Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

Forename(s) _____

Candidate signature _____

I declare this is my own work.

GCSE
PHYSICS

F

Foundation Tier Paper 1

Thursday 25 May 2023 Morning Time allowed: 1 hour 45 minutes

Materials

For this paper you must have:
- a ruler
- a scientific calculator
- the Physics Equations Sheet (enclosed).

Instructions

- Use black ink or black ball-point pen. Pencil should only be used for drawing.
- Fill in the boxesat the top of this page.
- Answer allquestions in the spaces provided.
- Do not write outsidethe box around each page or on blank pages.
- Do all rough work in this book. Cross through any work you do not want to be marked.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- In all calculations, show clearly how you work out your answer.

Information

- The maximum mark for this paper is 100.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
TOTAL	

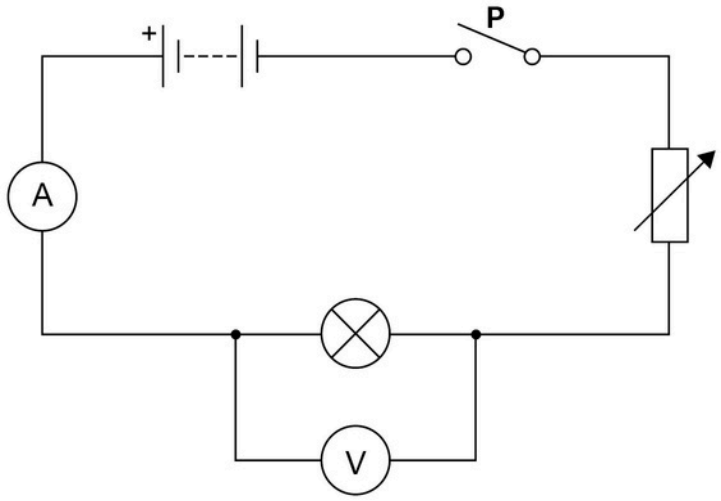
Answer all questions in the spaces provided.

Do not write outside the box

0 1 A student investigated how the current in a filament lamp varies with the potential difference across the lamp.

Figure 1 shows the circuit used.

Figure 1



0 1 . 1 What is component P ?

[1 mark]

Switch

0 1 . 2 Complete the sentences.

Choose answers from the box.

[2 marks]

charge	current	energy	potential difference	power

The ammeter in the circuit measures Current .

The voltmeter in the circuit measures Potential Difference .

Do not write outside the box

0 1 . 3 How will increasing the resistance of the variable resistor in Figure 1 affect each of the following quantities?
Tick (✓) one box in each row.

[3 marks]

Quantity	Decreases	Stays the same	Increases
Current in the circuit	✓		
Potential difference across the lamp	✓		
Total resistance of the circuit			✓

0 1 . 4 A charge flow of 15 coulombs passed through the filament lamp in a time of 60 seconds.

Calculate the current in the lamp.

Use the equation:

$$\text{current} = \frac{\text{charge flow}}{\text{time}}$$

[2 marks]

Current = $\frac{15}{60}$

Current = 0·25 A

Question 1 continues on the next page

Do not write outside the box

0 1.5 When the current in the filament lamp is 0.12 A, the potential difference across the lamp is 6.0 V.

Calculate the resistance of the filament lamp.

Use the equation:

$$\text{resistance} = \frac{\text{potential difference}}{\text{current}}$$

[2 marks]

$R = \frac{6.0}{0.12}$

Resistance = 50 Ω

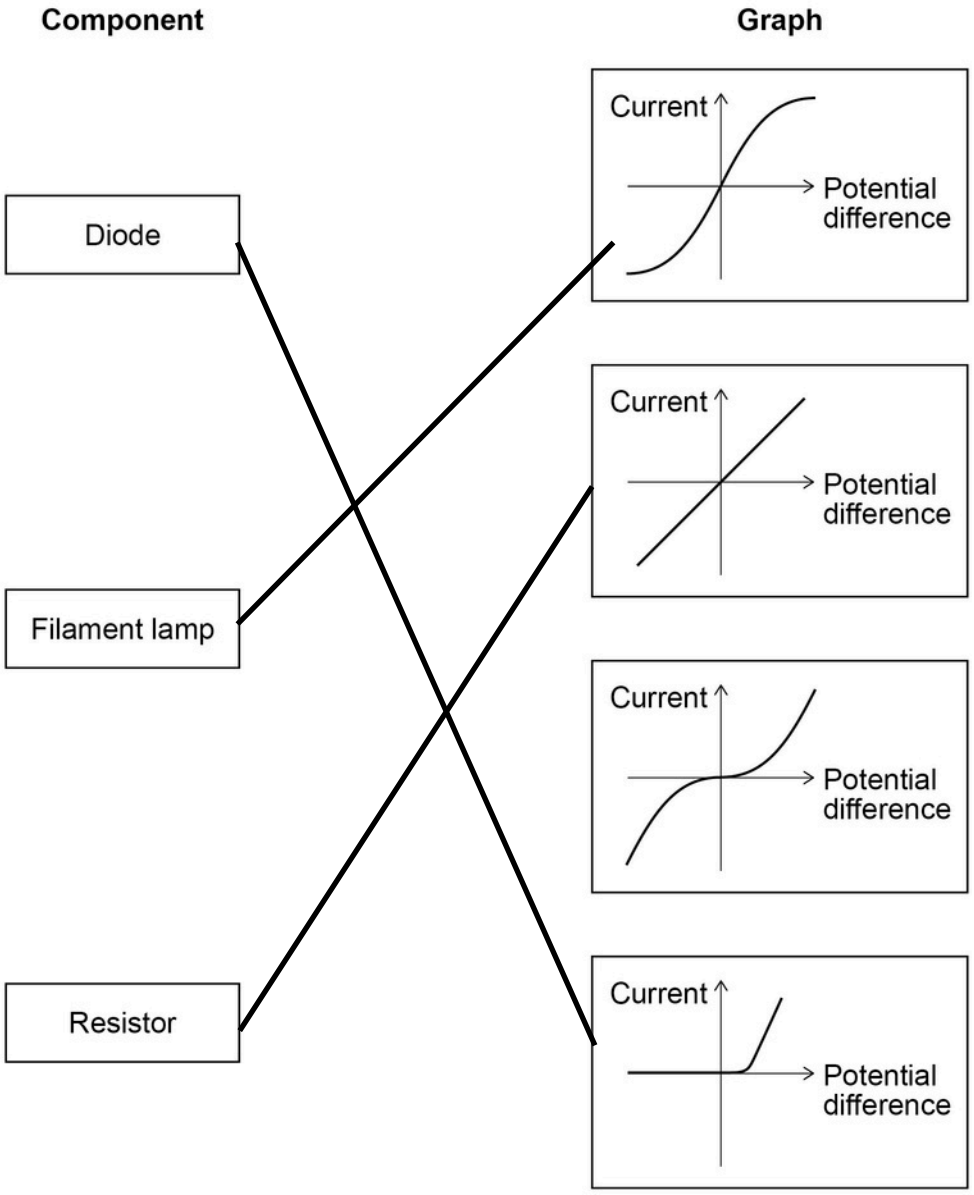
Do not write outside the box

0 1.6 The student repeated the investigation after replacing the lamp with a resistor at constant temperature and then a diode.

