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 boxes at the top of this page.
- Answer **all** questions in the spaces provided.
- Do not write outside the 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	

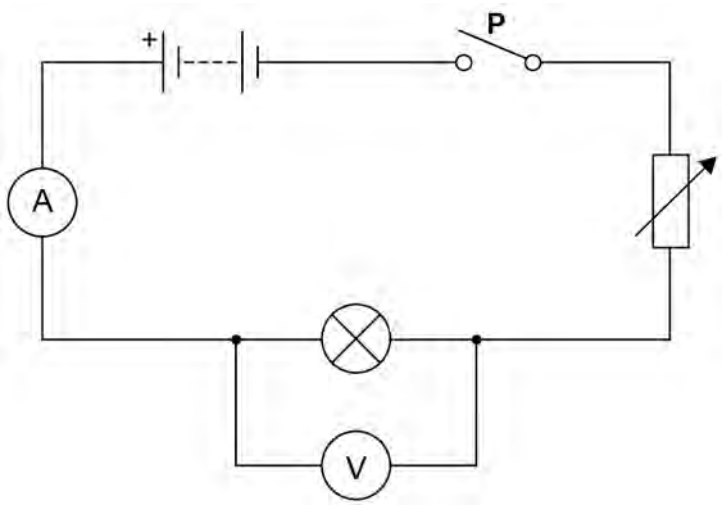
Answer **all** questions in the spaces provided.

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]

_____

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 _____ .

The voltmeter in the circuit measures _____ .

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?

[3 marks]

Tick (✓) **one** box in **each** row.

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 = _____ 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]

Resistance = _____ Ω

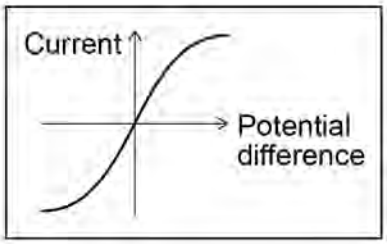
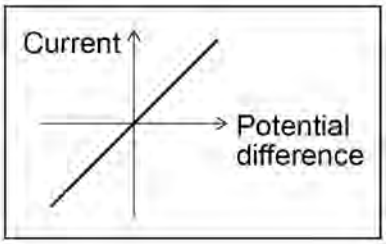
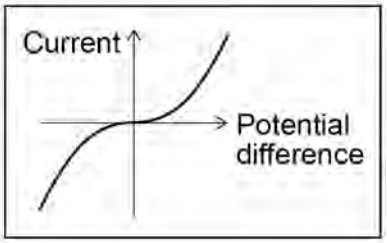
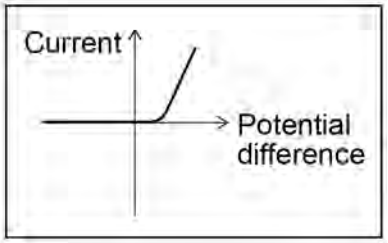
Do not write outside the box

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]

Component	Graph
Diode	
Filament lamp	
Resistor	
	

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 ☐

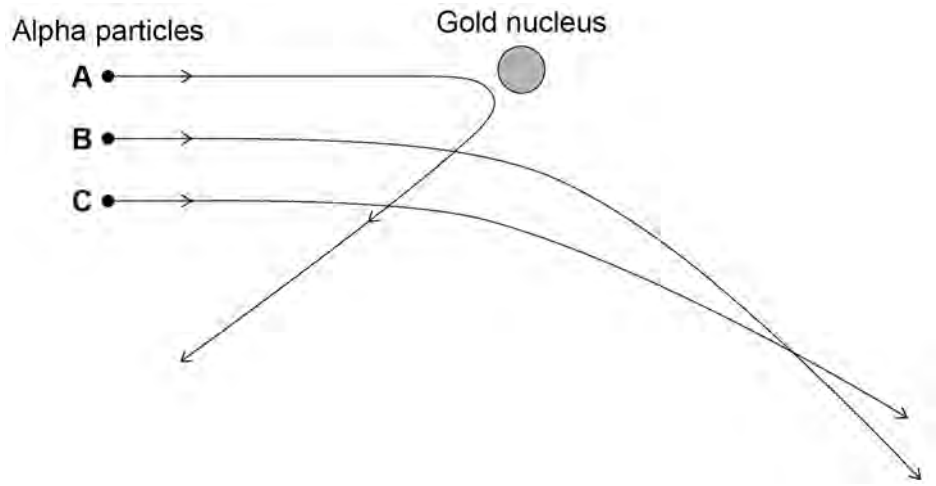
Question 2 continues on the next page

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 of a gold nucleus = _____ 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]

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

[1 mark]

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 _____ .

