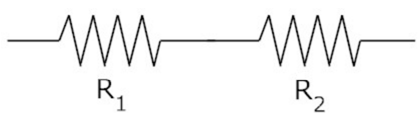
Resistors in Series and in Parallel

Series



- Voltage drop is different across each resistor
- The total voltage drop across the circuit is equal to the sum of the voltage drops across the individual resistors
- Current is the same through each resistor

Series (math)

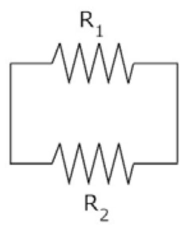
$$V_{eq} = V_1 + V_2$$

$$I_{eq} R_{eq} = I_1 R_1 + I_2 R_2$$

But… $$I_{eq} = I_1 = I_2$$

Therefore… $$\boxed{R_{eq} = R_1 + R_2}$$

Parallel



- Voltage drop across each resistor is the same
- Current through each resistor is different
- Total current through the circuit is the sum of the currents through each individual resistor

Parallel (math)

$$I_{eq} = I_1 + I_2$$

$$\frac{V_{eq}}{R_{eq}} = \frac{V_1}{R_1} + \frac{V_2}{R_2}$$

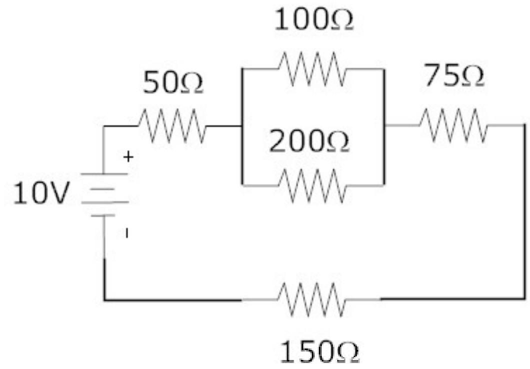
But… $$V_{eq} = V_1 = V_2$$

Therefore… $$\boxed{\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}}$$

Other Information

- A circuit with resistors in series is known as a **voltage divider**.
  - The voltage is divided among the resistors.
- A circuit with resistors in parallel is known as a **current divider**.
  - The current is divided among the resistors.

Solving Circuits



Calculate the equivalent resistance of the circuit, the voltage drop across each resistor, and the current through each resistor.

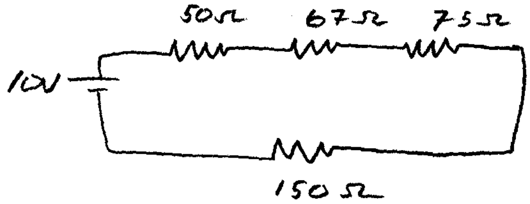
The $100\,\Omega$ and the $200\,\Omega$ resistors are in parallel

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

$$= \frac{1}{100\,\Omega} + \frac{1}{200\,\Omega}$$

$$\frac{1}{R_{eq}} = .015$$

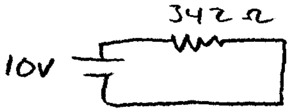
$$R_{eq} = 67\,\Omega$$



The $50\,\Omega$, $67\,\Omega$, $75\,\Omega$ and $150\,\Omega$ are in series

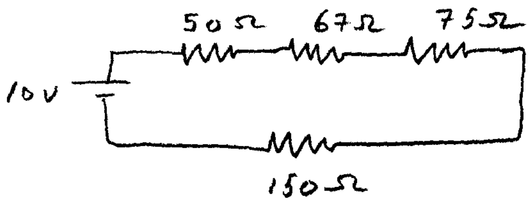
$$R_{eq} = 50\,\Omega + 67\,\Omega + 75\,\Omega + 150\,\Omega$$

$R_{eq} = 342\,\Omega$ ← The equivalent resistance of the circuit



$$V = IR$$

$$I = \frac{V}{R} = \frac{10V}{342\,\Omega} = 0.029A$$



Resistors are in series.
The same current flows through all resistors.

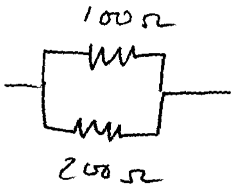
$I_{50\Omega} = 0.029A$ $\quad V_{50\Omega} = I_{50\Omega} R_{50\Omega} = (0.029A)(50\Omega) = 1.45V$

$I_{67\Omega} = 0.029A$ $\quad V_{67\Omega} = (0.029A)(67\Omega) = 1.94V$

$I_{75\Omega} = 0.029A$ $\quad V_{75\Omega} = (0.029A)(75\Omega) = 2.18V$

$I_{150\Omega} = 0.029A$ $\quad V_{150\Omega} = (0.029A)(150\Omega) = 4.35V$

The 67 Ω is the equivalent resistance of 2 resistors in parallel



Resistors are in parallel.
The voltage drop across each resistor is the same

$\underline{V_{100\Omega} = 1.94V}$

$\underline{I_{100\Omega}} = \frac{V_{100\Omega}}{R_{100\Omega}} = \frac{1.94V}{100\Omega} = \underline{0.019A}$

$\underline{V_{200\Omega} = 1.94V}$

$\underline{I_{200\Omega}} = \frac{1.94V}{200\Omega} = \underline{0.010A}$