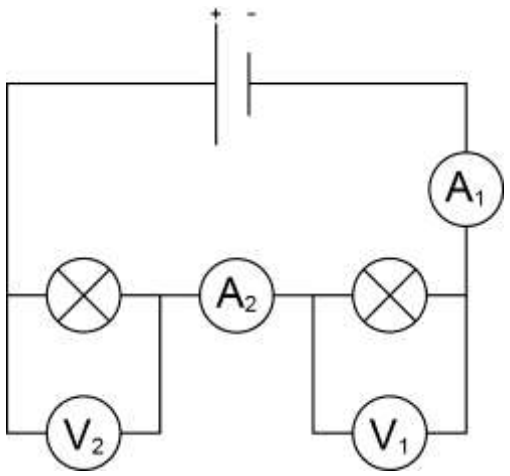
N5

Complex Circuits with Current and Voltage

Series Circuit



All bulbs are identical

(a) V_1 reads 3 V, what does V_2 read?

V_2 reads 3V since the bulbs are identical each bulb gets the same share of the voltage.

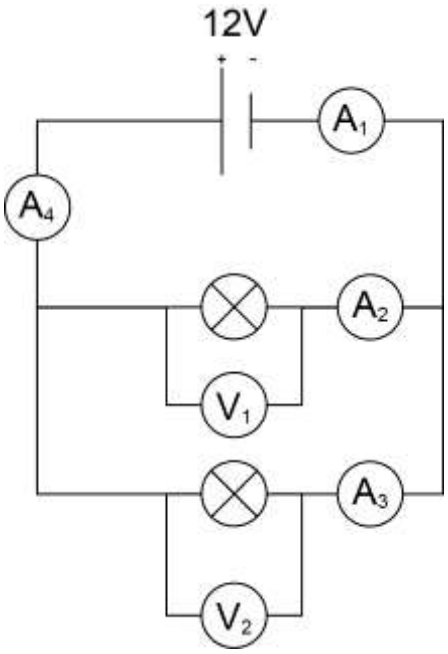
(b) Hence, calculate the voltage supply.

$V_s = V_1 + V_2$ therefore $V_s = 3 + 3 = 6V$

(c) The reading on ammeter A_2 is 1 A, what will the reading be on A_1?

The current is the same at all points in a series circuit therefore A_1 will read 1 A.

Parallel Circuit



All bulbs are identical

(a) What are the readings on voltmeters V_1 and V_2?

Both read 12 V, since in parallel each branch of the circuit receives the same voltage as the voltage supply.

(b) If A_1 reads 3A, calculate the readings on A_2, A_3 and A_4.

The current will split equally between both branches since the bulbs are identical.

Therefore, A_2 and A_3 will both read 1.5A.

A_4 will read 3A since this is the point in the circuit where the current recombines.

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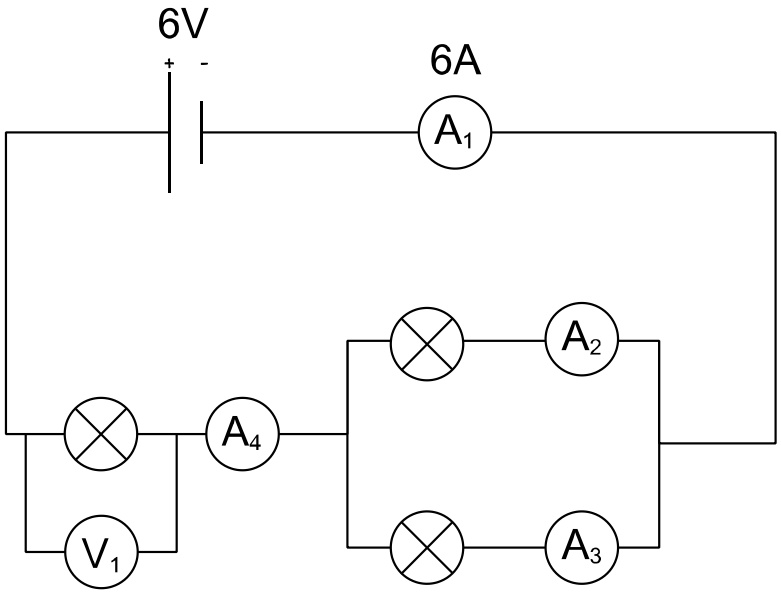
Combined series and parallel circuits



All bulbs are identical

(a) A_1 reads 6A, what are the readings on A_2, A_3 and A_4?

A_2 and A_3 = 3A, since the supply current is split between both branches equally.

A_4 = 6A, at this point the current recombines.

(b) What is the reading on V_1?

The parallel arrangement of bulbs will have half the resistance of the single bulb.

