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OCR GCSE PHYSICS A (J249): QUESTIONS BY TOPIC

Topic P3: Electricity (H)

GCSE Physics A Higher Tier (J249) · Topic P3

41 questions · 206 marks · Mark schemes included

OCR GCSE (9–1) Physics A (Gateway Science) J249, June 2018 – June 2025

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HOW TO USE THIS BOOKLET

Questions are grouped by specification sub-topic; within each sub-topic they run from the lowest mark tariff to the highest.

Click any heading or question row below to jump straight to it.

On every question page, click ANSWER in the top-right corner to jump to its mark scheme.

Diagrams, graphs, tables and data are printed exactly as they appeared in the original papers.

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QUESTIONS

41 questions · 206 marks · grouped by sub-topic, lowest tariff first



SUB-TOPIC P3.1

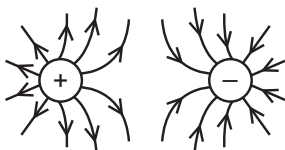
STATIC AND CHARGE

6 questions in this sub-topic · 23 marks · lowest tariff first

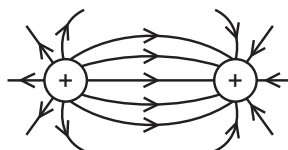


13 Look at the field line diagrams for positive and negative charges.

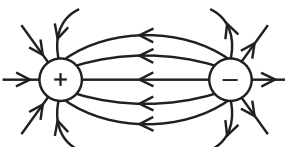
A



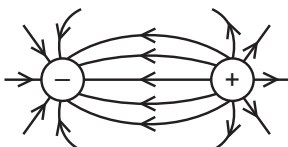
B



C



D



Which field line diagram is correct?

Your answer

[1]

- 4 Two balloons, A and B, repel each other when placed close together.

Which row in the table explains why?

	Balloon A	Balloon B
A	Equal numbers of protons and electrons	More protons than electrons
B	Equal numbers of protons and electrons	Equal numbers of protons and electrons
C	More electrons than protons	More electrons than protons
D	More electrons than protons	More protons than electrons

Your answer

[1]



- 4 A student holds a balloon near a narrow stream of water from a tap. The water is attracted to the balloon.

Why does this happen?

- A The water and the balloon are both negatively charged.
- B The water and the balloon are both positively charged.
- C The water and the balloon are not charged.
- D The water is positively charged and the balloon is negatively charged.

Your answer

[1]



7 Which row describes properties of electric fields and gravitational fields?

	Electric fields	Gravitational fields
A	attractive only	attractive only
B	attractive only	attractive and repulsive
C	attractive and repulsive	attractive only
D	attractive and repulsive	attractive and repulsive

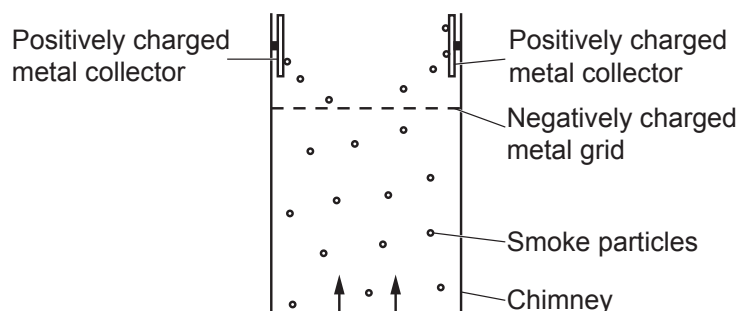
Your answer

[1]



- 22** An electrostatic dust precipitator uses static electricity to remove smoke particles from gases before the gases are released from a chimney in a factory.

The diagram shows an electrostatic dust precipitator in a chimney.



The smoke particles at the bottom of the chimney initially have a neutral charge. The smoke particles move upwards and pass through a negatively charged metal grid in the chimney.

- (a) (i)** Explain how the precipitator removes the smoke particles when the gases move upwards through the chimney.

Use ideas about charges.

.....

.....

.....

.....

..... [3]

- (ii)** Suggest why many scientists think these precipitators should be fitted to all factory chimneys.

.....

..... [1]

- (b)** The precipitator uses high voltages.

Why are high voltages dangerous?

.....

..... [1]

- (c)** The collectors receive 360 C of charge every two minutes.

Calculate the current in the collectors.

Use the equation: charge flow = current $\times$ time

Current = ... A [3]



16 A student investigates static electricity using a plastic ruler.

(a) (i) Explain in terms of electrons why the plastic ruler is not normally charged.

.....

.....

..... [2]

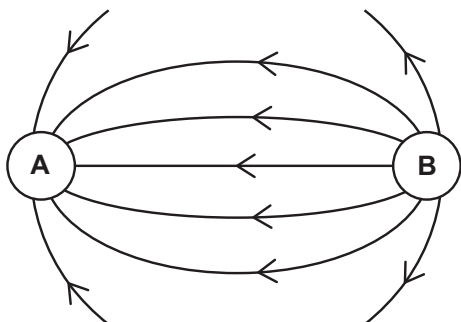
(ii) Explain in terms of electrons why the ruler becomes charged when the student rubs it with a cloth.

.....

.....

..... [2]

(b) The diagram shows the electric field between two charges, **A** and **B**.



(i) State the charges of **A** and **B**.

Use the diagram to explain your answer.

.....

.....

.....

..... [3]

(ii) Describe **one** similarity between the electric field line diagram and a magnetic field line diagram.

.....

..... [1]

(c) Calculate the charge when 200 J of energy is transferred with a potential difference of 40 V.

Use the equation: energy transferred = charge $\times$ potential difference

Charge = ... C [3]



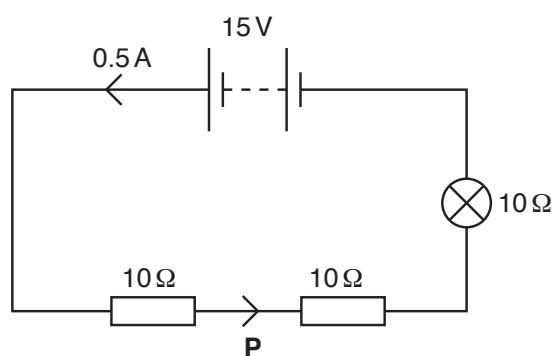
SUB-TOPIC P3.2

SIMPLE CIRCUITS

35 questions in this sub-topic · 183 marks · lowest tariff first



2 What is the current at point **P** in the circuit?



- A 0.5A
- B 7.5A
- C 15.0A
- D 20.5A

Your answer

[1]

1 Which of the following correctly describes the domestic electricity supply in the UK?

- A 230 V a.c. at 50 Hz
- B 230 V a.c. at 60 Hz
- C 230 V d.c. at 50 Hz
- D 230 V d.c. at 60 Hz

Your answer

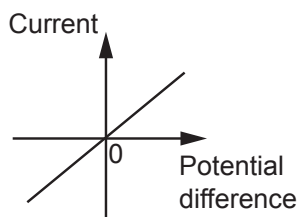
[1]



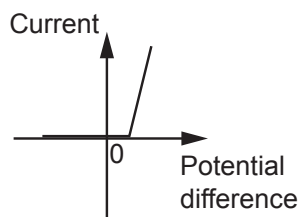
7 A student investigates four different electrical components.

She plots current-potential difference graphs for the components.

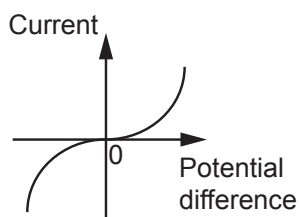
A



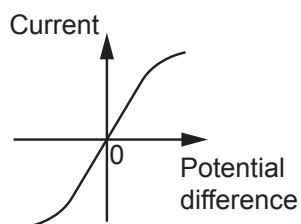
B



C



D

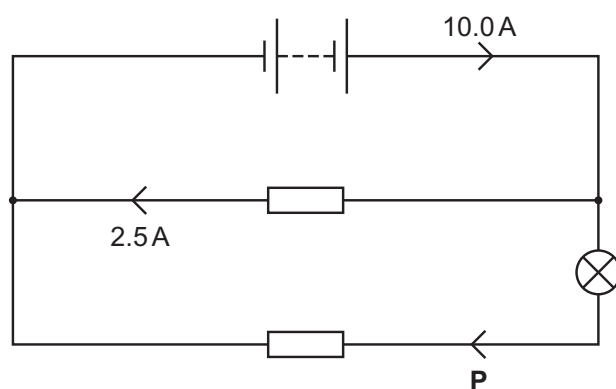


Which of the above shows the characteristic graph for a diode?

Your answer

[1]

9 Look at the circuit diagram.



What is the current at point **P** in the circuit?

- A 2.5 A
- B 5.0 A
- C 7.5 A
- D 10.0 A

Your answer

[1]

6 In a series circuit a current of $50\ \mu\text{A}$ flows.

Which current is the same size as $50\ \mu\text{A}$?

A $50 \times 10^{-6}\text{A}$

B $50 \times 10^{-3}\text{A}$

C $50 \times 10^3\text{A}$

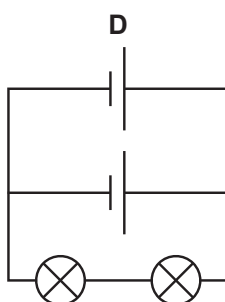
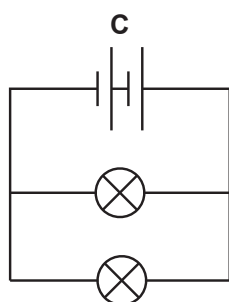
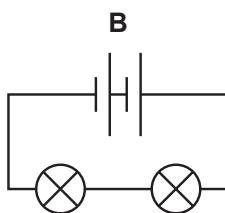
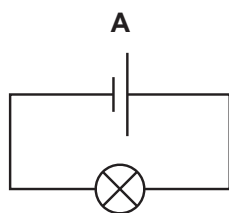
D $50 \times 10^6\text{A}$

Your answer

[1]



13 The diagrams show four different circuits using identical cells and identical lamps.



Which circuit will have the brightest lamps?

Your answer

[1]

7 The two statements describe the mains electricity supply:

- The a.c. potential difference between the earth wire and the live wire is **X** volts.
- The a.c. potential difference between the earth wire and the neutral wire is **Y** volts.

Which row of the table correctly completes the sentences?

	X	Y
A	0	0
B	0	230
C	230	0
D	230	230

Your answer

[1]



- 1 A current of 2A flows in a circuit.

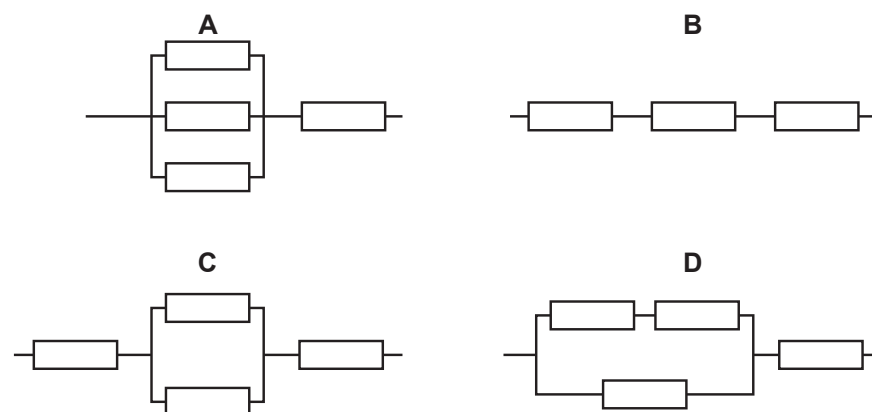
How much charge is transferred in 3 minutes?
Use the Data Sheet.