The student plotted a graph for each component.

Draw one line from each component to its graph.

[2 marks]

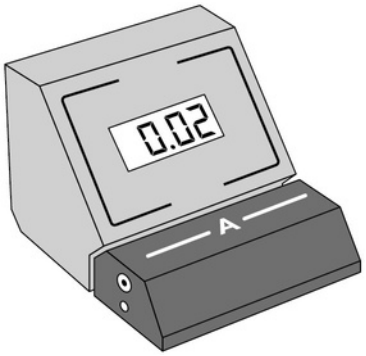


Do not write outside the box

0 1 . 7 Figure 2 shows an ammeter.

The ammeter is not connected to a circuit.

Figure 2



What type of error does the ammeter display?

[1 mark]

Tick (✓) one box.

A positive error ☐

A random error ☐

A zero error ☑

13

Do not write outside the box

0 2 Scientists developed different models of the atom as new discoveries were made.

0 2 . 1 Which particle in the atom was discovered first?

[1 mark]

Tick (✓) one box.

Electron ☑

Neutron ☐

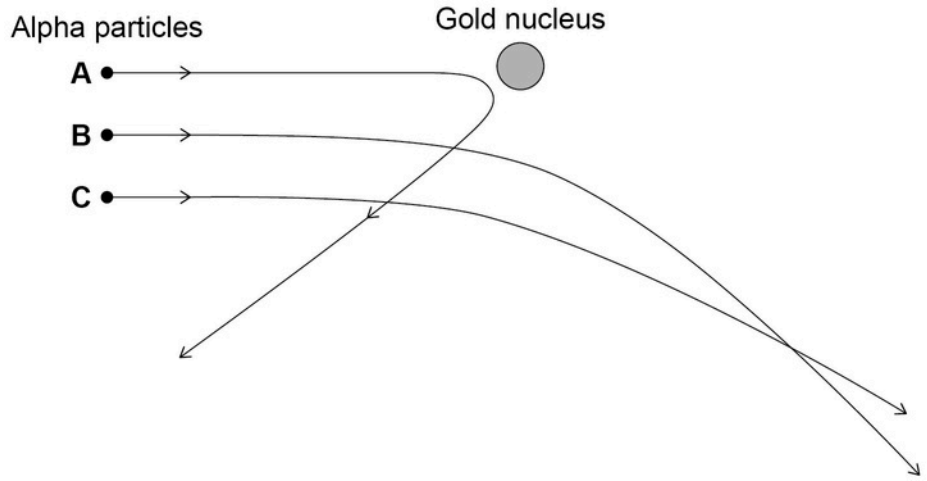
Proton ☐

Question 2 continues on the next page

Do not write outside the box

In an experiment that led to the nuclear model of the atom, alpha particles were directed at a sheet of gold foil.
Figure 3 shows the path of three alpha particles passing close to a gold nucleus.

Figure 3



0 2 . 2 An alpha particle has a radius of 1.7 femtometres.

The radius of a gold nucleus is 4.2 times larger than the radius of an alpha particle.

Calculate the radius of a gold nucleus in femtometres.

[2 marks]

radius= 1.7×4.2

Radius of a gold nucleus = 7.14 femtometres

Do not write outside the box

0 2 . 3 Alpha particles are deflected by the gold nucleus.

What are the charges on an alpha particle and a gold nucleus?

[1 mark]

Tick (✓) one box.

An alpha particle and a gold nucleus are both neutral. ☐

An alpha particle and a gold nucleus are both positively charged. ☑

An alpha particle is positively charged and a gold nucleus is neutral. ☐

0 2 . 4 Which statement describes the force between the alpha particle and the gold nucleus?

[1 mark]

Tick (✓) one box.

A contact force ☐

A force of attraction ☐

A force of repulsion ☑

There is no force ☐

0 2 . 5 Which alpha particle in Figure 3 experiences the largest force from the gold nucleus?

[1 mark]

Tick (✓) one box.

A ☑ B ☐ C ☐

Do not write outside the box

Table 1 lists different models of the atom in alphabetical order.

Table 1

Model
Bohr
Nuclear
Plum pudding
Tiny spheres that cannot be divided

0 2 . 6 Which model in Table 1 was developed first?

[1 mark]

Tiny spheres that can't be divide

0 2 . 7 Which model in Table 1 was developed last?

[1 mark]

Bohar

8

Do not write outside the box

0 3 Some isotopes emit nuclear radiation.

0 3 . 1 Carbon-12 and carbon-14 are both isotopes of carbon.

Complete the sentences.

Choose answers from the box.

[2 marks]

alpha particles	electrons	neutrons	protons

The nucleus of a carbon-12 atom and the nucleus of a carbon-14 atom have the same number of Proton .

The nucleus of a carbon-12 atom and the nucleus of a carbon-14 atom have a different number of Neutron .

0 3 . 2 Different radioactive isotopes have different half-lives.

What does 'half-life' mean?

[1 mark]

Tick (☒) one box.

Half the time taken for all of the nuclei in a sample to decay. ☐

The time taken for half the nuclei in a sample to decay. ☑

The time taken for one nucleus to split in half. ☐

Question 3 continues on the next page

Do not write outside the box

0 3 . 3 Table 2 shows the half-life of some different isotopes of carbon.

Table 2

Isotope	Half-life in seconds
Carbon-15	2.45
Carbon-16	0.75
Carbon-17	0.19
Carbon-18	0.09

Which isotope is the least stable?

[1 mark]

Tick (✓) one box.

