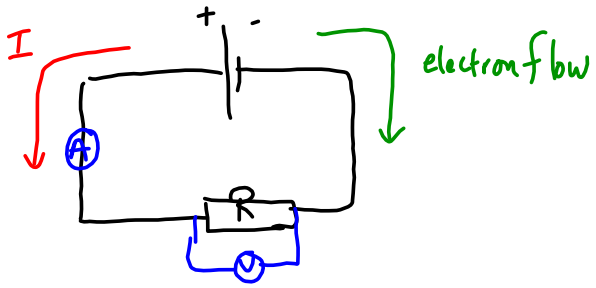
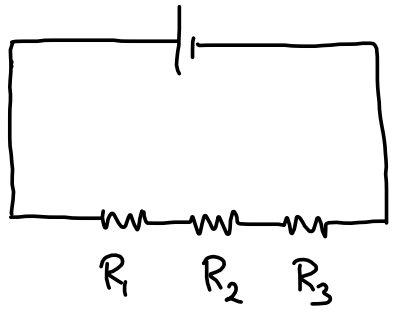
15-4 Series & Parallel Circuits

Ⓐ Ammeter – measures current placed in series

Ⓥ Voltmeter – measures potential difference between 2 points in the circuit placed in parallel



Series Circuit



The current through each resistor is the same.

The equivalent resistance is:

$$R_{TOT} = R_1 + R_2 + R_3 + \ldots R_n$$

Adding resistors in series increases the total resistance for the circuit

MP 7.18

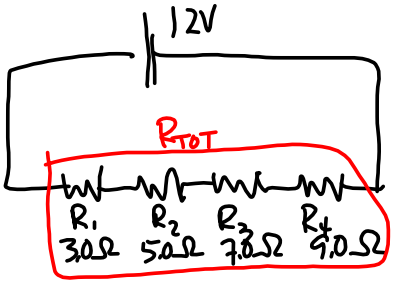
$R_1 = 3.0\,\Omega$
$R_2 = 5.0\,\Omega$
$R_3 = 7.0\,\Omega$
$R_4 = 9.0\,\Omega$
} series

$V = 12\,V$

a) $R_{TOT} = ?$

b) $I_{TOT} = ?$

c) $V_3 = ?$



a) Series: $R_{TOT} = 3.0\Omega + 5.0\Omega + 7.0\Omega + 9.0\Omega$

$R_{TOT} = 24.0\,\Omega$

b) $V = IR$

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

$I = \frac{12\,V}{24.0\,\Omega}$ $\frac{V}{A}$

$I = 0.50\,A$

c) $V_3 = I R_3$

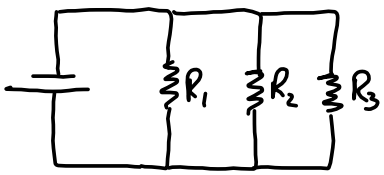
$V_3 = (0.50\,A)(7.0\,\Omega)$

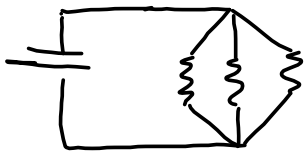
$V_3 = 3.5\,V$

$\frac{1}{2}(3 + 5 + 7 + 9)$

$\frac{3}{2} + \frac{5}{2} + \frac{7}{2} + \frac{9}{2}$

Parallel Circuit





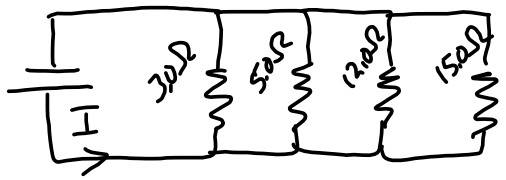
In a parallel circuit, the current is divided (split) between the resistors. The potential difference across each resistor is the same.

$$\frac{1}{R_{TOT}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots \frac{1}{R_N}$$

Adding resistors in parallel reduces the overal resistance.

MP 7.22

3.0Ω, 5.0Ω, 12.0Ω, 15.0Ω parallel
V = 60V



a) R_{TOT} = ?
b) I_{TOT} = ?
c) $I_{12.0}$ = ?

a) R_{TOT} ⇒

$$\frac{1}{R_{TOT}} = \frac{1}{3.0\Omega} + \frac{1}{5.0\Omega} + \frac{1}{12.0\Omega} + \frac{1}{15.0\Omega}$$

$$\frac{1}{R_{TOT}} = 0.68\,\Omega^{-1}$$

$$R_{TOT} = 1.46\,\Omega$$

b) $V = IR$

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

$$I = \frac{60V}{1.46\Omega}$$

$$I = 41A$$

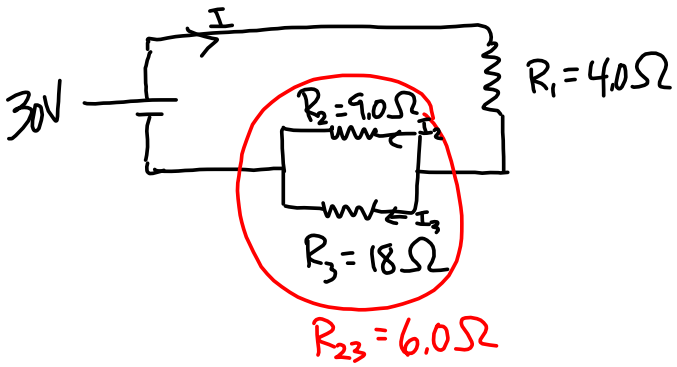
c) $V = IR$ ← for 12.0Ω

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

$$I = \frac{60V}{12.0\Omega}$$

$$I = 5.0A$$

Complex Circuit



$R_{23} = 6.0\Omega$

$$\frac{1}{R_{23}} = \frac{1}{R_2} + \frac{1}{R_3}$$

$$\frac{1}{R_{23}} = \frac{1}{9.0\Omega} + \frac{1}{18\Omega}$$

$$\frac{1}{R_{23}} = 0.17\Omega^{-1}$$

$$R_{23} = 6\Omega$$

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

$$R_{TOT} = 4.0\Omega + 6.0\Omega$$

$$R_{TOT} = 10.0\Omega$$

$$V = IR$$

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

$$I_{TOT} = \frac{30V}{10.0\Omega}$$

$$I_{TOT} = 3.0A$$

Resistor 1

$I_1 = 3.0A$

$R_1 = 4.0\Omega$

$V = ?$

$$V = IR$$

$$V = (3.0A)(4.0\Omega)$$

$$V = 12V$$

Resistor 2

$V = 18V$

$I = ?$

$R = 9.0\Omega$

$$V = IR$$

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

$$I = \frac{18V}{9.0\Omega}$$

$$I_2 = 2.0A$$

Resistor 3

$V = 18V$

$I = ?$

$R = 18\Omega$

$$V = IR$$

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

$$I = \frac{18V}{18\Omega}$$

$$I_3 = 1.0A$$