- A** 1.5 C
B 6.0 C
C 120 C
D 360 C

Your answer

[1]

8 A student sets up four arrangements, **A**, **B**, **C** and **D**, using identical fixed resistors.



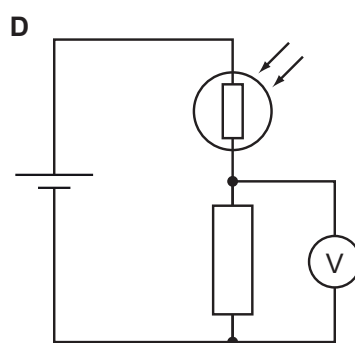
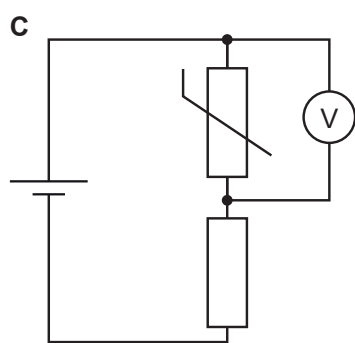
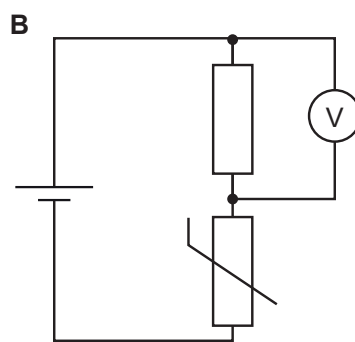
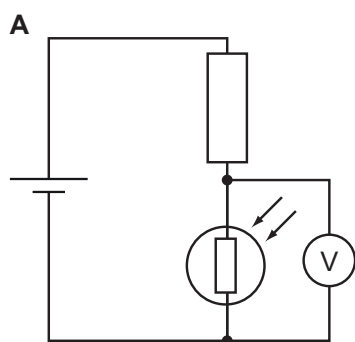
Which arrangement has the lowest resistance?

Your answer

[1]

11 An engineer uses a sensing circuit which produces a high output voltage when it gets dark.

Which circuit does the engineer use?



Your answer

[1]

7 A teacher plugs an electric kettle into the domestic electricity supply.

The kettle has a power rating of 2300 W.

What is the current in the kettle?

Use the Equation Sheet.

A 0.10 A

B 3 A

C 10 A

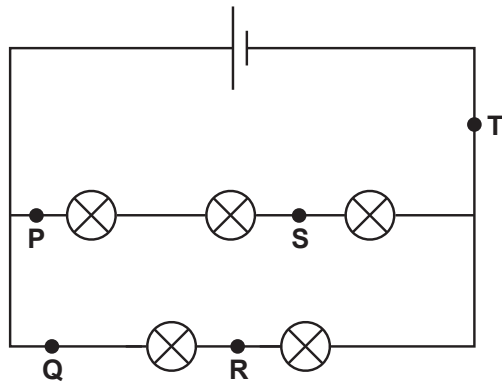
D 13 A

Your answer

[1]



- 3 A student makes a circuit using five identical lamps.



A current of 5A is measured at point **P**.

At which other point in the circuit is the current 5A?

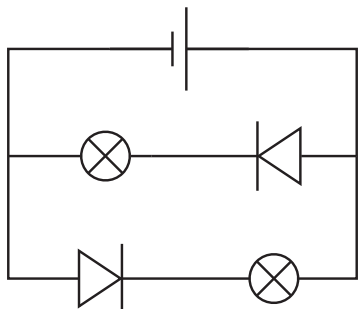
- A** Point **Q**
- B** Point **R**
- C** Point **S**
- D** Point **T**

Your answer

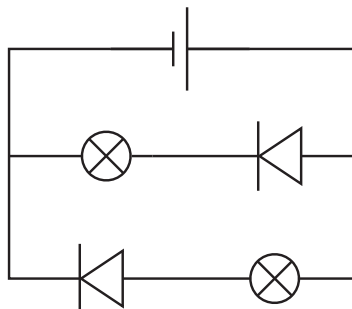
[1]

9 In which circuit will both lamps light up?

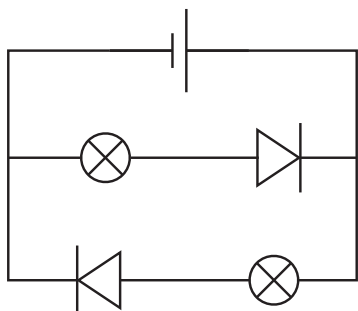
A



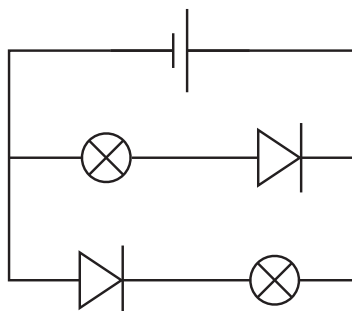
B



C



D



Your answer

[1]

- 2 Which row describes the potential difference for a washing machine and for a battery-operated torch?

	Washing machine	Torch
A	6 V a.c.	6 V a.c.
B	6 V d.c.	230 V d.c.
C	230 V a.c.	230 V d.c.
D	230 V a.c.	6 V d.c.

Your answer

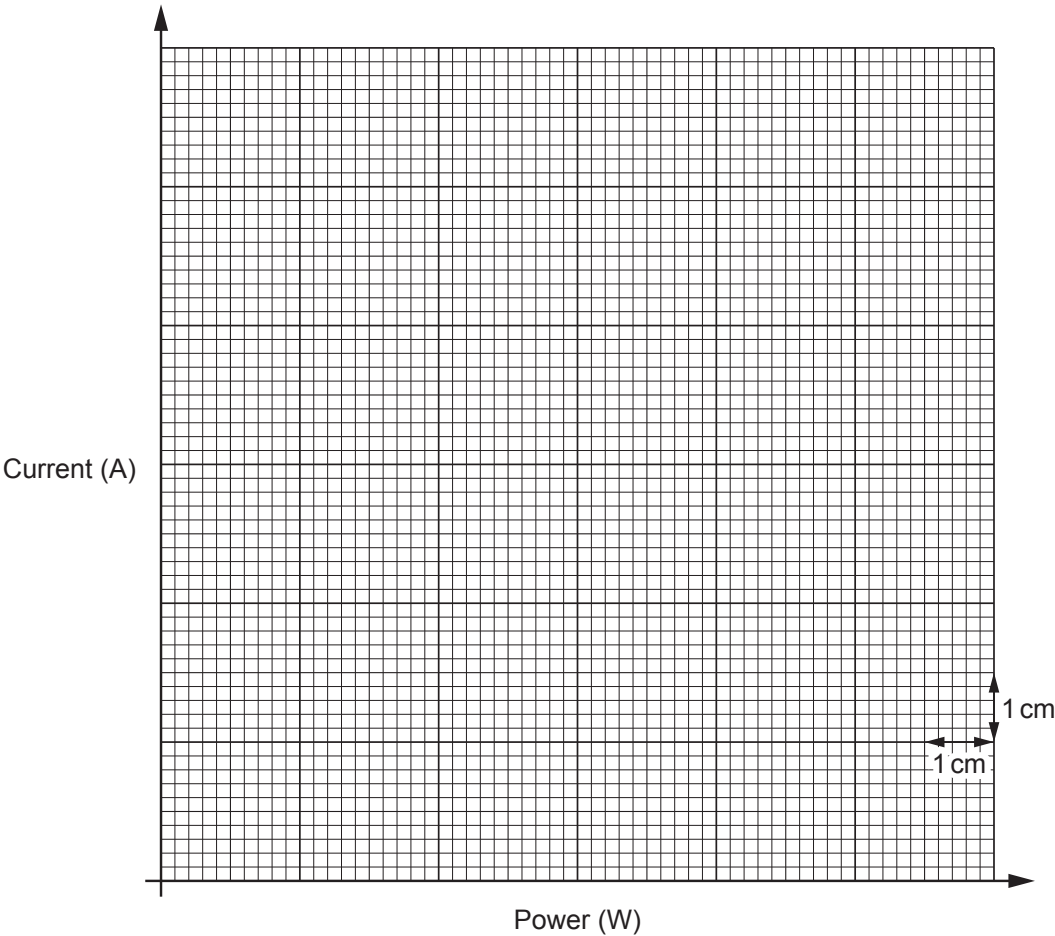
[1]



14 A student investigates how the power of an appliance changes the current in the live wire.

Power (W)	Current (A)
70	0.3
160	0.7
600	2.6
900	3.9
1200	5.2

The student plots a graph of the results using this graph paper.



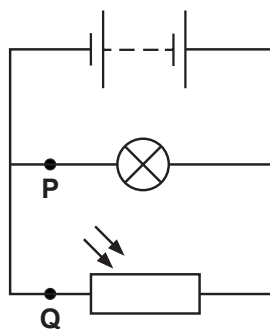
Which scales should the student use for each axis?

	Power (W)	Current (A)
A	1 cm = 100 W	1 cm = 0.5A
B	1 cm = 100 W	1 cm = 1.0A
C	1 cm = 200 W	1 cm = 0.5A
D	1 cm = 200 W	1 cm = 1.0A

Your answer

[1]

10 A teacher makes a parallel circuit with a battery, a lamp and an LDR.



The battery has a fixed potential difference.

The light intensity is increased.

Which row describes what happens to the current at point **P** and the current at point **Q**?

	Current at point P	Current at point Q
A	increases	increases
B	stays the same	decreases
C	stays the same	increases
D	stays the same	stays the same

Your answer

[1]

- 3 What is the function of the **neutral** wire in an electrical device?
- A To cause a potential difference between this wire and the earth wire
 - B To complete the circuit from the device back to the power supply
 - C To melt if the current through it is too high due to a fault
 - D To provide a low resistance path for the current if there is a fault

Your answer

[1]



8 Which row describes the domestic mains supply in the UK?

	Voltage (V)	Frequency (Hz)	Type of voltage output
A	50	230	alternating
B	50	230	direct
C	230	50	alternating
D	230	50	direct

Your answer

[1]



18* Two students, **P** and **Q**, investigate how the resistance of wire varies with its length. Each student uses different lengths of the **same** wire and the **same** equipment for their experiment.

- **Table 18.1** shows the data that student **P** obtained.
- **Table 18.2** shows the data that student **Q** obtained.

Table 18.1

Student P data

Length of wire (cm)	Resistance Trial 1 (Ω)	Resistance Trial 2 (Ω)	Mean resistance (Ω)	Resistance per unit length (Ω/cm)
10	12	20	16	1.6
15	25	30	28	1.9
19	21	29	25	1.32

Table 18.2

Student Q data

Length of wire (cm)	Resistance Trial 1 (Ω)	Resistance Trial 2 (Ω)	Mean resistance (Ω)	Resistance per unit length (Ω/cm)
10.0	11.0	11.2	11.1	1.10
20.0	19.8	20.2	20.0	1.00
30.0	33.0	33.2	33.1	1.10
40.0	48.0	48.4	48.2	1.20
50.0	55.1	55.5	55.3	1.10

The manufacturer of the wire states that the value for its resistance per unit length is $1.2\ \Omega/\text{cm}$.

Compare the data recorded in the two tables. Explain which student's data is the most accurate and precise.

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.....

.....

.....

