① $R = \rho \frac{L}{A}$ $\quad A = \pi r^2$

$R \propto \frac{1}{r^2}$

$\underline{.25}$

② $\underline{12\,\Omega}$ (The resistance of the resistor does not depend on current).

③ $R = \rho \frac{L}{A}$ $\quad A = \pi r^2$

$R \propto \frac{1}{r^2}$ $\quad r = .5$

$4R$ $\quad \underline{R = 40.0\,\Omega}$

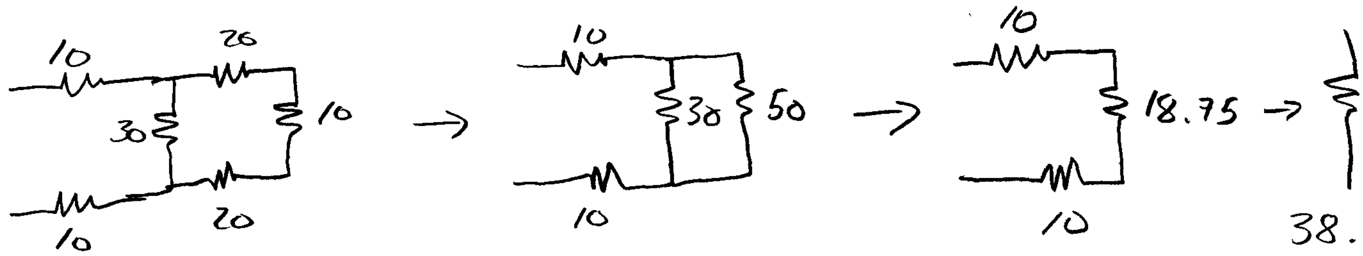
④ (a) $P = \frac{V^2}{R}$

$R = \frac{V^2}{P} = \frac{(220V)^2}{120W} = \underline{4.0 \times 10^2\ \Omega}$ $\quad (403\,\Omega)$

(b) $R = \rho \frac{L}{A}$ $\quad A = \pi r^2$

$L = \frac{\pi r^2 R}{\rho} = \frac{\pi (0.03 \times 10^{-3} m)^2 (403\,\Omega)}{2 \times 10^{-6}\ \Omega m} = \underline{0.57\ m}$

⑤



$\underline{38.8\,\Omega}$

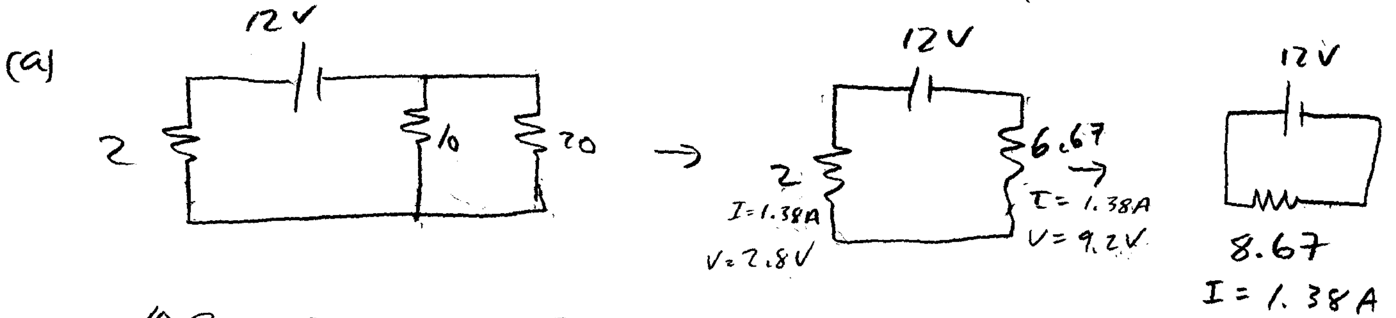
⑥ $\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$ $\quad R_1 = R_2 = \frac{R}{2}$

$= \frac{1}{\frac{R}{2}} + \frac{1}{\frac{R}{2}} = \frac{2}{R} + \frac{2}{R} = \frac{4}{R}$

