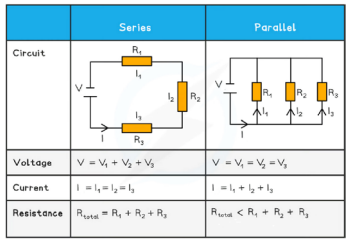
DC Circuits

Definitions

Electricity carries energy which is transformed into another type of energy.
Power is the rate at which the energy is transformed.
In a **series** circuit there is only one path for the current.
In a **parallel** circuit there is more than one path for the current to follow.



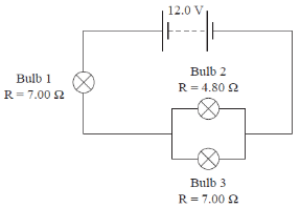
A complex circuit has elements of both series and parallel circuits. In **any circuit**, individual components still obey ohms law.

Equations

$V = IR$	Voltage	V	V
	Current	I	A
	Resistance	R	Ω
$P = IV$	Power	P	W (J s^{-1})
	Current	I	A
	Voltage	V	V
$P = \frac{\Delta E}{t}$	Power	P	W (J s^{-1})
	Change in Energy	ΔE	J
	Time	t	s
$R_T = R_1 + R_2 + \ldots$	Resistance	R	Ω
$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$	Resistance	R	Ω

Questions

CIRCUITS (2018;3)



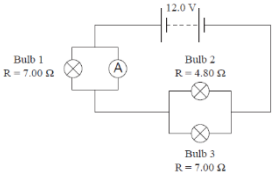
Use the circuit diagram to answer the questions below.

(a) Show that the total resistance of the circuit is approximately 10 Ω.

(b) Calculate the voltages across bulb 1 and bulb 2.

(c) Bulbs 2 and 3 are not the same brightness. Discuss which bulb is brighter, and why.

(d) An ammeter (with negligible resistance) is added to the previous circuit as shown. Discuss the effect adding the ammeter has on the current, the voltage, and hence the brightness of each bulb.



Terms

Ammeter: Device for measuring current (with a very small resistance so it does not affect the circuit when placed in series).
Direct current: An electrical current that always moves in one direction.
Electric circuit: Consists of a voltage source that maintains an electrical potential, a continuous conducting path for a current to follow, and a device where work is done by the electrical potential.
Electrical conductors: Materials that have electrons that are free to move throughout the material; for example, metals.
Electrical insulators: Materials that obstruct the flow of electric current.
Resistance: The property of opposing or reducing electric current.
Ohm's Law: Resistance is equal to voltage divided by current (R=V/I).
Power: The rate of doing work.
Voltage: The electric potential difference across a resistor.
Voltmeter: Device for measuring voltage (with a very large resistance so it does not affect the circuit when placed in parallel).

Tips

- The arrow for conventional current, I, is drawn the opposite way to the actual electron current (it is the electrons that move in a wire).
- Resistors in series add up using this formula: $R_T = R_1 + R_2 + \ldots$
- Resistors in parallel add up using this formula: $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$
- With a complex circuit, always work out it's behaviour by distinguishing between the series and parallel parts of the circuit and doing a step-by-step calculation.

Answers

(a) $$R_T = 7.00 + \left(\frac{1}{4.80} + \frac{1}{7.00}\right)^{-1} = 9.85\ \Omega$$

(b)
$$I = \frac{V}{R} = \frac{12}{9.85} = 1.22\ A$$
$$V_{bulb1} = IR = 1.22 \times 7.00 = 8.53\ \text{V}$$
$$V_{bulb2} = V_{supply} - V_{bulb1}$$
$$V_{bulb2} = 12 - 8.53 = 3.47\ \text{V}$$

(c) The voltage across each bulb is the same, however the current though bulb 2 is higher, due to having a lower resistance ($I = V/R$). Bulb 2 uses more power (2.51W vs 1.72 W) and is therefore brighter from $P = IV$.

(d) Adding the ammeter short circuits bulb 1 (all current goes through the ammeter and none through bulb 1, 0 V across bulb 1), causing bulb 1 to go out.
This causes the total resistance to drop (R_{total} = 2.85 Ω from 9.85 Ω), increasing the total current (I = V/R = 12/2.85 = 4.2 A) from 1.22 A. Voltage across bulbs 2 and 3 is now higher (12 V from 3.74 V). More current passes through bulbs 2 and 3, and a larger voltage is across bulbs 2 and 3, causing their respective brightness's to increase.