

4.2

Electricity

Exam-style questions — answers and mark schemes

101 questions • 227 marks

Written in the style of AQA papers, including the required practicals, maths and working scientifically.

How to use this booklet

Each answer gives the creditworthy points; one mark per point unless stated.

Alternative correct wording is credited — these are marking points, not model answers.

Calculations: the equation and the substitution each earn a mark, so a wrong final answer can still score. Error carried forward applies where stated.

Examiner notes flag the mistakes that actually lose marks in real examinations.

Command words used

State, Give, Name, Write down — a short factual answer, no explanation needed

Describe — say what happens, in order, without needing a reason

Explain — give a reason; 'because', 'so' or 'therefore' should appear

Calculate — show your working and give a unit

Determine — use data given, often from a graph or table

Estimate — an approximate value from reasonable assumptions

Suggest — apply what you know to an unfamiliar situation

Compare — say how things are similar and different, in the same sentence

Evaluate — give both sides, then a conclusion

Design, Plan — set out a method others could follow

Questions are labelled beside the marks where they are Higher Tier only, Separate Physics only, or Working scientifically — the apparatus, variables, accuracy, evaluation and maths skills that carry around a third of the marks in every AQA paper.

4.2.1 Current, potential difference and resistance

1 A circuit contains a cell, a switch, a fixed resistor and an ammeter in series. A voltmeter is connected across the resistor.

a State how an ammeter must be connected in a circuit. [1]

In series (with the component) (1)

b State how a voltmeter must be connected. [1]

In parallel (across the component) (1)

c Define electric current. [1]

The rate of flow of (electric) charge (1)

d Define potential difference. [1]

The energy transferred per unit charge (passed) (1)

e A charge of 180 C passes through the resistor in 90 s. Calculate the current. Maths skill [3]

$$Q = I t, \text{ so } I = Q \div t \text{ (1); } = 180 \div 90 \text{ (1); } = 2.0 \text{ A (1)}$$

f The potential difference across the resistor is 6.0 V. Calculate its resistance. Maths skill [3]

$$V = I R, \text{ so } R = V \div I \text{ (1); } = 6.0 \div 2.0 \text{ (1); } = 3.0 \, \Omega \text{ (1)}$$

g Calculate the energy transferred by the resistor in this time. Maths skill [3]

$$E = Q V \text{ (1); } = 180 \times 6.0 \text{ (1); } = 1080 \text{ J (1)}$$

2 A current of 0.45 A flows through a lamp for 4.0 minutes.

a Calculate the charge that flows. Maths skill [3]

$$\text{Convert: } 4.0 \text{ min} = 240 \text{ s (1); } Q = I t = 0.45 \times 240 \text{ (1); } = 108 \text{ C (1)}$$

Examiner note: Examiners report that failing to convert minutes to seconds is one of the commonest errors in this topic.

b The lamp is connected to a 230 V supply. Calculate the energy transferred. Maths skill [2]

$$E = Q V = 108 \times 230 \text{ (1); } = 24\,800 \text{ J (24\,840) (1)}$$

c Calculate the power of the lamp. Maths skill [2]

$$P = V I = 230 \times 0.45 \text{ (1); } = 104 \text{ W (103.5) (1)}$$

3 Explain, in terms of the particles in a metal, why a wire gets warm when a current flows through it.

Give your answer. [3]

Electrons flow through the wire and collide with the ions in the metal lattice (1); energy is transferred to the ions, which vibrate more (1); so the thermal store of the wire fills and its temperature rises (1)

4.2.1 Component characteristics • Required practicals 3 and 4

4

A student investigates how the resistance of a length of resistance wire depends on its length.

Length in cm	20	40	60	80	100
Potential difference in V	0.60	1.21	1.78	2.40	3.02
Current in A	0.30	0.30	0.30	0.30	0.30

- a** Calculate the resistance of the 60 cm length.

Maths skill [2]

$$R = V \div I = 1.78 \div 0.30 \text{ (1)}; = 5.9 \, \Omega \text{ (1)}$$

- b** Describe the relationship between resistance and length shown by the data.

Working scientifically [2]

Resistance increases as length increases (1); resistance is directly proportional to length, since V rises in proportion while I is constant (1)

- c** Name the independent and the control variables in this investigation.

Working scientifically [2]

Independent: length of wire (1); control: the current, the type and thickness of wire, or the temperature (1)

- d** Explain why the switch is opened between readings.

