Exercise walk-through

2.4
Series and parallel circuits (4.2.2)

AQA · GCSE · Physics

Circuit symbols, charge and current

- Circuit diagrams use standard **circuit symbols** .
- Learn the symbols for a cell, battery, open and closed switch, lamp, fuse, resistor, variable resistor, ammeter, voltmeter, **diode**, LED, **thermistor** and **LDR**.
- An ammeter is always connected **in series** with a component, and a voltmeter **in parallel** across it.
- For charge to flow, there must be a closed circuit with a source of potential difference, such as a cell. **Electric current** is the rate of flow of electrical **charge** :

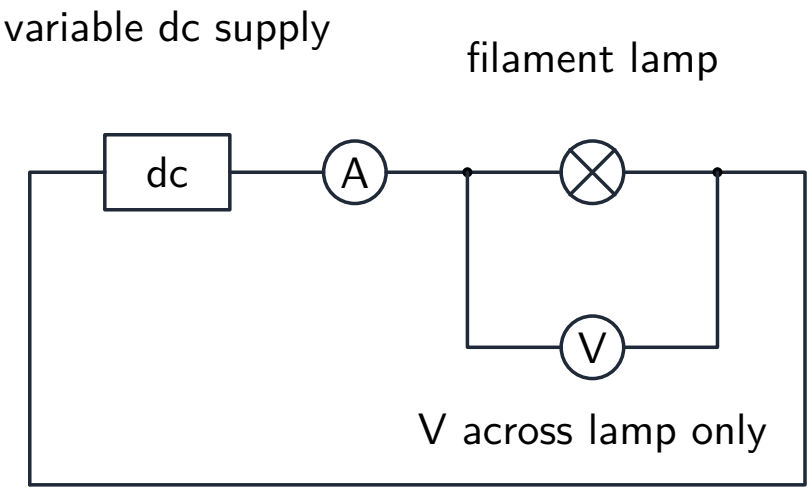
$$Q = It$$

Current, resistance and potential difference

- The current through a component depends on the potential difference across it and on its **resistance** :
- V is potential difference in volts (V), I is current in amperes and R is resistance in ohms (Ω).
- For the same potential difference, a bigger resistance gives a smaller current.
- **Worked example 4.** A potential difference of 0.45 V drives a current of 0.0075 A through a coin.

$$V = IR$$

Figure: Resistors and I–V characteristics



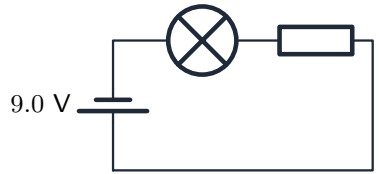
- Required practical 4: the ammeter is **in series** with the lamp, and the voltmeter is across it.
- Match each part of the diagram to the text.

Exercises 2.1·2.2

2.1 Calculate the total resistance of a 10 Ω resistor and a 20 Ω resistor in series. [2]



2.2 A lamp and a resistor are in series with a 9.0 V battery. The potential difference across the lamp is 6.0 V. Calculate the potential difference across the resistor. [2]



Exercises 2.1·2.2

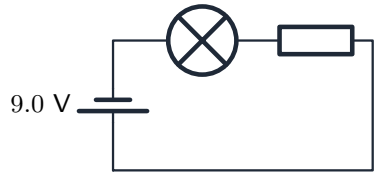
2.1 Calculate the total resistance of a 10 Ω resistor and a 20 Ω resistor in series. [2]



2.1

- $10 + 20 = \mathbf{30}\ \Omega$

2.2 A lamp and a resistor are in series with a 9.0 V battery. The potential difference across the lamp is 6.0 V. Calculate the potential difference across the resistor. [2]