Carbon-15 ☐

Carbon-16 ☐

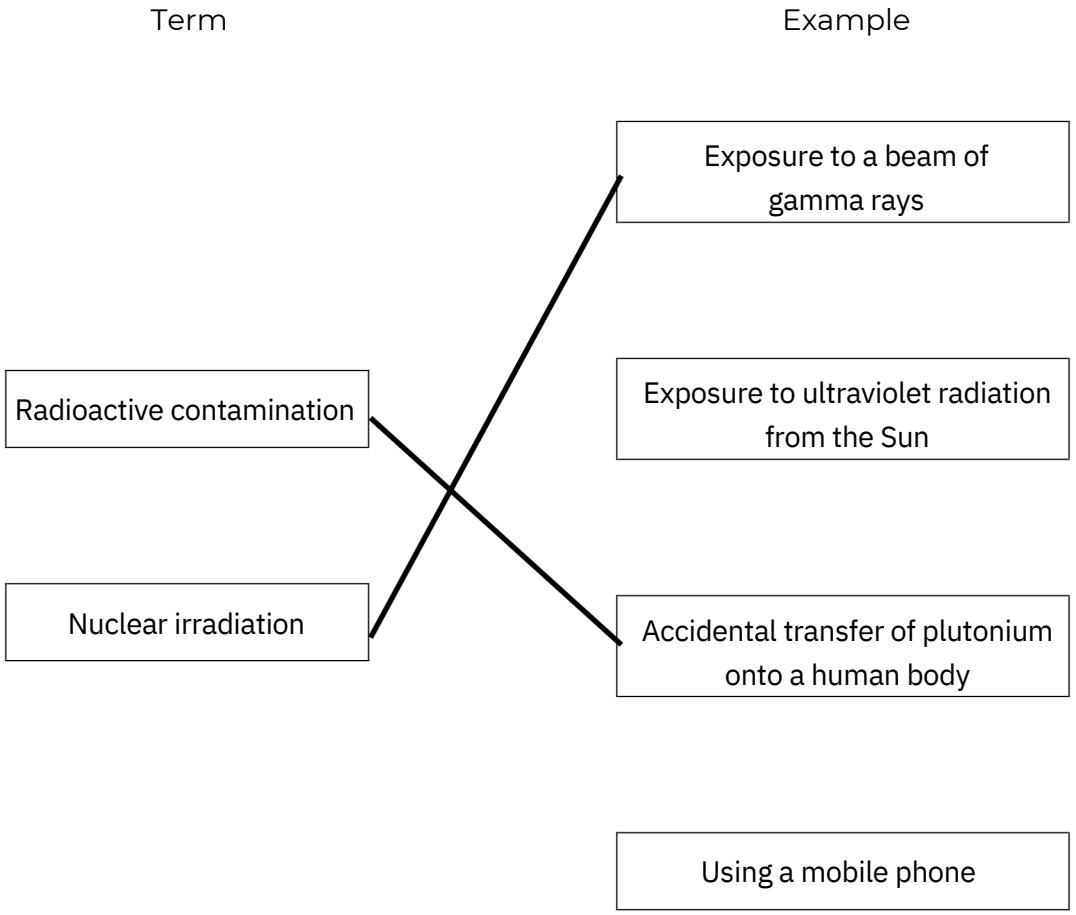
Carbon-17 ☐

Carbon-18 ☑

0 3 . 4 Workers in nuclear power stations must be aware of nuclear irradiation and radioactive contamination.

Draw one line from each term to an example of the term.

[2 marks]



Question 3 continues on the next page

Do not write outside the box

0 3 . 5 Why are workers required to walk across a sticky floor before leaving the nuclear power station?

Tick (✓) one box. [1 mark]

To remove alpha particles from their shoes. ☐

To remove gamma radiation from their shoes. ☐

To remove radioactive dust from their shoes. ☑

0 3 . 6 The places where people work and live contribute to the nuclear radiation they are exposed to.

Table 3 shows the mean daily dose of radiation caused by two different jobs.

Table 3

Job	Mean daily dose in mSv
Aeroplane pilot	0.072
Nuclear power station worker	0.00050

Calculate the number of days a nuclear power station worker must work before receiving the same dose that an aeroplane pilot receives in one day. [2 marks]

Number of days = $\frac{0.072}{0.00050}$

Number of days = 144

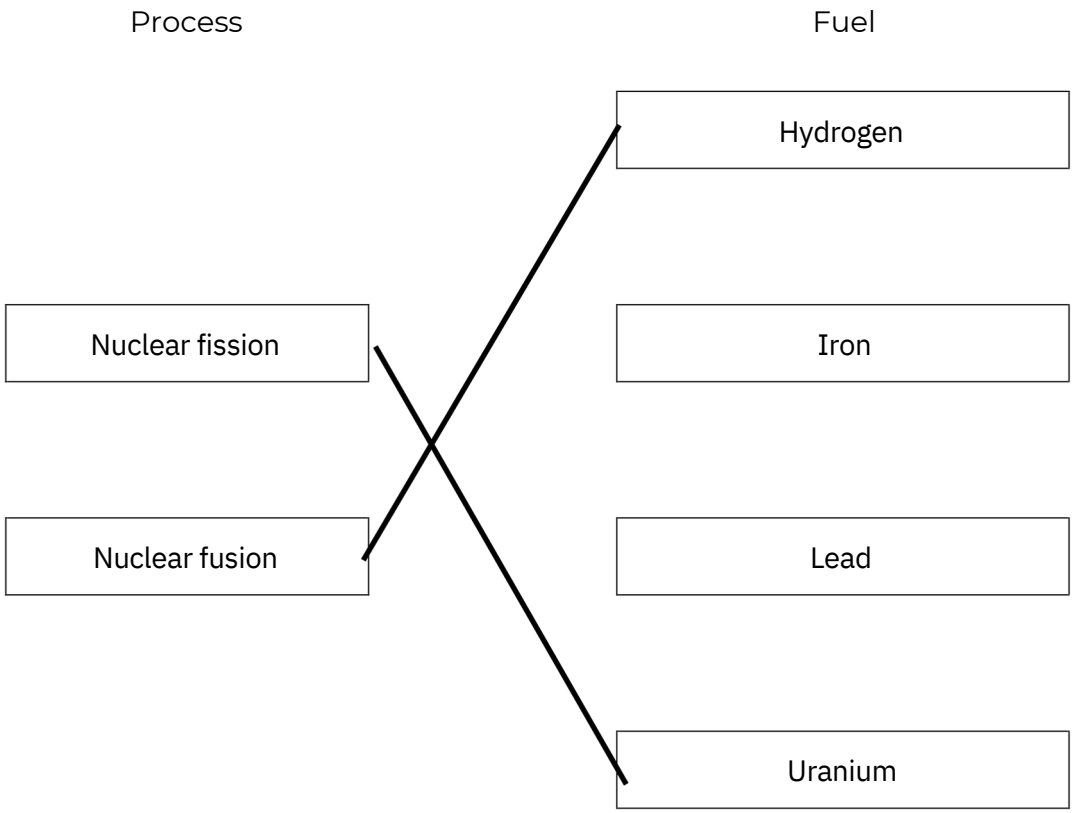
Do not write outside the box

0 3 . 7 The process of nuclear fission takes place in nuclear power stations.

The process of nuclear fusion takes place in the Sun.

Draw one line from each process to its fuel.