Working scientifically [2]

To stop the wire heating up (1); a hotter wire has a greater resistance, which would make the results invalid (1)

- e** One reading does not fit the pattern. Identify it and suggest a cause.

Working scientifically [2]

The 80 cm reading, which gives $8.0 \, \Omega$ rather than about $7.8 \, \Omega$ (1); the crocodile clip may not have been at exactly 80 cm, or the wire had warmed up (1)

- f** Describe how the student could improve the accuracy of the length measurement.

Working scientifically [2]

Tape the wire to a metre rule so it is straight (1); and read the rule at eye level at the point of contact of the clip, to avoid parallax error (1)

5

A student investigates the I–V characteristics of a filament lamp.

- a** Draw a labelled circuit diagram the student could use. Your diagram should include a variable resistor. Working scientifically [3]

Cell or battery, lamp, ammeter and variable resistor all in series (1); voltmeter in parallel with the lamp (1); all symbols drawn correctly with no gaps or lines through components (1)

Examiner note: Examiners note that drawing a line through the circle of an ammeter or voltmeter loses the mark.

- b** Describe the shape of the graph of current against potential difference for a filament lamp. [2]

An S-shaped curve through the origin (1); which becomes less steep as the potential difference increases (1)

- c** Explain the shape of this graph. [3]

As the current increases, the filament gets hotter (1); the ions vibrate with greater amplitude, so electrons collide with them more often (1); the resistance therefore increases, so the current rises less for each increase in potential difference (1)

- d** Describe and explain the graph obtained for a diode. [3]

Almost no current flows until the forward potential difference reaches about 0.6 V, after which the current rises steeply (1); in the reverse direction the current is essentially zero (1); because the resistance of a diode is very high in the reverse direction (1)

- e** Explain why the connections to the supply are reversed during the investigation. Working scientifically [1]

To obtain readings for negative values of potential difference, so the full characteristic can be plotted (1)

- f** State why a protective resistor is included in series with the diode. Working scientifically [1]

To limit the current, so the diode is not damaged (1)

6

The table shows readings taken for an ohmic conductor at constant temperature.

Potential difference in V	1.0	2.0	3.0	4.0	5.0
Current in A	0.08	0.16	0.24	0.32	0.40

- a** Plot a graph of current against potential difference on the grid provided. Working scientifically [4]

Sensible scales using more than half the grid (1); both axes labelled with quantity and unit (1); all points plotted correctly (1); single straight line of best fit through the origin (1)

Examiner note: Graphs drawn in pen cannot be corrected and candidates are penalised; the instruction is to use pencil.

- b** Determine the gradient of your line. Maths skill [2]

A large triangle used (1); gradient = $0.40 \div 5.0 = 0.08 \text{ A/V}$ (1)

- c** Use the gradient to determine the resistance of the conductor. Maths skill [2]

$R = 1 \div \text{gradient (1)}; = 1 \div 0.08 = 12.5 \Omega$ (1)

- d** Explain how the graph shows that the conductor is ohmic. [2]

The line is straight and passes through the origin (1); so current is directly proportional to potential difference, meaning the resistance is constant (1)

- e** A student misreads the current as 0.8 A rather than 0.08 A. Explain the effect on the calculated resistance. Working scientifically [2]

The resistance would be ten times too small, 1.25Ω (1); a power of ten error, which examiners see frequently when reading an ammeter scale (1)

7

Use the grid to plot the data from the previous question.

No answer is required here — the grid is for your graph. [0]

—

8

A thermistor and a light-dependent resistor are both connected in turn to a 6.0 V supply.

- a** Describe how the resistance of a thermistor changes with temperature. [1]

The resistance decreases as the temperature increases (1)

- b** Describe how the resistance of an LDR changes with light intensity. [1]

The resistance decreases as the light intensity increases (1)

- c** At 20 °C the thermistor has a resistance of 1200 Ω . Calculate the current through it. Maths skill [3]

$I = V \div R$ (1); $= 6.0 \div 1200$ (1); $= 0.0050$ A (5.0 mA) (1)

- d** Describe one practical use of a thermistor and one of an LDR. [2]

A thermistor in a thermostat, fire alarm or oven temperature control (1); an LDR in a street light or burglar alarm that switches on in the dark (1)

- e** Suggest how a thermistor could be used to switch on a fan when a room becomes too warm. [3]

As the room warms, the thermistor's resistance falls (1); so the current through the circuit, or the potential difference across another component, increases (1); when it reaches a set value a switch or relay operates the fan (1)

4.2.2 Series and parallel circuits

9

A 4.0 Ω resistor and a 6.0 Ω resistor are connected in series across a 12 V battery.

