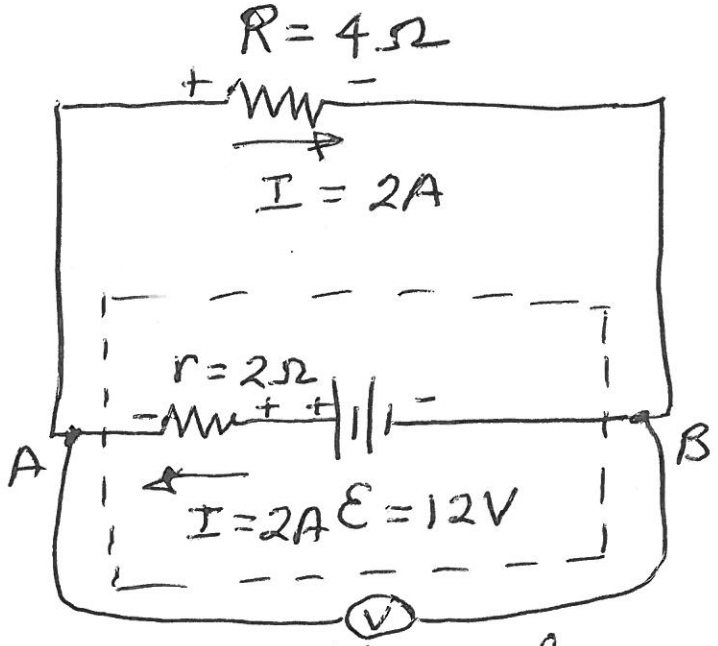
Physics 264 - Lecture 1

Effect = constant × cause

$$I = GV = \left(\frac{1}{R}\right)V$$

- I: current (A)
- G: conductance
- V: potential difference (V)
- R: resistance (Ω)



Battery with emf = 12V and internal resistance of $r = 2\Omega$

$$I = \frac{\mathcal{E}}{R+r} = \frac{12}{4+2} = \frac{12}{6} = 2A$$

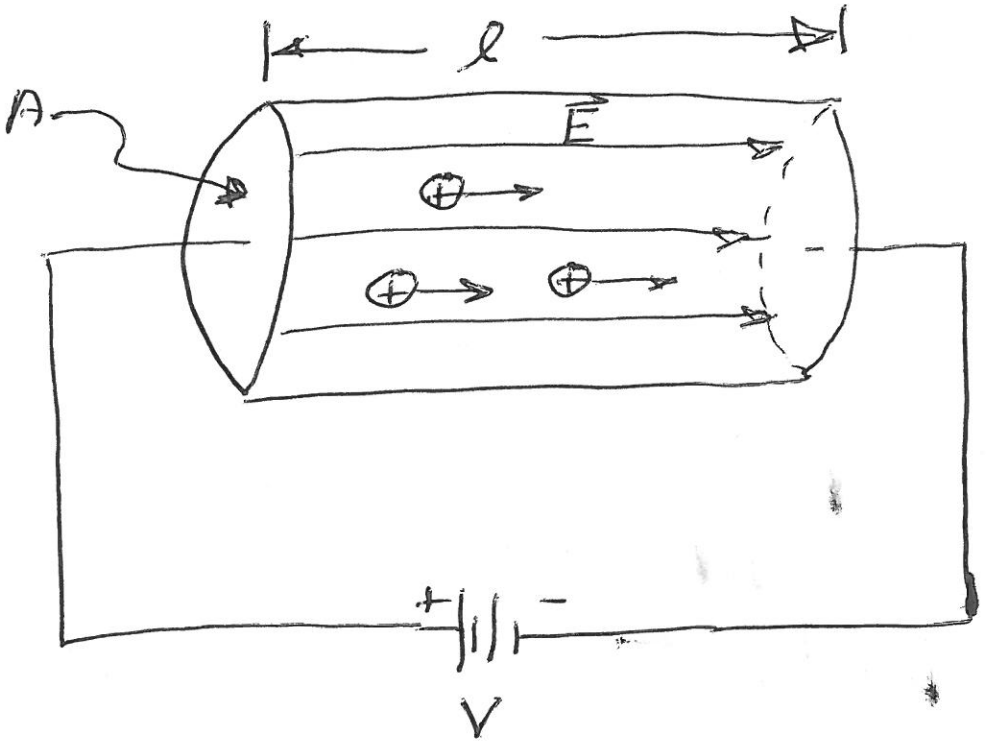
$$V_{AB} = \mathcal{E} - Ir = 12 - (2)(2) = 8V$$

