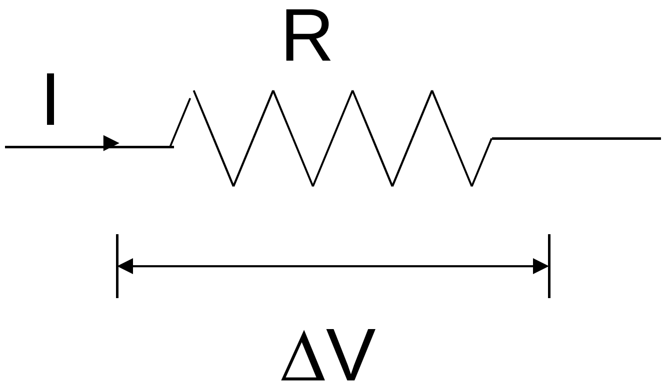
Class 18 Resistors in Parallel and Series

Power

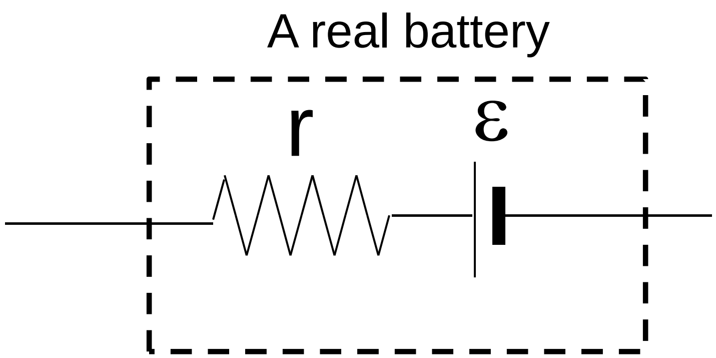
Power dissipated
in resistance R:

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



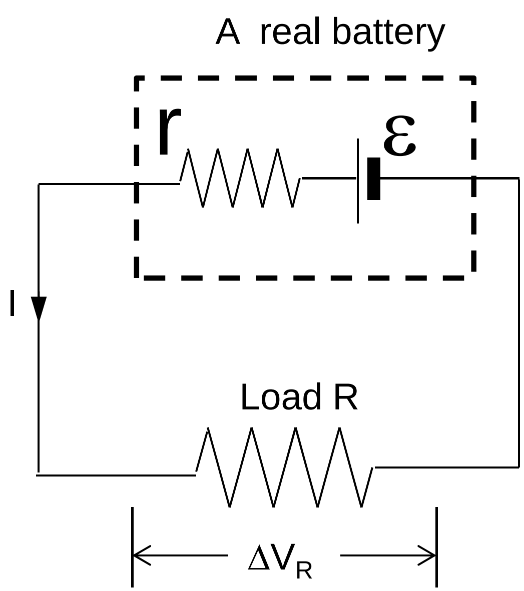
Units of power:
Watt (W) $\equiv$ J/s

Electromotive Force and Internal Resistance



Electromotive force (emf ε) is the maximum possible voltage the battery can provide between its terminal. You can think it like the voltage of an ideal battery with no internal resistance.

When connected externally:

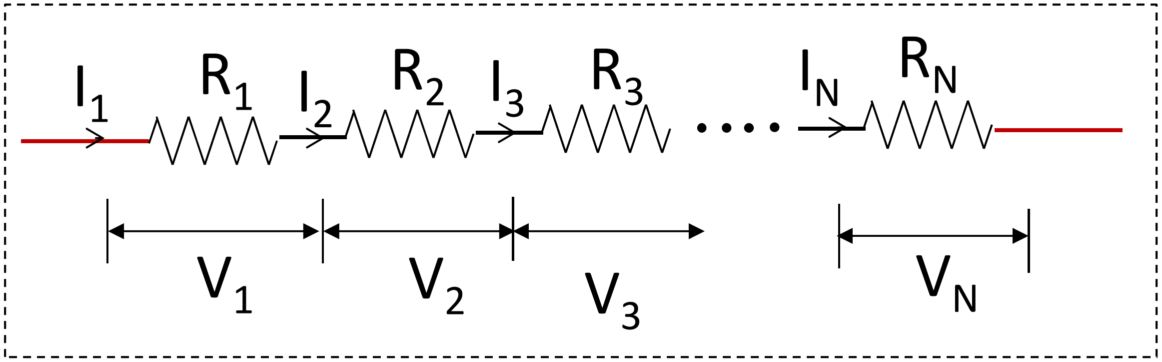


$$I = \frac{\varepsilon}{R + r}$$

$$\Delta V_R = IR = \frac{\varepsilon R}{R + r}$$

Voltage across the load resistance R will drop if more current is drawn from the battery (by making R smaller).