[2 marks]



11

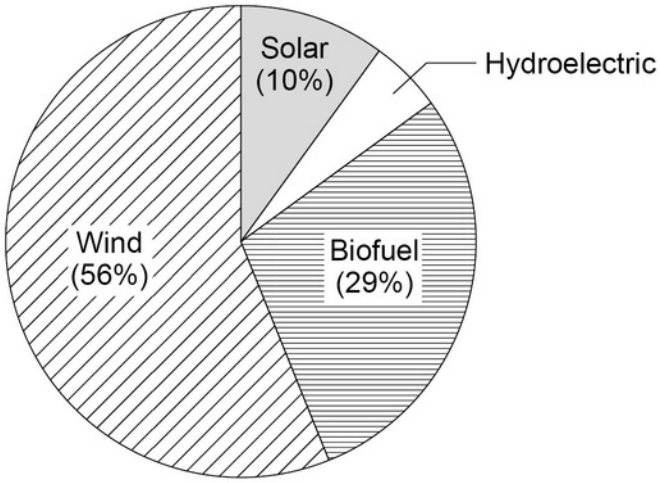
Turn over for the next question

Do not write outside the box

0 4 The UK uses renewable energy resources to generate some of its electricity.

Figure 4 shows the proportion of electricity generated by different renewable energy resources in the UK in 2020.

Figure 4



0 4 . 1 Calculate the percentage of electricity generated using hydroelectric power.

[2 marks]

Other energy resources = 95 (%)
Hydroelectric = 5 (%)

Percentage = _____ %

Do not write outside the box

A remote village in the UK uses a hydroelectric generator to provide electricity.

0 4 . 2 The mass of water that passes through the hydroelectric generator each day is 2 500 000 kg.
The change in vertical height of the water is 15.0 m.

gravitational field strength = 9.8 N/kg

Calculate the decrease in gravitational potential energy of the water.

Use the equation:

gravitational potential energy = mass × gravitational field strength × height

[2 marks]

$E_p = 2,500,000 \times 9.8 \times 15$

Decrease in gravitational potential energy = 367500 000 J

Question 4 continues on the next page

Do not write outside the box

Use the Physics Equations Sheet to answer questions 04.3 and 04.4

0 4 . 3 Write down the equation which links energy (*E*), power (*P*) and time (*t*).

[1 mark]

energy = power × time or E = P × t

0 4 . 4 The hydroelectric generator transfers electrical power of 3000 W to the village.

Calculate the energy transferred to the village in 60 minutes.

[3 marks]

t = 3600 s

E = 3000 × 3600

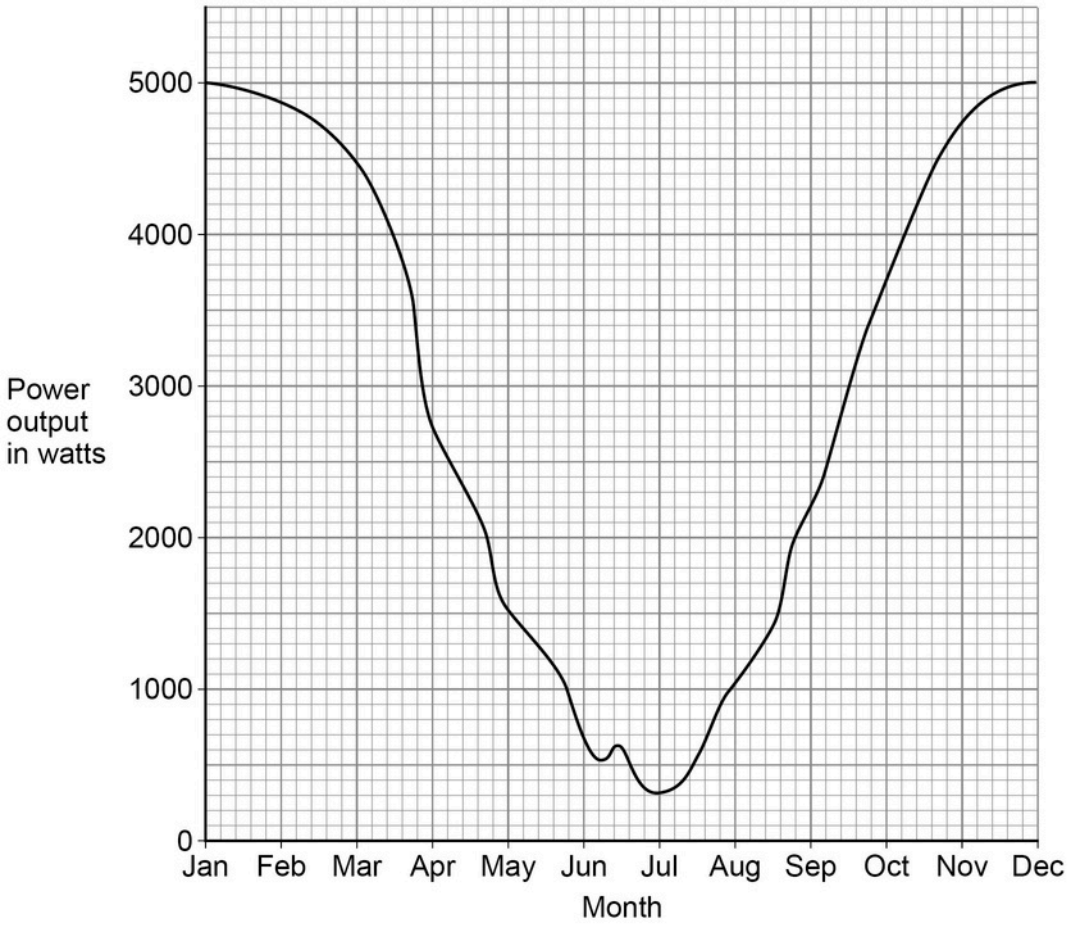
Energy transferred = 10800000 J

Do not write outside the box

0 4 . 5 The hydroelectric generator is turned by falling river water.

Figure 5 shows how the power output of the hydroelectric generator varied during one year.

Figure 5



Explain one reason why the power output varied.

[2 marks]

