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OCR GCSE PHYSICS A (J249): QUESTIONS BY TOPIC

Topic P3: Electricity (F)

GCSE Physics A Foundation Tier (J249) · Topic P3

62 questions · 248 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

62 questions · 248 marks · grouped by sub-topic, lowest tariff first



SUB-TOPIC P3.1

STATIC AND CHARGE

8 questions in this sub-topic · 26 marks · lowest tariff first



3 Static electricity can be produced when two materials are rubbed together.

Which two types of material could cause static electricity to be produced?

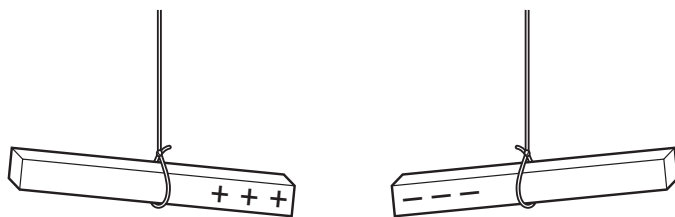
- A** Two insulators
- B** Two conductors
- C** One insulator and one conductor
- D** A metal and a non-metal

Your answer

[1]



- 2 Two charged rods are brought close together.



Which of the following explains what happens to the rods?

- A Like charges attract so the rods move towards each other.
- B Like charges repel so the rods move away from each other.
- C Opposite charges attract so the rods move towards each other.
- D Opposite charges repel so the rods move away from each other.

Your answer

☐

[1]

10 A student rubs two objects together. The two objects become **charged**.

	Type of objects	Charges which move
A	two insulators	positive
B	two insulators	negative
C	two metals	positive
D	two metals	negative

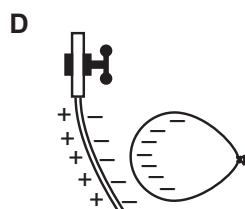
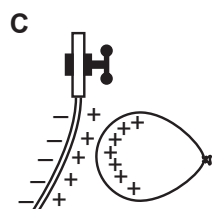
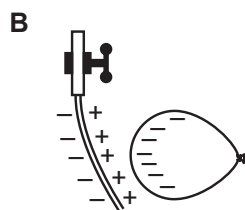
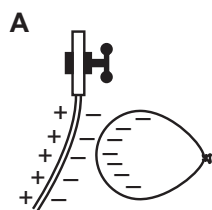
Which row in the table is correct?

Your answer

[1]



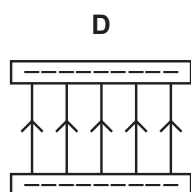
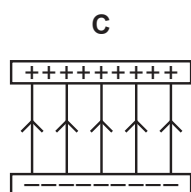
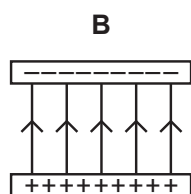
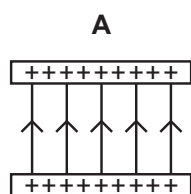
5 Which diagram correctly shows a charged balloon **attracting** a stream of water?



Your answer

[1]

8 Which diagram shows the electric field pattern between two parallel metal plates?



Your answer

[1]

9 Which statement can explain the effects of **static electricity**?

- A Atoms are transferred between objects.
- B Electrons are transferred between objects.
- C Neutrons are transferred between objects.
- D Protons are transferred between objects.

Your answer

[1]



18 This question is about static electricity.

(a)

(i) Describe how a teacher charges a balloon with a cloth.

..... [1]

(ii) When the teacher charges the balloon, it becomes **positively** charged.

Describe what happens to the charges on the balloon as the balloon becomes positively charged.

.....
 [1]

(iii) Explain why the balloon sticks to a negatively charged rod.

.....
 [1]

(b) Static electricity can build up in thunderclouds.

In one thundercloud the potential difference between the thundercloud and the ground is $5.0 \times 10^8 \text{ V}$.

When lightning strikes the ground, $7.5 \times 10^9 \text{ J}$ of energy is transferred.

Calculate the amount of charge which flows when lightning strikes.

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

Charge = ... C [3]

(c) Calculate the charge flow in a circuit when there is a current of 15A for 2 minutes.

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

Charge flow = ... C [3]



22 A student investigates static electricity using a plastic ruler.

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

.....

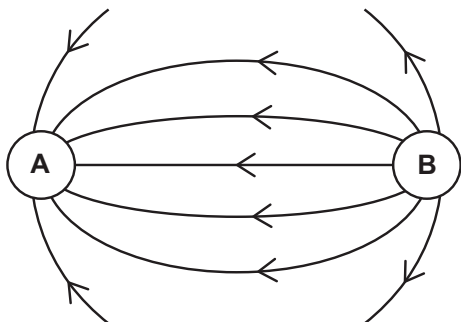
 [2]

- (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

54 questions in this sub-topic · 222 marks · lowest tariff first



2 Which voltage is the maximum voltage made when **four** 1.5 V cells are connected in **series**?

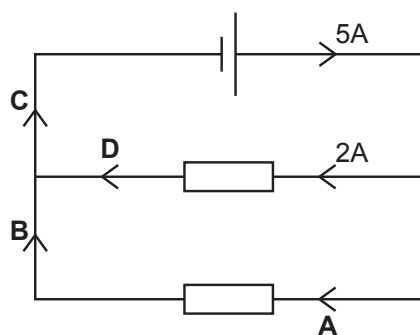
- A 0 V
- B 1.5 V
- C 3.0 V
- D 6.0 V

Your answer

[1]



6 This is a circuit.



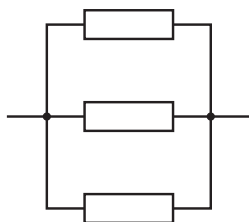
Which letter **A**, **B**, **C** or **D** shows the part of the circuit that carries a current of 2A?

Your answer

[1]

7 A student has 3 identical resistors. She arranges them in four different ways.

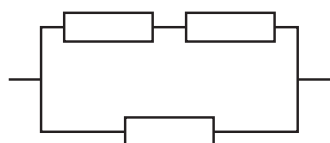
A



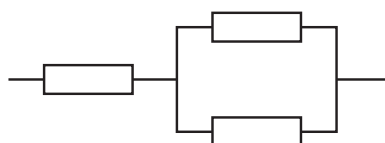
B



C



D



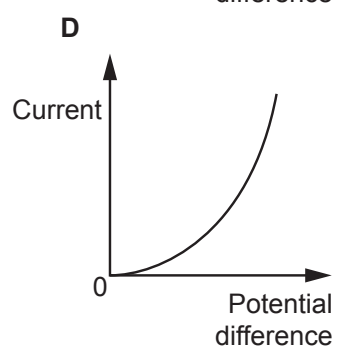
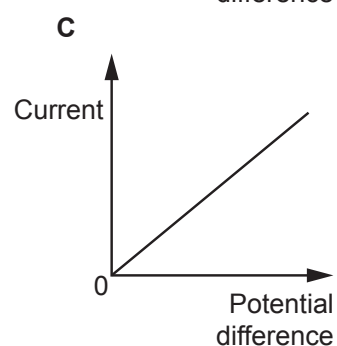
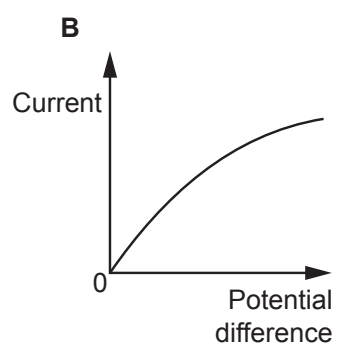
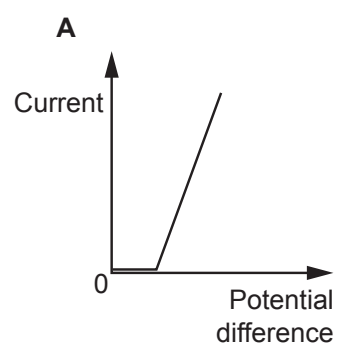
Which arrangement has the **most** resistance?

Your answer

[1]

- 4 A student investigates how current and potential difference vary in different components.

Look at the graphs of her results.



Which graph shows a filament lamp?

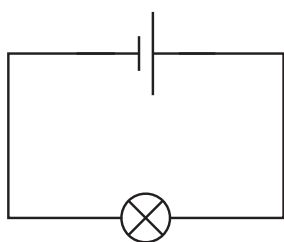
Your answer

[1]

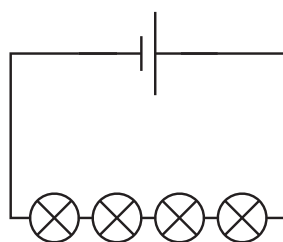
5 A student sets up four different circuits. He uses identical lamps and the same cell.

Look at the diagrams of his circuits.

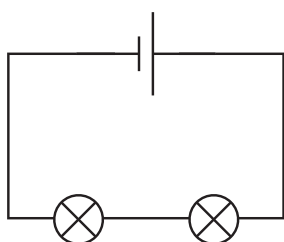
A



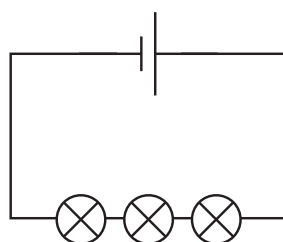
B



C



D



Which circuit has the brightest lamp(s)?

Your answer

[1]

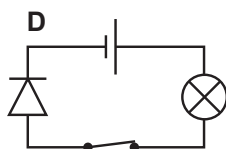
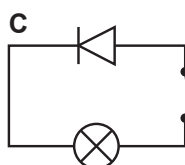
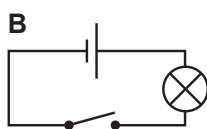
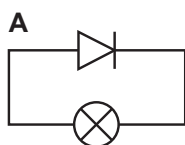
- 7 What conditions are needed for charge to flow?
- A A source of potential difference and two lamps.
 - B A complete circuit and two lamps.
 - C A complete circuit and a source of potential difference.
 - D A complete circuit and a source of resistance.

Your answer

[1]



5 A student sets up four electrical circuits.



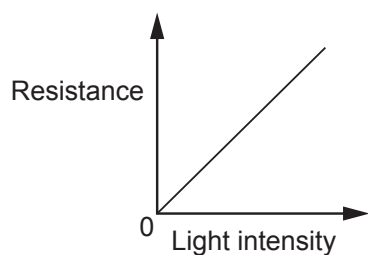
Identify in which circuit the lamp will light up.

Your answer

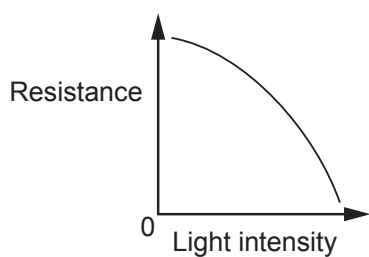
[1]

- 10 A student investigates how the resistance of a light dependent resistor (LDR) changes with light intensity.

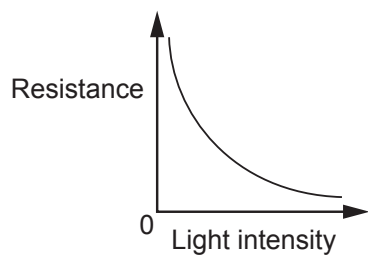
A



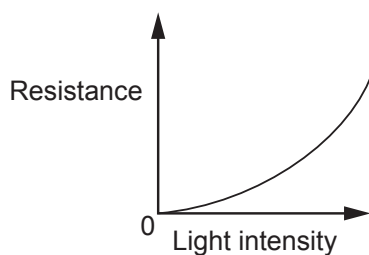
B



C



D



Which graph shows the correct relationship between the resistance of an LDR and light intensity?