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

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 ☐

Do not write outside the box

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]

Term	Example
Radioactive contamination	Exposure to a beam of gamma rays
Nuclear irradiation	Exposure to ultraviolet radiation from the Sun
	Accidental transfer of plutonium onto a human body
	Using a mobile phone

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?

[1 mark]

Tick (✓) **one** box.

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 = _____

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]

Process	**Fuel**
	Hydrogen
Nuclear fission	Iron
Nuclear fusion	Lead
	Uranium

11

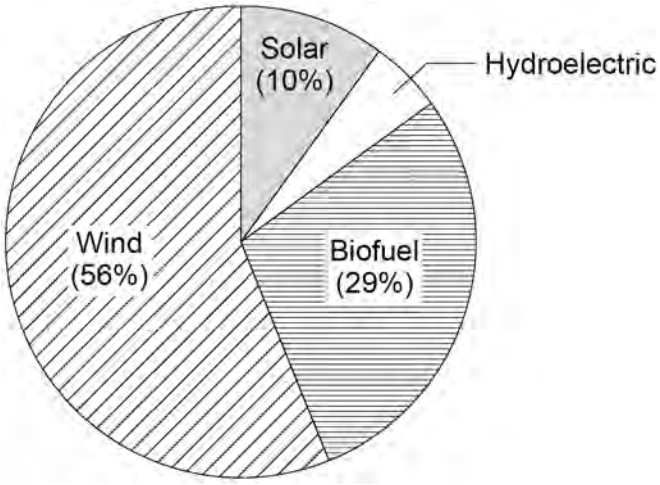
Turn over for the next question

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]

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]

Decrease in gravitational potential energy = _____ 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]

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]