Connecting Resistors in Series



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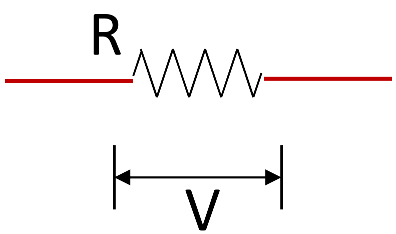


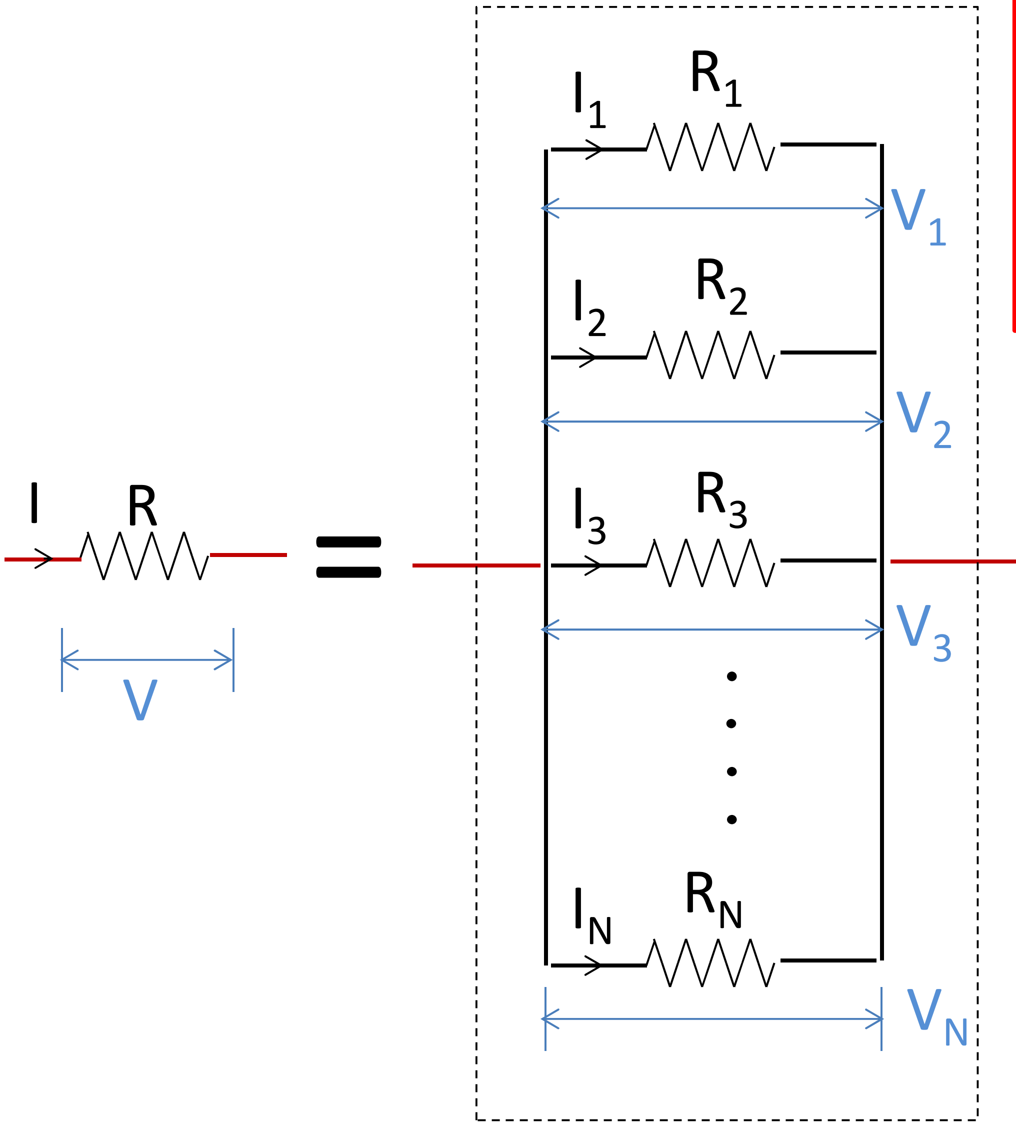
$$R_{eff} = R_1 + R_2 + R_3 + \cdots + R_N$$
$$I = I_1 = I_2 = I_3 = \cdots = I_N$$
$$V = V_1 + V_2 + V_3 + \cdots + V_N$$

1. Current through each individual resistor is the same: (why?)

$$I = I_1 = I_2 = I_3 = \cdots = I_N$$
$$\Rightarrow \frac{V}{R} = \frac{V_1}{R_1} = \frac{V_2}{R_2} = \frac{V_3}{R_3} = \cdots = \frac{V_N}{R_N}$$

2. Potential difference across each individual resistor should be different (unless they have the same resistance).

Connecting Resistors in Parallel



$$\frac{1}{R_{eff}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \cdots \frac{1}{R_N}$$

$$I = I_1 + I_2 + I_3 + \cdots I_N$$

$$V = V_1 = V_2 = V_3 = \cdots V_N$$

1. Potential difference across each individual resistor is the same: (why?)

$$V = V_1 = V_2 = V_3 = \cdots V_N$$

$$\Rightarrow I_1R_1 = I_2R_2 = I_3R_3 = \cdots I_NR_N$$

2. Current through each individual resistor should be different (unless they have the same resistance).