Your answer

[1]

12 Calculate the charge flow when a current of 20 mA flows for 2000 s.

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

- A** 40 C
- B** 100 C
- C** 40 000 C
- D** 100 000 C

Your answer

[1]



14 Which item uses the most power?

Use the equation: power = potential difference × current

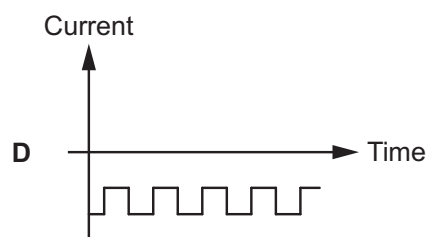
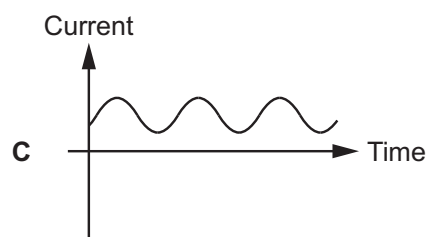
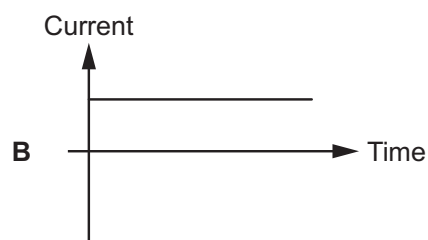
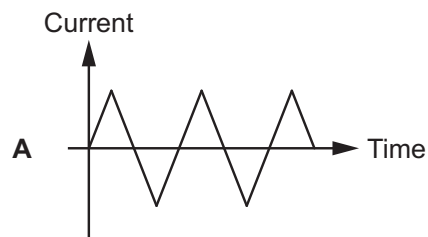
	Item	Current (A)	Potential difference (V)
A	Calculator	0.1	3
B	Mobile Phone	1.0	5
C	Radio	0.5	12
D	Torch	1.2	6

Your answer

[1]



8 Which graph shows an alternating current (a.c.)?



Your answer

[1]

11 The table shows the current and potential difference for four different lamps.

Which lamp has the highest **power**?

Use the equation: power = potential difference × current

	Current (A)	Potential difference (V)
A	2	5
B	3	4
C	4	2
D	5	1

Your answer

[1]



- 6** A current of 8 A flows in a circuit for 32 seconds.

Calculate the charge which flows in the circuit.

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

A 0.25 C

B 4.0 C

C 24.0 C

D 256 C

Your answer

[1]

14 A teacher sets up a circuit to turn on a heater when the temperature decreases.

Which component does the teacher need to use in their circuit?

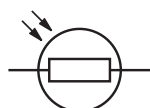
A



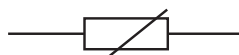
B



C



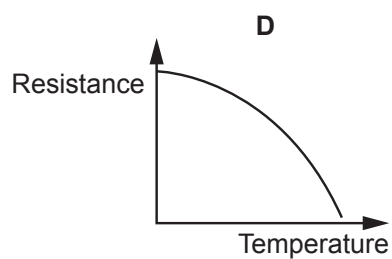
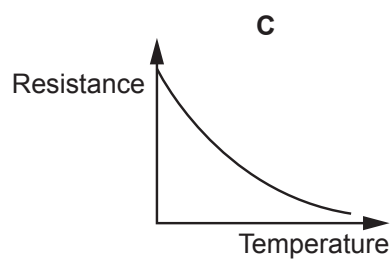
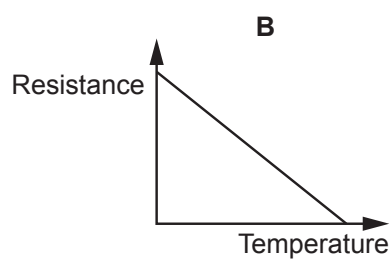
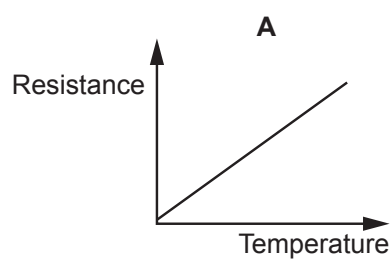
D



Your answer

[1]

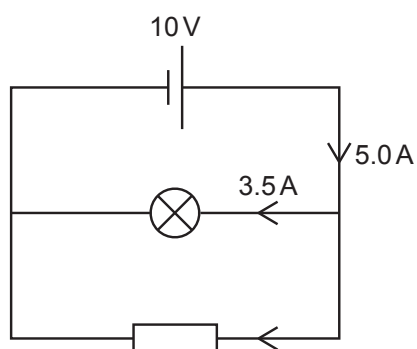
4 Which graph shows the relationship between temperature and resistance for a NTC thermistor?



Your answer

[1]

13 A student sets up an electrical circuit as shown in the diagram.



What is the value of the current flowing through the fixed resistor?

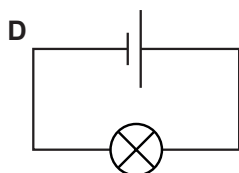
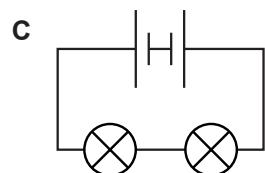
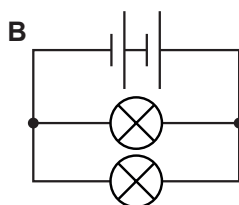
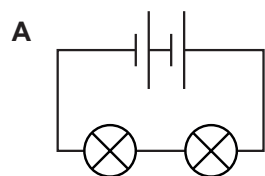
- A 1.5A
- B 3.5A
- C 5.0A
- D 8.5A

Your answer

[1]

- 4 A student connects four circuits using identical cells and identical lamps.

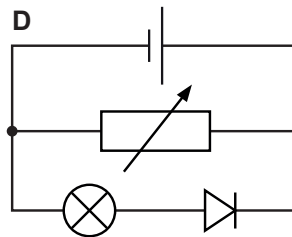
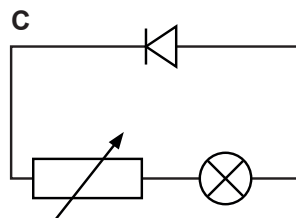
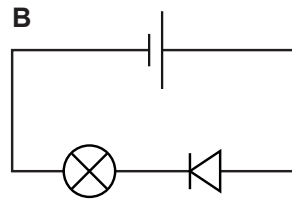
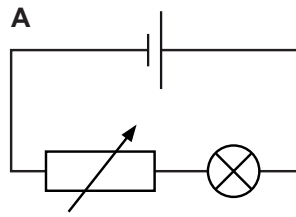
Which circuit has the **brightest** lamps?



Your answer

[1]

7 Which circuit diagram shows how the brightness of a lamp is changed using a variable resistor?



Your answer

[1]

- 9 Which row states the correct term used for the rate of flow of charge and a condition for charge to flow in a circuit?

	Rate of flow of charge	Condition for charge flow
A	current	closed circuit
B	current	open circuit
C	potential difference	open circuit
D	potential difference	closed circuit

Your answer

[1]

12 Which pair of resistors has the greatest total resistance?

A — $10\text{ k}\Omega$ — $1\text{ k}\Omega$ —

B — $10\text{ k}\Omega$ — 500Ω —

C — 1000Ω — 500Ω —

D — 1000Ω — 1000Ω —

Your answer

[1]



14 The current in a wire is 5.0A.

What is the charge flow in the wire in 2 minutes?

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

A 0.40 C

B 2.5 C

C 10 C

D 600 C

Your answer

[1]



1 The domestic supply in the UK is a.c.

What does a.c. stand for?

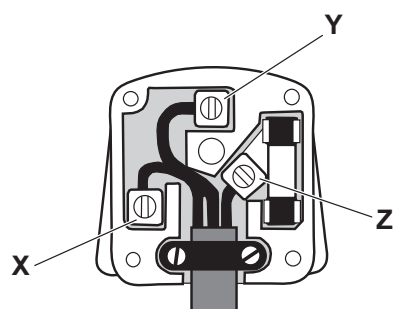
- A Alternative charge
- B Alternating current
- C Amplitude charge
- D Amplitude current

Your answer

[1]



- 5 This diagram shows the wiring inside an electric plug.



Which row shows the correct names of the three pins labelled **X**, **Y** and **Z**?

	X	Y	Z
A	earth	neutral	live
B	live	neutral	earth
C	neutral	earth	live
D	neutral	live	earth

Your answer

[1]

6 An electric lawnmower has this information.

The potential difference is 230 V.

The current is 7.0 A.

What is the power of the electric lawnmower?

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

A 0.030 W

B 32.9 W

C 230 W

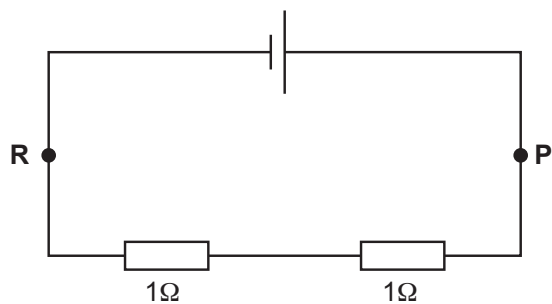
D 1610 W

Your answer

[1]



2 A student makes an electrical circuit.



The current at point **P** in the circuit is 2A.

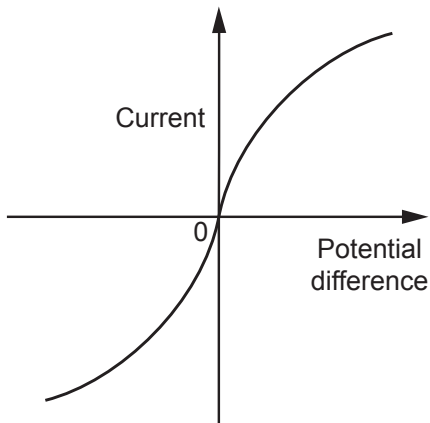
What is the current at point **R**?

- A 0A
- B 1A
- C 2A
- D 4A

Your answer

[1]

5 A current-potential difference graph of an electrical component is shown.



Which row describes the type of graph and identifies the electrical component?

	Type of graph	Component
A	linear	diode
B	linear	filament lamp
C	non-linear	diode
D	non-linear	filament lamp

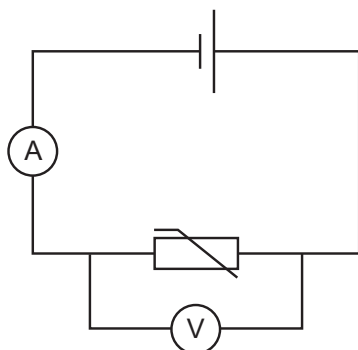
Your answer

[1]

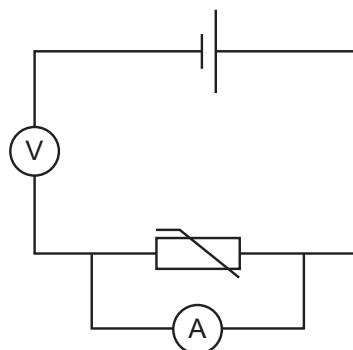
- 6 A student makes a circuit to measure the current in a thermistor and the potential difference across it.