- a** Calculate the total resistance. Maths skill [1]

$4.0 + 6.0 = 10$ Ω (1)

- b** Calculate the current in the circuit. Maths skill [3]

$I = V \div R$ (1); $= 12 \div 10$ (1); $= 1.2$ A (1)

- c** Calculate the potential difference across the 6.0 Ω resistor. Maths skill [2]

$V = I R = 1.2 \times 6.0$ (1); $= 7.2$ V (1)

- d** State the potential difference across the 4.0 Ω resistor, and explain how you know. [2]

4.8 V (1); because the potential differences across components in series add up to the supply potential difference (1)

- e** A third resistor is added in series. State and explain the effect on the current. [2]

The current decreases (1); because the total resistance increases and the supply potential difference is unchanged (1)

10

Two $12\ \Omega$ resistors are connected in parallel across a $6.0\ \text{V}$ supply.

- a Calculate the current through one resistor.

Maths skill [3]

Each branch has the full $6.0\ \text{V}$ across it (1); $I = V \div R = 6.0 \div 12$ (1); $= 0.50\ \text{A}$ (1)

- b Calculate the total current drawn from the supply.

Maths skill [1]

$0.50 + 0.50 = 1.0\ \text{A}$ (1)

- c Calculate the total resistance of the combination.

Maths skill [2]

$R = V \div I = 6.0 \div 1.0$ (1); $= 6.0\ \Omega$ (1)

- d Explain why adding a resistor in parallel decreases the total resistance of a circuit.

[3]

A further path is created for the charge to flow along (1); so the total current from the supply increases (1); the supply potential difference is unchanged, so by $R = V \div I$ the total resistance must be smaller (1)

Examiner note: A very common misconception is that resistances always add; in parallel the total is less than the smallest individual resistance.

- e Compare the brightness of two identical lamps connected in series with two connected in parallel across the same supply.

[3]

In parallel each lamp has the full supply potential difference across it, so each is brighter (1); in series the potential difference is shared, so each lamp has less across it and is dimmer (1); the parallel circuit draws a larger total current from the supply (1)

11

A string of decorative lights contains 20 identical lamps connected in series across a $230\ \text{V}$ supply.

- a Calculate the potential difference across each lamp.

Maths skill [2]

$230 \div 20$ (1); $= 11.5\ \text{V}$ (1)

- b One lamp fails and the circuit breaks. Explain why all the lamps go out.

[2]

There is only one path for the current (1); a break anywhere means the circuit is incomplete, so no current flows anywhere (1)

- c Suggest one advantage and one disadvantage of wiring the lights in parallel instead.

[2]

Advantage: if one lamp fails the others stay lit, as each branch is a separate complete circuit (1); disadvantage: each lamp would need to withstand the full $230\ \text{V}$, and the total current drawn would be much larger (1)

4.2.3 and 4.2.4 Domestic electricity, power and energy transfers

12

A three-pin plug contains a live wire, a neutral wire and an earth wire, and a fuse.

- a** Give the colours of the live, neutral and earth wires. [3]

Live brown (1); neutral blue (1); earth green and yellow (1)

- b** State the potential difference and frequency of the UK mains supply. [2]

230 V (1); 50 Hz (1)

Examiner note: Examiners report that a number of candidates still give 240 V; the specification value is 230 V.

- c** Explain the difference between direct and alternating potential difference. [2]

A direct potential difference is always in the same direction, from a cell or battery (1); an alternating potential difference repeatedly changes direction, as from the mains (1)

Examiner note: Answers referring to current 'flowing one way' are insufficient; the specification refers to potential difference.

- d** Explain how the earth wire and the fuse together protect the user of an appliance with a metal case. [4]

If the live wire touches the metal case, the case would become live (1); the earth wire provides a low-resistance path to earth (1); so a very large current flows through the live wire and the fuse (1); the fuse wire melts, breaking the circuit and disconnecting the live supply (1)

- e** Explain why the fuse is always placed in the live wire. [2]

So that when it melts the appliance is isolated from the live supply (1); if it were in the neutral wire the appliance would still be connected to 230 V and remain dangerous (1)

- f** Explain why a plastic-cased hairdryer does not need an earth wire. [2]

It is double insulated (1); no part the user can touch is made of metal or can become live (1)

13

An electric shower is rated at 9.2 kW and operates from the 230 V mains.