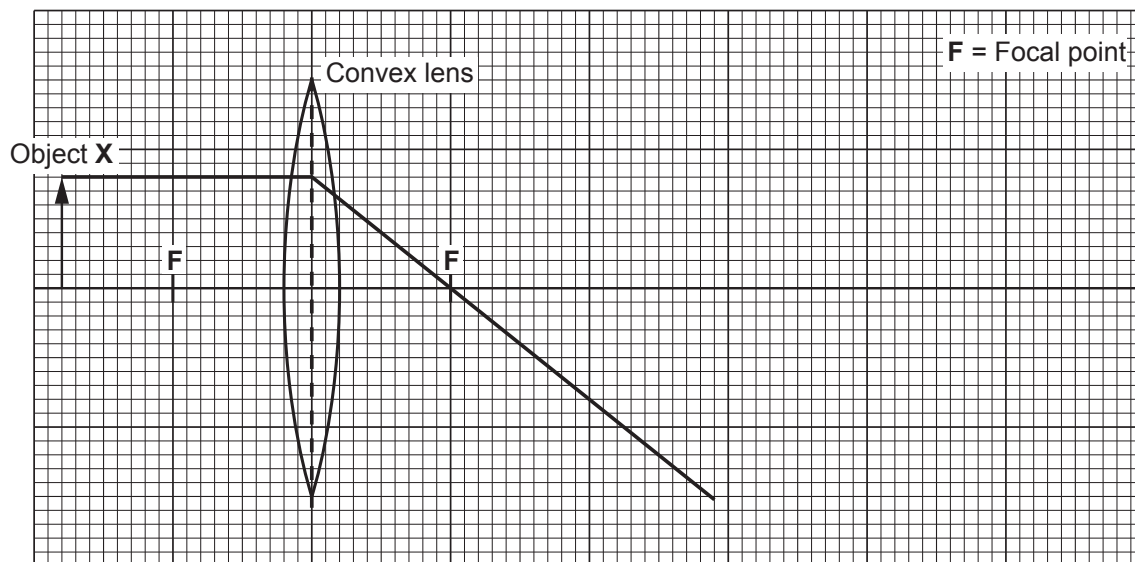


..... [6]

16 A projector is used to create a larger image of an object.

(a) The diagram shows one light ray as it passes through the convex lens.

Draw **one** more ray on the diagram to show where the image is formed. Label the image **Y**.



[2]

(b) The projector contains a white light source.

Explain how this white light source can be used to get **red** light.

.....
 [2]

(c) (i) The projector is connected to the mains power supply. The projector has an earth wire.

State the potential difference between the earth wire and the live wire in normal use.

Potential difference = ... V [1]

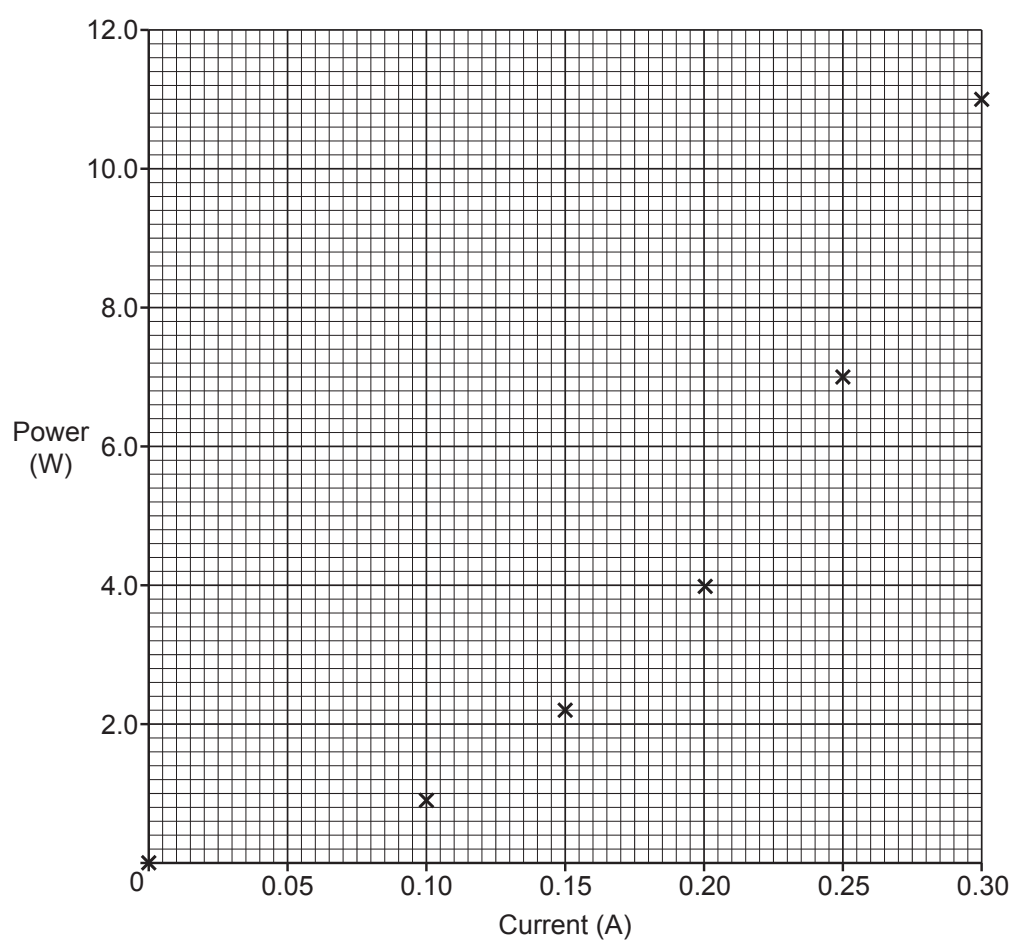
(ii) A projector with a plastic case does not need an earth wire.
 A projector with a metal case needs an earth wire.

Explain why.

.....

 [2]

- 24** A student investigates how the electrical power of a component changes with current. They plot a graph of their results.



- (a) Draw a line of best fit on the graph. [1]

- (b) Use the graph to describe the relationship between current and power for the component.

.....

 [2]

- (c) Use the graph to estimate the current when the power is 3.0 W.

Current = ... A [1]



(d) The student thinks that the resistance of the component increases as the current increases.

Use data from the graph to explain if the student is correct.

.....

.....

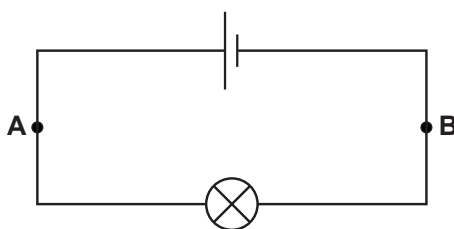
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.....

..... [3]



20 A teacher draws a simple electric circuit.



(a) Draw an arrow on the circuit to show the direction of electron flow. [1]

(b) How does the current at point **A** in the circuit compare to the current at point **B** in the circuit?

Tick (✓) **one** box.

Current at point **A** > current at point **B**

☐

Current at point **A** < current at point **B**

☐

Current at point **A** = current at point **B**

☐

[1]

(c) Calculate the charge flow in the lamp when there is a current of 0.45A for 30s.

Include the unit.

Use the Equation Sheet.

Charge flow = ... Unit [4]

(d) Apart from current and time, which other quantity is needed to calculate the energy transferred by the lamp?

Use the Equation Sheet.

..... [1]

17 A TV has the label below on it.

OCR TV

Voltage: 230 V

Power: 65 W

Frequency: 50 Hz

(a) Calculate the **current** in the TV when it is turned on.

Use the equation: power = potential difference × current

Give your answer to **2** significant figures.

Current = ... A [4]

(b) The TV is turned on for 30 minutes.

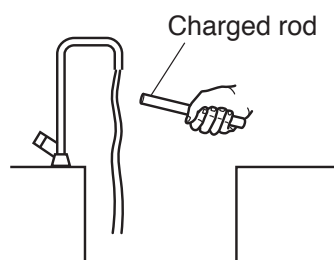
Calculate the energy transferred by the TV.

Energy used = ... J [4]



18 This question is about electrostatic charges.

A charged rod is brought towards a gentle stream of water from a tap.



(a) Explain how the charged rod affects the stream of water.

.....

.....

.....

.....

..... [3]

(b) (i) Write down the conditions needed for charge to flow through a conductor.

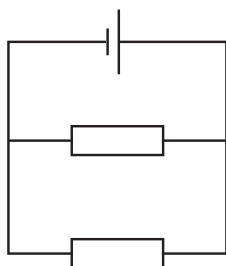
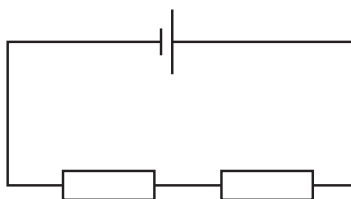
.....

..... [2]

(ii) Calculate the charge that flows past a point in a circuit with a 5.0A current for five minutes.

Answer = ... C [4]

19 A student builds two electrical circuits. Each circuit uses identical cells and identical fixed resistors.

**A****B**

(a) Explain why circuit **A** has a lower total resistance than circuit **B**.

.....

 [2]

(b) Another student investigates the resistance of a filament lamp.

(i) Explain why the resistance of a filament lamp increases when current increases.

.....

 [2]

(ii) Design a circuit diagram which could be used to investigate how the resistance of a filament lamp changes with current.

Use the circuit symbols below. Each symbol can be used once, more than once, or not at all.



[2]

- (iii) Describe how the student would use the circuit you have drawn in **19(b)(ii)** to investigate how the resistance of a filament lamp changes with current.

.....

.....

.....

.....

.....

..... [3]



17 A student does an experiment to calculate the resistance of an unknown component, **Y**.

The student sets up the circuit in **Fig. 17.1**.

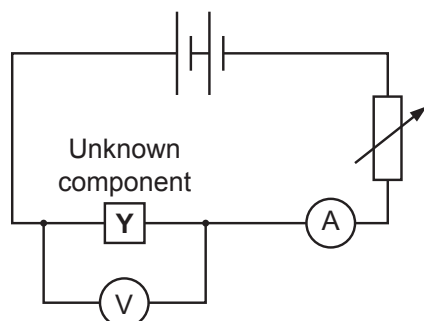


Fig. 17.1

(a) The student needs to be able to measure a current of up to 1 A.

The student has a choice of two different ammeters to use, ammeter **A** and ammeter **B**.

Fig. 17.2 shows the initial readings on the ammeters **before** they are connected to the circuit.

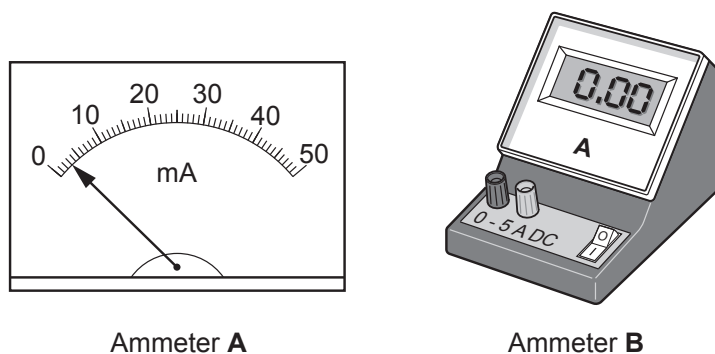


Fig. 17.2

Which ammeter is best for the student to use? Give **two** reasons.