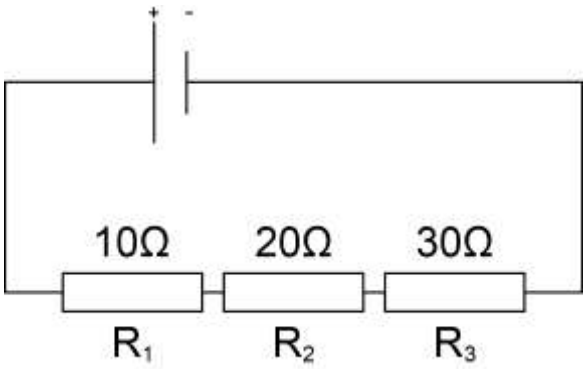
Therefore the parallel bulbs will receive only half the voltage the single bulb will get.

V_1 will read 4V and each bulb will receive only 2V.

[This is explained under the heading resistance in parallel]

N5 Calculations involving resistors in series and parallel.

Resistors in Series



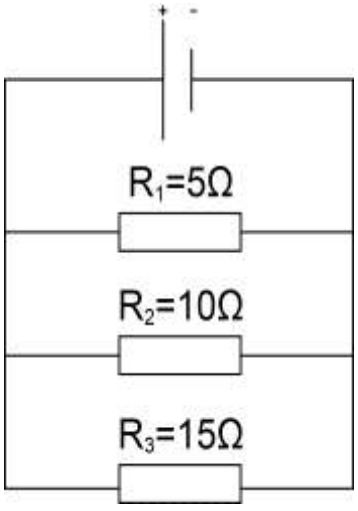
The **total resistance** of all three resistors in series is calculated using the following equation:

$$R_T = R_1 + R_2 + R_3$$

$$R_T = 10 + 20 + 30$$

$$R_T = 60\ \Omega$$

Resistors in Parallel



The **total resistance** of all three resistors in parallel is calculated using the following equation:

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

Therefore

$$\frac{1}{R_T} = \frac{1}{5} + \frac{1}{10} + \frac{1}{15}$$

- Multiply both the top and bottom of each fraction to make all the denominators the same.

$$\frac{1}{R_T} = \frac{6}{30} + \frac{3}{30} + \frac{2}{30}$$

- Add fractions

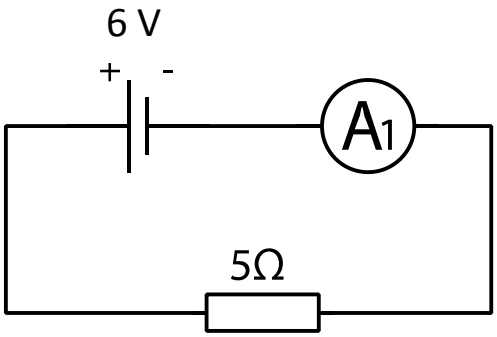
$$\frac{1}{R_T} = \frac{11}{30}$$

- Invert to calculate R_T

$$\frac{R_T}{1} = \frac{30}{11} = \mathbf{2.72\Omega}$$

More on resistors in parallel

Shown below is a simple series circuit complete with a 5Ω resistor.



Calculate the value of current through the resistor.

V = 6 V

R = 5 Ω

I = ?

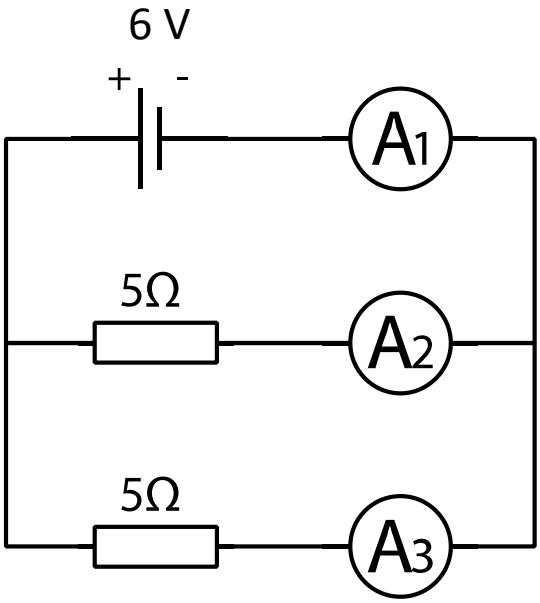
V = I x R

6 = I x 5

6/ 5 = I

I = 1.2 A

Now add another 5 Ω resistor in parallel to the original, the circuit now looks like:



Calculate the value of the current through ammeter A_1.

- To do this the total resistance of the circuit must be calculated first.

Step 1

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

$\frac{1}{R_T} = \frac{1}{5} + \frac{1}{5}$

$\frac{1}{R_T} = \frac{2}{5}$

R_T = 2.5 Ω

Step 2

V = I x R

6 = I x 2.5

6/ 2.5 = I

I = 2.4 A

This result shows that when another resistor is added in parallel the total resistance of a circuit is decreased and the current in the circuit is increased.

i.e. by adding an identical resistor in parallel the resistance has halved and the current drawn doubled.