- a** Calculate the current drawn by the shower. Maths skill [3]

$I = P \div V$ (1); $= 9200 \div 230$ (1); $= 40$ A (1)

- b** Explain why the shower must be wired with thicker cable than a table lamp. [2]

A much larger current flows (1); a thicker cable has a lower resistance, so less energy is dissipated as heat and the cable does not overheat (1)

- c** The shower is used for 8.0 minutes. Calculate the energy transferred, in joules. Maths skill [3]

$t = 480$ s (1); $E = P t = 9200 \times 480$ (1); $= 4.4 \times 10^6$ J (4 416 000 J) (1)

- d** Calculate the cost of this shower if electricity costs 28p per kWh. Maths skill [3]

Energy $= 9.2$ kW $\times (8 \div 60)$ h $= 1.227$ kWh (1); cost $= 1.227 \times 28$ (1); $= 34$ p (1)

14

A resistor of resistance $25\ \Omega$ carries a current of 0.80 A .

- a Calculate the power dissipated in the resistor.

Maths skill [3]

$$P = I^2 R \text{ (1); } = 0.80^2 \times 25 = 0.64 \times 25 \text{ (1); } = 16\text{ W (1)}$$

Examiner note: Forgetting to square the current is a frequent error, giving 20 W.

- b Calculate the energy transferred in 5.0 minutes.

Maths skill [2]

$$E = P t = 16 \times 300 \text{ (1); } = 4800\text{ J (1)}$$

- c Explain why electrical energy is transmitted across the National Grid at very high potential difference.

[4]

For a given power, a higher potential difference means a smaller current, since $P = V I$ (1); the power dissipated in the cables depends on $I^2 R$ (1); so a smaller current wastes far less energy as heat (1); step-up transformers raise the voltage for transmission and step-down transformers lower it for safe use (1)

15

The table gives the power ratings of four household appliances.

Appliance	Power in W	Time used per day
Fridge	150	24 hours
Television	90	4 hours
Kettle	2200	12 minutes
Oven	2500	45 minutes

- a Calculate the energy transferred by the television each day, in kWh.

Maths skill [2]

$$0.090\text{ kW} \times 4\text{ h (1); } = 0.36\text{ kWh (1)}$$

- b Determine which appliance transfers the most energy per day. Show your working.

Maths skill [3]

Fridge: $0.15 \times 24 = 3.6\text{ kWh (1)}$; kettle: $2.2 \times 0.2 = 0.44\text{ kWh}$ and oven: $2.5 \times 0.75 = 1.875\text{ kWh (1)}$; the fridge transfers the most (1)

- c Suggest why the fridge uses the most energy despite having the lowest power rating.

[2]

It is switched on for far longer than the others (1); energy transferred depends on both power and time, $E = P t$ (1)

- d Suggest two ways the household could reduce the energy it uses.

[2]

Boil only the water needed in the kettle (1); use the oven less, or keep the fridge door closed and set to a sensible temperature (1)

4.2.5 Static electricity

16

A polythene rod is rubbed with a dry cloth and becomes negatively charged.

- a** Explain how the rod becomes negatively charged. Separate Physics only [3]

Friction transfers electrons from the cloth to the rod (1); the rod gains electrons so it has an overall negative charge (1); the cloth loses the same number of electrons and is left equally positively charged (1)

Examiner note: Answers stating that positive charges move score no marks; only electrons are transferred.

- b** The rod is held near small pieces of paper, which jump up to it. Explain why. Separate Physics only [2]

The charged rod attracts electrons in the paper away from (or towards) the near surface, so the near surface has an opposite charge (1); unlike charges attract, so the paper is pulled towards the rod (1)

- c** Define an electric field. Separate Physics only [1]

A region in which a charged object experiences a force (1)

- d** Describe the electric field around an isolated negatively charged sphere. Separate Physics only [2]

The field lines are radial, pointing inwards towards the sphere (1); the field becomes weaker with distance, shown by the lines being further apart (1)

- e** Explain why a spark may jump when a charged object is brought close to an earthed conductor. Separate Physics · HT only [3]

As the separation decreases, the electric field strength between them increases (1); if the field becomes strong enough it ionises the air between them (1); the ionised air conducts, so charge flows suddenly and a spark is seen (1)

Working scientifically

- 17** A student investigates how the resistance of a thermistor changes with temperature using a water bath, a thermometer, an ammeter and a voltmeter.

a Name the independent, dependent and one control variable.

Working scientifically [3]

Independent: temperature (1); dependent: resistance, found from V and I (1); control: the supply potential difference, or the thermistor used (1)

b Explain why the student stirs the water before taking each reading.