The level of the water in the river varies and is lower in the summer months

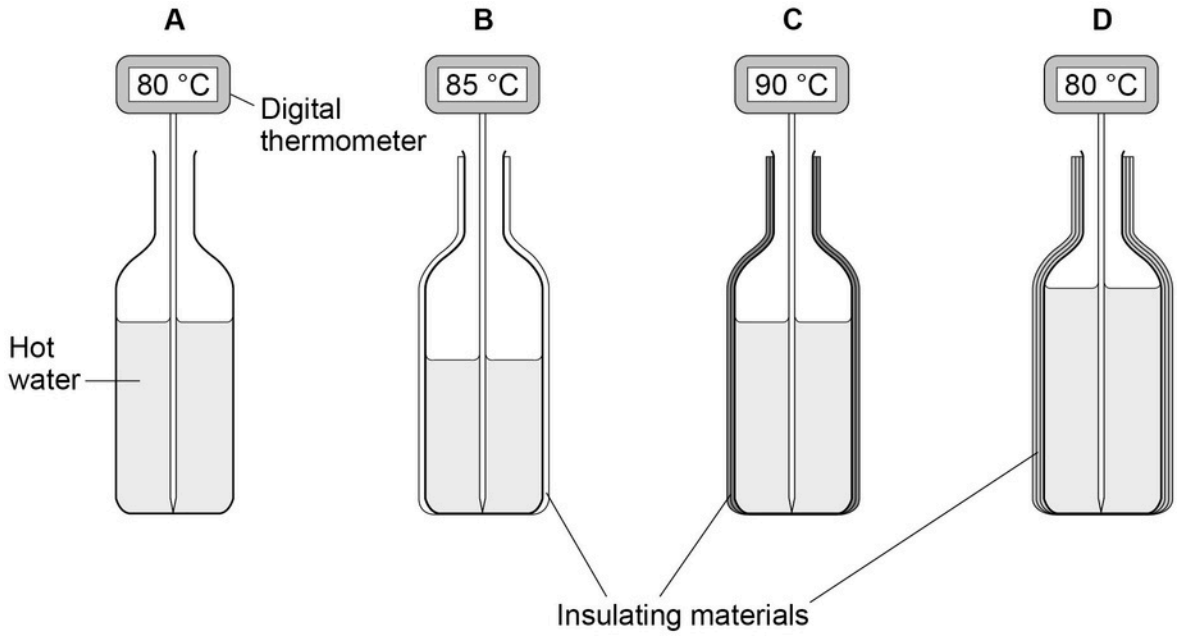
10

Turn over ►

Do not write outside the box

0 5 A student investigated how different insulating materials affect the energy transfer from bottles of very hot water.
Figure 6 shows some of the equipment used.

Figure 6



0 5 . 1 To prevent spillages the student used a funnel to pour very hot water into each bottle.

Why did the student use the funnel?

[1 mark]

Tick (✓) one box.

Preventing spillages was a control variable. ☐

To make the investigation valid. ☐

Using the funnel was a safety precaution. ☑

0 5 . 2 Why did the student not use insulation for bottle A?

[1 mark]

Tick (✓) one box.

Bottle A was the control. ✓

Bottle A was the fair test.

Bottle A was the independent variable.

Question 5 continues on the next page

Do not write outside the box

Do not write outside the box

The student recorded how much the temperature of the water in each bottle changed in five minutes.

0 5 . 3 What equipment could the student use to measure time?

[1 mark]

stopclock / stopwatch

0 5 . 4 Table 4 shows the results.

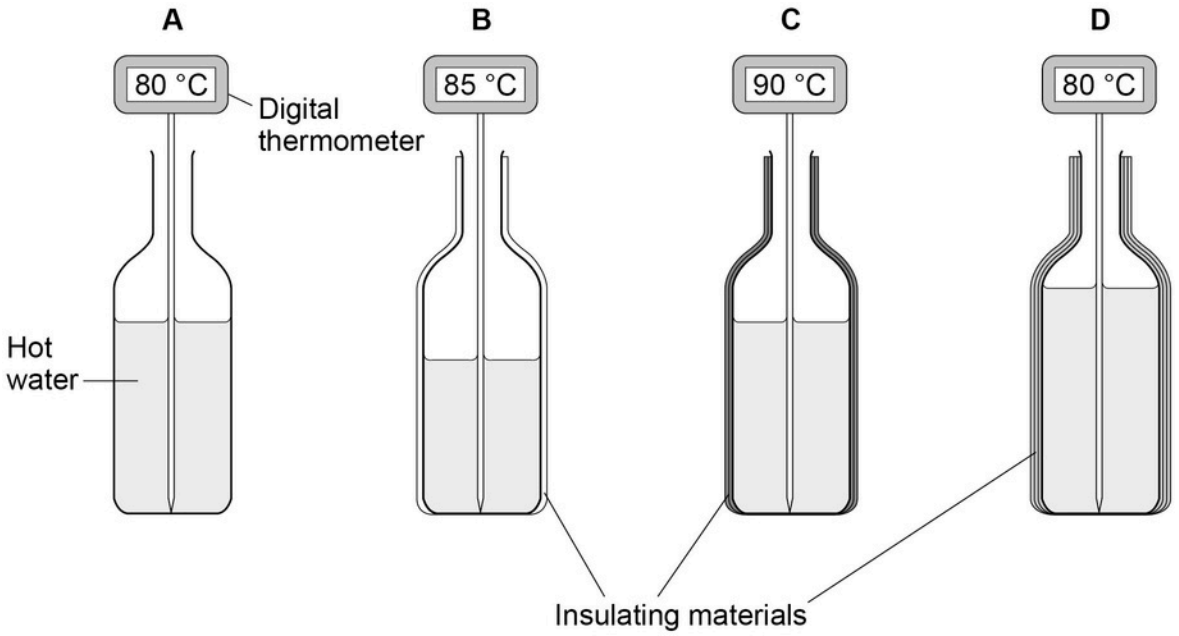
Table 4

Bottle	Insulation	Start temperature in °C	Final temperature in °C	Temperature change in °C
A	None	80	60	20
B	1 layer of paper	85	70	15
C	2 layers of card	90	75	15
D	3 layers of bubble wrap	80	70	10

Do not write outside the box

Figure 6is repeated below.

Figure 6



The student could not make a valid conclusion from the results about how different insulating materials affect the energy transfer.

Explain two ways that the student could improve the investigation to be able to make a valid conclusion.

Use Figure 6 and Table 4.

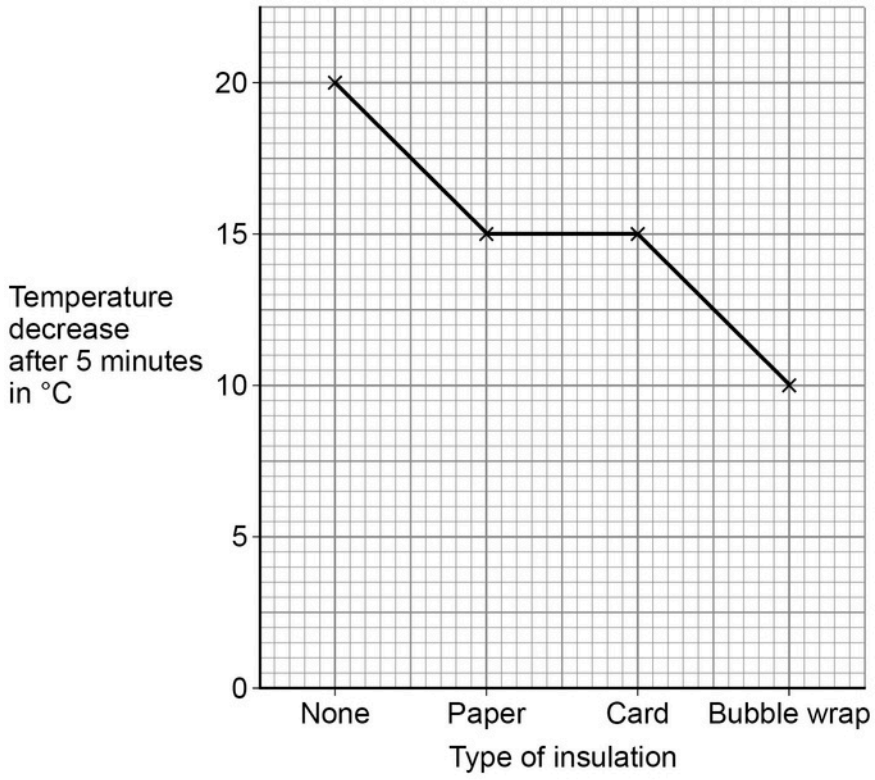
[4 marks]

• Use the same (start) temperature for each experiment
• Use the same number of layers of insulation

Do not write outside the box

0 5 . 5 Figure 7 shows the graph plotted by the student.