$R_{eq} = \underline{\frac{R}{4}}$

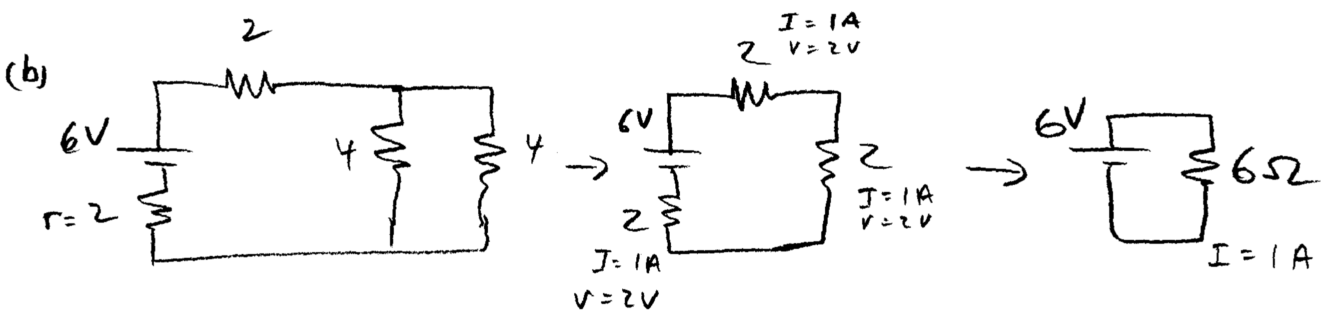
(7)

(a)



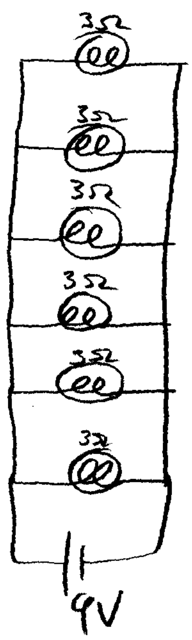
	10Ω	20Ω	2Ω
V =	9.2V	9.2V	2.8V
I =	0.92A	0.46A	1.38A

(b)



	4Ω	2Ω
V =	2V	2V
I =	0.5A	1A

(8)



$$P = \frac{V^2}{R}$$

- since the bulbs are in parallel, the voltage drop will be the same (9V) across each light bulb
- all light bulbs have the same resistance so all bulbs will have the same power.
- If one bulb burns out, the remaining bulbs are still in parallel and therefore will STILL have a voltage drop of 9V, giving the same power.

∴ the brightness will be the same.

(9) (a) Toaster: $P = IV$

$$I = \frac{P}{V} = \frac{1200\,W}{220\,V} = \underline{5.45\,A}$$

Mixer: $I = \frac{P}{V} = \frac{500\,W}{220\,V} = \underline{2.27\,A}$

(b) $E = Pt$

Toaster: $E = 1200\,W \times 1\,h = 1200\,Wh = \underline{1.2\,kWh}$

Mixer: $E = 500\,W \times 1\,h = 500\,Wh = \underline{0.5\,kWh}$

(10) (a) $P = IV$

$$I = \frac{P}{V} = \frac{2000\,W}{220\,V} = \underline{9\,A}$$

(b) $P = \frac{V^2}{R}$

$$R = \frac{V^2}{P} = \frac{(220\,V)^2}{2000\,W} = \underline{24\,\Omega}$$

(c) $Q = mc\Delta T$

$= (2\,kg)(4200\,J\,kg^{-1}\,K^{-1})(90 - 15\,°C)$

$= 6.3 \times 10^5\,J$

$P = 2000\,W = 2000\,J\,s^{-1}$

$$\frac{6.3 \times 10^5\,J}{2000\,J\,s^{-1}} = 315\,s = \underline{5.25\,min} = 0.0875\,h$$

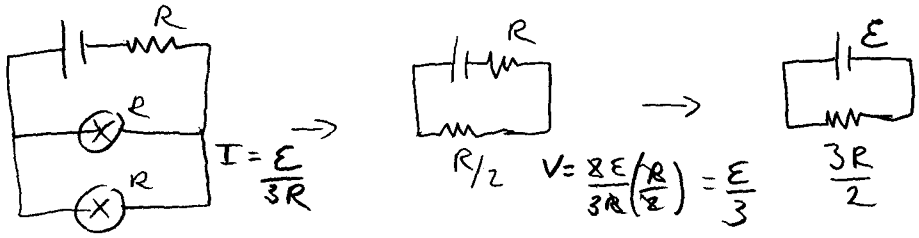
(d) $2000\,W\,(.0875\,h) = 175\,Wh = 0.175\,kWh\,(\$0.10) = \underline{\$0.02}$