Working scientifically [2]

To make the temperature uniform throughout the water bath (1); so the thermometer reading is the same as the temperature of the thermistor (1)

c Identify one hazard and give a precaution.

Working scientifically [2]

Hot water could scald (1); keep the water below boiling and handle the beaker with tongs or a heatproof mat (1)

d The student takes readings at 10°C intervals from 20°C to 80°C . Explain why this is better than taking only two readings.

Working scientifically [2]

It shows the shape of the relationship rather than just two points (1); and allows anomalies to be identified and a curve of best fit to be drawn (1)

e The ammeter has a resolution of 0.01 A and the readings are around 0.03 A . Explain the problem this causes.

Working scientifically [3]

The resolution is large compared with the readings (1); so the percentage uncertainty in each reading is large (1); a milliammeter with a higher resolution should be used instead (1)

Examiner note: Candidates often write 'precision' here; examiners require the term 'resolution'.

- 18** Two students measure the resistance of the same resistor. Student A records $47\ \Omega$, $48\ \Omega$ and $47\ \Omega$. Student B records $44\ \Omega$, $52\ \Omega$ and $46\ \Omega$. The true value is $47\ \Omega$.

a State which student's results are more precise, and explain why.

Working scientifically [2]

Student A (1); their repeated readings are close together, which is what precision means (1)

b State which student's results are more accurate, and explain why.

Working scientifically [2]

Student A (1); their mean of $47.3\ \Omega$ is closer to the true value of $47\ \Omega$ (1)

c Calculate the mean of student B's results.

Maths skill [1]

$(44 + 52 + 46) \div 3 = 47.3\ \Omega$ (1)

d Suggest one cause of the spread in student B's readings.

Working scientifically [1]

Loose or inconsistent connections, or the resistor warming up between readings (1)

e Explain why repeating a measurement does not remove a systematic error.

Working scientifically [2]

A systematic error shifts every reading by the same amount, in the same direction (1); so the mean is still wrong, and the instrument must be checked for a zero error or recalibrated (1)

19

A manufacturer claims that its energy-saving lamp 'uses 80% less electricity than a filament lamp for the same brightness'. A consumer group tests the claim.

- a** Describe how the group could test the claim fairly.

Working scientifically [3]

Measure the power of each lamp using a joulemeter or by measuring current and potential difference (1); compare lamps that give the same light output, measured with a light meter at a fixed distance (1); repeat with several lamps of each type and calculate means (1)

- b** The group finds the saving is 72%. Suggest why this differs from the manufacturer's claim.

Working scientifically [2]

The manufacturer may have tested under ideal conditions or compared with a different filament lamp (1); or the difference is within the uncertainty of the measurements (1)

- c** Explain why the group's findings are more trustworthy if they are peer reviewed before publication.

Working scientifically [2]

Other scientists check the method and conclusions for errors or bias (1); so false or exaggerated claims are less likely to be published (1)

20

A circuit is set up with a battery of unknown potential difference, a $15\ \Omega$ resistor and a lamp in series. The current is 0.40 A and the potential difference across the lamp is 3.0 V.

- a** Calculate the potential difference across the resistor.

Maths skill [2]

$$V = IR = 0.40 \times 15\ (1); = 6.0\ \text{V}\ (1)$$

- b** Determine the potential difference of the battery.

Maths skill [1]

$$6.0 + 3.0 = 9.0\ \text{V}\ (1)$$

- c** Calculate the resistance of the lamp at this current.

Maths skill [2]

$$R = V \div I = 3.0 \div 0.40\ (1); = 7.5\ \Omega\ (1)$$

- d** The lamp is replaced by one of higher resistance. State and explain the effect on the current.

[2]

The current decreases (1); because the total resistance of the series circuit increases while the supply potential difference is unchanged (1)

- e** Calculate the total energy transferred by the circuit in 2.0 minutes.

Maths skill [3]

$$P = VI = 9.0 \times 0.40 = 3.6\ \text{W}\ (1); t = 120\ \text{s}\ (1); E = Pt = 432\ \text{J}\ (1)$$

21

A student uses a joulemeter to measure the energy transferred by a 12 V motor lifting a load.

- a The joulemeter reads 480 J and the motor runs for 40 s. Calculate the power input.

Maths skill [2]

$$P = E \div t = 480 \div 40 \text{ (1)}; = 12 \text{ W (1)}$$

- b Calculate the current drawn by the motor.