Microscopic View

Effect = constant × cause

$$\vec{J} = \sigma \vec{E} = \frac{1}{\rho} \vec{E}$$

- $\vec{J}$: current density
- σ: conductivity
- ρ: resistivity
- $\vec{E}$: electric field



$$I = \int \vec{J} \cdot d\vec{a} \qquad \vec{E} = -\vec{\nabla} V$$

$$J = \frac{1}{\rho} E$$

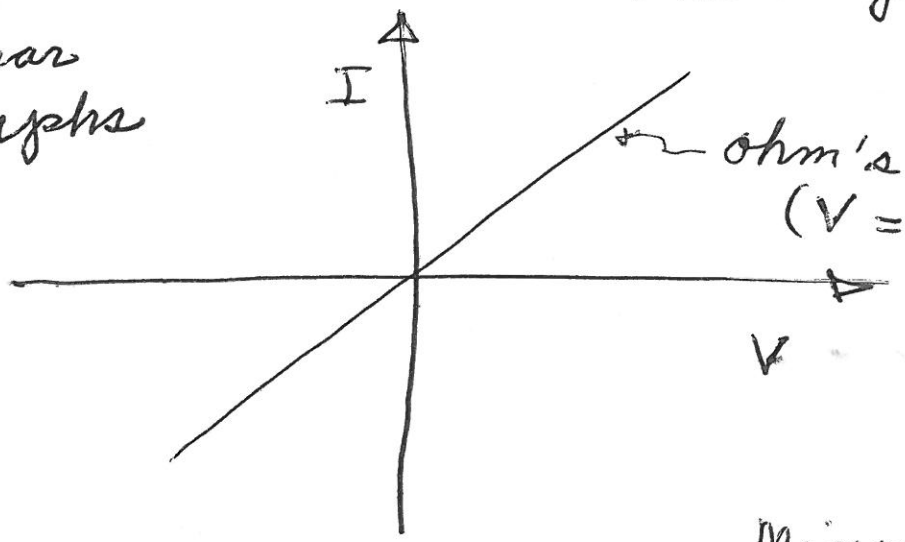
$$\frac{I}{A} = \frac{1}{\rho}\left(\frac{V}{\ell}\right)$$