Figure 7



The student should not have plotted a line graph.

What type of graph should the student have plotted?

Give a reason for your answer.

[2 marks]

Type of graph bar chart

Reason type of insulation is not numerical values

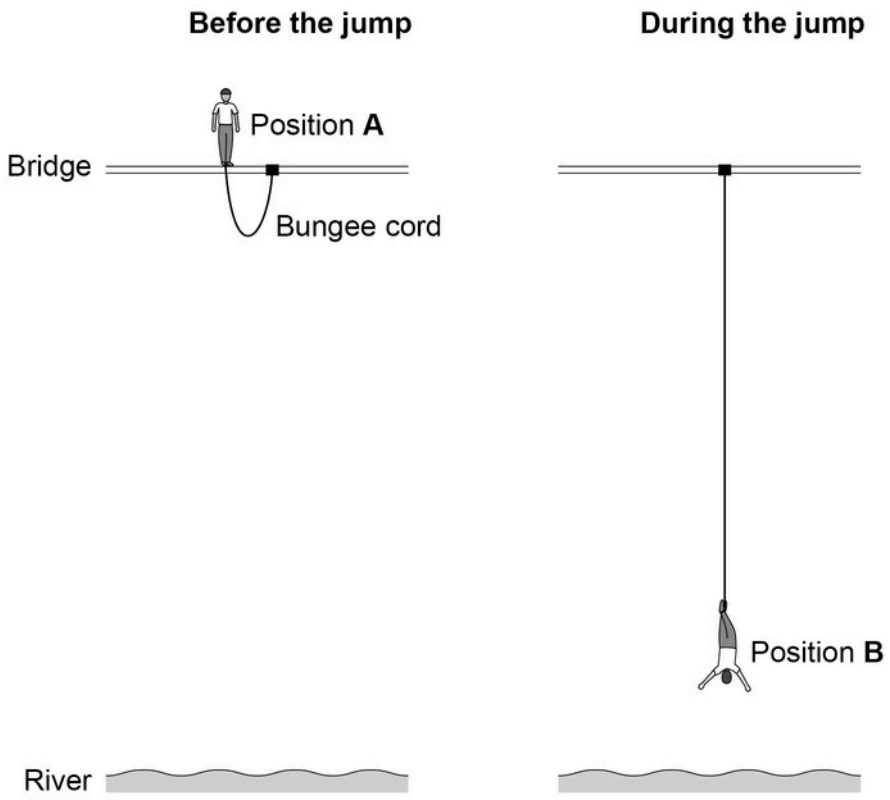
9

Do not write outside the box

0 6 Figure 8 shows a student before and during a bungee jump.

The diagram is not to scale.

Figure 8



0 6 . 1 In position B, the student is moving towards the river and the bungee cord is stretching.

How do the energy stores in position B compare with the energy stores in position A?

[3 marks]

Tick (✓) one box in each row.

Energy store	Less than at A	The same as at A	More than at A
The student's gravitational potential energy	✓		
The student's kinetic energy			✓
The bungee cord's elastic potential energy			✓

Do not write outside the box

0 6 . 2 The bungee cord behaves like a spring with a spring constant of 78.4 N/m.

At one point in the bungee jump, the extension of the bungee cord is 25 m.

Calculate the elastic potential energy stored by the bungee cord.

Use the equation:

elastic potential energy = 0.5 × spring constant × extension2

[2 marks]

$E_e = 0.5 \times 78.4 \times 25^2$

$E_e = 24,500$

Elastic potential energy = _____ J

Do not write outside the box

Table 5 shows information about different bungee cords.

Table 5

Bungee cord	Spring constant in N/m	Maximum extension before snapping in metres
A	78.4	36
B	82.0	24
C	84.5	12

0 6 . 3 Bungee cord C will have a smaller extension than A or B for any bungee jumper.

Give the reason why.

[1 mark]

Bungee cord C have a smaller extension than A or B for any bungee jumber because of greatest spring constant

0 6 . 4 Which bungee cord would be safest to use for a person with a large weight?

Give a reason for your answer.

[2 marks]

Bungee cord A

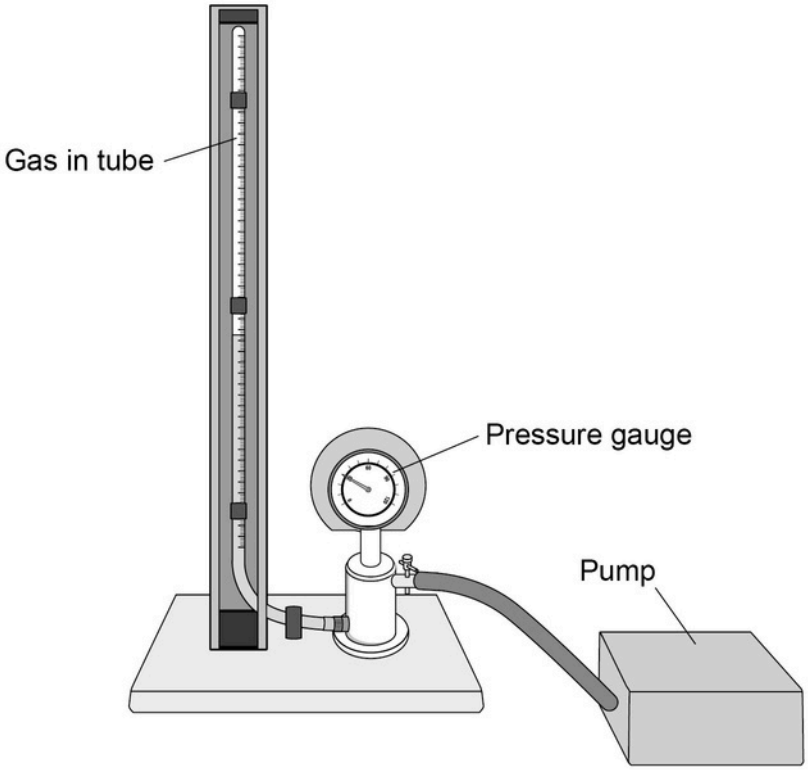
Reason Greatest extension before snapping

8

Do not write outside the box

0 7 A teacher demonstrated the relationship between the pressure and the volume of a fixed mass of gas at a constant temperature.
Figure 9 shows the equipment used.