Maths skill [2]

$$I = P \div V = 12 \div 12 \text{ (1)}; = 1.0 \text{ A (1)}$$

- c The motor lifts a load of 15 N through 1.6 m. Calculate the useful work done.

Maths skill [2]

$$W = F s = 15 \times 1.6 \text{ (1)}; = 24 \text{ J (1)}$$

- d Calculate the efficiency of the motor.

Maths skill [2]

$$24 \div 480 \text{ (1)}; = 0.05 \text{ (5\%)} \text{ (1)}$$

- e Suggest two reasons why the efficiency is low.

[2]

Energy is dissipated by friction in the bearings and gears (1); and by heating of the motor windings as current flows through their resistance (1)

22

A student tests three resistors using the same supply and records the readings below.

Resistor	Potential difference in V	Current in A
X	6.0	0.50
Y	6.0	0.20
Z	6.0	1.20

- a Calculate the resistance of each resistor.

Maths skill [3]

$$X: 6.0 \div 0.50 = 12 \Omega \text{ (1)}; Y: 6.0 \div 0.20 = 30 \Omega \text{ (1)}; Z: 6.0 \div 1.20 = 5.0 \Omega \text{ (1)}$$

- b Identify the resistor that dissipates the most power, and justify your answer with a calculation.

Maths skill [3]

$$P = V I \text{ (1)}; X = 3.0 \text{ W}, Y = 1.2 \text{ W}, Z = 7.2 \text{ W (1)}; \text{resistor Z dissipates the most (1)}$$

- c Predict the total resistance if X and Y are connected in series.

Maths skill [1]

$$12 + 30 = 42 \Omega \text{ (1)}$$

- d Predict whether the total resistance of X and Z in parallel is more or less than 5.0 Ω , and explain.

[2]

Less than 5.0 Ω (1); the total resistance of a parallel combination is always less than the smallest individual resistance, because there are more paths for the charge (1)

23

Explain why connecting an ammeter in parallel with a component, instead of in series, can damage the circuit.

Give your answer.

Working scientifically [2]

An ammeter has a very low resistance (1); connecting it in parallel provides a near short circuit, so a very large current flows, which can damage the ammeter or the supply (1)

- 24** A technician must choose a fuse for a 1150 W appliance used on the 230 V mains. Fuses available are rated 3 A, 5 A and 13 A.

a Calculate the normal operating current.

Maths skill [2]

$$I = P \div V = 1150 \div 230 \text{ (1)}; = 5.0 \text{ A (1)}$$

b State which fuse should be chosen, and explain why.

[2]

The 13 A fuse (1); the fuse rating must be just above the normal operating current, and a 5 A fuse would melt in normal use (1)

Extended response

- 25** An electrician is called to a house where a metal-cased washing machine has given someone a small electric shock.

Explain how the live, neutral and earth wires, together with the fuse, should work to make the appliance safe, and suggest what may have gone wrong.

[6]

Level 3 (5–6 marks): a coherent account of the role of each wire and the fuse, with a sensible fault diagnosis. Level 2 (3–4 marks): several correct points about the wiring or the fuse, with limited linkage. Level 1 (1–2 marks): simple statements. Indicative content: the live wire carries the alternating potential difference at 230 V; the neutral wire completes the circuit and is near 0 V; the earth wire is connected to the metal case and is at 0 V; if the live wire works loose and touches the case, the case becomes live; the earth wire then provides a low-resistance path to earth so a very large current flows; this melts the fuse in the live wire, disconnecting the supply; the fuse rating should be just above the normal operating current; possible faults include a broken or disconnected earth wire, a fuse rated far too high so it did not melt, or the appliance not being earthed at all.

- 26** A student is given two circuits containing identical lamps and an identical battery: one with the lamps in series and one with the lamps in parallel.

Compare the two circuits in terms of current, potential difference, total resistance and the brightness of the lamps. Explain your answers.

[6]

Level 3 (5–6 marks): all four quantities compared with explanation. Level 2 (3–4 marks): two or three compared with some explanation. Level 1 (1–2 marks): isolated statements.

Indicative content: in series there is one path, so the same current flows through both lamps; the supply potential difference is shared between them, so each has half; the total resistance is the sum of the two, so the current from the battery is small and the lamps are dim; in parallel each lamp has the full supply potential difference across it; the current splits between the branches and recombines at the junction; the total resistance is less than that of one lamp, so the total current from the battery is larger; each lamp is therefore brighter, and if one lamp fails in parallel the other stays lit, whereas in series both go out.