Which circuit is correct?

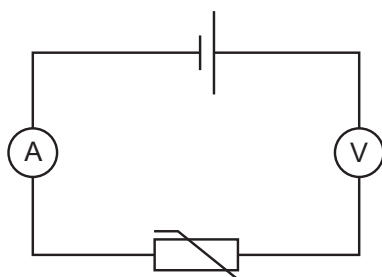
A



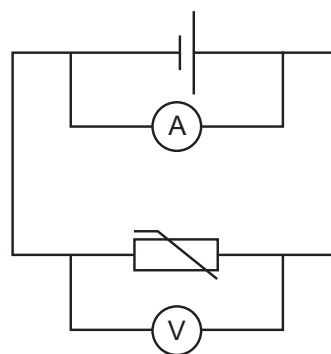
B



C



D



Your answer

[1]

- 13** An electrician measures the potential difference (p.d.) between two different wires, **X** and **Y**, in a plug.

The plug is wired correctly and working safely.

The p.d. between wire **X** and wire **Y** is 0 V.

Which row shows the correct name of wire **X** and wire **Y**?

	Wire X	Wire Y
A	earth	live
B	earth	neutral
C	live	earth
D	live	neutral

Your answer

[1]

- 15** 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]

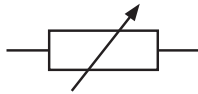


1 Which component gives out light?

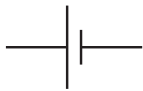
A



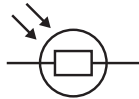
B



C



D



Your answer

[1]

- 6** There is a current of 50 mA in a wire for 250 s.

What is the charge flow?

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

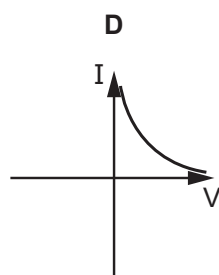
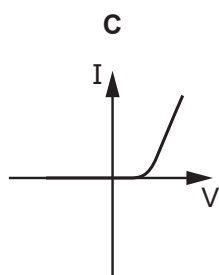
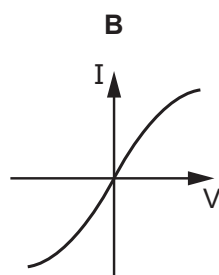
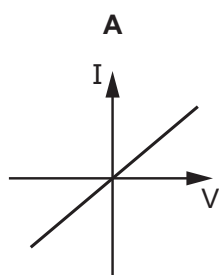
- A** 5.0 C
- B** 12.5 C
- C** 5000 C
- D** 12500 C

Your answer

[1]



11 Which is the current–potential difference (I–V) characteristic graph for a **diode**?



Your answer

[1]

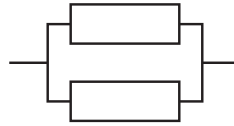
14 A student connects identical resistors together.

Which combination of resistors has the **lowest** resistance?

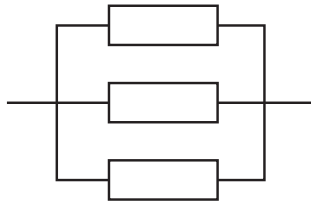
A



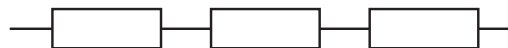
B



C



D



Your answer

[1]

7 What is the function of the **earth wire** in an electrical device?

- A To complete the circuit
- B To melt if the current is too high due to a fault
- C To provide a low resistance path for the current if there is a fault
- D To provide power to the device

Your answer

[1]



17 A student sets up a circuit using a diode, a lamp and a variable resistor, as shown in **Fig. 17.1**.

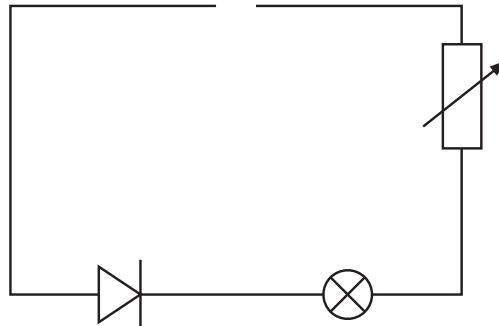


Fig. 17.1

Draw a cell in the circuit on **Fig. 17.1** so that the lamp would light up.

[2]

24 (a) A TV has a power rating of 0.2 kW.

Calculate the energy transferred, in kWh, if the TV is switched on for 4 hours.

Energy transferred = ... kWh [3]

(b) A different TV works with a 12.0 V battery. It has a current of 3.19 A.

Calculate the power rating of the TV.

Power = ... W [3]



19* A group of students investigate the resistance of an LDR.

The students change the distance between the LDR and the lamp and measure the resistance of the LDR.

The results are plotted on a graph.

Fig. 19.1 shows the experiment set-up and **Fig. 19.2** shows the graph of the students' results.

Fig. 19.1

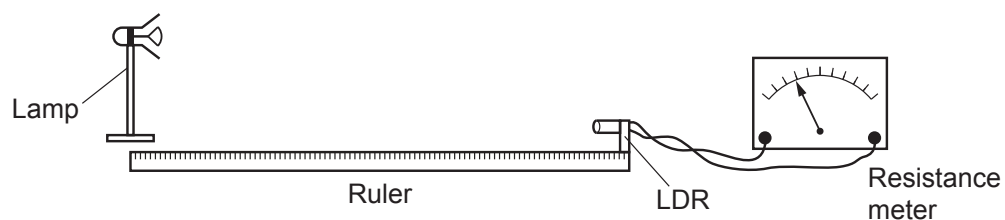
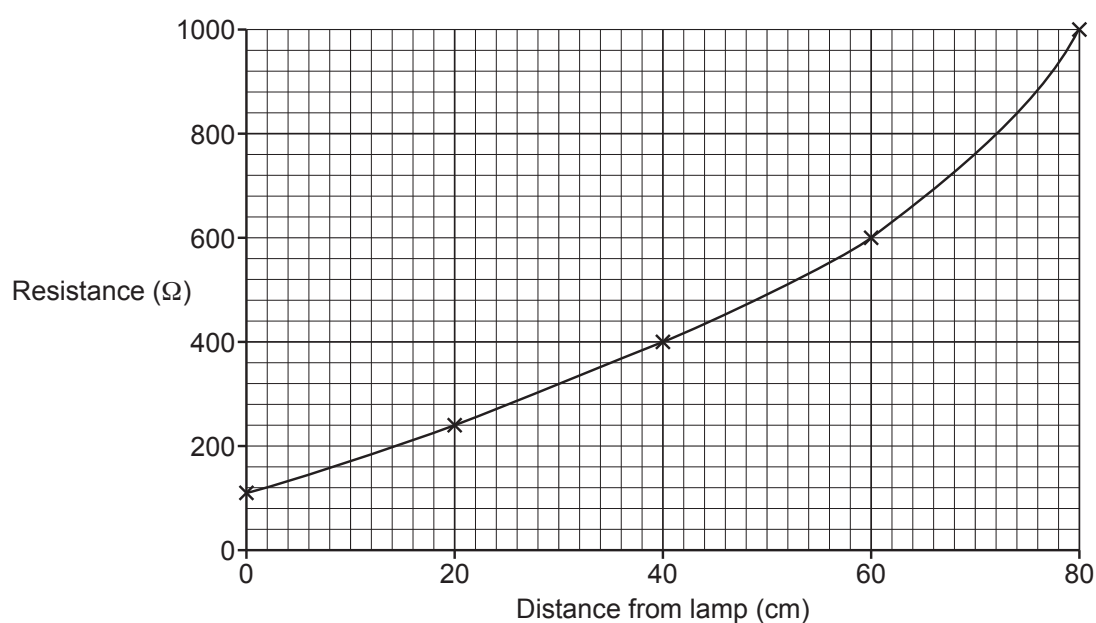


Fig. 19.2

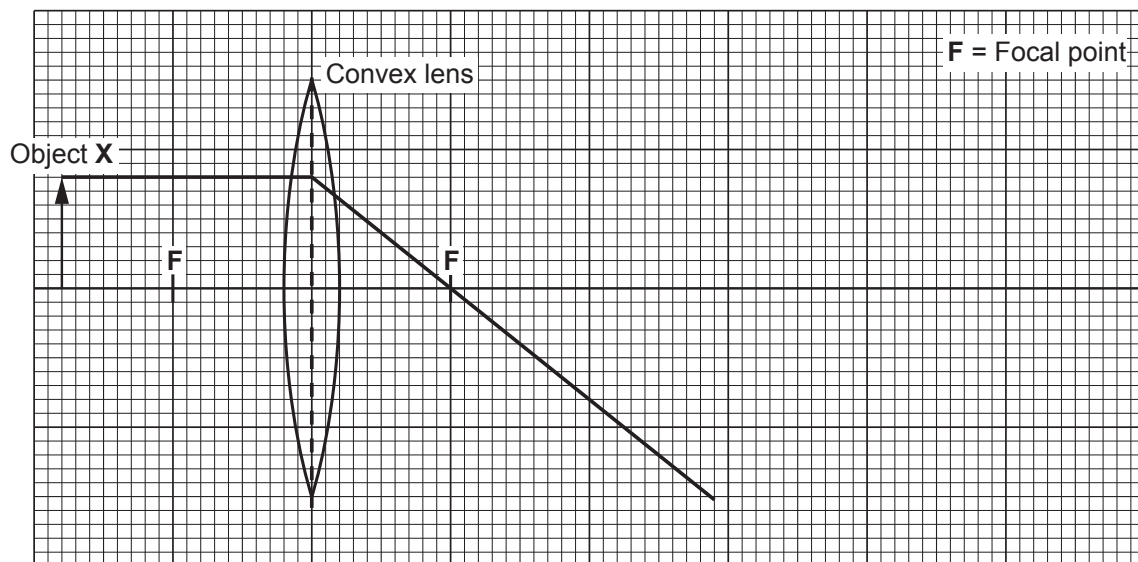


[6]

21 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]

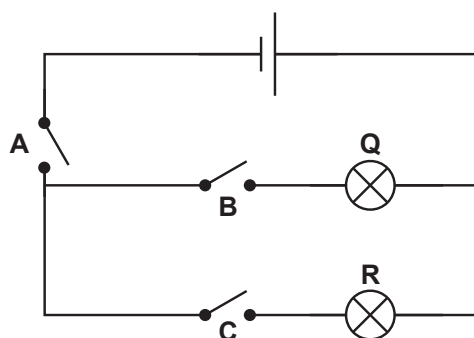
(ii) A projector with a plastic case does not need an earth wire.
 A projector with a metal case needs an earth wire.

Explain why.

.....

 [2]

17 A student makes a circuit using a cell, three switches and two identical filament lamps.



(a) Which switch or switches does the student close so that **only** lamp **Q** lights up?

..... [1]

(b) Which switch or switches does the student close so that **only** lamp **R** lights up?

..... [1]

(c) The switches are closed so that **both** lamp **Q** and lamp **R** light up.

Which sentence describes the brightness of lamp **Q** and lamp **R**?

Tick (✓) **one** box.

Both lamps are the same brightness.

☐

Lamp **Q** is brighter than lamp **R**.

☐

Lamp **R** is brighter than lamp **Q**.

