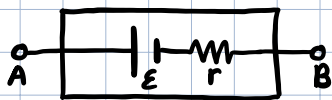


Internal Resistance of a Battery

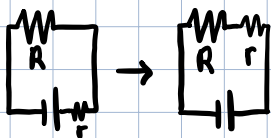
- There are resistors in batteries!



r = internal resistance V_{AB} = terminal voltage

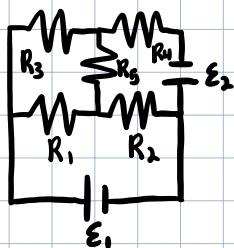
$$V_{AB} = \mathcal{E} - Ir$$

- The lowest V_{AB} can go is 0, so $I_{\max} = \frac{\mathcal{E}}{r}$
- You can treat r as a resistor in series



Kirchhoff's Laws

- Consider the following:

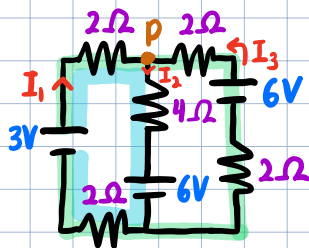


Junction Law: $\sum I_{\text{in}} = \sum I_{\text{out}}$

Loop Law: $\sum \mathcal{E} - \sum IR = 0$ for any complete loop around a circuit

Rely on the facts that $\mathcal{E} > 0$ from - to + terminals and $IR > 0$ as you go across a resistor in the same direction as the current

- Example: Find I_1, I_2, I_3



Loop 1

$$3 - 2I_1 + 2I_3 - 6 + 2I_3 - 2I_1 = 0 \rightarrow 4I_1 - 4I_3 = -3$$

P

$$I_1 + I_3 = I_2$$

Loop 2

$$3 - 2I_1 - 4I_2 - 6 - 2I_2 = 0 \rightarrow 4I_1 + 4I_2 = -3$$

Solving yields $I_1 = -\frac{1}{2}$, $I_2 = -\frac{1}{4}$, $I_3 = \frac{1}{4}$; I_1 and I_2 being negative means they're pointed wrong way in diagram.