Figure 9



0 7 . 1 Complete the sentence.

Choose the answer from the box.

[1 mark]

circular paths	random directions	the same direction

Particles in a gas move in random directions.

Do not write outside the box

0 7 . 2 Complete the sentence.

Choose the answer from the box.

[1 mark]

a constant speed	a constant velocity	a range of speeds

Particles in a gas move with a range of speeds.

Question 7 continues on the next page

Do not write outside the box

0 7 . 3 Table 6 shows some of the results.

Table 6

Pressure in kPa	Volume in cm3
300	10
200	15
150	20
120	25
100	30

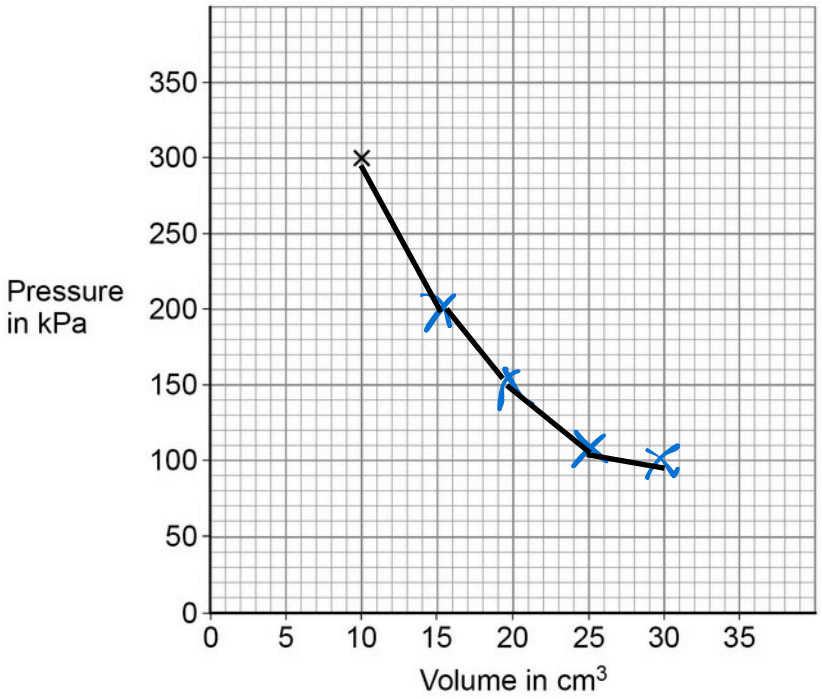
Complete Figure 10. The first point has been plotted for you.

You should:

- plot the points from Table 6
- draw the line of best fit.

[3 marks]

Figure 10



Do not write outside the box

0 7 . 4 The relationship between the pressure and the volume of a gas is given by the equation:

pressure × volume = constant

Calculate the constant when the pressure of the gas was 300 kPa.

Use Table 6.

[2 marks]

300 x 10 = Constant

Constant = 3000

Constant = _____ kPa cm3

0 7 . 5 When the volume of the gas increases, the pressure in the gas decreases.

The temperature of the gas stays the same.

How does increasing the volume affect each of the following quantities?

[3 marks]

Tick (✓) one box in each row.

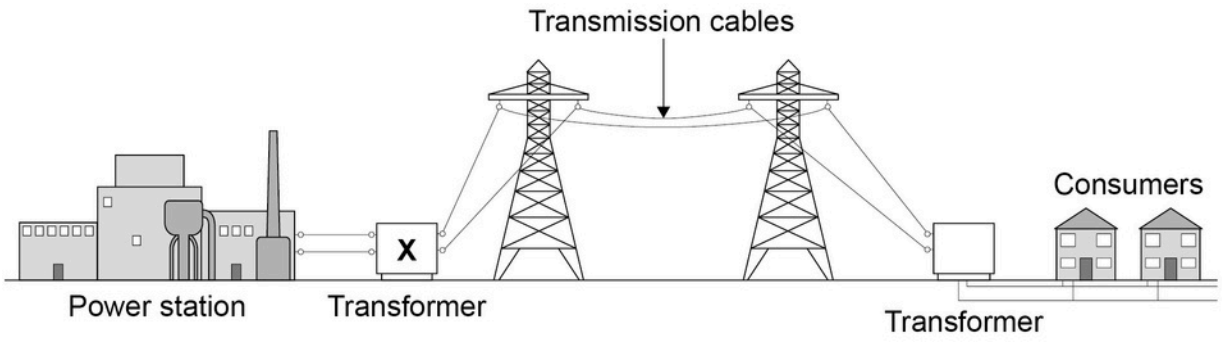
Quantity	Decreases	Stays the same	Increases
Mean time between collisions of the particles with the tube			✓
Mean distance between the particles			✓
Mean speed of the particles		✓	

10

Do not write outside the box

0 8 Figure 11 shows how the National Grid connects a power station to consumers.

Figure 11



0 8 . 1 Complete the sentences.

[2 marks]

Transformer X causes the potential difference to increase .

decrease

Transformer X causes the current to .

Use the Physics Equations Sheet to answer questions 08.2 and 08.3.

0 8 . 2 Which equation links current (I), power (P) and resistance (R)?

[1 mark]

Tick (✓) one box.

$P = \frac{I}{R}$ ☐

$P = \frac{I}{R^2}$ ☐

$P = I^2R$ ✓

$P = \frac{R}{I}$ ☐

Do not write outside the box

0 8 . 3 A transmission cable has a power loss of 1.60 × 109 W.

The current in the cable is 2000 A.

Calculate the resistance of the cable. [3 marks]

$1.60 \times 10^9 = 2000^2 \times R$

$R = \frac{1.60 \times 10^9}{2000^2}$

Resistance = 400 Ω

Use the Physics Equations Sheet to answer questions 08.4 and 08.5.

0 8 . 4 Write down the equation which links efficiency, total energy input and useful energy output. [1 mark]

efficiency = useful energy output / total energy input

0 8 . 5 The total energy input to the National Grid from one power station is 34.2 GJ.

The National Grid has an efficiency of 0.992

Calculate the useful energy output from this power station to consumers in GJ. [3 marks]

$0.992 = \frac{\text{useful energy output}}{34.2}$

$= 0.992 \times 34.2$

Useful energy output = 33.9 GJ

10

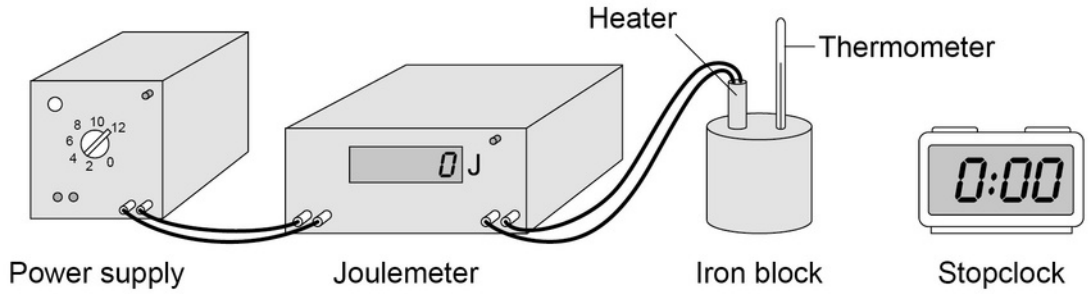
Turn over ▶

Do not write outside the box

0 9 Figure 12 shows the equipment a student used to determine the specific heat capacity of iron.