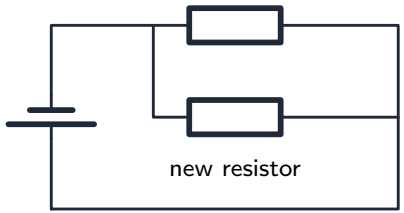


2.2

- $9.0 - 6.0 = \mathbf{3.0}\ \text{V}$

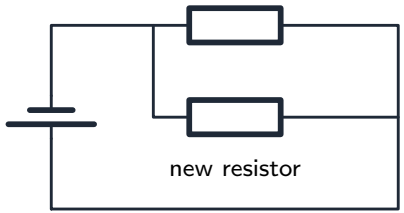
Exercise 2.3

2.3 A second resistor is connected in parallel with the first. What happens to the total resistance of the circuit? Explain why. [2]



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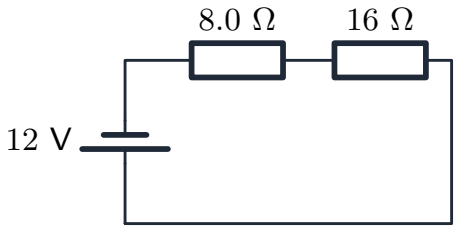


2.3

- it decreases; there are more paths for the current, so the total current is larger for the same potential difference

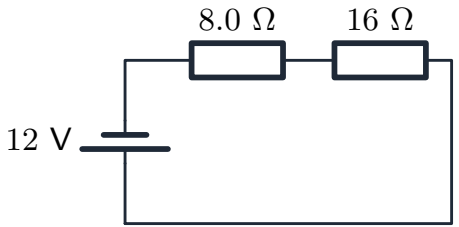
Exercise 3.1

3.1 An 8.0 Ω and a 16 Ω resistor are connected in series to a 12 V supply. Calculate the current. [3]



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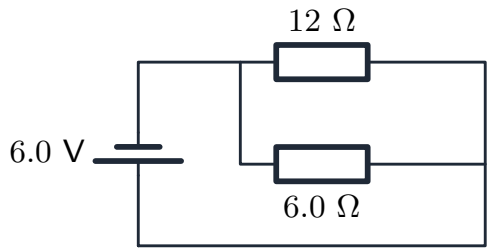


3.1

- $R_{total} = 8.0 + 16 = 24\ \Omega$
- $I = 12 \div 24$
- $I = \mathbf{0.50}\ \text{A}$

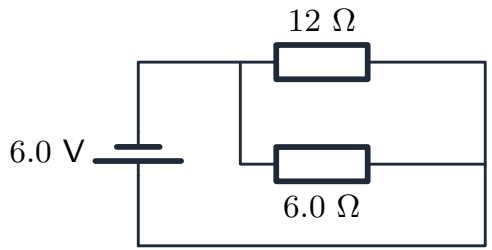
Exercise 3.2

3.2 A 12 Ω and a 6.0 Ω resistor are connected in parallel to a 6.0 V supply. Calculate the current in each branch and the total current. [3]



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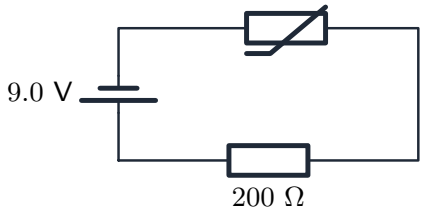
- 12 Ω branch: $6.0 \div 12 = 0.50$ A
- 6.0 Ω branch: $6.0 \div 6.0 = 1.0$ A
- total = **1.5** A

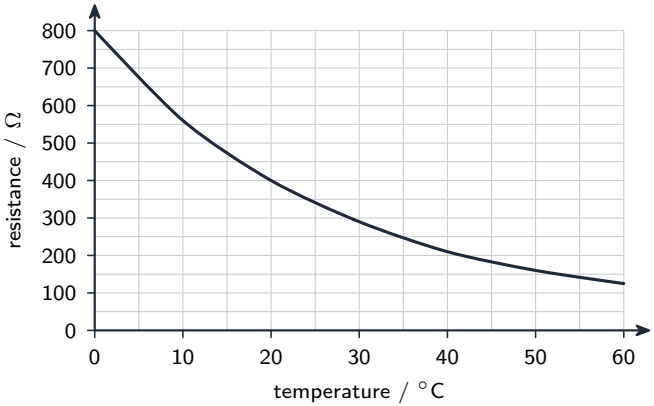
Setup for exercise 3.3

3.3 A thermistor and a 200 Ω resistor are in series with a 9.0 V battery. The graph shows how the resistance of the thermistor changes with temperature.

