Resistance and Circuit analysis

Kirchoff's voltage law

- Electric potential difference is also referred to as voltage

- Kirchoff's Voltage Law:
  - In any complete path in an electric circuit, the total electric potential increase at the source(s) is equal to the total electric potential decrease throughout the rest of the cicuit

  - $V_{series} = V_1 + V_2 + V_3 + ...$

  - $V_{parallel} = V_1 = V_2 = V_3 = ...$

Kirchoff's Current Law

- In electric circuits, junctions are points where the current can split to follow more than one path

- Kirchoff's Current Law:
  - In a closed circuit, the amount of current entering a junction is equal to the amount of current exiting a junction.

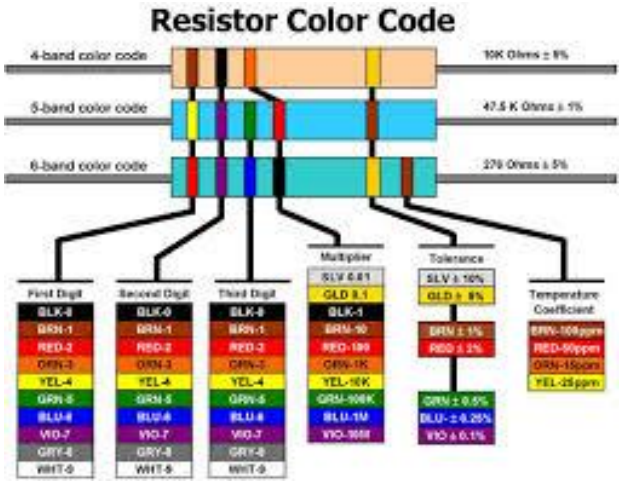
  - $I_{series} = I_1 = I_2 = I_3 = ...$

  - $I_{parallel} = I_1 + I_2 + I_3 + ...$

Electrical resistance

- Electrical resistance (R):
  - a property of matter that describes how difficult it is for electric current to travel through a material

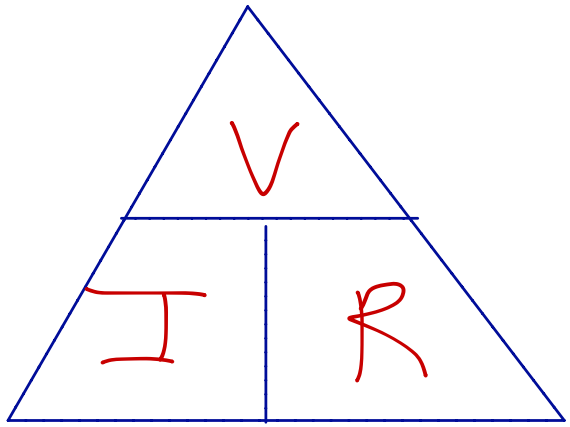
- Resistor
  - an electrical device that has a specific resistance value



Ohm's law

- The voltage in a conductor is proportional to the current if the temperature remains constant.

$$R = \frac{V}{I}$$



$$R = \frac{\Delta V}{I}$$

Ohm's Law

- R
  - resistance measured in volts per ampere (ohms)
- V
  - voltage measured in volts (V)
- I
  - electric current measured in amperes or amps (A)

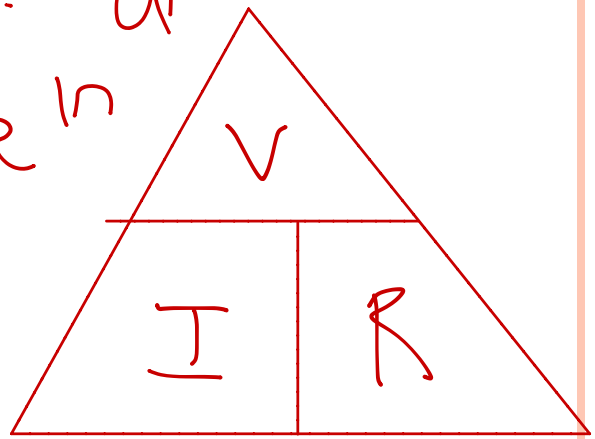
Measuring resistance

- Ohmmeter
  - a device that measures electrical resistance
  - connected in parallel and ***must never*** be used on a live circuit

Example # 1 – Calculating resistance

- Calculate the resistance if the voltage drop is 12.0 V and the current is 8.0 mA.

must be in amps



Given: $V = 12.0\ V$

$I = 8.0\ mA$

$= 0.008\ A$

Unknown: R = resistance

Step: $R = \frac{V}{I}$

$= 12\ V / 0.008\ A$

$\therefore R = 1500\ \Omega$

Symbol for Ohms

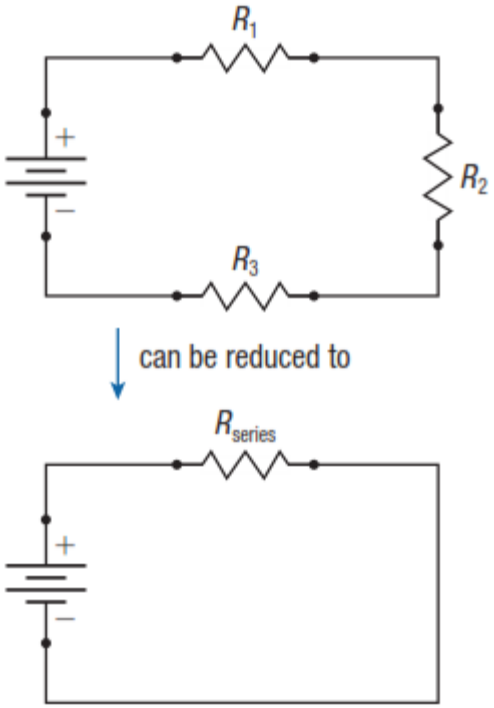
Equivalent resistance

- A single resistance that can replace all the resistances in an electrical circuit while maintaining the same current when connected to the same source