Ammeter

Reason 1

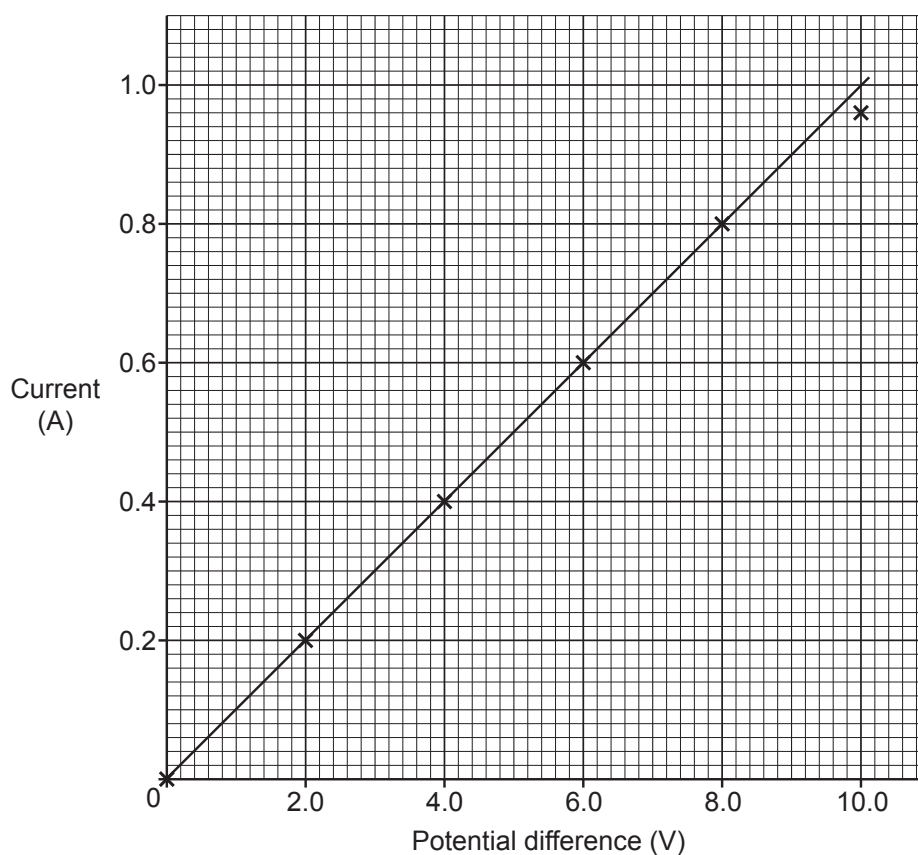
.....

Reason 2

.....

[2]

- (b) The student takes readings of potential difference and current for component **Y** and plots them on a graph.



- (i) Explain why the student thinks that component **Y** is a fixed resistor.

.....
.....
.....
..... [2]

- (ii) The student has correctly plotted the point at 10.0V on the graph.

Suggest **one** reason why the point is not on the line of best-fit.

.....
..... [1]

(iii) Suggest **two** ways the student can check if their results are reproducible.

1

.....

2

.....

[2]

(c) The resistor has a resistance of $10.0\ \Omega$.

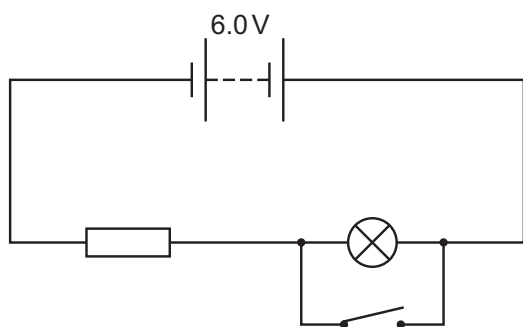
Calculate the power of the resistor when the current is 0.5 A .

Use the equation: power = (current)² × resistance

Power = ... W [2]



17 A scientist sets up an electrical circuit.



The lamp and the resistor each have a resistance of $5.0\ \Omega$ so that the total resistance in the circuit is $10.0\ \Omega$.

- (a) (i) Calculate the current in the circuit when the switch is open.
Use the Data Sheet.

Current = ... A [3]

- (ii) State the potential difference across the resistor when the switch is open.

Potential difference = ... V [1]

- (b) The switch is now **closed**.

- (i) Describe how the current through the resistor changes. Explain your answer.

.....

 [2]

- (ii) Describe how the potential difference across the resistor changes. Explain your answer.

.....

 [2]

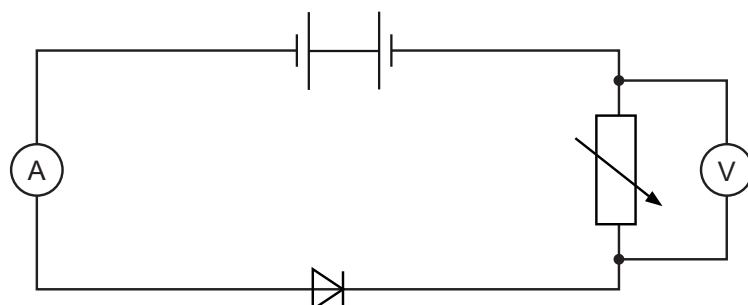
- (iii) State the potential difference across the lamp when the switch is closed.

Potential difference = ... V [1]

19 A student investigates the current–potential difference characteristics of a diode.

Fig. 19.1 shows the circuit diagram the student sets up to measure the current in the diode and the potential difference across the diode.

Fig. 19.1



(a) The student has made **two** mistakes when setting up the circuit.

Identify the two mistakes and explain how to correct them.

Mistake 1

Correction 1

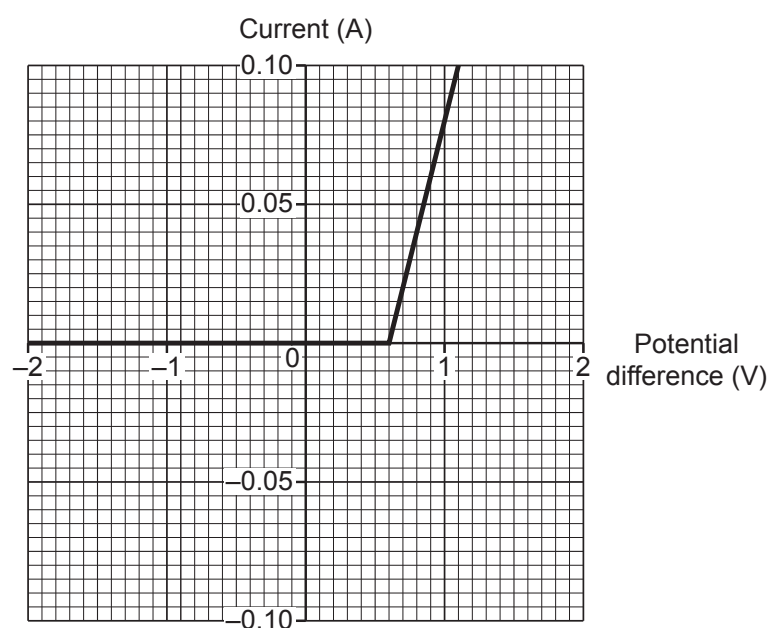
Mistake 2

Correction 2

[4]

- (b) The student corrects the circuit and records the current for different values of the potential difference. **Fig. 19.2** shows a graph of their results.

Fig. 19.2



- (i) State the potential difference when the diode starts to conduct.

..... [1]

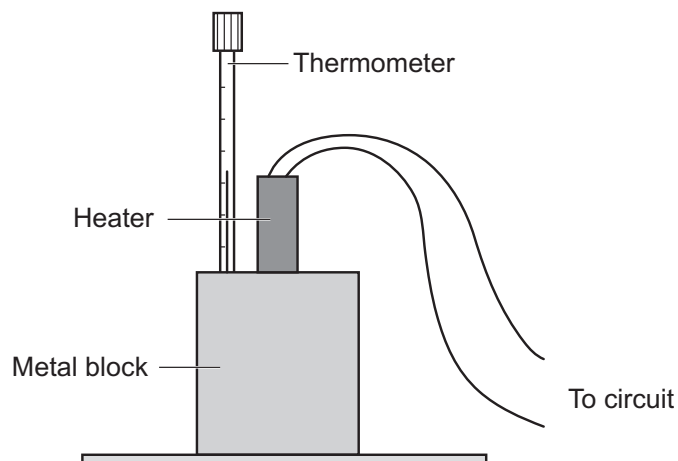
- (ii) Use the gradient of the graph to calculate a value for the resistance of the diode when it is conducting.

Resistance = ... Ω [4]

20 A student does an experiment to measure the specific heat capacity of a metal block.

Fig. 20.1 shows the student's equipment.

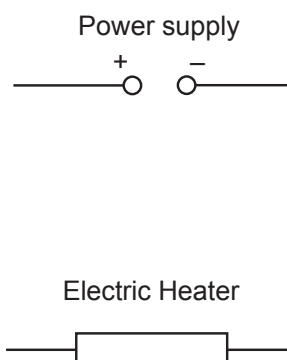
Fig. 20.1



(a) The student measures current and potential difference to calculate the power of the heater.

Complete the circuit diagram in **Fig. 20.2** to show how the student measures current and potential difference.

Fig. 20.2



[2]

- (b) (i) The table shows the student's results.

Energy supplied to heater	24 kJ
Starting temperature	20 °C
Final temperature	45 °C
Change in temperature	25 °C
Mass of block	2.0 kg

Use the data in the table to calculate the specific heat capacity of the metal block.

Use the Data Sheet.

Specific heat capacity = ... J/kg °C [4]

- (ii) The value calculated in (b)(i) is higher than the actual value.
The student recorded all data correctly.

Suggest why the value calculated is higher than the actual value.

Use Fig. 20.1.

.....
..... [1]

- (iii) Suggest how the experiment could be improved.

Use Fig. 20.1.

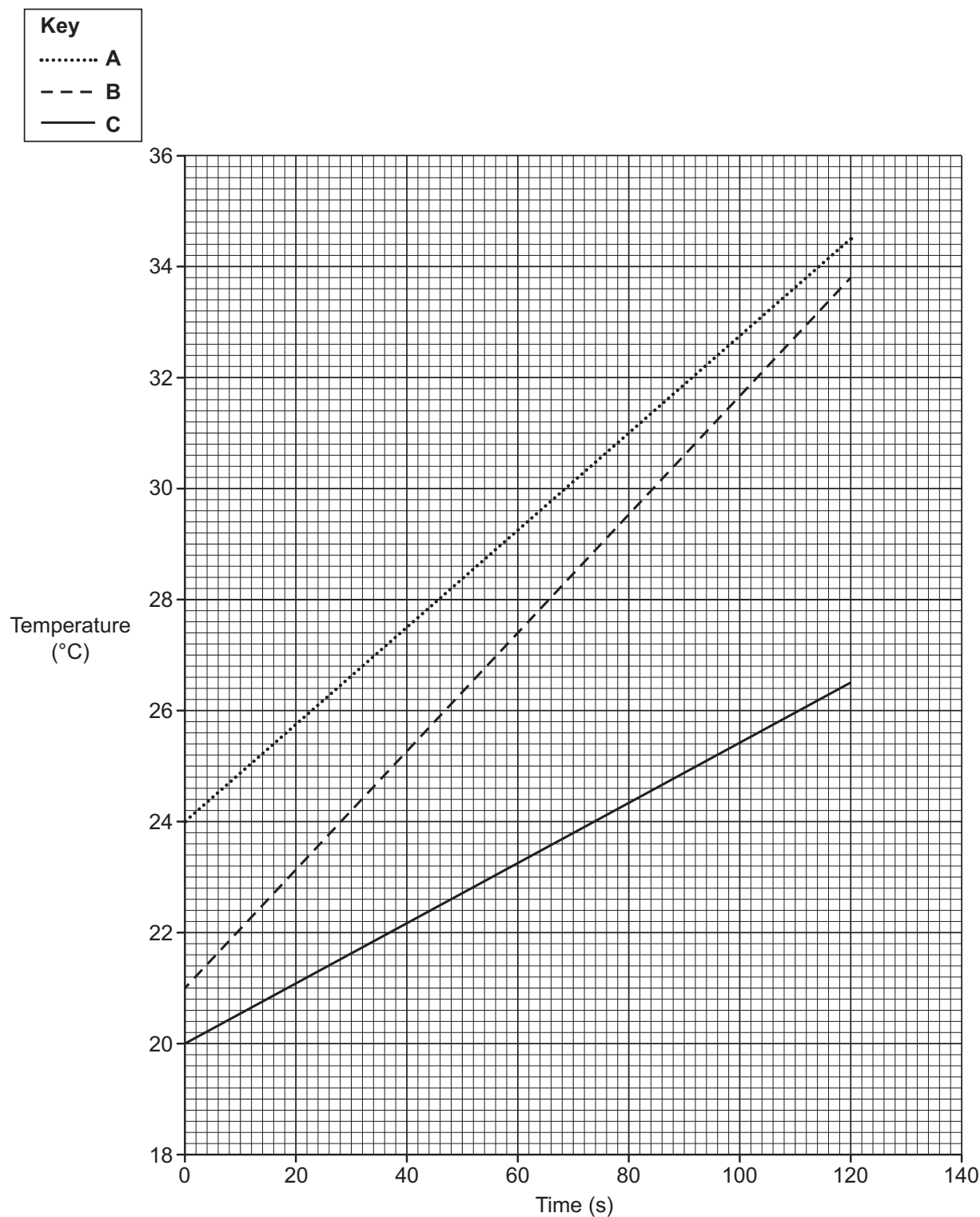
.....
..... [1]



(c) The student repeats the same experiment using 3 different blocks, **A**, **B** and **C**.