☐

[1]

(d) Explain your answer to (c).

.....

..... [1]

- (e) Complete the sentences to explain what happens to the resistance of the metal wire inside the filament lamp when the current increases.

Use words or phrases from the list.

atoms	decreases	elastic potential	electrons
increases	protons	stays the same	thermal

As the current increases, the resistance of the metal wire

The collide more often with the positive ions in the wire.

This increases the energy of the wire.

[3]



23 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]**



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

The student sets up the circuit in **Fig. 24.1**.

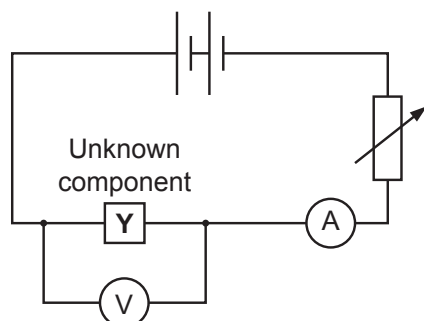
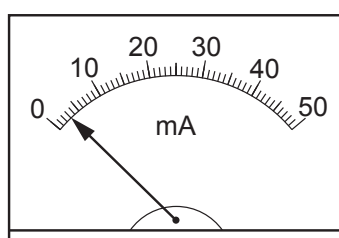


Fig. 24.1

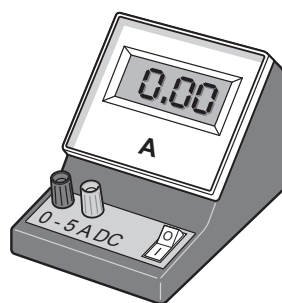
(a) The student needs to be able to measure a current of up to 1 A.

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

Fig. 24.2 shows the initial readings on the ammeters **before** they are connected to the circuit.



Ammeter A



Ammeter B

Fig. 24.2

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

Ammeter

Reason 1

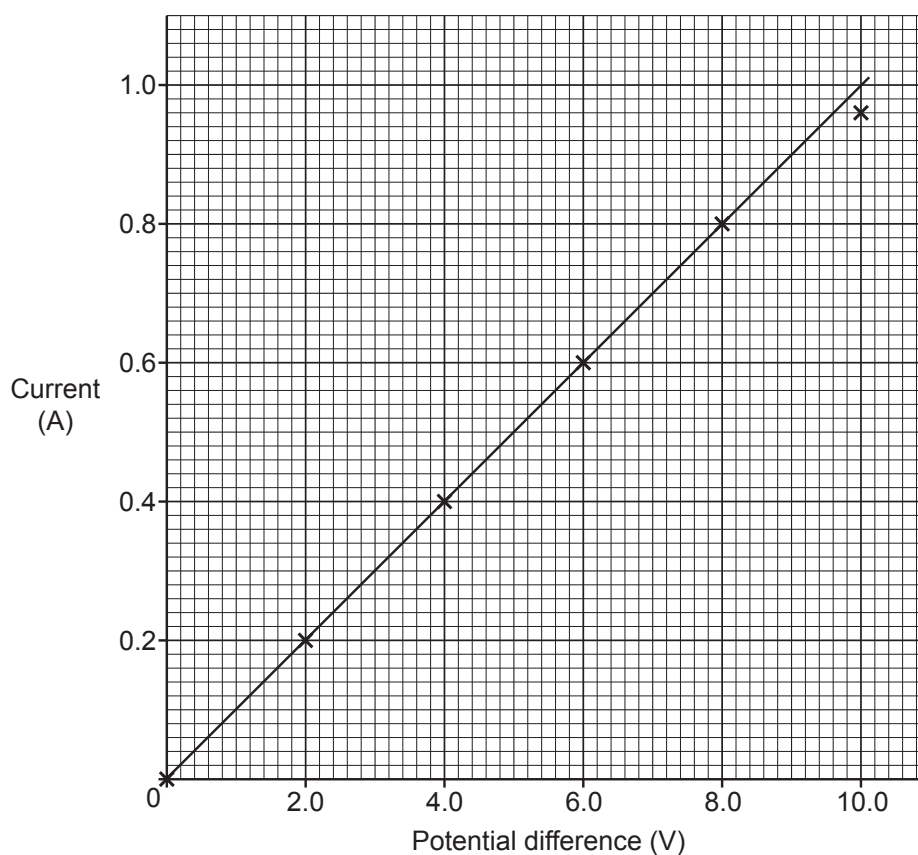
.....

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 $10.0\ \Omega$.

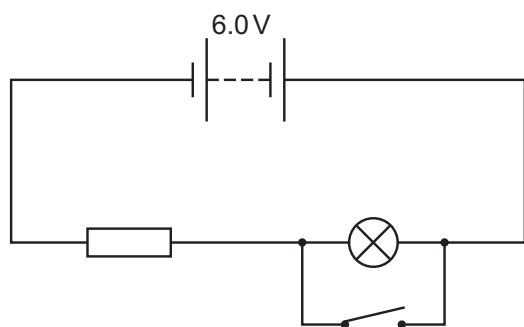
Calculate the power of the resistor when the current is 0.5 A .

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

Power = ... W [2]



24 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.

.....

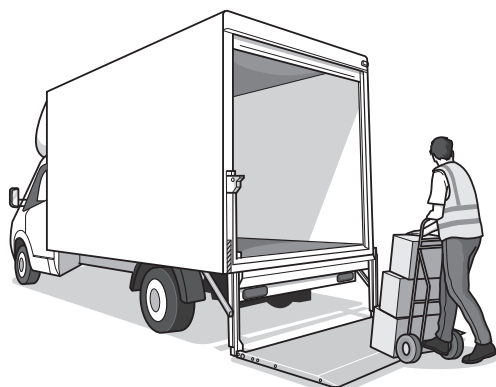
 [2]

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

Potential difference = ... V [1]



- 22 (a)** A delivery driver is loading boxes onto a lorry. The boxes are moved from the ground to the lorry using an electric lift.



- (i)** Calculate the work done when boxes with a weight of 0.6 kN are lifted a vertical distance of 0.8 m from the ground to the lorry.

Use the equation: work done = force $\times$ distance

Work done = ... J [3]

- (ii)** The power of the lift is 50 W .

Calculate the time taken for the lift to move these boxes from ground to lorry level.

Use the equation: power = work done / time taken

Time taken = ... s [3]

- (iii)** The lorry uses a 24 V battery to power the 50 W lift.

Calculate the current which flows while the lift is in use.

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

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

Current = ... A [4]

20 (a)* A student investigates the resistance of a thermistor at different temperatures.

The student uses a Bunsen burner to heat the water in a beaker to three different temperatures. The student uses an ohmmeter to measure the resistance of the thermistor at each temperature.

Fig. 20.1 shows how the student sets up their experiment and **Fig. 20.2** shows a graph of their results.

Fig. 20.1

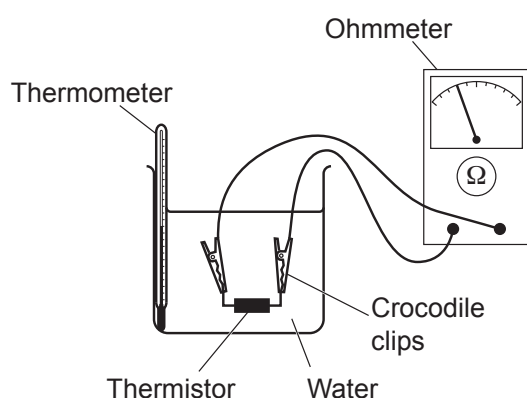
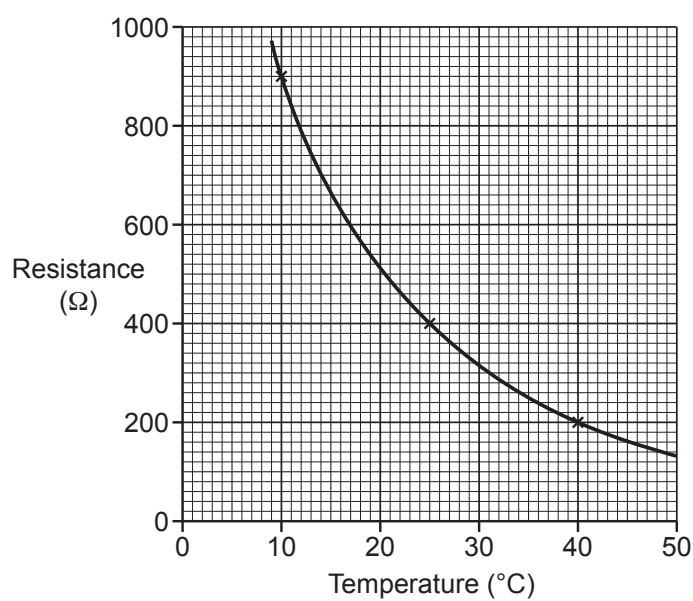


Fig. 20.2



Describe the trend shown by the graph.

Suggest how the student's method could be improved. Include ideas about accuracy and precision.

.....

.....

.....

.....

.....

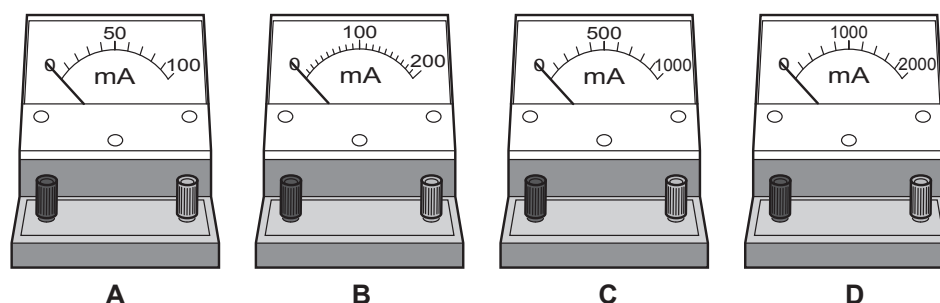
.....

.....

- (b) At one of the temperatures, the current in the thermistor is 300 mA.

Fig. 20.3 shows a choice of ammeters that the student can use to measure this current accurately.

Fig. 20.3



Which ammeter should the student use to measure a current of 300 mA?

Ammeter

Explain your answer.

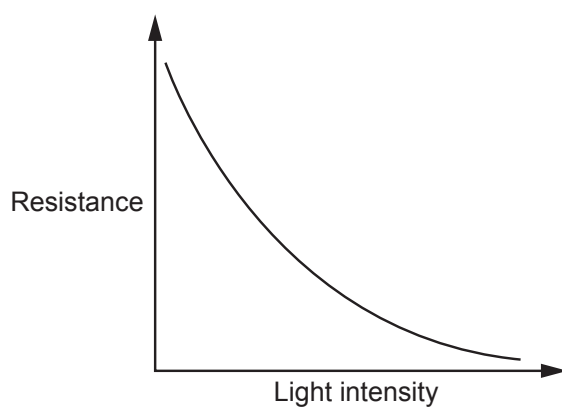
.....

.....

.....

[2]

- (c) The graph shows how the resistance changes for a light dependent resistor (LDR).



State **one** use for a light dependent resistor and describe how it is used.

.....

.....

.....

[2]

16 A student uses four electrical appliances for different lengths of time.

Look at the table.

