

GCSE / IGCSE Physics – Electricity

GCSE/IGCSE · Total marks: 60 · Answers on the last page

Charge, current and potential difference, resistance, series and parallel circuits, I–V characteristics, electrical power and mains electricity. Calculator allowed; allow about 60 minutes. Use $Q = It$, $V = IR$, $P = IV$, $E = Pt$ and $E = QV$.

Section A – Skills

1. A current of 2.5 A flows through a lamp for 4 minutes. Calculate the charge that flows through the lamp. [2]
2. A resistor has a potential difference of 12 V across it and a current of 3 A through it.
 - (a) Calculate its resistance.
 - (b) State what happens to the current if the potential difference is doubled and the resistance stays constant. [3]
3. A $4\ \Omega$ resistor and a $6\ \Omega$ resistor are connected in series to a 12 V battery.
 - (a) Calculate the total resistance.
 - (b) Calculate the current in the circuit.
 - (c) Calculate the potential difference across the $6\ \Omega$ resistor. [4]
4. The same $4\ \Omega$ and $6\ \Omega$ resistors are now connected in parallel across the 12 V battery.
 - (a) Calculate the current through each resistor.
 - (b) Calculate the total current from the battery.
 - (c) Hence find the total resistance of the parallel combination. [4]
5. A kettle is rated 230 V , 2300 W .
 - (a) Calculate the current in the kettle.
 - (b) Calculate the resistance of the heating element.
 - (c) Calculate the energy transferred when the kettle runs for 3 minutes. [5]

Section B – Exam-style

6. A student measures the current through a filament lamp as the potential difference across it is increased from 0 to 12 V .
 - (a) Describe the shape of the I–V graph for the filament lamp.
 - (b) Explain, in terms of the metal ions and electrons, why the resistance of the lamp changes as the current increases.
 - (c) Describe how the I–V graph for a fixed resistor at constant temperature differs from that of the lamp. [6]
7. A thermistor is connected in series with a fixed resistor and a 6 V battery. A voltmeter is connected across the fixed resistor.
 - (a) State what happens to the resistance of the thermistor as its temperature rises.
 - (b) Explain what happens to the voltmeter reading as the temperature rises.
 - (c) Suggest one practical use of this circuit. [5]
8. Mains electricity in the UK is supplied at 230 V , 50 Hz .
 - (a) Explain what is meant by 50 Hz .
 - (b) State the potential of the live wire and the neutral wire with respect to earth.

(c) A hair dryer with a metal casing is rated 920 W. Calculate the current and choose a suitable fuse from 3 A, 5 A and 13 A.

(d) Explain how the earth wire and fuse together protect the user if the live wire touches the metal casing. [8]

9. A battery transfers 1500 C of charge at a potential difference of 230 V through a heater.

(a) Calculate the energy transferred.

(b) The heater runs for 50 s. Calculate the power of the heater. [4]

Section C – Challenge

10. A $2\ \Omega$ resistor is connected in series with a parallel combination of a $3\ \Omega$ resistor and a $6\ \Omega$ resistor. The circuit is connected to a 12 V supply.

(a) Show that the total resistance of the circuit is $4\ \Omega$.

(b) Calculate the current from the supply.

(c) Calculate the potential difference across the parallel combination.

(d) Calculate the current in the $3\ \Omega$ resistor. [7]

11. A student investigates how the resistance of a wire depends on its length using an ammeter, a voltmeter, a metre rule and a low-voltage supply.

(a) Describe how the student should carry out the investigation, including two ways to keep the results accurate.

(b) A 0.50 m length of the wire has resistance $2.0\ \Omega$. Predict the resistance of a 1.25 m length of the same wire and explain your reasoning. [6]

12. (a) A 3 kW electric heater is used for 5 hours. Electricity costs 15 p per kWh. Calculate the cost.

(b) Electricity is transmitted around the National Grid at very high voltage. Explain why step-up transformers are used at the power station and why this reduces energy losses. [6]

Answers

Check your working against these. If an answer does not match, try the question again before looking for the method.

1. $Q = It = 2.5 \times 240 = 600 \text{ C}$
2. (a) $R = \frac{V}{I} = 4 \Omega$
(b) Current doubles to 6 A
3. (a) 10Ω
(b) $I = \frac{12}{10} = 1.2 \text{ A}$
(c) $V = 1.2 \times 6 = 7.2 \text{ V}$
4. (a) 3 A through 4Ω , 2 A through 6Ω
(b) 5 A
(c) $R = \frac{12}{5} = 2.4 \Omega$ (less than the smallest resistor)
5. (a) $I = \frac{P}{V} = 10 \text{ A}$
(b) $R = \frac{V}{I} = 23 \Omega$
(c) $E = Pt = 2300 \times 180 = 414\,000 \text{ J}$ (414 kJ)
6. (a) Curve through the origin with gradient decreasing as V increases (flattens); symmetric for negative V
(b) Higher current heats the filament; metal ions vibrate more; electrons collide more often with ions, so resistance increases
(c) Straight line through the origin (ohmic conductor); current is directly proportional to p.d.
7. (a) Resistance decreases
(b) Total resistance falls, so current increases; p.d. across the fixed resistor ($V = IR$) increases, and the thermistor takes a smaller share of the 6 V
(c) Thermostat / temperature sensor for a heating system or fire alarm
8. (a) The alternating current changes direction 50 times per second (50 complete cycles per second)
(b) Live about 230 V; neutral about 0 V
(c) $I = \frac{920}{230} = 4 \text{ A}$; use the 5 A fuse
(d) A large current flows from live through the casing to earth via the low-resistance earth wire; this current exceeds the fuse rating, the fuse wire melts and disconnects the live supply, so the casing cannot give a shock
9. (a) $E = QV = 1500 \times 230 = 345\,000 \text{ J}$
(b) $P = \frac{345\,000}{50} = 6900 \text{ W}$
10. (a) Parallel pair: $\frac{1}{R} = \frac{1}{3} + \frac{1}{6} = \frac{1}{2}$ so 2Ω ; total $2 + 2 = 4 \Omega$
(b) 3 A
(c) $V = 3 \times 2 = 6 \text{ V}$
(d) $I = \frac{6}{3} = 2 \text{ A}$ (and 1 A in the 6Ω)
11. (a) Connect the wire in series with the ammeter and supply, voltmeter in parallel across the chosen length; use a crocodile clip to vary the length in steps (e.g. every 10 cm); record V and I and calculate $R = V/I$; keep current low or switch off between readings to prevent heating; repeat and average; check for zero errors; keep the wire straight and taut
(b) Resistance is directly proportional to length, so $R = 2.0 \times \frac{1.25}{0.50} = 5.0 \Omega$
12. (a) $3 \times 5 = 15 \text{ kWh}$; cost $15 \times 15 = 225 \text{ p} = \pounds 2.25$
(b) Step-up transformers increase the p.d.; for the same power $P = IV$, the current is smaller;

heating losses in the cables depend on I^2R , so a lower current greatly reduces energy wasted as heat; step-down transformers reduce the p.d. to 230 V for safe domestic use

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