Exercise 3.3 (a)

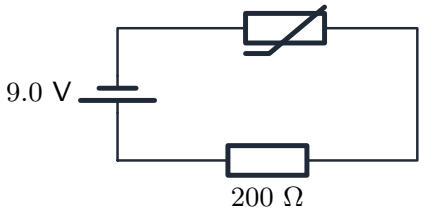
(a) Use the graph to find the resistance of the thermistor at 20 °C. [2]

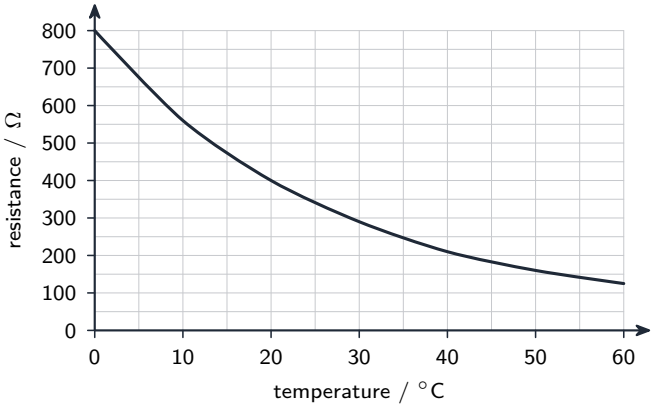




Exercise 3.3 (a)

(a) Use the graph to find the resistance of the thermistor at 20 °C. [2]





(a) read at 20 °C; **400** Ω

Exercise 3.3 (b)

3.3 A thermistor and a 200 Ω resistor are in series with a 9.0 V battery. The graph shows how the resistance of the thermistor changes with temperature.

(b) Calculate the current in the circuit at 20 °C. [3]

Exercise 3.3 (b)

3.3 A thermistor and a 200 Ω resistor are in series with a 9.0 V battery. The graph shows how the resistance of the thermistor changes with temperature.

(b) Calculate the current in the circuit at 20 °C. [3]

(b) $R_{total} = 400 + 200 = 600\ \Omega$; $I = 9.0 \div 600 = \mathbf{0.015}$ A

Exercise 3.3 (c)

3.3 A thermistor and a 200 Ω resistor are in series with a 9.0 V battery. The graph shows how the resistance of the thermistor changes with temperature.

(c) Describe what happens to the potential difference across the 200 Ω resistor as the temperature rises. Explain why. [2]

Exercise 3.3 (c)

3.3 A thermistor and a 200 Ω resistor are in series with a 9.0 V battery. The graph shows how the resistance of the thermistor changes with temperature.

(c) Describe what happens to the potential difference across the 200 Ω resistor as the temperature rises. Explain why. [2]

(c) it increases; the thermistor's resistance falls, so the current increases and $V = IR$ across the resistor is larger

Exercise 3.3 (d)

3.3 A thermistor and a 200 Ω resistor are in series with a 9.0 V battery. The graph shows how the resistance of the thermistor changes with temperature.

(d) Describe how a student could find out how the total resistance changes when resistors are added in series and in parallel. [6]

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3.3 A thermistor and a 200 Ω resistor are in series with a 9.0 V battery. The graph shows how the resistance of the thermistor changes with temperature.

(d) Describe how a student could find out how the total resistance changes when resistors are added in series and in parallel. [6]

(d) points to include:

- connect one resistor to a power supply with an ammeter in series and a voltmeter across the resistors
- record V and I and calculate $R = V \div I$
- add a second and third resistor in series, measuring V and I each time
- repeat, adding the resistors in parallel instead
- in series the total resistance increases; in parallel it decreases
- keep the supply the same and switch off between readings so the resistors do not heat up

Levels: **5–6** a full, logical answer with correct physics and correct terms; **3–4** several correct points, partly linked; **1–2** one or two relevant points.