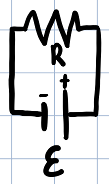
Direct Current Circuits

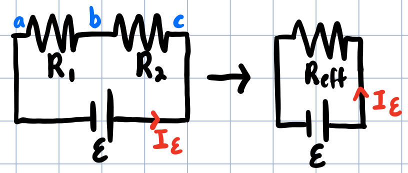
- ε is called the "electromotive force" or "emf", but it's actually the voltage between two materials that make up the two terminals of a battery
- Simple circuit:



I = conventional current = flow of charge

$\varepsilon = IR, \quad P = \varepsilon I = I^2R = \frac{\varepsilon^2}{R}$

- Series circuit:

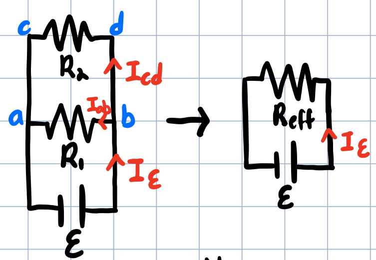


$I_\varepsilon = I_{ab} = I_{bc} = I \qquad \varepsilon = V_{ab} + V_{bc}$

$\rightarrow I_\varepsilon R_{eff} = I_{ab}R_{ab} + I_{bc}R_{bc} \rightarrow R_{eff} = R_{ab} + R_{bc}$

So $R_{eff} = \sum_{i=1}^{N} R_i$.

- Parallel circuit:

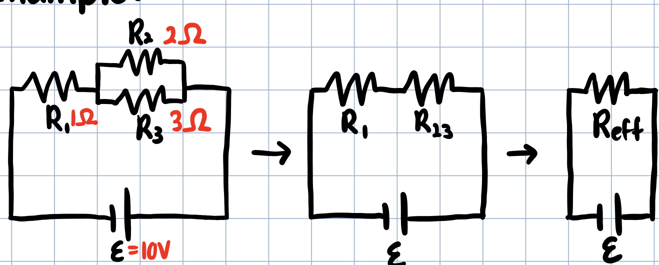


$I_\varepsilon = I_{ab} + I_{cd} \quad \varepsilon = V_{ab} = V_{cd}$

$\rightarrow \frac{\varepsilon}{R_{eff}} = \frac{V_{ab}}{R_{ab}} + \frac{V_{cd}}{R_{cd}} \rightarrow \frac{1}{R_{eff}} = \frac{1}{R_{ab}} + \frac{1}{R_{bc}}$

So $\frac{1}{R_{eff}} = \sum_{i=1}^{N} \frac{1}{R_i}$.

- In series, larger resistor dissipates more power whereas the smaller one does when in parallel
- Example:



$R_{eff} = 1 + \frac{1}{\frac{1}{2}+\frac{1}{3}} = 2.2\,\Omega \qquad I_\varepsilon = \frac{10}{2.2} = 4.55\,A \qquad P_\varepsilon = 10 \times 4.55 = 45.5\,W$

$I_1 = 4.55\,A \qquad V_1 = 4.55 \times 1 = 4.55\,V \qquad V_2 = 5.45\,V \qquad V_3 = 5.45\,V$

$I_2 = \frac{5.45}{2} = 2.73\,A \qquad I_3 = \frac{5.45}{3} = 1.82\,A \qquad P_1 = 4.55^2 = 20.70\,W \qquad P_2 = 14.88\,W \qquad P_3 = 45.5\,W$