(29) (a) - bulbs are in parallel and therefore have the same voltage drop across them, $\mathcal{E}$

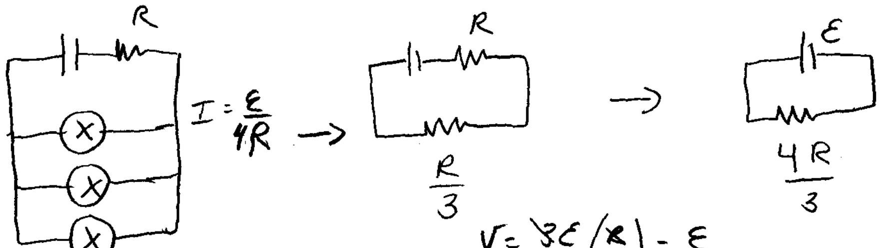
- bulbs are identical and so they pull the same current

$\therefore$ the brightness will be the <u>same</u>

(b)

① 

$I = \frac{\mathcal{E}}{3R}$ $\rightarrow$ $R/2$ $V = \frac{2\mathcal{E}}{3R}\left(\frac{R}{2}\right) = \frac{\mathcal{E}}{3}$ $\rightarrow$ $\frac{3R}{2}$ $I = \frac{2\mathcal{E}}{3R}$

② 

$I = \frac{\mathcal{E}}{4R}$ $\rightarrow$ $\frac{R}{3}$ $\rightarrow$ $\frac{4R}{3}$ $I = \frac{3\mathcal{E}}{4R}$

$V = \frac{3\mathcal{E}}{4R}\left(\frac{R}{3}\right) = \frac{\mathcal{E}}{4}$

$$\frac{P_1}{P_2} = \frac{I_1^2 R_1}{I_2^2 R_2} = \frac{\left(\frac{\mathcal{E}}{3R}\right)^2 R}{\left(\frac{\mathcal{E}}{4R}\right)^2 R} = \frac{\frac{1}{9}}{\frac{1}{16}} = \frac{16}{9}$$ <u>times brighter</u>

(30) $V_D = 8\,V$ $\quad V_R = 12V - 8V = 4V$

$I_D = 2A$ $\quad I_R = 2A$ (resistors are in series)

$$R = \frac{V}{I} = \frac{4V}{2A} = \underline{2\,\Omega}$$

(31) (a) P (only one device in the circuit)

(b) $2P$ (two devices in parallel - same $\mathcal{E}$, same I - so both dissipate P)

(c) $\frac{P}{2}$ (two devices in series)

(d) $R_{eq} = \left(\frac{1}{2R} + \frac{1}{R}\right)^{-1} = \frac{3R}{2}$ So Power dissipated would be $\frac{3}{2}P$

(32) an ideal voltmeter has $R = \infty\,\Omega$
so all of voltage would be dropped across the voltmeter

$\underline{12\,V}$

(33) same reasoning as 32

$\underline{6\,V}$

(34) (a) Internal resistance = slope $= -\frac{\Delta V}{\Delta I} = \frac{-(2.4 - 8)}{(8 - 3.2)} = \underline{1.2\,\Omega}$

(b) $V = Ir = (3.2\,A)(1.2\,\Omega) = 3.84\,V$ across the internal resistor.