Appliance	Power (W)	Time used (hours)
Hair dryer	1500	0.3
TV	100	5
Toaster	2000	0.2
Light bulb	10	12

- (a) (i) Which appliance uses the **most** energy?
- [1]
- (ii) Which appliance uses the **least** energy?
- [1]

(b) Here are three different components and their use in the home.

Match the component to its correct use.

One has been done for you.

Component	Use
LDR	Operating a heating system
Thermistor	Monitoring the position of a door
Variable resistor	Turning on lights when it gets dark

[2]

- (c) A charge of 44 000 C flows through a light bulb. The potential difference is 230 V.

Calculate the energy transferred.

Use the equation: Charge = Energy ÷ Potential difference

Record your answer to 2 significant figures.

Answer = ... C [4]

- (d) (i) A student has completed her homework on static electricity.

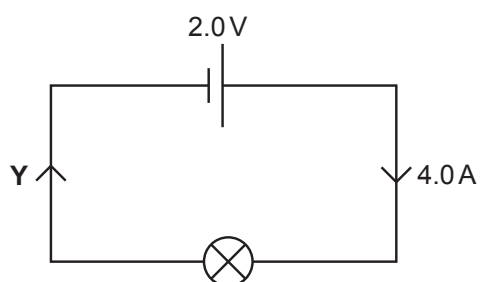
Look at her homework.

- 1 Static charge only builds up on insulators.
- 2 Opposite charges attract.
- 3 Like charges repel.
- 4 Only positive charges can move.

Identify the student's mistake and correct it.

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

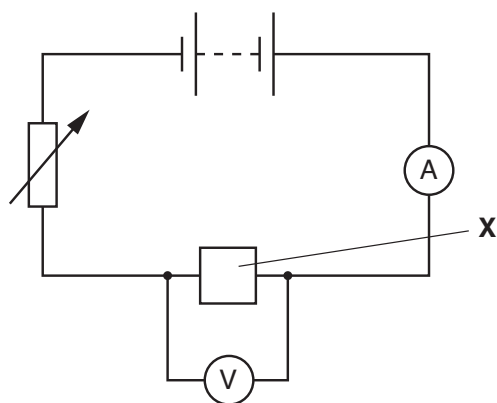
(ii) When charges move, a current flows.



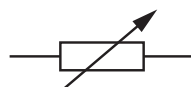
Write down the current flowing at point **Y** in the circuit.

Answer = ... A [1]

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



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



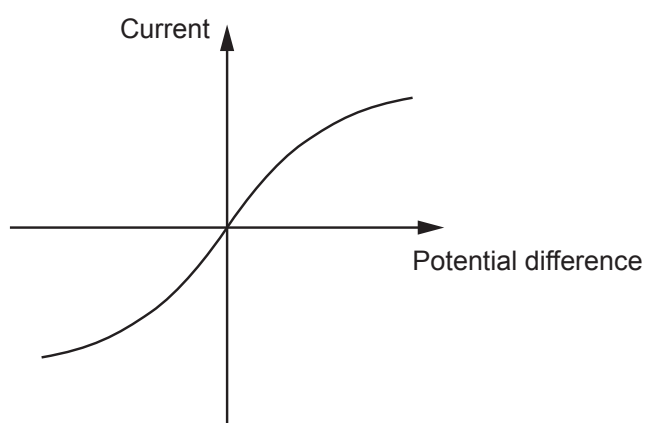
..... [1]

(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]

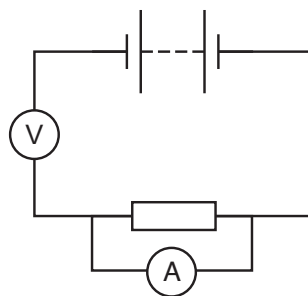
- (ii) Calculate the power of component **X** when a current of 0.25A flows.

Answer = ... W [3]



- 17 A student sets up a circuit to find out the resistance of an unknown resistor. The student makes **three** mistakes in their circuit.

Look at the circuit diagram of their experiment.



- (a) (i) Write down the **three** mistakes the student makes.

1

.....

2

.....

3

.....

[3]

- (ii) For **one** of the mistakes identified in (a)(i) describe how the student can fix the error.

.....

.....

[1]

- (b) The student finds that the current is 20 mA when the potential difference is 4.0 V.

Calculate the **resistance** of the unknown resistor.

Include the **unit** for resistance in your answer.

Use the equation: resistance = potential difference ÷ current.

Resistance = ... Unit = ... [4]



(c) Calculate the **charge** that flows when a current of 2.5A flows for 30 seconds.

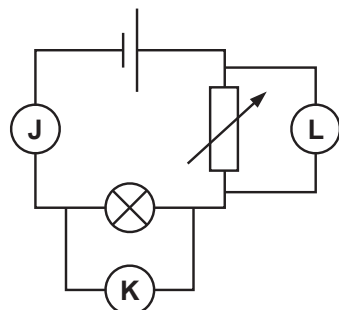
Charge = ... C [3]



17 A teacher investigates the resistance of a filament lamp.

Fig. 17.1 shows the circuit the teacher uses.

Fig. 17.1



- (a) The teacher takes measurements of the current through the filament lamp and the potential difference across it.

In which position, **J**, **K** or **L**, should the teacher place the ammeter and voltmeter?

Ammeter position: Voltmeter position: [2]

- (b) Four students discuss the purpose of the component  in this circuit.

Student **A** says: "It is used to change the current flowing in the circuit."

Student **B** says: "It is used to change the resistance of the cell."

Student **C** says: "It is used to change the potential difference of the cell."

Student **D** says: "It is used to change the total resistance of the circuit."

Which **two** students have made a correct statement about the component?

Tick (✓) **two** boxes.

A ☐

B ☐

C ☐

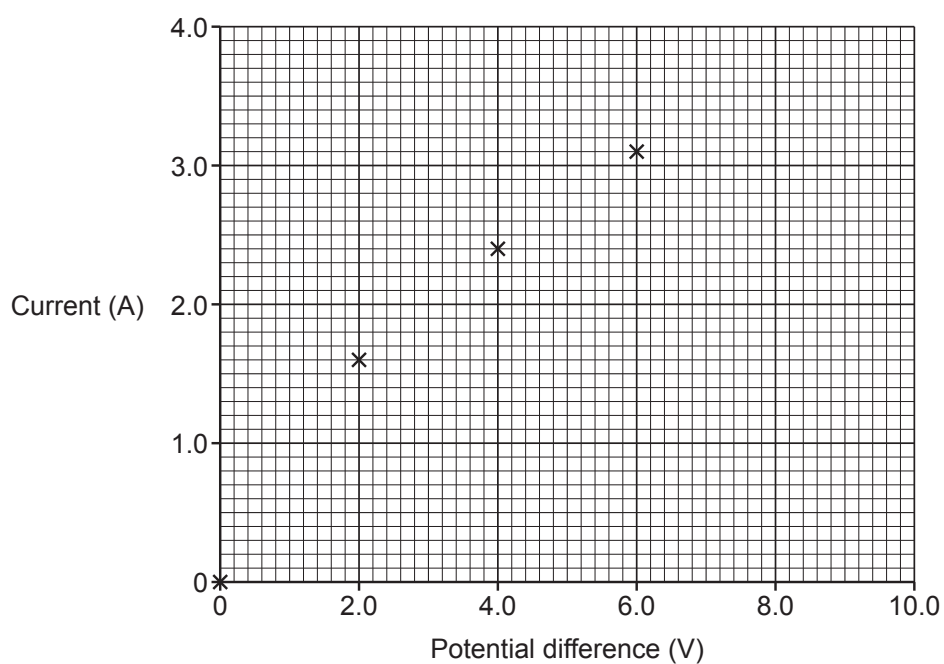
D ☐

[2]

- (c) The teacher records their results in the table and plots the graph shown in Fig. 17.2.

Potential difference (V)	Current (A)
0.0	0.0
2.0	1.6
4.0	2.4
6.0	3.1
8.0	3.6
10.0	4.0

Fig. 17.2



(i) Plot the **two** missing points on **Fig. 17.2** and draw a line of best fit. [2]

(ii) Calculate the power dissipated by the filament lamp when the potential difference is 5.0V.

Use **Fig. 17.2** and the equation: power = potential difference $\times$ current

Power = ... W [2]

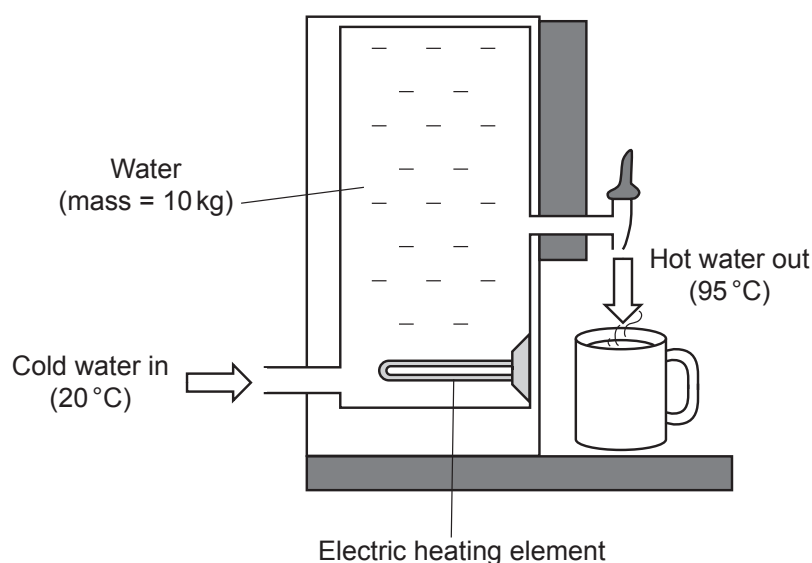
(iii) Calculate the energy transferred if the filament lamp is used for 2 minutes.

Use your answer from **(b)(ii)** and the equation: energy transferred = power $\times$ time

Energy = ... J [3]



- 19 An electric water heater is used to make hot water for drinks.



- (a) The water heater is plugged into the mains supply and turned on.

Explain why the temperature of the water increases.
Write about energy stores in your answer.

.....

.....

.....

..... [2]

- (b) The temperature of the water increases from 20 °C to 95 °C.
The mass of water is 10 kg.
The specific heat capacity of water is 4200 J/kg °C.

Calculate the energy required to increase the temperature of the water.

Use the equation:

change in thermal energy = mass × specific heat capacity × change in temperature

Energy = ... J [3]

- (c) (i) The power of the water heater is 1840 W.
The p.d. of the mains supply is 230 V.

Calculate the current in the heating element.

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

Current = ... A [3]

- (ii) An engineer says, 'You should use a water heater with a higher current.'

Suggest **two** reasons why this is a good idea.

- 1
.....
2
..... [2]

- (d) The water heater is plugged into the mains supply.
The water heater has a metal case.

Which wire(s) should be connected in the electric plug of the water heater?

Tick (✓) one, two **or** three boxes.