$$\frac{V}{I} = \rho\,\frac{\ell}{A}$$

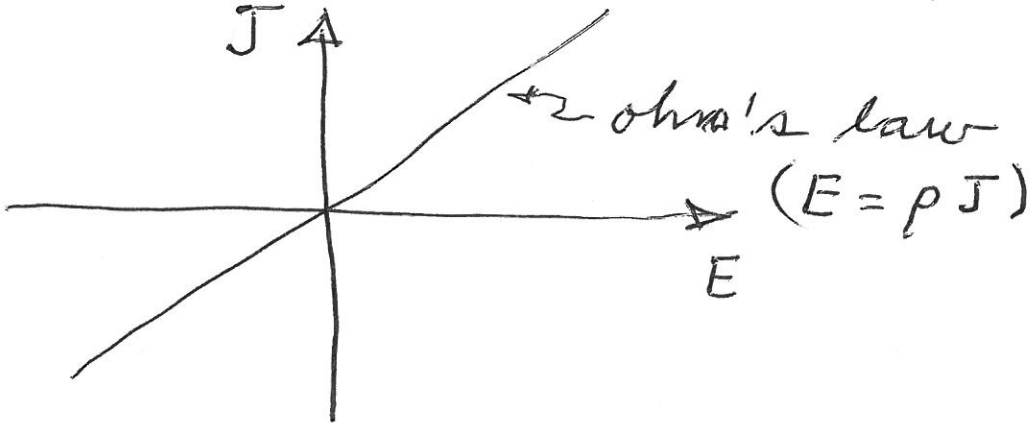
$$\boxed{R = \rho\,\frac{\ell}{A}}$$

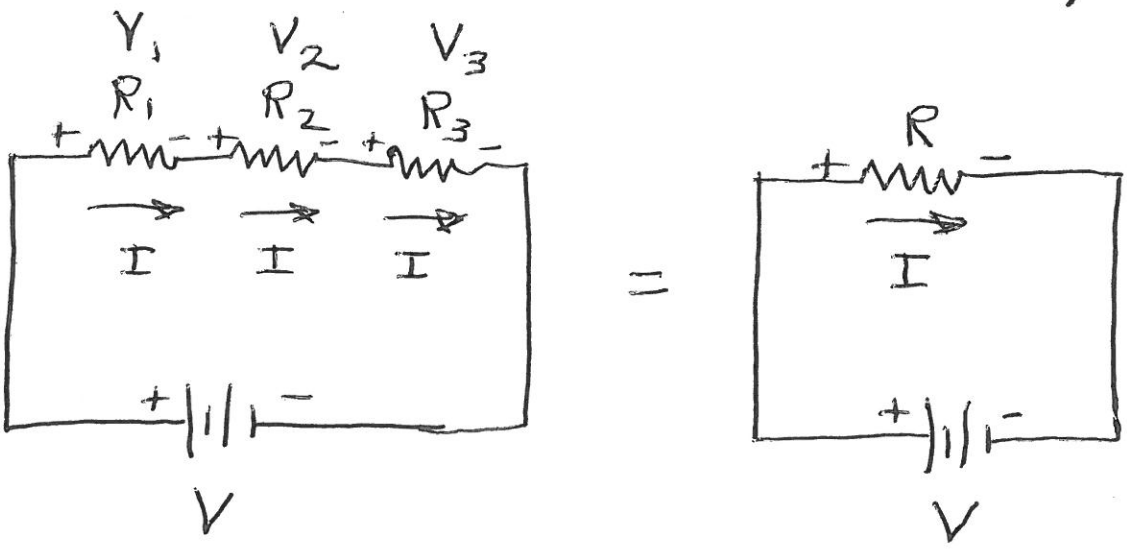
Linear graphs

Macroscopic view



Microscopic view



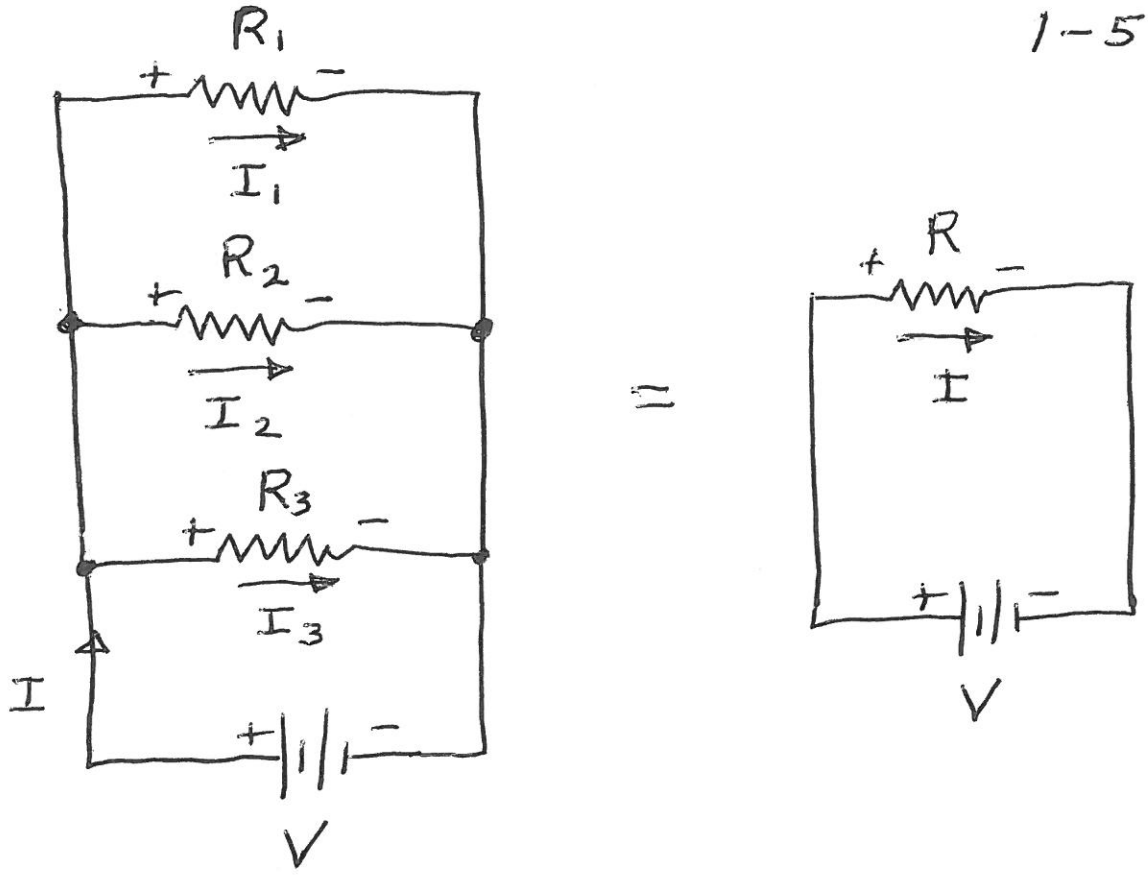


Series resistors

$$V = V_1 + V_2 + V_3$$

$$\cancel{I}R = \cancel{I}R_1 + \cancel{I}R_2 + \cancel{I}R_3$$

$$\boxed{R = R_1 + R_2 + R_3}$$

