Ohm's Law & Kirchoff's Laws

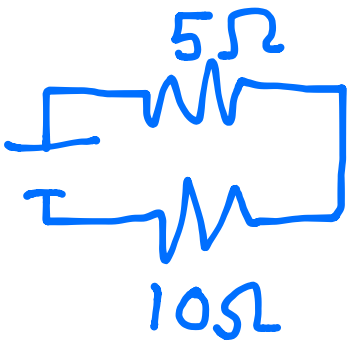
Resistance - measure of how easily current flows.

- scalar - symbol = R - units = Ohms (Ω)
- depends on length, cross-sectional area, material
  - long, thin wires → more resistance.
- Converts electrical energy into thermal energy
  - ↳ Good - lightbulb, stove, hairdryer
  - ↳ Bad - xBox 360, computer

Resistors have resistance
- wires + batteries do, but we'll ignore that.

Equivalent Resistance - total resistance of several resistors.

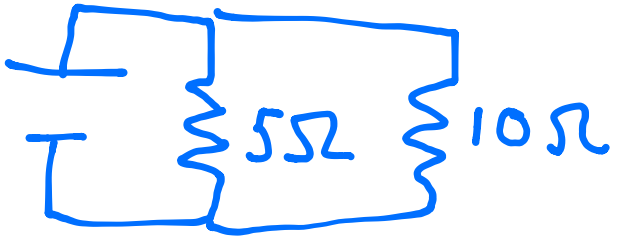
Series



$R_{eq} = 15\Omega$

$$R_{eq} = R_1 + R_2 + \ldots + R_N$$

Parallel



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

$$R_{eq} = \frac{1}{\frac{1}{5} + \frac{1}{10}} = \frac{1}{\frac{2}{10} + \frac{1}{10}}$$

$$= \frac{1}{3/10}$$

$$= 3.33\Omega$$

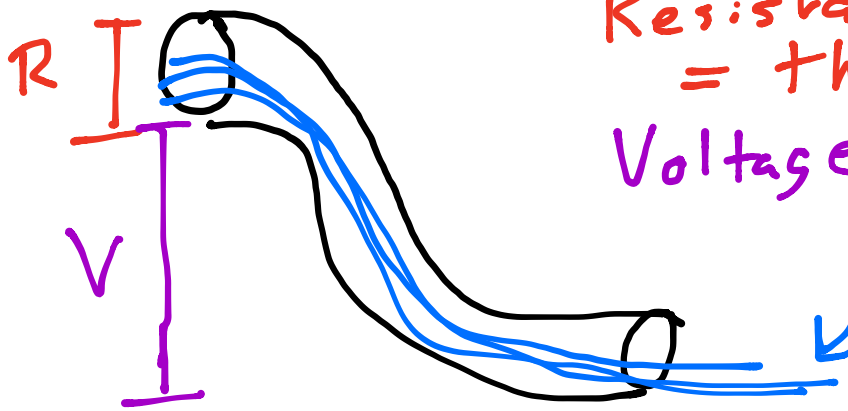
Ohm's Law - relates voltage, current, and resistance

$$V = IR \qquad I = V/R \qquad R = V/I$$

A toaster is connected to 110V and 2A runs through it.

$$R = \frac{110}{2} = 55\Omega$$

Circuits are like water slides:



Resistance = thickness

Voltage = height

current.

Joule's Law - power in circuits

$$P = W/t \qquad W = Vq$$

$$P = \frac{Vq}{t} \Rightarrow P = IV$$

$$P = IV = I(IV) = I^2R$$

↳ Joules Law

$$P = IV = \left(\frac{V}{R}\right)V = \frac{V^2}{R}$$

↳ Joule again

The toaster's power is:

$$P = IV = 2 \cdot 110 = 220\ W$$

or

$P = I^2R = 2^2 \cdot 55 = 220W$

$P = V^2/R = \overset{or}{=} \frac{110^2}{55} = \frac{12100}{55} = 220W$

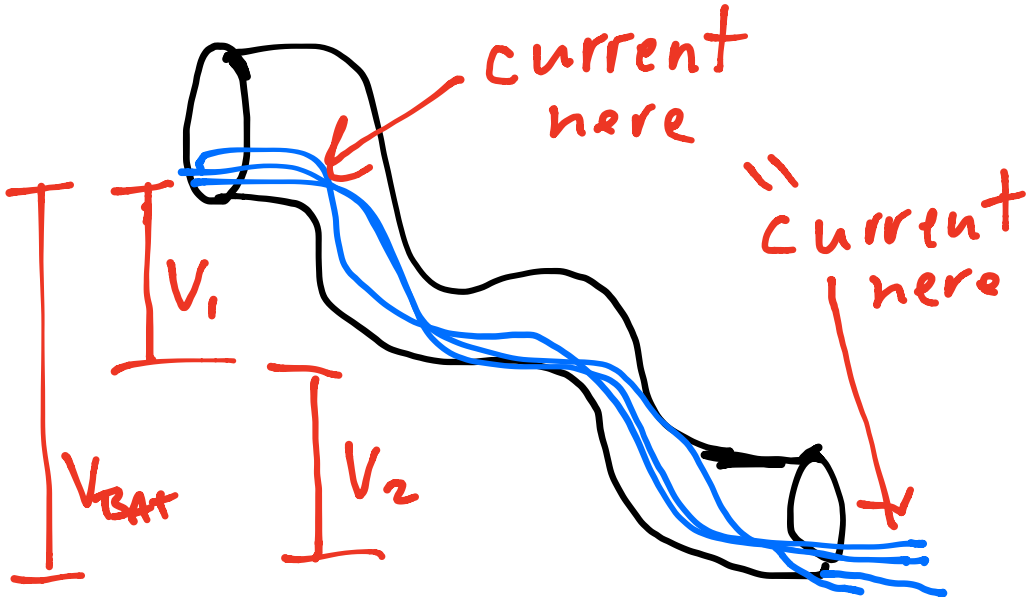
Kirchoff's Laws

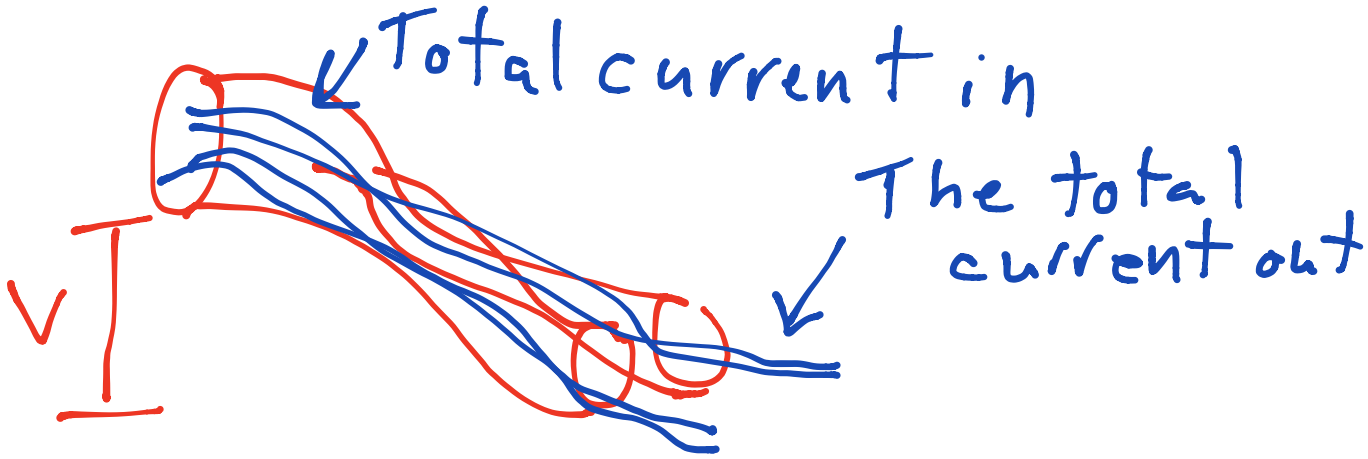
1. Law of Currents

- the total current entering a junction = current leaving the junction.

2. Law of Voltages

- the total voltage drop around a path of a circuit = voltage of the battery




Total current in
The total current out
V