The iron block the student used has two holes, one for the heater and one for the thermometer.

Figure 12



0 9 . 1 Before the power supply was switched on, the thermometer was used to measure the temperature of the iron block.
The student left the thermometer in the iron block for a few minutes before recording the initial temperature.

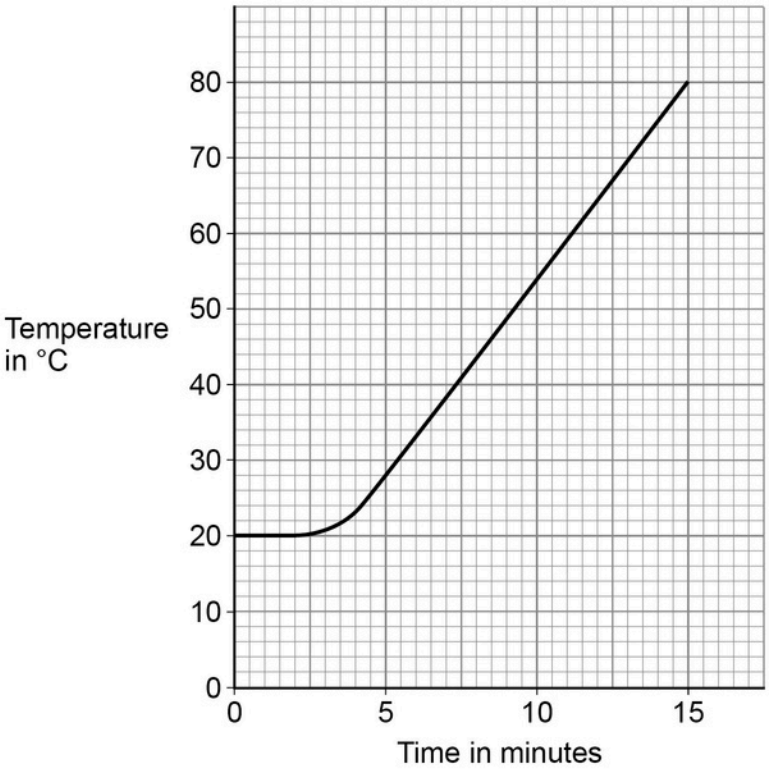
Suggest why.
[1 mark]

So the thermometer temperature was the same as the temperature of the iron block

Do not write outside the box

0 9 . 2 Figure 13 shows how the temperature changed after the power supply was switched on.

Figure 13



The energy transferred to the iron block between 5 and 10 minutes was 26 000 J.

The mass of the iron block was 2.0 kg.

Calculate the specific heat capacity of iron.

Use information from Figure 13 and the Physics Equations Sheet. [4 marks]

$\Delta\theta = (54 - 28) = 26\,^{\circ}C$

$2600 = 2.0 \times c \times 26$

$c = \frac{2600}{2.0 \times 26}$

Specific heat capacity = 500 J/kg °C

Turn over ►

Do not write outside the box

0 9 . 3 The student repeated the investigation but wrapped insulation around the iron block.

What effect will adding insulation have had on the investigation?

[2 marks]

Tick (✓) two boxes.

- The calculated specific heat capacity will be more accurate. ☑
- The iron block will transfer thermal energy to the surroundings at a lower rate. ☑
- The power output of the heater will be lower than expected. ☐
- The temperature of the iron block will increase more slowly than expected. ☐
- The uncertainty in the temperature measurement will be greater. ☐

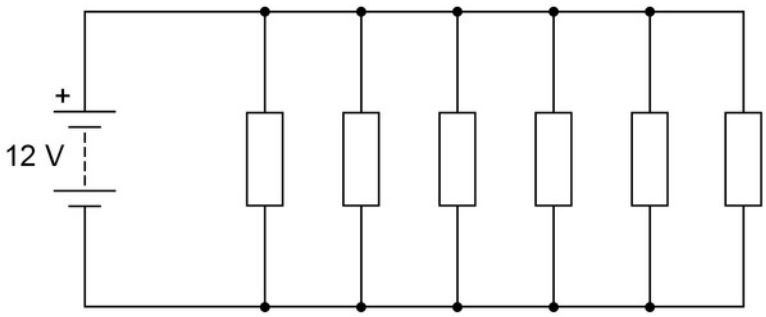
7

Do not write outside the box

1 0 Figure 14 shows an electrical circuit used to heat the windscreen of a car.

Each resistor in the circuit represents a heating element.

Figure 14



1 0 . 1 The 12 V battery supplies direct potential difference.

What is meant by 'direct potential difference'?

[1 mark]

Polarity of the potential difference doesn't change

Use the Physics Equations Sheet to answer questions 10.2 and 10.3.

1 0 . 2 Which equation links charge flow (Q), energy (E) and potential difference (V)?

[1 mark]

Tick (☒) one box.

$E = \frac{V}{Q}$ ☐

$E = QV$ ☒

$E = \frac{Q}{V}$ ☐

$E = \frac{V^2}{Q}$ ☐

Do not write outside the box

1 0 . 3 Calculate the charge flow through the 12 V battery when the battery transfers 5010 J of energy.

[3 marks]

$5010 = Q \times 12$

$Q = \frac{5010}{12}$

Charge flow = 417.5 C

1 0 . 4 Ice forms on the windscreen at a temperature of 0 °C.

The electrical circuit transfers 5010 J of energy to the ice.

A mass of 0.015 kg of ice melts.

Calculate the specific latent heat of fusion of water.

Use the Physics Equations Sheet.

[3 marks]

$5010 = 0.015 \times L$

$L = \frac{5010}{0.015}$

Specific latent heat of fusion of water = 334000 J/kg

Do not write outside the box

1 0 . 5 The electrical circuit was left switched on while the ice changed from a solid to a liquid and increased in temperature to 5 °C.
Explain the changes in the arrangement and movement of the particles as the ice melted and the temperature increased to 5 °C.

[6 marks]

particles in a solid are in a regular pattern
• particles in a liquid are in a random arrangement
• particles in a solid are vibrating about fixed positions
• particles in a liquid are moving freely
• as the ice changes to water the temperature remains constant
• because as the ice changes to water the potential energy of the particles increases
• as the water warms the particles move faster
• so the kinetic energy of the particles increases
• internal energy is the total kinetic and potential energy of all the particles

14

END OF QUESTIONS

There are no questions printed on this page

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