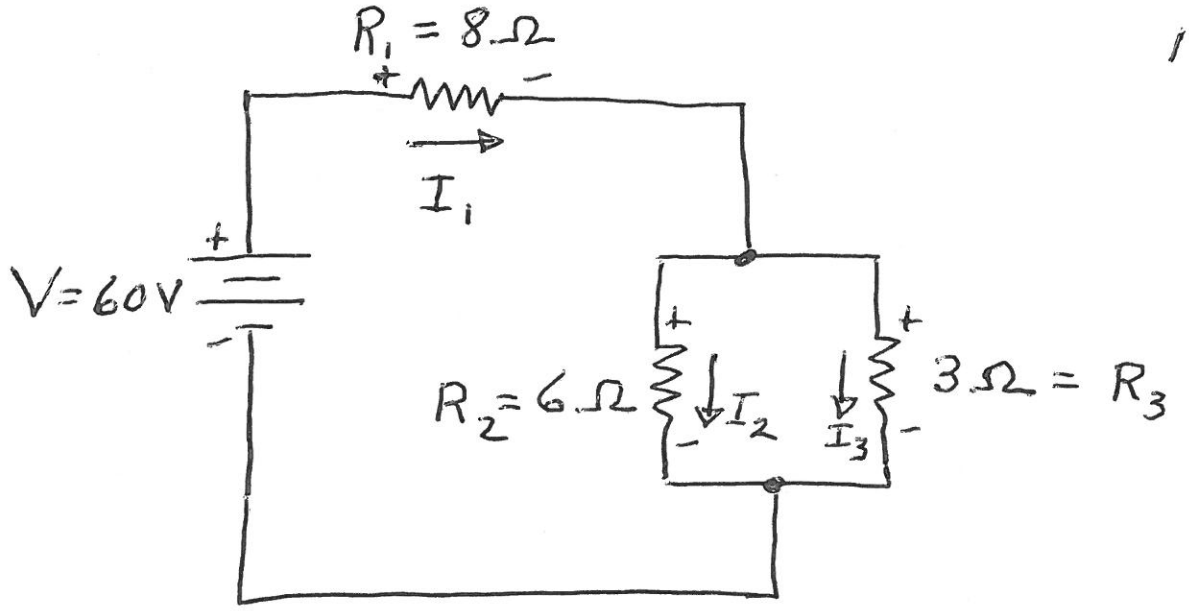


Parallel resistors

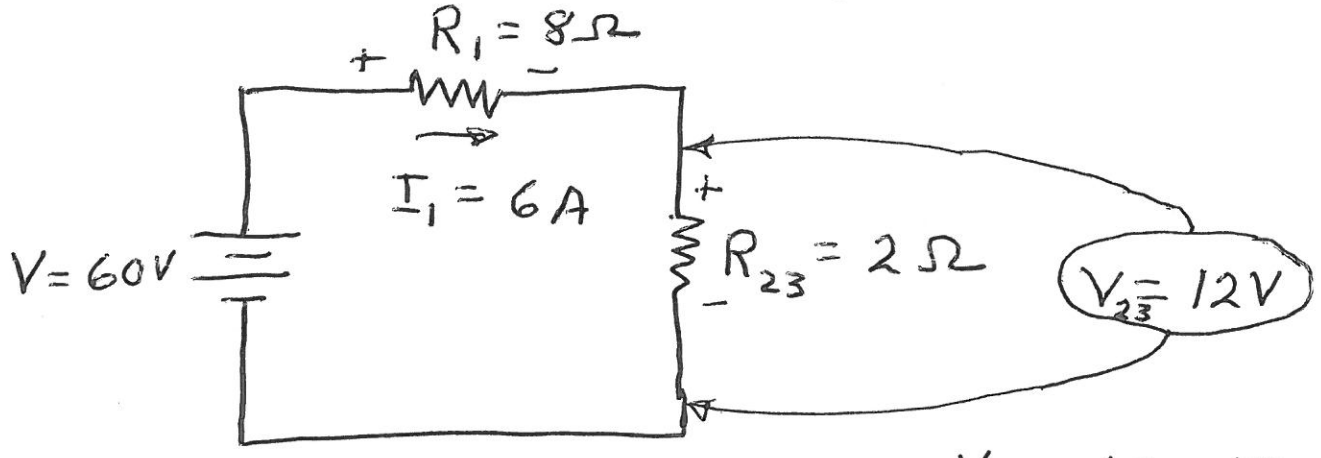
$$I = I_1 + I_2 + I_3$$

$$\frac{\cancel{V}}{R} = \frac{\cancel{V}}{R_1} + \frac{\cancel{V}}{R_2} + \frac{\cancel{V}}{R_3}$$

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



$$R_{23} = \frac{R_2 R_3}{R_2 + R_3} = \frac{(6)(3)}{6+3} = 2\,\Omega$$



$$V_{23} = 60 - 48 = 12\,V$$