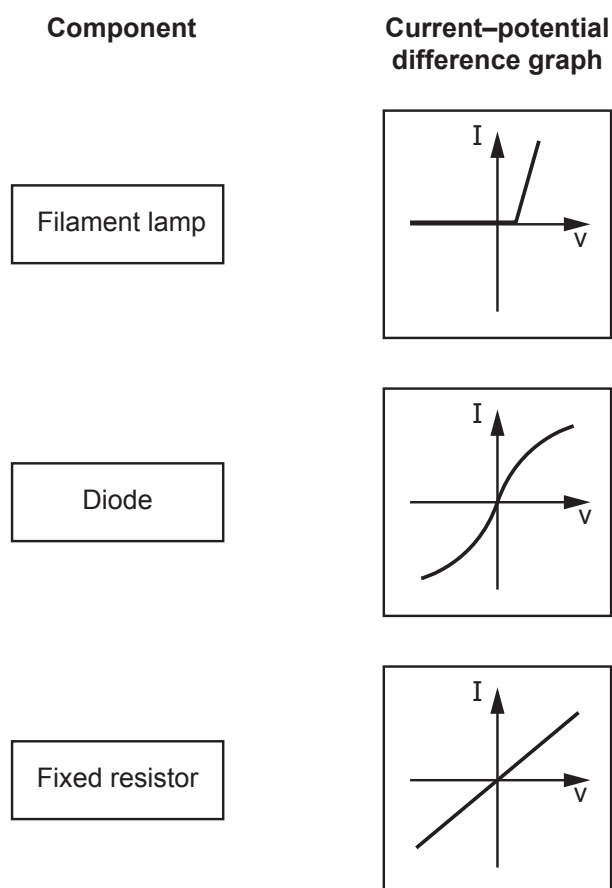
- Earth wire ☐
Live wire ☐
Neutral wire ☐

[1]

- 17 (a) A student draws current–potential difference (I–V) graphs for three different components. These are shown in **Fig. 17.1**.

Draw one line from each **component** to its correct **current–potential difference graph**.

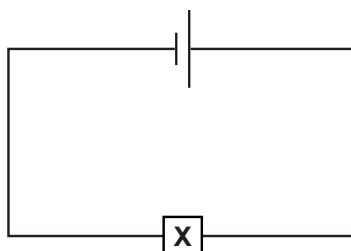
Fig. 17.1



[2]

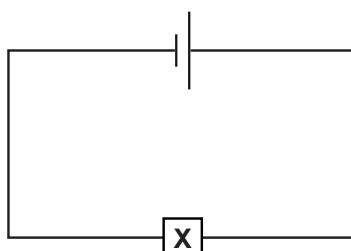
- (b) The student uses the circuit in **Fig. 17.2** to investigate the current in component **X** and the potential difference across it.

Fig. 17.2



- (i) State the name of the measuring instrument the student uses to measure the current in the circuit.
 [1]
- (ii) Draw the circuit symbol for the measuring instrument in (b)(i) in a correct position in **Fig. 17.2**.
 [2]
- (iii) State the name of the measuring instrument the student uses to measure the potential difference across component **X**.
 [1]
- (iv) Draw the circuit symbol for the measuring instrument in (b)(iii) in a correct position in **Fig. 17.3**.
 [2]

Fig. 17.3



(c) Component **X** has a resistance of 6.0Ω .

A current of 4.0A flows through component **X**.

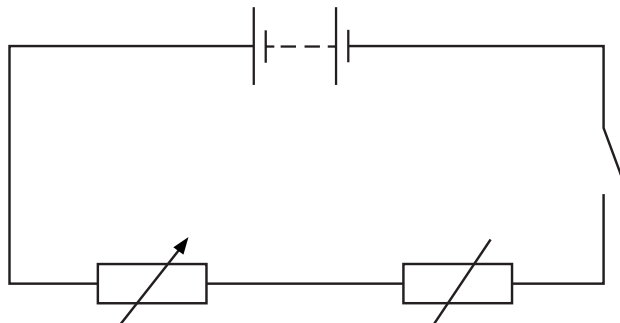
Calculate the potential difference across component **X**.

Use the Equation Sheet.

Potential difference = ... V [3]

22 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

☐

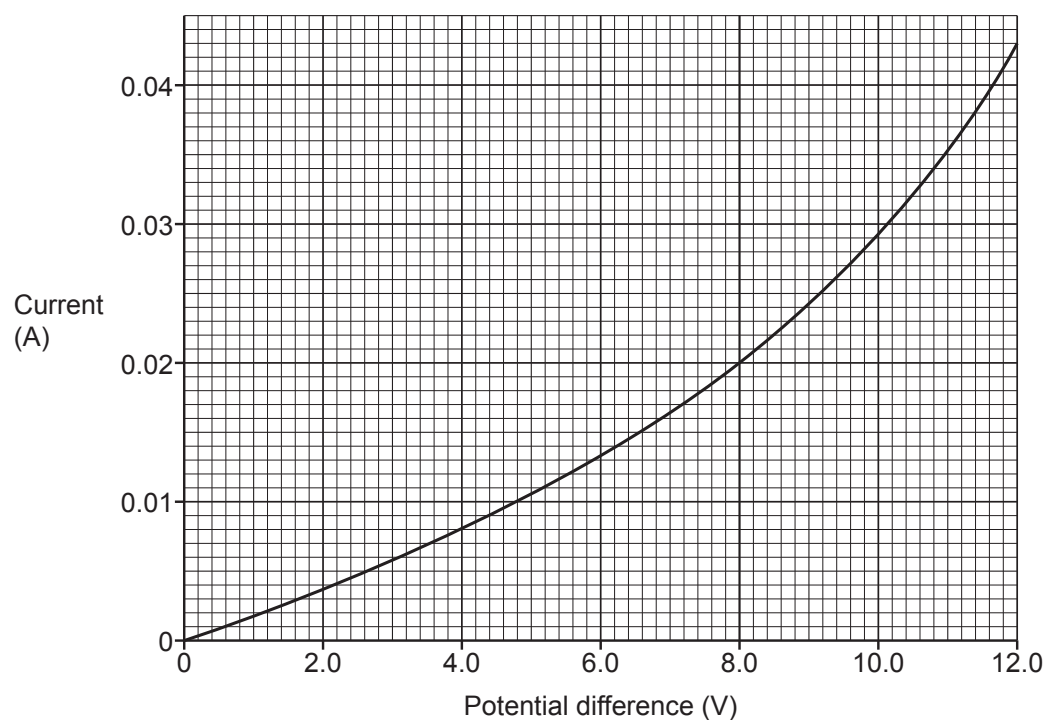
[1]

- (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

21

- (a)** In a shop, a lift moves customers a vertical distance of 12 m from the ground floor to the top floor.

The maximum weight of passengers allowed in the lift is 4500 N.

- (i)** Calculate the maximum mass of passengers allowed in the lift.

Use the equation: gravitational force = mass $\times$ gravitational field strength

Mass = ... kg [4]

- (ii)** Calculate the work done in moving the maximum weight of passengers between the ground floor and the top floor.

Use the equation: work done = force $\times$ distance

Work done = ... J [2]

- (iii)** The lift takes 1.2 minutes to move the passengers from the ground floor to the top floor.

Calculate the power needed to move the maximum weight of passengers in the lift.

Use your answer from part **(a)(ii)** and the equation: power = $\frac{\text{work done}}{\text{time}}$

Power = ... W [3]



(b) The power of the motor of another lift is 920 W.

The potential difference across the motor of this lift is 230 V.

Calculate the current in the motor.

Use the Equation Sheet.

Current = ... A [4]



17 A student sets up the circuit in **Fig. 17.1** to investigate the resistance of a lamp.

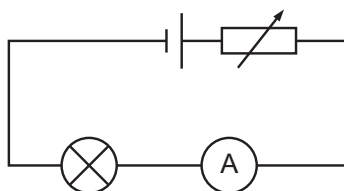


Fig. 17.1

- (a) (i) The student also needs to add a voltmeter to the circuit.
On **Fig. 17.1** **draw** where the voltmeter should be connected. [2]
- (ii) The student takes readings of potential difference and current and records them in **Table 17.1**.

Potential difference (V)	Current
1.0	1.000
2.0	1.9
3.0	2.7
4.0	3.2
5.0	3.5

Table 17.1

There are **two** mistakes in the results table.

Write down the **two** mistakes and suggest how they could be corrected.

Mistake 1:

Correction 1:

Mistake 2:

Correction 2:

[4]

- (iii) Calculate the resistance of the lamp when the potential difference is 4.0V in **Table 17.1**.

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

Resistance = ... Ω [3]

- (b) The student plots the results from **Table 17.1** on the graph in **Fig. 17.2**.

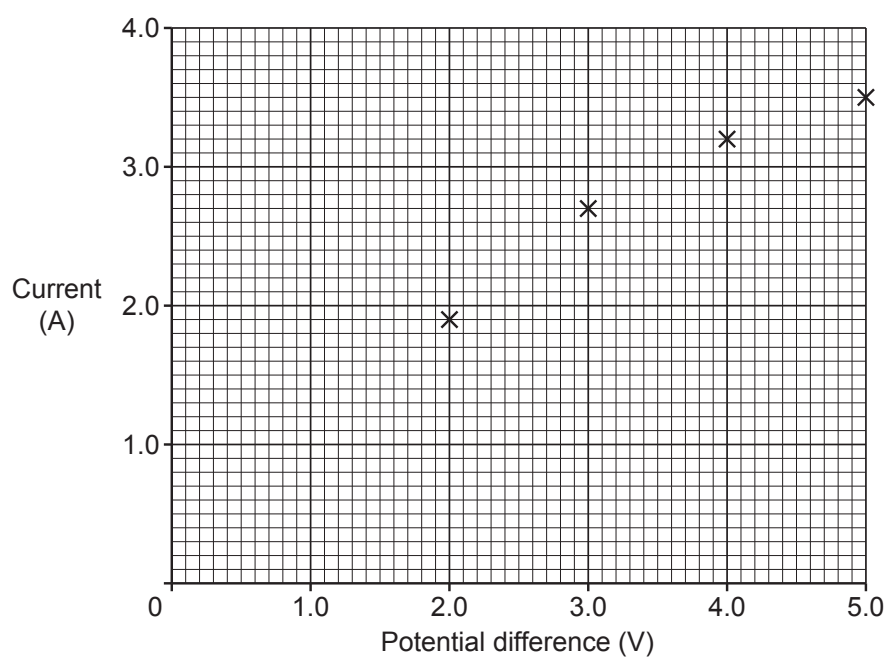


Fig. 17.2

- (i) Plot the missing point at 1.0V on the graph **and** draw a line of best fit. [2]

- (ii) Describe the relationship between potential difference and current.

Use data from the graph to support your answer.

.....

.....

.....

..... [2]

- (iii) Explain how you could use the circuit in **Fig. 17.1** to investigate the resistance of a fixed resistor instead of a lamp.

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

- (iv) Explain how and why the graph in **Fig. 17.2** would look different for a fixed resistor at a constant temperature.

