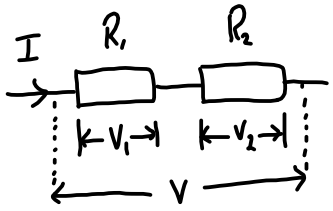
Resistors in series



- Consider two resistors R_1 and R_2 connected in series:
- The current I through each of the resistors is the same
- The pot. diff across R_1 is V_1 and across R_2 is V_2
- The pot. diff across both resistors is V
- The total resistance is R

Conservation of energy: $V = V_1 + V_2$

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

$V = IR$

$IR = IR_1 + IR_2$

$R = R_1 + R_2$

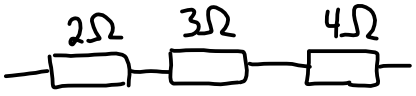
So in general, for resistors in series, the equivalent resistance can be found:

$$R = R_1 + R_2 + R_3 + \ldots\ldots R_n$$

Connecting resistors in series increases the total resistance

Example

Determine the resistance of this combination of resistors.

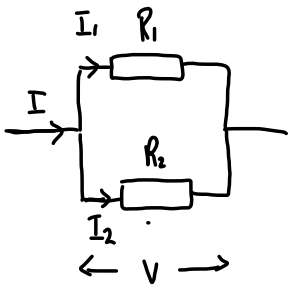


$R = R_1 + R_2 + R_3$

$R = 2\Omega + 3\Omega + 4\Omega$

$R = 9\Omega$

Resistors in Parallel



- Consider two resistors R_1 and R_2 connected in parallel.
- The pot. diff V across each of the resistors is the same.
- The current through R_1 is I_1 and through R_2 is I_2
- The total current is I
- The total resistance is R

Conservation of Charge: $I = I_1 + I_2$

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

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

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

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

In general, for resistors in parallel, the total resistance can be found:

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

Connecting resistors in parallel decreases the total resistance.

Consider 3 10Ω resistors:

series: $R = 10\Omega + 10\Omega + 10\Omega = 30\Omega$

parallel: $\frac{1}{R} = \frac{1}{10\Omega} + \frac{1}{10\Omega} + \frac{1}{10\Omega}$

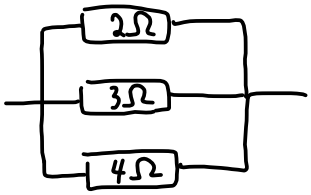
$$\frac{1}{R} = \frac{3}{10\Omega}$$

so $R = \frac{10\Omega}{3}$

$R = 3.3\Omega$

Example

Determine the resistance of these combination of resistors

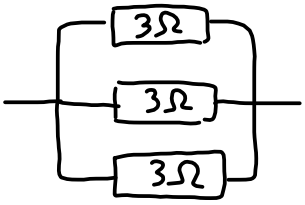


$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_2}$$

$$\frac{1}{R} = \frac{1}{2} + \frac{1}{3} + \frac{1}{4}$$

$$\frac{1}{R} = 1.08\overline{3}$$

$$R = 0.92\,\Omega$$



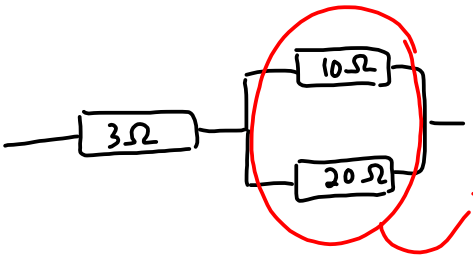
$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$\frac{1}{R} = \frac{1}{3\Omega} + \frac{1}{3\Omega} + \frac{1}{3\Omega}$$

$$\frac{1}{R} = \frac{3}{3\Omega}$$

$$R = \frac{3\Omega}{3}$$

$$R = 1\,\Omega$$



$$\frac{1}{R} = \frac{1}{10\Omega} + \frac{1}{20\Omega}$$

$$R = 6.7\,\Omega$$

$$R = R_1 + R_{23}$$

$$R = 3\Omega + 6.7\,\Omega$$

$$R = 9.7\,\Omega$$