8 V across battery

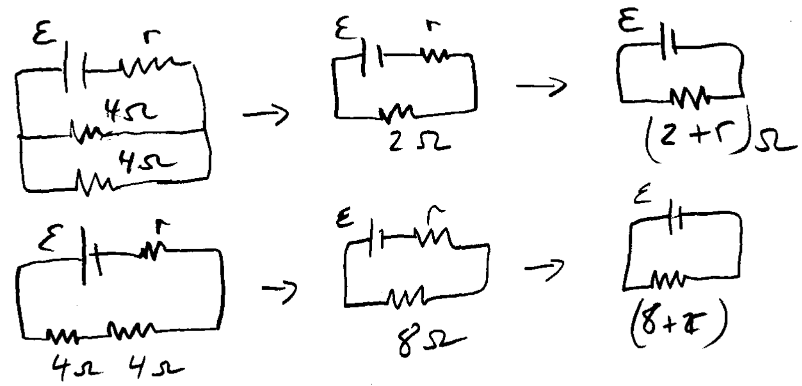
$\therefore\ \mathcal{E} = 8V + 3.84V = \underline{12\,V}$

(35) $I_R = \frac{V}{R} = \frac{1.2\,V}{1.5\,\Omega} = 0.8\,A$

from graph $0.8\,V \rightarrow 1.6\,V$

$\therefore$ Emf $= 1.2V + 1.6V = \underline{2.8\,V}$

(36)



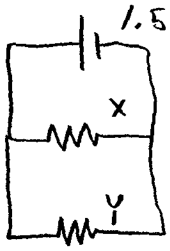
$\mathcal{E} = I(2+r) = 3(2+r)$

$\mathcal{E} = I(8+r) = 1.4(8+r)$

(b) $3(2+r) = 1.4(8+r)$
$6 + 3r = 11.2 + 1.4r$
$1.6r = 5.2$
$r = \underline{3.25\,\Omega}$

(a) $\mathcal{E} = 3(2+r)$
$= 3(2 + 3.25)$
$= \underline{16\,V}$

(37) (a)



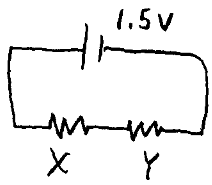
from graph (1.5V)

$I_x = 2.67A$

$I_y = 1.53A$

Total Current $= I_x + I_y = 2.67A + 1.63A = \underline{4.2A}$

(b)



$V_x + V_y = 1.5V$

$I_x = I_y$

using the graph, find a current that gives two voltages that add to 1.5V

$I = 1.1A \qquad (V_x = 0.6V,\ V_y = 1.0V)$

(38) - voltage will not change (parallel circuit)

- PTC R increases, so I decreases
- NTC R decreases, so I increases

<u>A will be dimmer, B will be brighter</u>

(39) (a) <u>39 Ω</u> (from graph)

(b) $R_{eq} = R_{NTC} + 25$

$I = \frac{V}{R} = \frac{9.0V}{R_{NTC} + 25}$

Voltmeter is measuring voltage drop across R_{NTC}.

$V = IR = \frac{9.0(R_{NTC})}{R_{NTC} + 25}$

(c) $V = \frac{9.0(39\Omega)}{39\Omega + 25} = \underline{5.5V}$

(d) - Voltmeter reading can be calibrated for temperature.
- as temperature changes, the voltage will change.

(40) (a) 4.0 V

(b) $R = \frac{V}{I} = \frac{4\,V}{0.2\,A} = 20\,\Omega$

(c) $R_{eq} = \left(\frac{1}{60} + \frac{1}{20}\right)^{-1} = 15\,\Omega + 60\,\Omega = 75\,\Omega$ (Total R)

$I = \frac{V}{R} = \frac{8\,V}{75\,\Omega} = 0.107\,A$

$V = IR = (0.107\,A)(15\,\Omega) = \underline{1.6\,V}$

(d) $I = \frac{V}{R} = \frac{1.6\,V}{20\,\Omega} = \underline{0.08\,A}$

(e) there is not enough current to light the bulb.

(41) (a) $R_{eq} = \left(\frac{1}{100\,\Omega} + \frac{1}{100\,\Omega}\right)^{-1} = 50\,\Omega + 100\,\Omega = 150\,\Omega$

$I = \frac{V}{R} = \frac{6\,V}{150\,\Omega} = 0.04\,A$

$V = IR = (0.04\,A)(50\,\Omega) = \underline{2\,V}$

(b) $R_{eq} = \left(\frac{1}{110\,\Omega} + \frac{1}{100\,\Omega}\right)^{-1} = 52.38 + 100\,\Omega = 152.38\,\Omega$

$I = \frac{V}{R} = \frac{6\,V}{152.38} = 0.039\,A$

$V = IR = (0.039\,A)(52.38) = \underline{2.06\,V}$