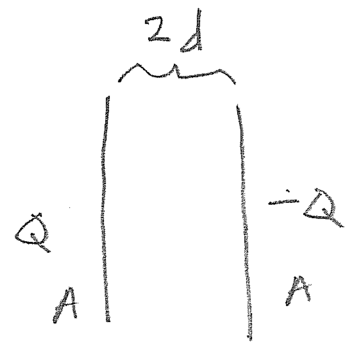
$\boxed{U = U_0/2}$

The energy decreases by a factor of $\boxed{2}$

(b)



$C_0 = \frac{\epsilon_0 A}{d}$



$C = \frac{C_0}{2}$

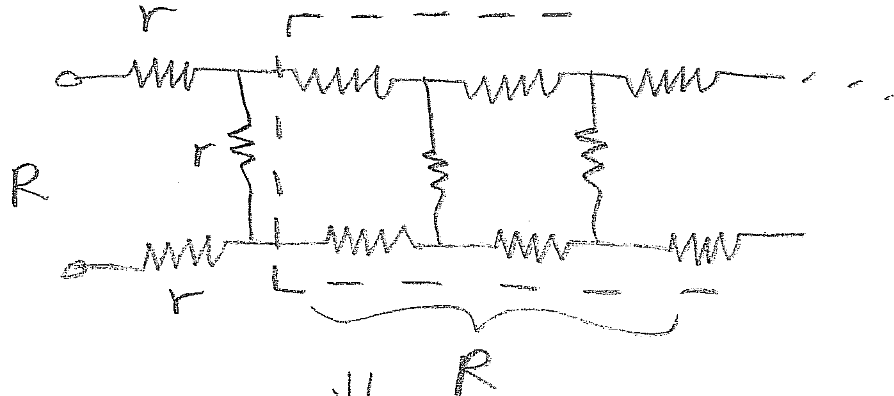
$U_0 = \frac{Q^2}{2C_0}$

$U = \frac{Q^2}{2(C_0/2)}$

$\boxed{U = 2U_0}$

The energy increases by a factor of $\boxed{2}$

8



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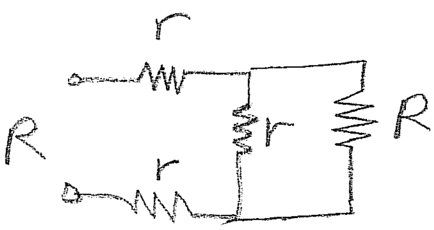

$$R = r + r + \frac{1}{\frac{1}{r} + \frac{1}{R}}$$

$$R = 2r + \frac{rR}{r+R}$$

$$R(r+R) = 2r(R+r + rR$$

$$\cancel{Rr} + R^2 = 2rR + 2r^2 + \cancel{rR}$$

$$R^2 - 2rR - 2r^2 = 0$$

$$R = \frac{2r + \sqrt{4r^2 + 8r^2}}{2} = \boxed{r(1+\sqrt{3})}$$

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a) $(.06 \text{ kw})(12 \text{ hr}) \dfrac{14¢}{\text{kw-hr}} = \boxed{10¢}$

b) $(1.5 \text{ kw}) (\tfrac{1}{2} \text{ hr}) \left(\dfrac{14¢}{\text{kw-hr}}\right) = \boxed{11¢}$

c) $(2 \text{ kw})(8 \text{ hr}) \left(\dfrac{14¢}{\text{kw-hr}}\right) = \boxed{\$2.24}$

d) $(.1 \text{ kw}) (8 \text{ hr}) \left(\dfrac{14}{\text{kw-hr}}\right) = \boxed{11¢}$