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



MARK SCHEMES

official Pearson Edexcel mark schemes



Question				Answer	Marks	AO element	Guidance
3				A ✓	1	1.1	



Question			Answer	Marks	AO element	Guidance
2			C ✓	1	1.2	



Question	Answer	Marks	AO element	Guidance
10	B ✓	1	1.1	



Question	Answer	Marks	AO element	Guidance
5	B	1	1.2	



Question	Answer	Marks	AO element	Guidance
8	B	1	1.1	



Question	Answer	Marks	AO element	Guidance
9	B	1	1.1	



18	(a)	(i)	Rub the balloon (against the cloth) ✓	1	1.2	ALLOW rubbing them together
		(ii)	(There is a) transfer of electrons from the balloon / to the cloth/ AW ✓	1	1.2 x1	ALLOW it loses electrons / negative charges. DO NOT ACCEPT transfer of protons / neutrons / positive charges.
		(iii)	Opposite charges <u>attract</u> / AW ✓	1	2.1 x1	ALLOW opposites <u>attract</u> . ALLOW negatives <u>attract</u> to positives ORA
	(b)		First check the answer on the answer line If answer = 15 (C) award 3 marks $Q = E / V$ ✓ $Q = 7.5 \times 10^9 / 5.0 \times 10^8$ ✓ $Q = 15$ (C) ✓	3	1.2 2.1 2.1	ALLOW substituting into original equation for 1 mark. $7.5 \times 10^9 = Q \times 5.0 \times 10^8$
	(c)		First check the answer on the answer line If answer = 1800 (C) award 3 marks $(Q = It)$ $t = 2 \times 60 = 120$ (s) ✓ $Q = 15 \times 120$ ✓ $Q = 1800$ (C) ✓	3	1.1 2.1 2.1	ALLOW 2 marks for an answer of 30 (C) – conversion of time not completed

22	(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 they lose/gain 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 positive and negative poles

Question	Answer	Marks	AO element	Guidance
22 (b) (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 ✓ = 5 (C) ✓	3	1.2 2.1 2.1	

Question				Answer		Marks	AO element	Guidance	
2				D ✓		1	2.2		



Question				Answer	Marks	AO element	Guidance
6				D ✓	1	2.1	



Question				Answer	Marks	AO element	Guidance
7				B ✓	1	2.2	



Question				Answer	Marks	AO element	Guidance
4				B ✓	1	2.2	



Question				Answer	Marks	AO element	Guidance
5				A ✓	1	2.2	



Question				Answer	Marks	AO element	Guidance
7				C ✓	1	1.1	



Question				Answer	Marks	AO element	Guidance
5				D	1	2.2	



Question				Answer	Marks	AO element	Guidance
10			C		1	2.2	



Question				Answer	Marks	AO element	Guidance
12			A		1	2.1	



Question				Answer	Marks	AO element	Guidance
14				D	1	1.1	



Question			Answer	Marks	AO element	Guidance
8			A ✓	1	1.1	



Question			Answer	Marks	AO element	Guidance
11			B ✓	1	2.1	



Question			Answer	Marks	AO element	Guidance
6			D ✓	1	2.1	



Question			Answer	Marks	AO element	Guidance
14			D ✓	1	2.2	



Question	Answer	Marks	AO element	Guidance
4	C ✓	1	1.2	



Question	Answer	Marks	AO element	Guidance
13	A ✓	1	2.1	



Question	Answer	Marks	AO element	Guidance
4	B	1	2.2	



Question	Answer	Marks	AO element	Guidance
7	A	1	2.2	



Question	Answer	Marks	AO element	Guidance
9	A	1	1.1	



Question	Answer	Marks	AO element	Guidance
12	A	1	2.1	



Question	Answer	Marks	AO element	Guidance
14	D	1	2.1	



Question	Answer	Marks	AO element	Guidance
1	B	1	1.1	



Question	Answer	Marks	AO element	Guidance
5	C	1	1.1	



Question	Answer	Marks	AO element	Guidance
6	D	1	2.1	



Question	Answer	Marks	AO element	Guidance
2	C	1	2.2	ALLOW 2 / 2A



Question	Answer	Marks	AO element	Guidance
5	D	1	1.2	



Question	Answer	Marks	AO element	Guidance
6	A	1	2.2	



Question	Answer	Marks	AO element	Guidance
13	B	1	1.1	



Question	Answer	Marks	AO element	Guidance
15	D	1	2.1	



Question	Answer	Marks	AO element	Guidance
1	A	1	1.2	



6	B	1	2.1	A: $250+50$ B: $(50+1000)\times 250$ C: $250+(50+1000)$ D: 50×250
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Question	Answer	Marks	AO element	Guidance
11	C	1	1.1	



Question	Answer	Marks	AO element	Guidance
14	C	1	2.2	

Question	Answer	Marks	AO element	Guidance
7	C	1	1.1	



17			Correct symbol for a cell ✓ Cell connected correct way around (for current to flow) ✓	2	1.1 1.2	
Question			Answer	Marks	AO element	Guidance



24	(a)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.8 (kWh) award 3 marks Recall (Energy transferred =) power $\times$ time ✓ 0.2×4 ✓ (Energy =) 0.8 (kWh) ✓	3	1.2 ALLOW correct equation in any form ALLOW 200×4 or $200 \times 4 \times 60 \times 60$ or 200×14400 or $200 \times 4 \times 60$ or $0.2 \times 4 \times 60 \times 60$ or 0.2×14400 or $0.2 \times 4 \times 60$ for one mark 2.1 ALLOW 800 or 2 880 000 or 2880 or 48 000 or 48 for two marks 2.1
	(b)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 38.28 (W) award 3 marks Recall (Power =) potential difference $\times$ current ✓ 12×3.19 ✓ (P =) 38.28 (W) ✓	3	1.2 ALLOW correct equation in any form 2.1 2.1 ALLOW 38.3 (W) or 38 (W)

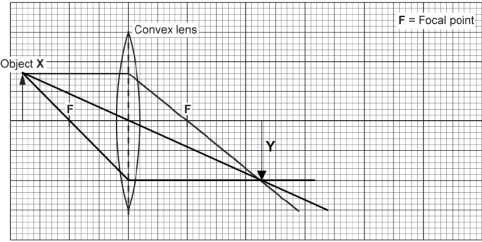


20	*	Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question. Level 3 (5–6 marks) Circuit A identified as a parallel circuit and having the brightest lamps AND Detailed explanation of why A has the brightest lamps AND Identification of control variables <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) Circuit A identified as a parallel circuit and having the brightest lamps AND An explanation of why A has the brightest lamps OR Identification of control variables <i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i> Level 1 (1–2 marks) Circuit A identified as having the brightest lamps. OR Identification that circuit A is in parallel. OR Identification of control variables <i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i> 0 marks <i>No response or no response worthy of credit.</i>	6	1.2 x 2 2.2 x 2 3.2b x 1 3.3a x 1 AO1.2 Demonstrate knowledge and understanding of series and parallel circuits For example: - circuit A is parallel - circuit B is series - both circuits have one cell AO2.2 Apply knowledge and understanding of series and parallel circuits For example: - resistance is lower in circuit A / ORA - more current flows in circuit A / ORA AO3.2b Analyse information and ideas to draw conclusions For example: - lamps in circuit A are brighter / ORA AO3.3a Analyse information to develop experimental procedure by identifying control variables - same (number of) lamps - same (number of) cells
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19	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) Detailed description of the trend shown with use of data AND detailed suggestions to improve the accuracy [A] AND precision [P] of the results. <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) Basic description of the trend shown and suggestions to improve the accuracy / precision of the results. OR Detailed description of the trend shown with use of data . <i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i> Level 1 (1–2 marks) Basic description of the trend shown, e.g. resistance goes up with distance. OR Basic suggestion to improve the accuracy or precision of the results, e.g. repeat readings. <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>	6	4 x 3.1a 2 x 3.3b AO3.1a Analyses the results to interpret the trend shown by the graph. For example - as distance (from the lamp) increases, resistance increases or the inverse - as light intensity increases, resistance decreases - relationship is not linear - rate of increase of resistance is higher further from / lower closer to the lamp - resistance increases at an increasing rate - at 0cm from the lamp the resistance is 100Ω - at 20cm from the lamp the resistance is 240Ω - at 40cm from the lamp the resistance is 400Ω - at 60cm from the lamp the resistance is 600Ω - at 80cm from the lamp the resistance is 1000Ω AO3.3b Analyses the information to improve experimental procedures. For example - put the lamp directly in line with the LDR [A] - measure from the bulb directly to the LDR [A] - use a digital meter [P] - use resistance meter with higher resolution [P] - reduce other light sources, e.g. close blinds [A] - repeat readings (and calculate a mean) [P] - reduce the interval between readings/take readings every 10cm [P] - repeat readings and discard anomalies [A]
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21	(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
21	(c)	(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

17	(a)	A and B ✓	1	2.2	Both A and B are required for this mark
	(b)	A and C ✓	1	2.2	Both A and C are required for this mark
	(c)	Both lamps have the same brightness ✓	1	2.2	
	(d)	Any ONE from: They have the same resistance ✓ Both lamps have the same current ✓ Both lamps have the same potential difference/voltage ✓ Both lamps have the same current and potential difference ✓	1	2.2	ALLOW lamps are in parallel IGNORE The lamps are identical (repeat of question stem) DO NOT ACCEPT current/resistance/voltage is the same throughout the circuit
	(e)	increases ✓ electrons ✓ thermal ✓	3	1.2 x3	Words must appear in the correct order ALLOW heat

23	(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) $E = 116000 \text{ (J)}$ ✓

24	(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	

24	(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)

22	(a)	(i)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 480 (J) award 3 marks (0.6 kN $\Rightarrow$) 600 N ✓ 600 $\times$ 0.8 ✓ 480 (J) ✓	3	1.2 2.1 2.1	
		(ii)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 9.6 (s) award 3 marks (Rearrangement) Time taken = work done / power ✓ 480 $\div$ 50 ✓ 9.6 (s) ✓	3	1.2 2.1 2.1	ALLOW ECF from (a)(i)
		(iii)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 2.1 (A) award 4 marks (Rearrangement) Current = power / potential difference or $I = P / V$ ✓ 50 / 24 ✓ 2.08(3) (A) ✓ 2.1 (A) (2 sig.fig) ✓	4	1.2 2.1 2.1 1.2	ALLOW voltage for potential difference



20	(a)	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) Detailed description of the trend shown by the graph and detailed suggestions to improve the experimental method. <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) Description of the trend shown by the graph and some simple suggestions to improve the experimental method. OR Detailed description of the trend shown by the graph. OR Detailed suggestions to improve the experimental method. <i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i> Level 1 (1–2 marks) Simple description of the trend indicated. OR Some simple suggestions to improve the experimental method.	6	3 x 3.1a 3 x 3.3b	AO3.1a Analyses the results to interpret the trend shown by the graph. For example, - as temperature increases, resistance decreases / ORA - relationship is not linear - rate of increase/decrease/change of resistance is higher at lower temperatures / ORA - resistance decreases at a decreasing rate - two points from graph to illustrate a change e.g. at 10°C the resistance is 900Ω / at 25°C the resistance is 400Ω / at 40°C the resistance is 200Ω AO3.3b Analyses the information to improve experimental procedures. For example, - Stir water (to ensure even temperature) - Use a water bath - Repeat readings and take a mean / ignore anomalies - Use a digital meter / Use a digital thermometer / temperature probe - Take additional temperature readings (3 is not enough) - Use a wider range of temperatures / Use temperatures over 50°C / Use temperatures below 10°C - Only submerge the actual thermistor / Don't submerge the crocodile clips/electrical connections - Check ohmmeter for zero error
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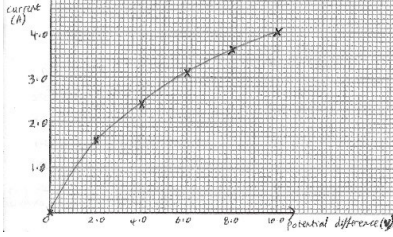
Question			Answer	Marks	AO element	Guidance
			<i>The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear.</i> 0 marks <i>No response or no response worthy of credit.</i>			Thermometer should not touch the sides/bottom of the beaker Thermometer closer to thermistor
	(b)		C ✓ And any one from: (Idea that) ammeters A and B cannot measure up to 300 mA ✓ (Idea that) on ammeter D, 300 mA is between marks on the ammeter (so cannot be measured accurately) / smaller resolution ✓	2	2.2 3.2a	ALLOW the smallest scale that goes to 300 (mA) ORA (idea that) ammeter C has a mark at 300 mA ORA (idea that) ammeter C has higher resolution
	(c)		Streetlights / phone/screen brightness / automatic (head)lights / security lights / alarm clocks / light meter / smoke detector / digital camera / motion detector ✓ (Light) turns on when it is dark / turns off/dims in dim light / motion is detected when light levels change ✓	2	1.1 1.2	ALLOW any sensible suggestion that uses a light sensor ALLOW function controlled by change in light level (for suggested use)