- Each block is made of a different metal but has the same mass.
- The power of the heater stays the same.

The graph shows how the temperature of blocks **A**, **B** and **C** change with time.



Which metal has the **highest** specific heat capacity?

Tick (✓) **one** box.

A ☐

B ☐

C ☐

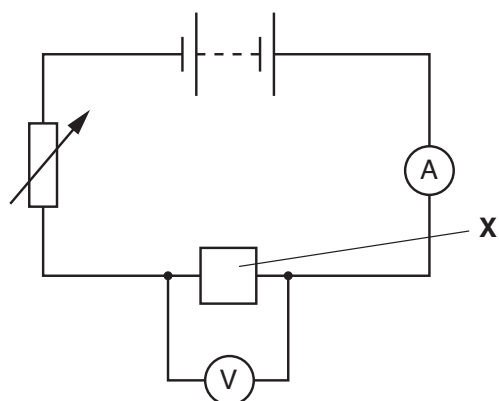
State a reason for your answer.

.....

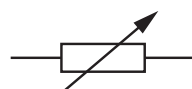
..... [2]



16 A student builds a circuit to investigate the resistance of component **X**.



(a) (i) What is the name of this component?



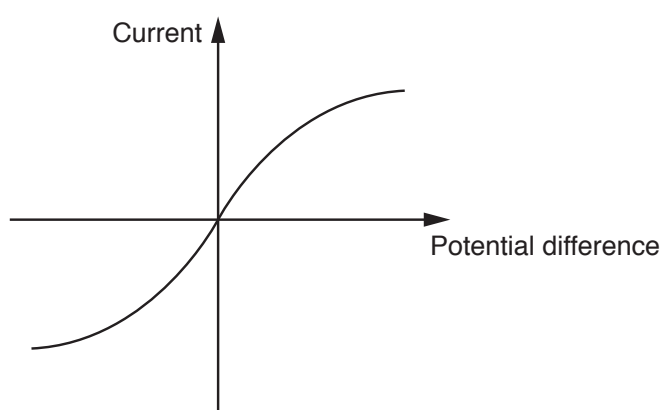
..... [1]

(ii) Why is this component needed in this circuit?

..... [1]

(b) The student uses the circuit to take current and potential difference readings.

The student plots a graph of her results.



(i) Look at the graph. What is component **X** in the circuit?

..... [1]

- (ii) The resistance of component **X** varies as the potential difference changes.

Describe how the graph shows this and explain why this happens.

.....
.....
.....
..... [3]

- (c) Component **X** has a resistance of $16\ \Omega$ when a current of 0.25A flows.

- (i) Calculate the potential difference across component **X**.

Use the equation: Potential difference = Current $\times$ Resistance

Answer = ... V [2]

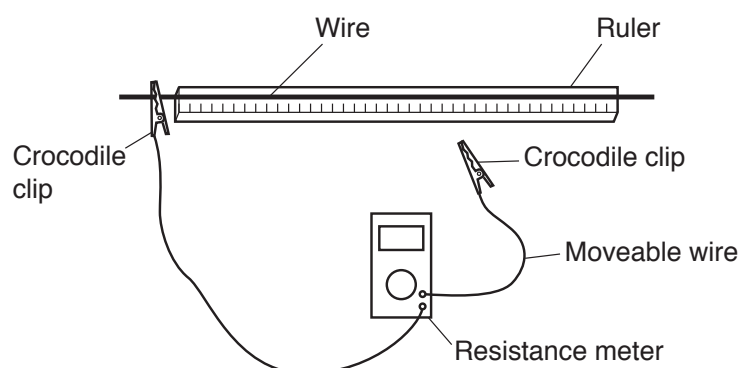
- (ii) Calculate the power of component **X** when a current of 0.25A flows.

Answer = ... W [3]



19 Two students investigate the resistance of a wire.

They tape a length of wire to a metre ruler and connect it to a resistance meter using crocodile clips.



Look at their results.

Length of wire (cm)	Resistance (Ω)			
	Attempt 1	Attempt 2	Attempt 3	Mean
25	8.8	8.3	8.5	8.533
50	16.2	16.1	16.4	16.4
75	23.5	23.8	18.7	23.7
100	30.8	31.1	31.0	31.0

(a) (i) Describe the pattern shown by these results.

Use data in your answer.

.....

 [2]

(ii) The students made **two** mistakes when they recorded their results and completed the table.

Identify the mistakes **and** explain what they should have done.

.....

 [2]

- (iii) The students have correctly handled an error in their results.

Identify the error and explain how it was correctly handled.

.....

.....

..... [2]

- (iv) The students plan to plot a graph of mean resistance against length.

What would you expect a graph of these results to look like?

.....

.....

..... [2]

- (b) (i) The actual mean resistance values are more than expected.

Suggest **two** possible errors with the experiment.

.....

.....

..... [2]

- (ii) For **one** of the errors, suggest how the experimental procedure could be improved.

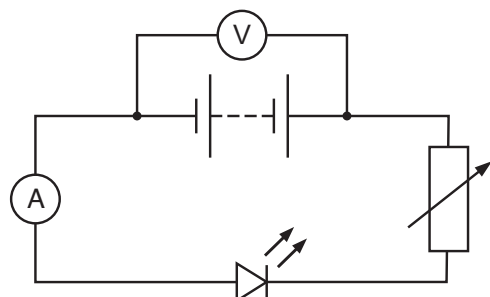
.....

..... [1]

19 A student investigates the electrical characteristics of a light emitting diode (LED).

The student builds a circuit to investigate how the current through an LED and the potential difference across it vary when the LED lights up.

Look at the circuit diagram.

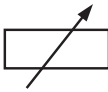


(a) (i) The student has made **two** errors connecting the circuit.

Identify the errors.

1

2 [2]

(ii) What is the purpose of the component  in the circuit?

..... [1]

(b) The student then connects the circuit correctly. He measures the current through the LED as 0.03A when the potential difference across it is 3.0V.

(i) Calculate the resistance of the LED.

Use the equation: potential difference = current $\times$ resistance

Resistance = ... Ω [3]

- (ii) Calculate the charge which flows when this LED operates for 2.5 minutes.

Charge = ... C [4]

- (iii) Calculate the energy transferred when this LED operates for 2.5 minutes.

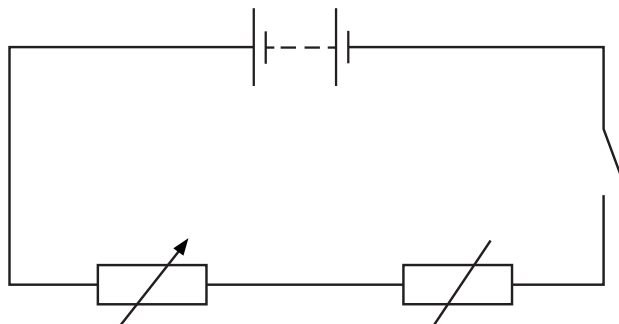
Use the equation: energy transferred = charge $\times$ potential difference

Energy transferred = ... J [2]



16 A student investigates the current–potential difference (I–V) characteristic graph for a thermistor.

The diagram shows the circuit that the student builds.



(a)

- (i)** The student connects an ammeter and a voltmeter into the circuit to take the measurements needed for their investigation.

Draw **one** ammeter and **one** voltmeter in the correct positions in this circuit.

[3]

- (ii)** Why does the student use a variable resistor in the circuit?

Tick (✓) **one** box.

To change the current in the circuit

☐

To change the potential difference of the battery

☐

To change the temperature of the circuit

☐

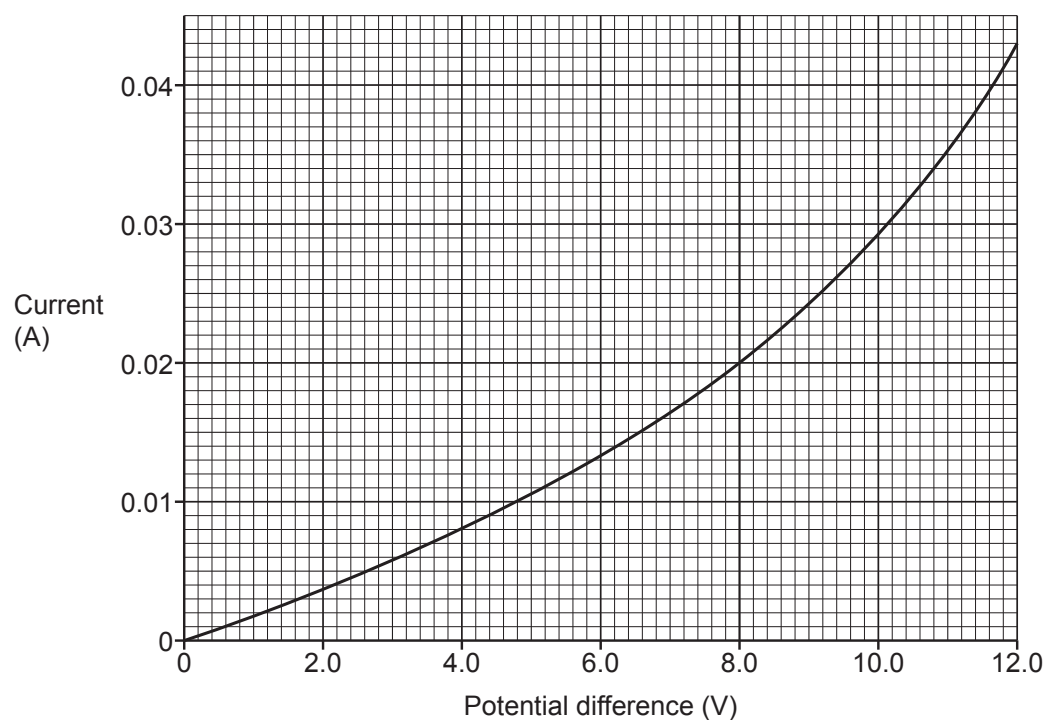
[1]

- (iii)** Explain why the student switches the circuit off between taking the readings of current and potential difference.

.....

..... **[1]**

(b) The student takes readings of current and potential difference and plots them on a graph.



(i) Describe the trend shown by the graph.

.....

 [2]

(ii) How does the resistance of the thermistor change as the potential difference increases?

..... [1]

(iii) State the current in the thermistor when the potential difference across the thermistor is 8.0V.

Use the graph.

Current = ... A [1]

(iv) Calculate the resistance of the thermistor when the potential difference across the thermistor is 8.0V.

Use the equation: potential difference = current $\times$ resistance

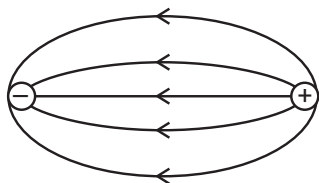
Resistance = ... Ω [3]

Turn over

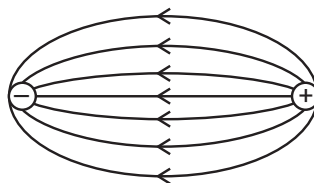
18 This question is about electricity.

