Begin with CQs

19.2.c

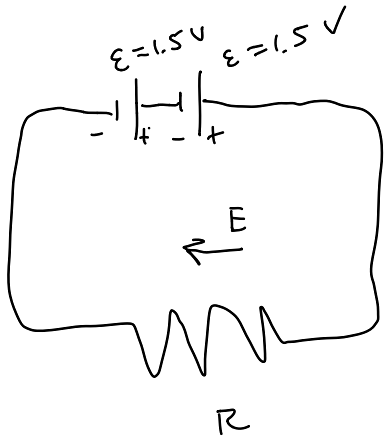
$$R = \frac{L}{A\sigma}$$

$$R_c = 1.7\,\Omega$$

$$R_{cu} = \frac{L}{(0.1mm)^2\, 5.8\times10^7} = \frac{L}{(0.0001^2)(5.8\times10^7)} = 1.7$$

$$L = (1.7)(1\times10^{-4})^2(5.8\times10^7) = 0.986\text{ m} \approx 1\text{m}$$

19.2.e



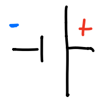
$I = 0.075$ A

Path in direction of I?

$\Delta V = -IR$

$$\varepsilon + \varepsilon - IR = 0 \Rightarrow 2\varepsilon = IR \Rightarrow R = \frac{2\varepsilon}{I} = \frac{3}{0.075} = 40\Omega$$

Circuit Diagrams

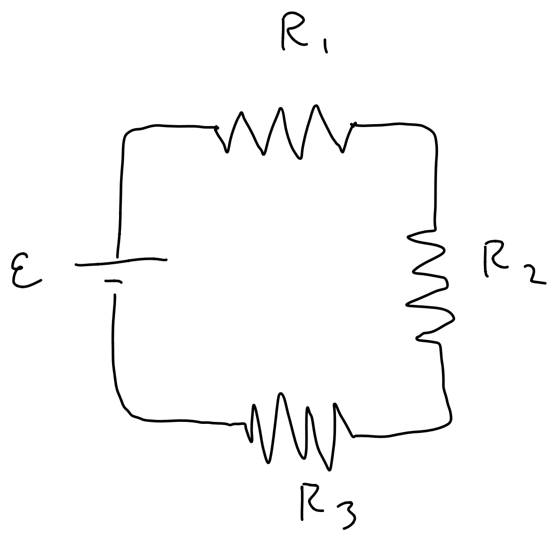


Battery


Resistor


Capacitor

Question:



Elements connected along a single path are in <u>series</u>

What is I_1, I_2, I_3?

Loop Rule + Ohm's Law

$\mathcal{E} - I_1R_1 - I_2R_2 - I_3R_3 = 0$

Series:

Node rule:

$I_1 = I_2, I_2 = I_3$

$I_1 = I_2 = I_3 = \underline{I}$

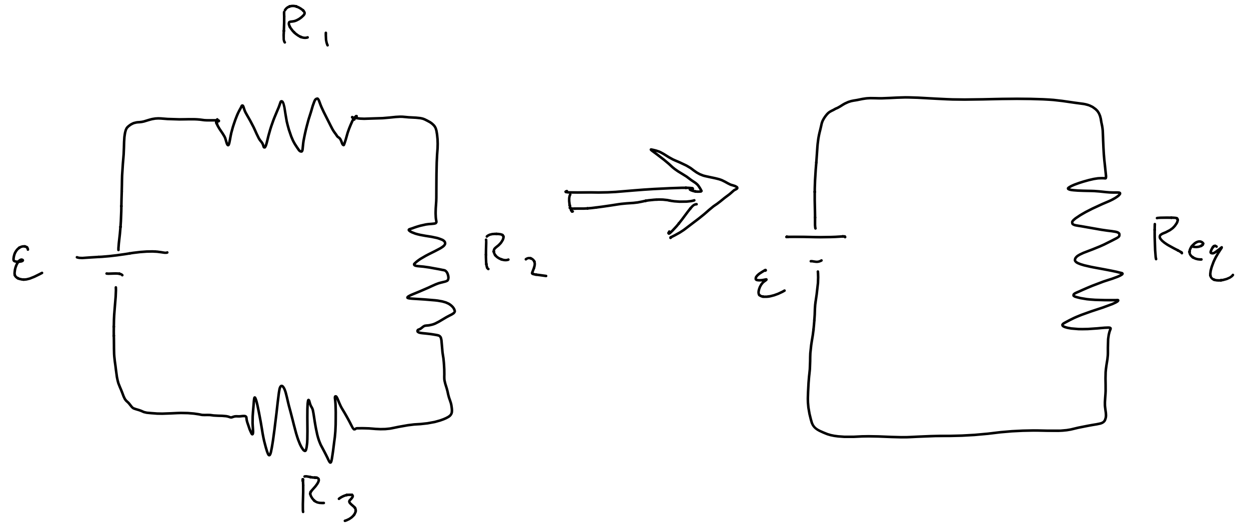
$\mathcal{E} - IR_1 - IR_2 - IR_3 = 0$

$\mathcal{E} = I(R_1 + R_2 + R_3)$

$\mathcal{E} = I R_{eq}$

$R_{eq} = R_1 + R_2 + R_3$

$I = \mathcal{E}/R_{eq}$

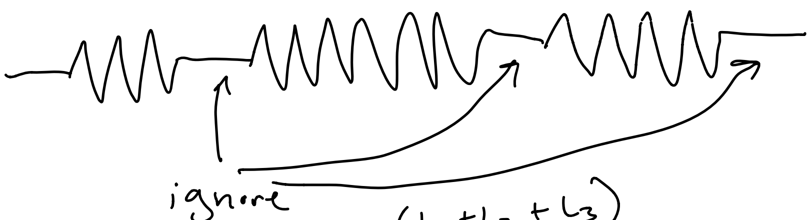


In series: 

$$R_{eq} = \sum_{i=1}^{N} R_i$$

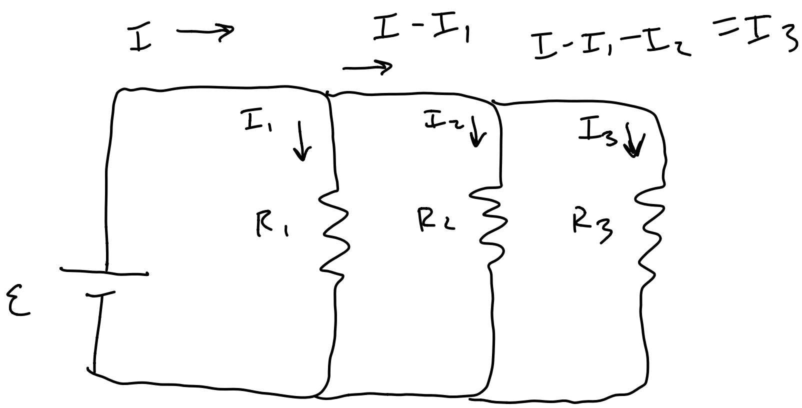
3 resistors with same A & σ

$R_1 = \frac{L_1}{\sigma A}$ $\quad R_2 = \frac{L_2}{\sigma A}$ $\quad R_3 = \frac{L_3}{\sigma A}$



$$R = \frac{(L_1 + L_2 + L_3)}{\sigma A}$$

What about:



Parallel resistors

$$\varepsilon - I_1 R_1 = 0 \qquad I_1 R_1 = I_2 R_2 = I_3 R_3 = \varepsilon$$

$$\varepsilon - I_2 R_2 = 0$$

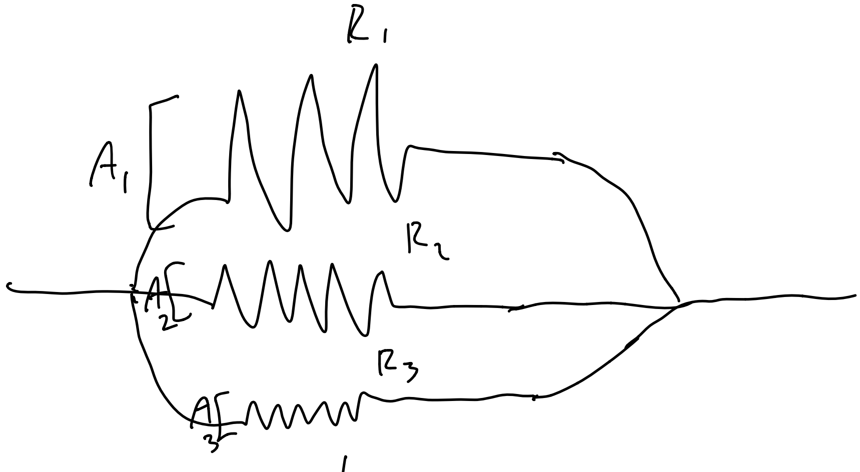
$$\varepsilon - I_3 R_3 = 0$$

$$I = I_1 + I_2 + I_3$$

$$I = \frac{\varepsilon}{R_1} + \frac{\varepsilon}{R_2} + \frac{\varepsilon}{R_3} = \varepsilon\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)$$

$$I = \varepsilon\left(\frac{1}{R_{eq}}\right)$$

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

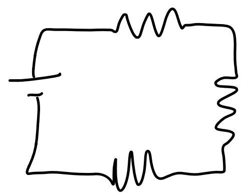


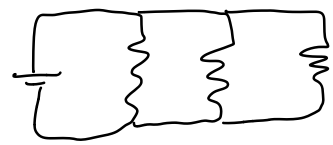
$$R_{eq} = \frac{L}{\sigma(A_1 + A_2 + A_3)}$$

$$\frac{1}{R_{eq}} = \frac{\sigma}{L}\left(A_1 + A_2 + A_3\right) = \frac{\sigma A_1}{L} + \frac{\sigma A_2}{L} + \frac{\sigma A_3}{L}$$

$$= \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

Elements Connected in...

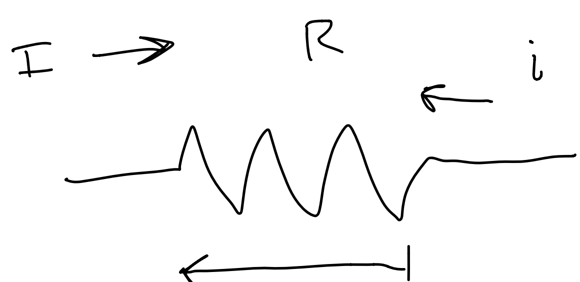




	Series	Parallel
Voltage	$\mathcal{E} = V_1 + V_2 + V_3$	$\mathcal{E} = V_1 = V_2 = V_3$
Current	$I = I_1 = I_2 = I_3$	$I = I_1 + I_2 + I_3$
Resistance	$R_{eq} = R_1 + R_2 + R_3$	$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

Question:

Energy dissipated in a resistor



ΔV positive

$\Delta U = -e\Delta V$

$\Delta K = 0$

ΔU goes into heat

Energy gained by resistor $= \Delta E = e\Delta V$

$$\text{Power} = \frac{\Delta E}{\Delta t} = \frac{I\,\Delta t\,\Delta V}{\Delta t} = I\,\Delta V$$

$$P = I\Delta V$$

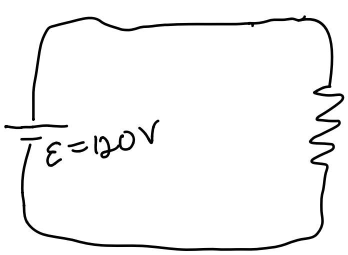
$$\Delta V = IR, \quad P = I^2 R$$

Unit: Watt $\left(\frac{J}{s}\right)$

Example: A 60 W light bulb

What is the current?

USA outlets: $\Delta V = 120\,V$



$$P = I\Delta V$$

$$\mathcal{E} - \Delta V = 0$$

$$\frac{P}{\Delta V} = I, \quad \frac{60}{120} = I = 0.5\,A$$

Resistance?

$$I = \frac{\Delta V}{R} \Rightarrow R = \frac{\Delta V}{I} = \frac{120}{0.5} = 240\,\Omega$$

Resistance of a 150 W bulb?

$$R = \frac{\Delta V}{I} = \frac{\mathcal{E}}{I} = \frac{\mathcal{E}}{P/\mathcal{E}} = \frac{\mathcal{E}^2}{P} = \frac{120^2}{150} = 96\,\Omega$$

$$P = I\mathcal{E}, \quad I = \frac{P}{\mathcal{E}}$$