16	(a)	(i)	TV ✓	1	3.2b	
		(ii)	Light bulb ✓	1	3.2b	
	(b)		LDR Operating a heating system Thermistor Monitoring the position of a door Variable resistor Turning on lights when it gets dark	2	2 x 2.1	1 mark for each correct link
	(c)		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 10 000 000 (J) award 4 marks Rearrange to energy = charge × potential difference ✓ 44 000 × 230 ✓ 10 120 000 ✓ 10 000 000 (2 sf) (J) ✓ OR Substitute correctly 44 000 (C) = energy ÷ 230 (V) ✓ Rearrange to energy = 44 000 (C) × 230 (V) ✓ = 10 120 000 (J) ✓ = 10 000 000 (2 sf) (J) ✓	4	2.1 2.1 2.1 1.2	Fourth mark is for correct rounding If answer line has 10 120 000 (J) award 3 marks m.p.2 can include m.p.1 if equation not written m.p.2 can include m.p.1 as above
	(d)	(i)	Error: only positive charges can move ✓ Correction: negative charges/electrons can move ✓	2	3.2a	ALLOW indication on the student's notebook
					1.2	
	(d)	(ii)	4A ✓	1	1.2	

22	(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' ✓ } 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

17	(a)	(i)	The voltmeter is in series ✓ The ammeter is in parallel ✓ One of the cells is connected the wrong way round / AW ✓	3	3.2b 3.2b 3.2b	ALLOW reverse arguments: E.g. voltmeter should be in parallel ✓ E.g. ammeter should be in series ✓ ALLOW The cells/batteries are incorrectly connected / facing each other
		(ii)	Any one from: Put the voltmeter in parallel with the resistor ✓ Put the ammeter in series ✓ Turn around one of the cells/AW ✓	1	3.3b	ALLOW swap the meters over or AW
	(b)		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 200 Ω award 4 marks Unit conversion $20(\text{mA}) = 0.02(\text{A})/20 \times 10^{-3}(\text{A})$ ✓ $R = 4.0 \div 0.02$ ✓ $R = 200$ ✓ Ω ✓	4	1.2 2.1 2.1 1.2	If final unit is $\text{k}\Omega$ or V/mA, this unit conversion is not needed so mp1 is subsumed into mp2 ECF incorrect or absent conversion of mA to A e.g. a bald answer of 0.2 gains mp2 & mp3 unless the unit is $\text{k}\Omega$ or V/mA, when all 4 marks are awarded. Mark unit independently ALLOW ohm(s) or V/A or V/mA if consistent with working
	(c)		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 75 (C) award 3 marks Charge flow = current $\times$ time / $Q = It$ ✓ $Q = 2.5 \times 30$ ✓ $Q = 75 (\text{C})$ ✓	3	1.2 2.1 2.1	Mp1 can be assumed if correct substitution follows No ECF from incorrect equation

17	(a)	(Ammeter position) J ✓ (Voltmeter position) K ✓	2	2 x 2.2	
	(b)	A ✓ D ✓	2	2 x 3.2a	
	(c) (i)	Both points correctly plotted ✓ Appropriate curved line of best fit drawn ✓ 	2	2 x 1.2	ALLOW points plotted within +/- half a small square ECF candidates own curve from incorrectly plotted points Must be curved and agree reasonably with the first 4 points. Allow ± 1 small square for the line paths near the last two points provided that the curve is smooth.
	(ii)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 14 (W) award 2 marks 5 x 2.8 ✓ 14 (W) ✓	2	2 x 2.1	ALLOW ECF for incorrect reading/plotting of current from graph within +/- half a small square
	(iii)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 1680 (J) award 3 marks 2 minutes = 120 seconds ✓ 14 x 120 ✓ = 1680/1700 (J) ✓	3	1.2 2.1 2.1	ALLOW ECF from (c)(ii) ALLOW 2 marks for 28 (J) (no unit conversion) ALLOW 3 marks for 1.68/1.7 k(J) if k inserted

19	(a)	Any two from: Energy transferred electrically from the supply to the heating element or energy transferred by heating from element to the water. ✓ (So) thermal energy store of the element increases. ✓ (So) thermal energy store of water increases. ✓	2	2 × 2.1	IGNORE conduction and convection (as question refers to energy stores).
	(b)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 3 150 000 (J) award 3 marks Temperature change = $95 - 20 = 75^{\circ}\text{C}$ ✓ Change in thermal energy = $10 \times 4200 \times 75$ ✓ (Change in thermal energy =) 3 150 000 (J) ✓	3	2.2 2 × 2.1	ALLOW ECF from their temperature change.
	(c) (i)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 8 (A) award 3 marks Current = power ÷ p.d ✓ (Current =) $1840 \div 230$ ✓ (Current =) 8 (A) ✓	3	1.2 2 × 2.1	Rearrangement of the given equation

Question	Answer	Marks	AO element	Guidance
(c) (ii)	Any two from: The power would be higher ✓ The water would heat up quicker ✓ (So) more water could be heated (in the same time) ✓	2	3.2a	IGNORE Higher currents are more dangerous IGNORE it would get hotter
(d)	<u>All</u> three boxes ticked ✓	1	1.2	



17	(a)	(i)	Component Current-potential difference graph ✓✓	2	2 x 1.2	All 3 correct = 2 marks 1 or 2 correct = 1 mark
	(b)	(i)	Ammeter ✓	1	1.2	IGNORE Ampmeter / Anmeter ALLOW phonetic spellings
		(ii)	Correct symbol for ammeter ✓ Placed in series (anywhere in the circuit) ✓	2	1.1 2.2	ALLOW incorrect symbol for this mark
		(iii)	Voltmeter ✓	1	1.2	ALLOW phonetic spellings
		(iv)	Correct symbol for voltmeter ✓ Placed in parallel with the resistor ✓	2	1.1 2.2	ALLOW incorrect symbol for this mark
	(c)		First check the answer on answer line If answer = 24 (V) award 3 marks (V=) IR ✓ (V=) 4 x 6 ✓ (V=) 24 (V) ✓	3	1.2 2.1 2.1	ALLOW V=IR in any form

22	(a)	(i)	Correct circuit symbols for voltmeter AND ammeter ✓ Ammeter correctly positioned ✓ Voltmeter correctly connected in parallel ✓	3	1.1 3.3a 3.3a	Voltmeter and ammeter can be anywhere in the circuit for this mark Ammeter in series with the components 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	1.2 2.2 2.2	Substitution and rearrangement can be in any order ALLOW values substituted correctly into equation in any form e.g. $8.0 = 0.02 \times \text{resistance}$ (MP2) ECF part (b)(iii)

21	(a)	(i)	First check the answer on the answer line If answer = 450 (kg) award 4 marks $(W = mg)$ $m = W / g \checkmark$ $g = 10 \text{ (N/kg)} \checkmark$ $m = 4500 / 10 \checkmark$ $m = 450 \text{ (kg)} \checkmark$	4	1.2 1.1 2.1 2.1	45000 kg scores 1 mark (incorrect use of g) ALLOW mass = gravitational force / gravitational field strength ALLOW 9.8 or 9.81 ALLOW $4500 = \text{mass} \times 10/9.8/9.81$ for 2 marks ALLOW answers between 458.7 and 460 for 4 marks
		(ii)	First check the answer on the answer line If answer = 54000 (J) award 2 marks $(W = Fd)$ $W = 4500 \times 12 \checkmark$ $W = 54000 \text{ (J)} \checkmark$	2	2.1 2.1	

Question			Answer	Marks	AO element	Guidance
		(iii)	First check the answer on the answer line If answer = 750(W) award 3 marks $(P = W/t)$ 1.2 minutes = 72 seconds $\checkmark$ $P = 54000 / 72 \checkmark$ $P = 750 \text{ (W)} \checkmark$	3	1.2 2.1 2.1	ALLOW "answer from 21aii $\div$ 72" ECF ALLOW "answer from 21aii $\div$ 1.2" ECF ALLOW correct result of above ECF ALLOW $54\,000 \div 1.2$/incorrect conversion seen for 1 mark ECF ALLOW 45 000 for 2 marks ECF
	(b)		First check the answer on the answer line If answer = 4(.0) (A) award 3 marks $P = IV \checkmark$ $I = P / V \checkmark$ $I = 920 / 230 \checkmark$ $I = 4(.0) \text{ (A)} \checkmark$	4	1.2 1.2 2.1 2.1	Substitution and rearrangement can be in any order ALLOW equation in any form ALLOW values substituted correctly into equation in any form e.g. $920=230 \times I$ (MP3)

17	(a)	(i)	Correct symbol for a voltmeter ✓ Voltmeter is in parallel with the lamp ✓	2	1.1 2.2	ALLOW voltmeter in parallel with lamp and ammeter
		(ii)	Mistake: Units for current are missing ✓ Correction: Add A/amps/amperes/mA (for the unit) ✓ Mistake: Current is not recorded to correct number of decimal places / 1d.p. Correction: Current should be recorded to 1 d.p./1.0A ✓	4	3.2a 3.2b 3.2a 3.2b	ALLOW Current at 1.0 V is recorded to 4 significant figures ALLOW current should be recorded to 2 sig figs
		(iii)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 1.25 (Ω) award 3 marks Rearrange to give resistance = potential difference ÷ current ✓ $4(.0) \div 3.2$ ✓ $= 1.25 (\Omega)$ ✓	3	 1.2 2.1 2.1	ALLOW 1.3 (Ω) ✓✓✓ (ALLOW $R = V \div I$) Choice of V, I for wrong data point loses this mark but can get mp1 for equation and mp3 for evaluation ecf. Mp3 may depend on units chosen for current in (a)(ii).
	(b)	(i)	Point 1,1 correctly plotted within ½ small square ✓ Suitable curved line of best-fit drawn ✓	2	2.2 x 2	Should be within 1 small square of each point. May not be extrapolated to (0,0,)
		(ii)	Current increases as potential difference increases/AW ✓ Rate of increase reduces/current increases more slowly with potential difference/AW ✓	2	3.1a 3.1a	IGNORE it is a straight line ALLOW (they are) not proportional / not linear ALLOW resistance increases as current goes up/filament gets hotter
		(iii)	Change lamp for a (fixed) resistor ✓ Measure current for different potential differences/AW ✓	2	1.2 x 2	ALLOW repeat the experiment
		(iv)	Straight line (through the origin)/ current is (directly) proportional to voltage ✓ Resistance is constant./not changing/ fixed ✓	2	1.2 x 2	ALLOW obeys Ohm's Law