- (a)** The diagrams show the electric fields between different charges. The charges are the **same distance** apart in both electric fields.

Electric field **A**



Electric field **B**



An identical charged particle is placed in each electric field.

Explain in which electric field, **A** or **B**, the particle experiences the **strongest** force.

.....

 [2]

- (b)** Which conditions are needed for charge to flow?

Tick (✓) **two** boxes.

closed circuit

☐

open circuit

☐

source of potential difference

☐

source of resistance

☐

[2]

- (c) A student has written two sentences about the resistance of different electrical components.

The resistance of a filament lamp is so high in one direction, that no current can pass through.

The resistance of a thermistor changes as the light intensity changes.

The student has made **two** mistakes about the components.

Identify the mistakes and write the correct word or words to replace each of them.

Mistake 1

Correct word(s) 1

Mistake 2

Correct word(s) 2

[4]

- (d) Calculate the current in a 180 W resistor when the potential difference across the resistor is 12 V.

Use the equation: power = potential difference $\times$ current

Current = ... A [3]

- (e) Calculate the energy transferred when 20 C of charge moves through a potential difference of 12 V.

Use the equation sheet.

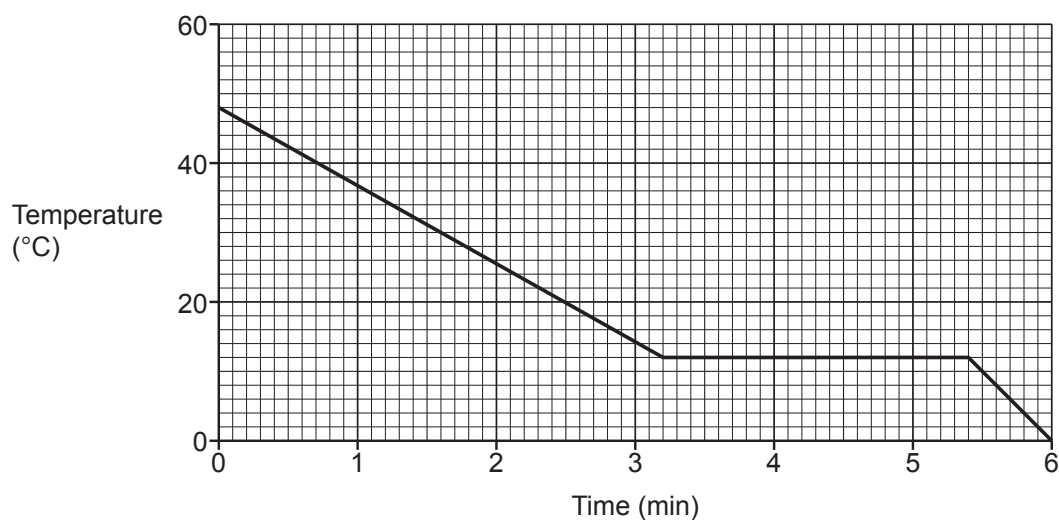
Energy transferred = ... J [3]



23 A scientist investigates how liquids cool when they are placed in a freezer.

(a) The scientist places 200 g of liquid **A** in a freezer.

The graph shows how the temperature changes with time as the liquid cools.



(i) What is the initial temperature of liquid **A**?

Initial temperature = ... °C [1]

(ii) What is the freezing point of liquid **A**?

Freezing point = ... °C [1]

(iii) Liquid **A** has a specific heat capacity of 3750 J/kg °C.

Calculate the energy needed to cool the liquid from its initial temperature until it starts to freeze.

Use the Equation Sheet.

Energy = ... J [4]



(b)

(i) Liquid **B** is placed in the freezer.

The freezer needs 54 kJ of energy to cool liquid **B** from its initial temperature to its freezing point. This takes 360 s.

Calculate the minimum power of the freezer needed to cool liquid **B**.

Use the equation: energy transferred = power × time

Minimum power = ... W **[4]**

(ii) Why is the actual power needed to cool liquid **B** larger than your answer to **(b)(i)**?

..... **[1]**

(c) The power of a different portable freezer is 240 W.

The components in the freezer have a total resistance of $0.80\ \Omega$.

Calculate the current in the freezer.

Use the Equation Sheet.

Give your answer to **2** significant figures.

Current = ... A **[4]**



MARK SCHEMES

official Pearson Edexcel mark schemes



Question				Answer	Marks	AO element	Guidance
13				D ✓	1	1.1	



Question				Answer	Marks	AO element	Guidance
4				C ✓	1	1.1	



Question	Answer	Marks	AO element	Guidance
4	D ✓	1	1.1	



Question	Answer	Marks	AO element	Guidance
7	C	1	1.1	



22	(a)	(i)	Any three from: The <u>metal grid</u> gives the (smoke) particles a charge / gains electrons ✓ The (smoke) particles gain a <u>negative</u> charge ✓ The (smoke) particles are repelled by the metal grid ✓ The (smoke) particles are attracted by / stick to the metal collectors ✓ Opposite charges attract / like charges repel ✓	3	3 x 1.2	The <u>metal grid</u> gives the (smoke) particles a negative charge scores the first two marking points
		(ii)	Any one from: It stops / reduces the small particles / smoke being released into the atmosphere / environment ✓ It stops / reduces people having to breathe the small particles / smoke ✓ It stops / reduces smog / pollution ✓	1	2.2	IGNORE all references to CO ₂ / SO ₂ / greenhouse gases / acid rain
	(b)		High voltages can cause electric shocks / electrocution ✓	1	1.1	IGNORE unqualified it is dangerous IGNORE heating ALLOW description of electrocution in terms of damage to nervous system or heart
	(c)		First check the answer on answer line If answer = 3 (A) award 3 marks I = Q ÷ t ✓ I = 360 ÷ 120 ✓ I = 3 (A) ✓	3	1.2 2.1 2.1	ALLOW 180 (A) 2 marks (no unit conversion). Rearrangement of equation ALLOW ECF for incorrect time conversion if clearly shown.

16	(a)	(i)	(Ruler has) equal numbers of protons and electrons / ORA ✓ So (effects of positive charges and negative charges) cancel out / AW / ORA ✓	2	2 x 1.1	ALLOW equal numbers of positive and negative charges/opposite charges / ORA ALLOW ruler has not lost/gained electrons / ORA ALLOW ruler is/atoms are neutral unless there is a loss/gain of electrons / ORA ALLOW if the ruler had been charged, movement of electrons (to/from the air) would discharge it ALLOW overall/net charge is zero/neutral / ORA IGNORE just charge is neutral
		(ii)	Electrons are transferred (from/to the ruler or from/to the cloth) / ORA ✓ And any one from: Charges are no longer equal / AW ✓ Different numbers of protons and electrons / AW ✓ Effects no longer cancel out / AW ✓	2	2 x 1.1	ALLOW electrons are lost/gained DO NOT ALLOW protons/positive charges move ALLOW ruler becomes negative/positive with correct movement of electrons ✓✓
	(b)	(i)	They must be opposite/unlike charges / one is positive and one is negative / one is a proton and one is an electron ✓ And any two from: They are being attracted ✓ The arrows show a force on the positive (charge)/(charge) B ✓ Forces/field (lines) go from positive to negative ✓ (Charge) A is negative AND (charge) B is positive ✓	3	3 x 1.2	ALLOW A is positive and B is negative for this mark only ALLOW forces/field (lines) go from B to A ALLOW maximum of 1 mark if described as opposite poles / positive and negative poles

Question	Answer	Marks	AO element	Guidance
	(ii) Any one from: North and South (poles) (replace positive and negative charges) ✓ The arrows/field lines go from North to South (as opposed to positive to negative) ✓ They have similar shape field (patterns) ✓ Closeness of field lines represents strength of field (in each case) ✓ Opposite <u>poles</u> (and opposite charges) attract ✓ Both show direction of field (lines)/forces ✓	1	1.1	
(c)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 5(.00) (C) award 3 marks (Rearrange equation) (charge =) energy transferred / potential difference ✓ (charge =) 200 / 40 ✓ (charge =) 5 (C) ✓	3	1.2 2.1 2.1	

Question			Answer	Marks	AO element	Guidance
2			A ✓	1	2.1	



Question				Answer	Marks	AO element	Guidance
1				A ✓	1	1.1	



Question				Answer	Marks	AO element	Guidance
7				B ✓	1	1.2	



Question				Answer	Marks	AO element	Guidance
9				C ✓	1	1.1	



Question				Answer		Marks	AO element	Guidance	
6				A ✓		1	1.2		



Question				Answer	Marks	AO element	Guidance
13				C ✓	1	2.2	



Question				Answer	Marks	AO element	Guidance
7				C ✓	1	1.1	



Question	Answer	Marks	AO element	Guidance
1	D ✓	1	2.1	



Question	Answer	Marks	AO element	Guidance
8	A ✓	1	2.1	



Question	Answer	Marks	AO element	Guidance
11	A	1	2.2	



Question	Answer	Marks	AO element	Guidance
7	C	1	2.1	



Question	Answer	Marks	AO element	Guidance
3	C	1	2.2	ALLOW S



Question	Answer	Marks	AO element	Guidance
9	B	1	2.2	



Question	Answer	Marks	AO element	Guidance
2	D	1	2.1	



Question	Answer	Marks	AO element	Guidance
14	A	1	2.2	



Question	Answer	Marks	AO element	Guidance
10	C	1	2.2	



Question	Answer	Marks	AO element	Guidance
3	B	1	1.1	

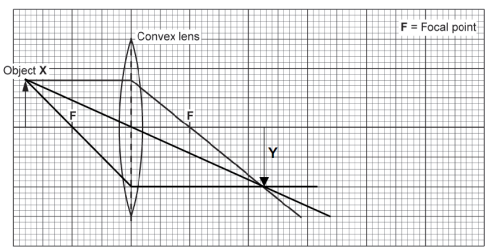


Question	Answer	Marks	AO element	Guidance
8	C	1	1.1	



18		Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question. Level 3 (5–6 marks) Comparisons between the two sets of data and with the manufacturer's data in terms of accuracy AND comparison in precision of the two sets of data. <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i> Level 2 (3–4 marks) Comparisons between the accuracy of the two sets of data or with the manufacturer's data AND a simple comparison in precision of the two sets of data OR A comparison between the accuracy of the two sets of data or with the manufacturer's data AND comparison in precision of the two sets of data <i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i>	6	1 x 3.1a 1 x 3.1b 2 x 3.2a 2 x 3.2b AO3.1a/3.1b Analyse information to interpret and evaluate the accuracy and precision of the data. For example • P has taken 3 readings, but Q has taken 5 readings • Different lengths of wire have been used • P lengths recorded to nearest cm; Q lengths recorded to nearest mm or different sig figs /decimal places • Resistance data has been recorded to different numbers of sig figs/decimal places • Both sets of data have repeat readings and calculated the mean AO3.2a Analyse information to make judgements about the accuracy and precision of the data. For example • P has unequal intervals / Q has equal intervals (10cm) between the readings • P has small range (9cm), Q has large range (50cm) • P has recorded their resistance data to zero decimal places • Q has repeat resistance readings closer together • For Q, resistance per length are similar • Reading for P 15 cm mean resistance is more than for 19 cm
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Question	Answer	Marks	AO element	Guidance
	Level 1 (1–2 marks) There is a simple comparison between the two sets of data or with the manufacturer's data OR a simple explanation is given about accuracy or precision <i>The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear.</i> 0 marks <i>No response or no response worthy of credit.</i>			AO3.2b Analyse information to draw conclusions about the accuracy and precision of the data. For example: • Q is more accurate since resistance per unit length is closer to the true value of $1.2 \Omega / \text{cm}$ • Q is more accurate as Q used longer lengths of wire (which reduces the heating effect) • Q's readings are more precise as the repeat readings are closer together