- Symbol is R_{total} or R_t

Resistors in Circuits

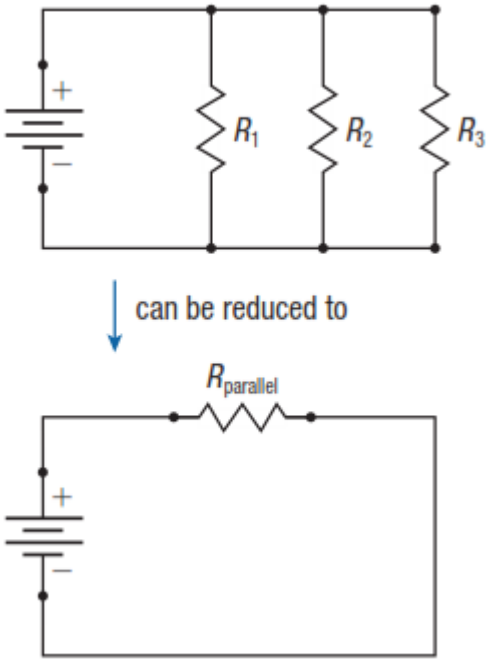
- Resistors in Series
  - substitute Ohm's Law into KVL
  - generates an equivalent resistance
  - $R_t = R_{series} = R_1 + R_2 + R_3 + ...$



Resistors in circuits

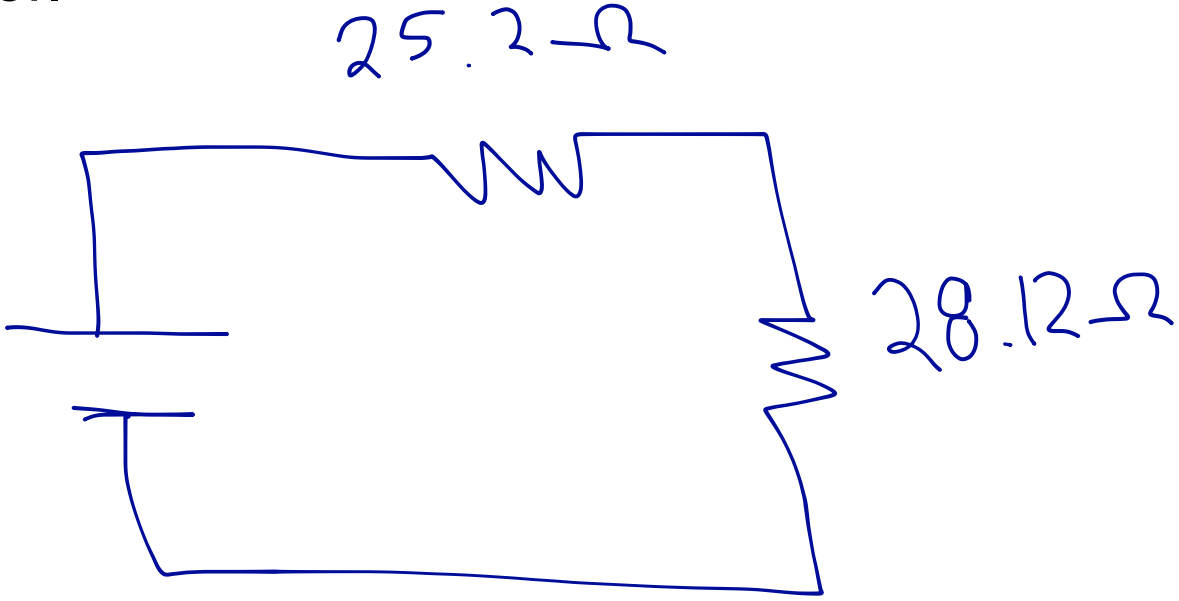
- Resistors in parallel
  - Substitute Ohm's Law (isolate I) into KCL
  - generate an equivalent resistance
  - Equation:

$$\frac{1}{R_t} = \frac{1}{R_{parallel}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots$$



Example #2

- Determine the equivalent resistance for a 25.2 ohm resistor connected in series with a 28.12 ohm resistor.



$R_T = 25.2\,\Omega + 28.12\,\Omega$

$R_T = 53.3\,\Omega$

Example #3

- Determine the equivalent resistance of a 120 ohm resistor connected in parallel with a 60 ohm resistor.

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\frac{1}{R_T} = \frac{1}{120} + \frac{1}{60}$$

$$\frac{1}{R_T} = \frac{1}{120} + \frac{2}{120}$$

$$\frac{1}{R_T} = \frac{3}{120}$$

$$R_T = \frac{120}{3}$$

$$R_T = 40\Omega$$