16	(a)	Either ray (centre ray or focal ray) drawn as indicated below ✓  Image upside down AND in the correct place ✓	2	2 × 2.2	ALLOW just one ray drawn If no rays drawn (or incorrect) but image is inverted, slightly larger and roughly in the correct place then award this mark IGNORE position of Y (if arrow is in the correct place) ALLOW tolerance of +/- 2 squares for image position
	(b)	A (red) filter is needed ✓ (The red filter) absorbs all colours/frequencies/wavelengths except red (light) ✓	2	2 × 2.1	ALLOW The red filter absorbs blue and green (light/frequency/wavelength) (but not red) ALLOW the filter transmits red light <u>only</u> / <u>only</u> lets red (light/frequency/wavelength) through
	(c) (i)	230 (V) ✓	1	1.1	

Question	Answer	Marks	AO element	Guidance
(ii)	(Earth wire together with fuse) prevents user from getting electric shock (if there is a fault) ✓ Plastic case is an insulator (so earth wire not required) ✓	2	2 × 1.1	ALLOW metal case could cause electric shock if no earth wire / AW ALLOW idea of earth wire carries current to Earth / AW ALLOW prevents projector becoming live / AW ALLOW plastic case is not a conductor / does not conduct electricity/current ALLOW appliance is double insulated

24	(a)	A sensible curve drawn from (0,0) ✓	1	2.2	DO NOT ALLOW a straight line
	(b)	As current increases, power increases ✓ But As current increases power increases at a faster / increasing rate ✓✓	2	2 x 3.1a	ALLOW As power increases, current increases DO NOT ALLOW Power is (directly) proportional to current squared (since the data does not support this proposal) for the second mark
	(c)	Current read-off to less than half a small square from candidate's graph for a power of 3.0 W ✓	1	2.2	
	(d)	Any sensible reference to $P=I^2R$ / $P=IV$ and $R=V/I$ ✓ One calculation of resistance from graph ✓ Second calculation of resistance from the graph and conclusion drawn (showing increase) ✓	3	1.2 2.2 3.2b	ALLOW ECF from candidate's line Numerical examples using plotted data points: 0.9W and 0.10A: $0.9 \div 0.10^2 = 90\Omega$ 2.2W and 0.15A : $2.2 \div 0.15^2 = 98\Omega$ 4W and 0.20A: $4 \div 0.20^2 = 100\Omega$ 7W and 0.25A: $6 \div 0.25^2 = 112\Omega$ 11W and 0.30A: $11 \div 0.30^2 = 122\Omega$



20	(a)	Any clockwise arrow ✓	1	2.1	ALLOW arrow indications anywhere
	(b)	A = B ✓	1	2.1	
	(c)	First check the answer on the answer line If answer = 13.5 C award 4 marks Q = It ✓ Q = 0.45 x 30 ✓ Q = 13.5 ✓ C ✓	4	1.2 2.1 2.1 1.1	ALLOW 14(.0) Unit mark is an independent mark ALLOW Coulombs for the unit
	(d)	Potential difference / p.d ✓	1	3.2a	Mark first quantity written ALLOW voltage / V ALLOW resistance / power



17	(a)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.28 (A) award 4 marks Rearrange equation current = power ÷ potential difference/ $I = P \div V$ ✓ $I = 65 \div 230$ ✓ $I = 0.2826086$ ✓ $I = 0.28 \text{ (A)}$ ✓	4	1.2 2.1 2.1 1.2	 NOTE If answer not to 2 sig figs max 3 marks ALLOW one mark for any calculated answer to 2sf
	(b)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 117000 (or 116000) (J) award 4 marks $E = P \times t$ ✓ Unit conversion 30 minutes = 1800 seconds ✓ $E = 65 \times 1800$ ✓ $E = 117000 \text{ (J)}$ ✓	4	1.2 1.2 2.1 2.1	ALLOW ECF from (a) $E = Q \times V$ or $I \times t \times V$ $E = 0.28 \times 1800 \times 230$ ALLOW ECF for incorrect time conversion ALLOW three marks for 1950 (J) $E = 116000 \text{ (J)}$ ✓



18	(a)		Rod attracts water ✓ • Opposite charges attract ✓ • water has both + and – charges / idea of polarisation / AW ✓	3	3 x 1.2	IGNORE positive electrons / movement of protons / ions for this answer. ALLOW Water bends or moves towards rod OR for candidates that have misinterpreted the diagram as repulsion of water then ALLOW Rod repels water / water bends or moves away from rod ✓ • Like charges repel ✓ • water has both + and – charges / idea of polarisation / AW ✓
	(b)	(i)	potential difference ✓ closed or complete circuit ✓	2	2 x 1.1	IGNORE ions / charge ALLOW voltage ALLOW higher level answers eg. must have delocalised electrons / electrons that are free to move
		(ii)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 1500 (C) award 4 marks $Q = It$ ✓ $t = 5 \times 60 = 300 \text{ (s)}$ ✓ $Q = 5 \times 300$ ✓ $Q = 1500 \text{ (C)}$ ✓	4	1.1 2.1 2.1 2.1	

19	(a)			2	2x2.1	Assume answer refers to circuit A unless indicated otherwise ALLOW (Circuit A) is parallel and has 2 loops/paths (for the current to flow through) / AW ALLOW higher level response i.e. correct equation for resistors in parallel ALLOW (Circuit) B is series and has only 1 loop/path (for the current to flow through) / AW ALLOW maximum of 1 mark for (circuit) A is parallel/has two loops/paths and (circuit) B is series/has one loop/path
	(b)	(i)	Any two from: (more current means) ions vibrate more / AW ✓ (more current means) more electrons collide with ions (in the lattice) / AW ✓ (more collisions mean) harder for electrons to pass through wire/lamp) / AW ✓ (which) increases temperature (and therefore resistance) / AW ✓	2	2x1.1	ALLOW atoms/particles/molecules for ions ALLOW (lamp) heats up / high(er) temperature
		(ii)	Lamp, cell, ammeter and variable resistor in series ✓ Voltmeter in parallel with the lamp ✓	2	2x2.2	IGNORE voltmeter in series for this mark ALLOW voltmeter in parallel with ammeter and lamp but not variable resistor

Question			Answer	Marks	AO element	Guidance
		(iii)	Measure current and potential difference/voltage ✓ Any two from: Change current/variable resistor/pd (value) ✓ Take at least 3 sets of different V and I readings ✓ Calculate the resistance using V/I or using the current and pd values / plot a graph of V against I ✓	3	3x1.2	ALLOW take readings on ammeter and voltmeter IGNORE repeating same V and I readings ALLOW graph of I against V / graph of I against R

17	(a)	Ammeter B AND Ammeter B does not have a zero error / ammeter A has a zero error ✓ Ammeter B can read a current of 1 A / ammeter A cannot read up to a current of 1 A / only reads to 50 mA ✓	2	3.3b x 2	ALLOW ammeter A does not start at zero ALLOW Ammeter A does not read high enough DO NOT ALLOW higher degree of precision / digital
	(b) (i)	(For a fixed resistor) V is (directly) proportional to I / $V=IR$ ✓ And gives a straight-line graph through the origin ✓	2	3.2b x 2	ALLOW calculation of resistance of $10\ \Omega$ from the gradient of the graph for two different points for 1 mark ALLOW constant gradient through the origin
	(ii)	Any one from: (Higher current) gives greater heating effect ✓ Apparatus was not left to cool between readings ✓	1	3.3b	ALLOW the resistor / component had heated up DO NOT ALLOW random error
	(iii)	Ask someone else to repeat your experiment ✓ Repeat experiment using different equipment ✓	2	3.3b x 2	IGNORE just repeat experiment
	(c)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 2.5 (W) award 2 marks $0.5^2 \times 10$ ✓ 2.5 (W) ✓	2	2.1 2.1	

17	(a)	(i)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.6 award 3 marks current = potential difference / resistance ✓ 6.0 / 10 ✓ 0.6 (A) ✓	3	1.2 2.1 2.1	ALLOW p.d. / pd for potential difference
		(ii)	3 (V)	1	2.2	
	(b)	(i)	Current increases ✓ (Because total) resistance (in the circuit) decreases ✓	2	3.1a 2.2	ALLOW Current has alternative path / round the lamp / does not pass through lamp ALLOW lamp is short-circuited ALLOW p.d. across lamp has decreased ALLOW two marks for correct calculation of 1.2 A
		(ii)	Potential difference increases ✓ Any one from: (Because) current through the resistor has increased ✓ (Because) the p.d. from the cells is not split across two components / not shared with the lamp / AW ✓	2	3.1a 2.2	ALLOW ECF for current decreases in (b)(i) one mark for potential difference decreases and one mark for current in resistor has decreased
		(iii)	0 (V)	1	2.2	ALLOW 3 (V) if answer to (a)(ii) = 0 (V)

19	(a)	(Idea that) the cells are facing each other / the cells cancel each other out / a (left) cell is connected the wrong way around ✓ Arrange the cells to face in the same direction / turn one / left cell around ✓ <u>Voltmeter</u> is in the incorrect place / not across the diode ✓ Place voltmeter in parallel / across the diode (instead) ✓	4	4 x 3.3b	ALLOW answers in either order but correction must match the mistake DO NOT ALLOW cells incorrectly set up unless qualified ALLOW remove the (left) cell IGNORE diode in wrong position ALLOW swap diode and variable resistor																																		
	(b)	(i)	0.6 V ✓	1	2.2																																		
		(ii)	For gradient calculated First check the answer on answer line If answer = 5(0) (Ω) award 4 marks Sensible non-zero value from graph ✓ Gradient = 0.2 ✓ Resistance = 1 ÷ gradient / 1 ÷ 0.2 ✓ Resistance = 5(0) (Ω) ✓ Or For direct R = V / I method Sensible non-zero values from graph ✓ Resistance calculation, e.g. 1.1 ÷ 0.1 ✓✓ Value of resistance, e.g. 11 (Ω) ✓	4	1.2 2.1 2.1 2.1	Sensible values from graph <table><tr><th>V / V</th><th>I / A</th><th>R / Ω</th></tr><tr><td>0.65</td><td>0.01</td><td>65</td></tr><tr><td>0.70</td><td>0.02</td><td>35</td></tr><tr><td>0.75</td><td>0.03</td><td>25</td></tr><tr><td>0.80</td><td>0.04</td><td>20</td></tr><tr><td>0.85</td><td>0.05</td><td>17</td></tr><tr><td>0.90</td><td>0.06</td><td>15</td></tr><tr><td>0.95</td><td>0.07</td><td>13.6</td></tr><tr><td>1.00</td><td>0.08</td><td>12.5</td></tr><tr><td>1.05</td><td>0.09</td><td>11.6</td></tr><tr><td>1.10</td><td>0.10</td><td>11</td></tr></table> No ECF from incorrect read-off error	V / V	I / A	R / Ω	0.65	0.01	65	0.70	0.02	35	0.75	0.03	25	0.80	0.04	20	0.85	0.05	17	0.90	0.06	15	0.95	0.07	13.6	1.00	0.08	12.5	1.05	0.09	11.6	1.10	0.10	11
V / V	I / A	R / Ω																																					
0.65	0.01	65																																					
0.70	0.02	35																																					
0.75	0.03	25																																					
0.80	0.04	20																																					
0.85	0.05	17																																					
0.90	0.06	15																																					
0.95	0.07	13.6																																					
1.00	0.08	12.5																																					
1.05	0.09	11.6																																					
1.10	0.10	11																																					

20	(a)		Power supply attached to electric heater AND correct symbol for ammeter in series with heater ✓ Correct symbol for voltmeter in parallel with heater or power supply ✓	2	2 × 1.2	Maximum of 1 mark if a line drawn through the ammeter and/or voltmeter IGNORE extra ammeters/other components in series ALLOW 1 mark for incorrect symbols for ammeter and voltmeter in the correct places
	(b)	(i)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 480 (J / kg °C) award 4 marks 24 kJ = 24 000 J ✓ Rearrangement: Specific heat capacity = change in thermal energy ÷ (mass × change in temperature) ✓ (Specific heat capacity =) 24 000 ÷ (2 × 25) ✓ (Specific heat capacity =) 480 (J / kg °C) ✓	4	2 × 1.2 2 × 2.1	ALLOW 2 marks for 24 ÷ (2 × 25) or 2.4 × 10 ⁿ ÷ (2 × 25) ALLOW 3 marks for answer of 0.48 or 4.8 × 10 ⁿ (J/kg°C)
		(ii)	(Idea that) thermal energy is lost/wasted to the surroundings / not all energy supplied to the heater is transferred into the metal block ✓	1	3.2a	ALLOW heat for thermal energy ALLOW thermal energy is dissipated (to the surroundings)
		(iii)	Any one from: Insulate the metal block ✓ Put the heater further into the metal block / use a smaller heater ✓ Use oil/lubricant to improve contact between heater and block ✓ Repeat and calculate the mean ✓	1	3.3b	ALLOW add lid

Question		Answer	Marks	AO element	Guidance
20	(c)	Block C (has the highest specific heat capacity) ✓ It has the smallest change in temperature (for the same rate of input in energy) ✓	2	3.2b 3.1b	No mark if block A or B chosen ALLOW it has the lowest gradient/slope ALLOW it has the slowest change in temperature IGNORE (idea that) it needs more energy to raise temperature by 1°C

16	(a)	(i)	variable resistor ✓	1	1.2	ALLOW rheostat IGNORE potentiometer
		(ii)	Control / change / vary / increase / decrease / AW the resistance / current in the circuit ✓	1	1.2	DO NOT ALLOW merely 'changes the voltage or changes p.d.' BUT ALLOW: changes the potential difference or voltage across (component) X
	(b)	(i)	(filament) bulb / lamp ✓	1	3.2a	
		(ii)	gradient / slope (of graph) changes (as potential difference / voltage changes) ✓ idea of increasing resistance (with more p.d.) / ORA ✓ idea of increasing temperature / AW ✓	3	3.1a 1.2 2.2	ALLOW 'graph / line / slope levels off' / non-linear Resistance increases with greater temperature ✓✓
	(c)	(i)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 4 (V) award 2 marks 0.25 x 16 ✓ 4 (V) ✓	2	2.1 2.1	
		(ii)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 1 (W) award 3 marks P = IV ✓ P = 0.25 x 4 ✓ P = 1 (W) ✓ OR P = I ² R ✓ P = 0.25 ² x 16 ✓ P = 1 (W) ✓	3	1.2 2.1 2.1 1.2 2.1 2.1	ALLOW e.c.f. from part ci

19	(a)	(i)	as the length of the wire increases the resistance increases / proportional relationship / ORA ✓ BUT idea of directly proportional ✓✓	2	2 x 3.2b	IGNORE positive correlation Numerical answers must USE values rather than merely quoting values Eg. (approximately) doubling the length, doubles the resistance / ORA ✓✓ Eg. Increases by 7 to 8Ω per 25cm / 0.3Ω (allow 0.28 to 0.32) per cm ✓✓
		(ii)	mean for 25cm (is recorded to 3 decimal places) and it should be recorded to one decimal place ✓ mean for 50cm is incorrect and it should be 16.2Ω ✓	2	2 x 3.3a	Error and a solution required for each marking point. ALLOW answer in terms of sig. figs: Eg. mean for 25cm is recorded to 4 sig. figs. – it should be recorded to 2 sig. figs.
		(iii)	75cm attempt 3 or 18.7 (is an anomaly) ✓ it has not been included in the mean ✓	2	2 x 3.2a	
		(iv)	straight line through the origin scores ✓✓ straight line / linear relationship / proportional and not through origin scores ✓	2	2 x 3.1a	ALLOW answers shown on a diagram ALLOW directly proportional ✓✓ DO NOT ALLOW a curved line through origin IGNORE positive correlation (in written comments)

Question			Answer	Marks	AO element	Guidance
	(b)	(i)	Any two from: (extra resistance due to) connecting leads too long / too thin ✓ (extra) resistance of the croc clips / connections ✓ croc clip is not at 0cm / the end of the ruler / length of resistance wire longer than intended / AW ✓ Heating effect of wires ✓	2	2 x 3.1b	DO NOT ALLOW idea of less resistance Eg. Crocodile clips rusted / poor conductor / bad or loose connections IGNORE crocodile clips in wrong place unless qualified correctly. Eg. croc clips too far apart ALLOW Parallax error on meter (if it is analogue) / meter not calibrated (so resistance higher)
		(ii)	Any one from: make the connecting wires as short as possible ✓ keep croc clips clean / solder connections ✓ place croc clip exactly at the end of the ruler / at 0cm / AW✓	1	3.3b	Solution needs to be consistent with an error identified in part i. OR a new specified error ALLOW: use thicker connecting wires ALLOW let wire(s) cool between readings / Securely fix croc clip / calibrate meter / avoid parallax error

19	(a)	(i)	LED / cells connected the wrong way around OR ✓ Voltmeter is across the battery/cells OR voltmeter should be across the LED ✓	2	2x3.2a	ALLOW diode IGNORE voltmeter in wrong place
		(ii)	Any one from: Control/change/alter the current (in the circuit) ✓ Control/change/alter the potential difference/voltage (across the LED) ✓	1	1.2	DO NOT ALLOW to vary the resistance
	(b)	(i)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 100 (Ω) award 3 marks Resistance = potential difference ÷ current / $R = V \div I$ ✓ $R = 3.0 \div 0.03$ ✓ $R = 100 (\Omega)$ ✓	3	1.2 2.1 2.1	
		(ii)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 4.5 (C) award 4 marks Charge flow = current × time / $Q = I \times t$ ✓ $t = 2.5 \text{ minutes} = 150 \text{ seconds}$ ✓ $Q = 0.03 \times 150$ ✓ $Q = 4.5 (\text{C})$ ✓	4	1.2 1.2 2.1 2.1	ALLOW 3 marks for an answer of 0.075 (C) (time not converted to seconds) ✓✓✓
		(iii)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 13.5 (J) award 2 marks $E = 4.5 \times 3.0$ ✓ $E = 13.5 (\text{J})$ ✓	2	2.1 2.1	ECF from 19(b)(ii) ALLOW 14(J)

16	(a)	(i)	Correct circuit symbols for voltmeter AND ammeter ✓ Ammeter correctly positioned ✓ Voltmeter correctly connected in parallel ✓	3	1.1	Voltmeter and ammeter can be anywhere in the circuit for this mark	
		3.3a	Ammeter in series with the components				
		3.3a	Voltmeter is in parallel with the thermistor (and ammeter) only				
		(ii)	To change the current in the circuit ✓	1	2.2		
	(iii)	To stop the components/circuit becoming hot / to keep the components at room temperature / AW ✓	1	3.3b	ALLOW To get accurate readings. IGNORE to save energy		
	(b)	(i)	As the potential difference increases, the current increases / ORA ✓ at a faster rate ✓	2	2 × 3.1a	ALLOW voltage/V/p.d. for potential difference and A or I for current. (Not C) IGNORE (positive) correlation IGNORE proportional unspecified DO NOT ALLOW directly/inversely proportional ALLOW non-linear ALLOW As the current increases the potential difference increases at a slower rate for 2 marks	
(ii)		It decreases ✓	1			3.2a	
(iii)		0.02 (A) ✓	1			2.2	
(iv)		First check the answer on the answer line If answer = 400 (Ω) award 3 marks (V=IR) $R = \frac{V}{I}$ ✓ $R = \frac{8}{0.02}$ ✓ $R = 400 (\Omega)$ ✓	3				Substitution and rearrangement can be in any order
		1.2		ALLOW values substituted correctly into equation in any form e.g. $8.0 = 0.02 \times \text{resistance}$ (MP2)			
		2.2		ECF part (b)(iii)			
				2.2			



18	(a)	B (no mark) AND Any two from: Stronger (electric) field ✓ Larger/greater charge ✓ More (electric) field lines ✓ (Electric) field lines are closer together ✓ Greater (electric) field density ✓	2	2.2x2	DO NOT ALLOW A (CON) DO NOT ALLOW reference to magnet / magnetic field / line(s) (zero marks - CON)
	(b)	closed circuit ☒ open circuit ☐ source of potential difference ☒ source of resistance ☐ One correct tick ✓ Two correct ticks ✓✓	2	1.1x2	DO NOT ALLOW three or four ticks
	(c)	Mistake: filament lamp ✓ Correction: diode ✓ AND Mistake: thermistor ✓ Correction: light dependent resistor / LDR ✓ OR Mistake: light intensity ✓ Correction: temperature ✓	4	3.2a 1.1 3.2a 1.1	ALLOW light emitting diode or LED ALLOW Thermistor changes with temperature not with light ✓✓ ALLOW light for light intensity ALLOW thermal energy for temperature

Question	Answer	Marks	AO element	Guidance
(d)	First check the answer on the answer line If answer = 15 (A) award 3 marks (P = IV) (I =) $P \div V$ ✓ (I =) $180 \div 12$ ✓ (I =) 15 (A) ✓	3	1.2 2.1 2.1	ALLOW 1 mark for correct substitution into unrearranged equation
(e)	First check the answer on the answer line If answer = 240 (J) award 3 marks (Energy transferred =) VQ ✓ (E =) 12×20 ✓ (E =) 240 (J) ✓	3	1.2 2.1 2.1	

23	(a)	(i)	48°C	1	3.2a	
		(ii)	12°C	1	3.2a	
		(iii)	First check the answer on the answer line If answer = 27,000 (J) award 4 marks $(E = mc\theta)$ 200 g = 0.2(00) kg ✓ $\theta = 48 - 12 = 36^\circ\text{C}$ ✓ $E = 0.2 \times 3750 \times (48 - 12)$ ✓ $E = 27,000 / 2.7 \times 10^4$ ✓	4	1.2 1.2 2.2 2.2	ALLOW 27 kJ for full marks ALLOW ECF from (a)(i) and (a)(ii) IGNORE -ve sign ALLOW 3 marks for $E = 2.7 \times 10^7$ J (did not convert g to kg)
	(b)	(i)	First check the answer on the answer line If answer = 150 (W) award 4 marks $(E = Pt)$ $P = E / t$ ✓ $E = 54 \times 1000 = 54000$ J ✓ $P = 54000 / 360$ ✓ $P = 150$ (W) ✓	4	1.2 1.2 2.1 2.1	 ALLOW 1.5 x 10 ⁿ for 3 marks (no or incorrect conversion of kJ)
		(ii)	Any one from: Not 100% efficient / AW ✓ Energy is <u>gained</u> from the surroundings ✓ There is not enough insulation of the fridge ✓	1	3.2a	IGNORE energy is lost to surroundings (unless clearly related to the efficiency of the motor) ALLOW cooling fridge / other contents

Question			Answer	Marks	AO element	Guidance
	(c)		First check the answer on the answer line If answer = 17 (Ω) award 4 marks $P = I^2 R$ ✓ $(I =) \sqrt{(240 / 0.80)}$ ✓ $I = 17.32$ (A) ✓ $I = 17$ (A) ✓ (2 sig fig)	4		1.2 ALLOW equation in any form 2.1 ALLOW substitution into unrearranged equation for this mark 2.1 ALLOW any number of significant figures for this mark 1.2 ALLOW an incorrectly <u>calculated</u> value to 2 sig figs if working shown IGNORE unqualified 2 sig fig ALLOW 300 (A) for 2 marks (check correct equation used)