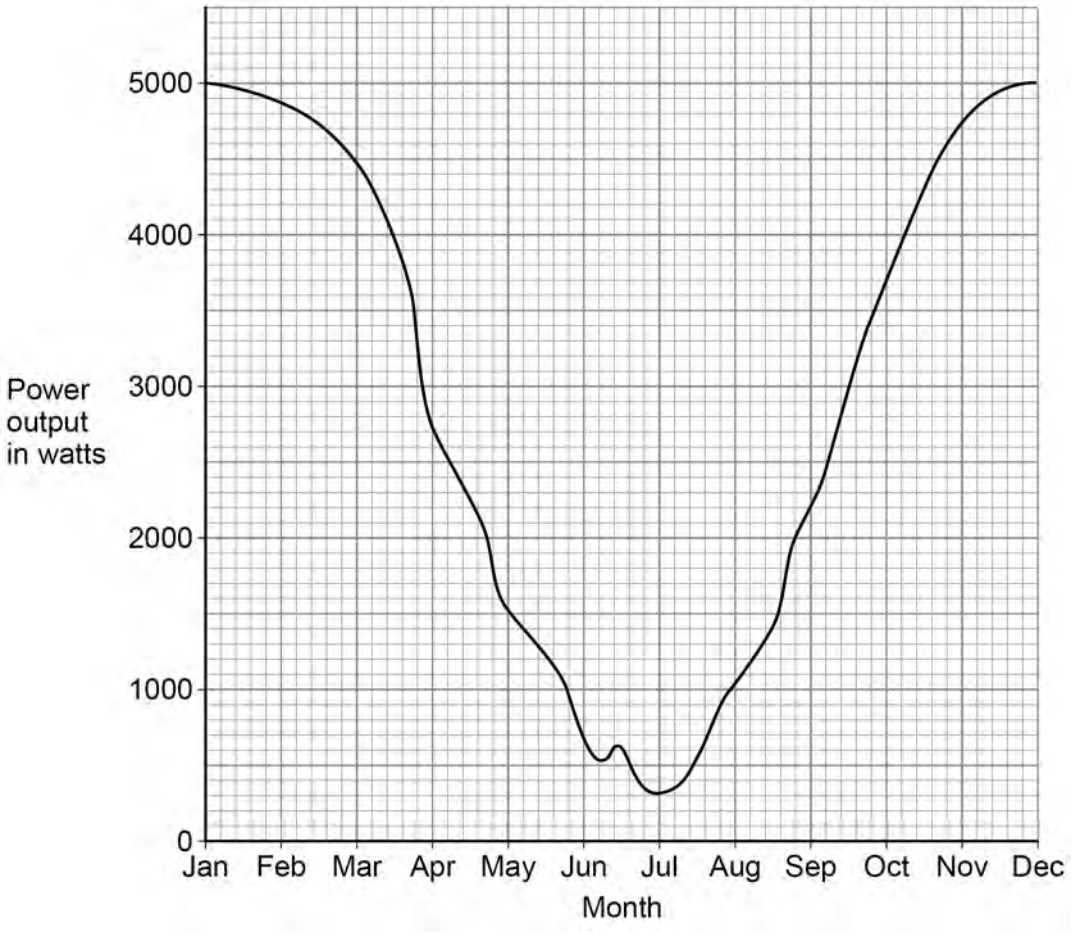
Energy transferred = _____ J

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]

10

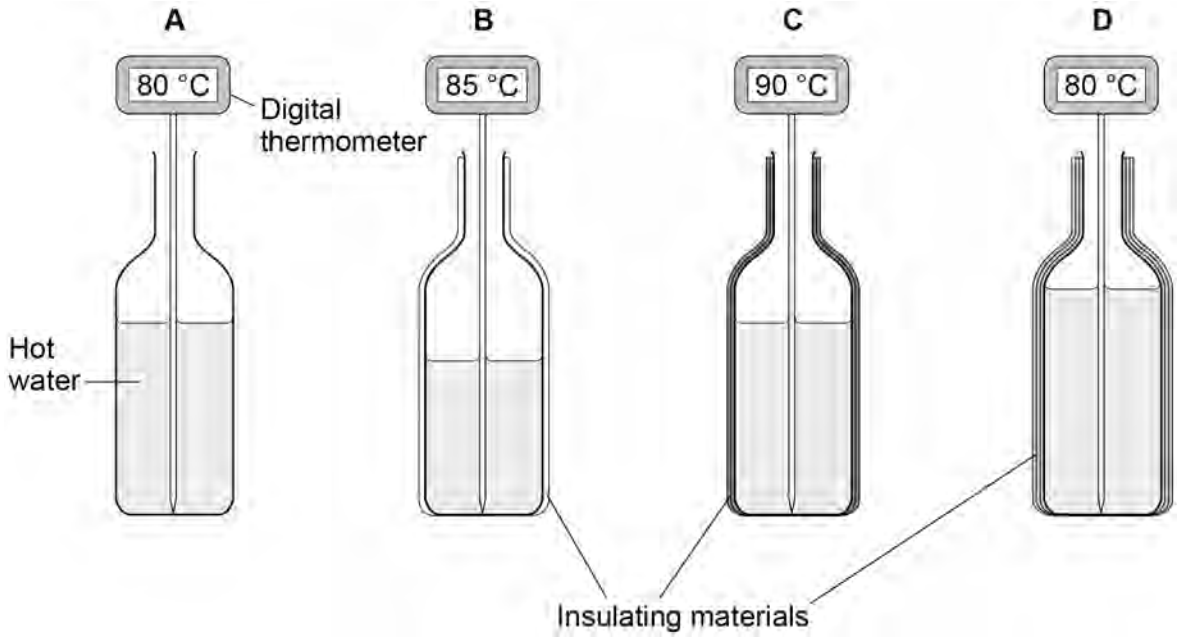
Turn over ►

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. ☐

Do not write outside the box

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

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]

0 5 . 4 **Table 4** shows the results.

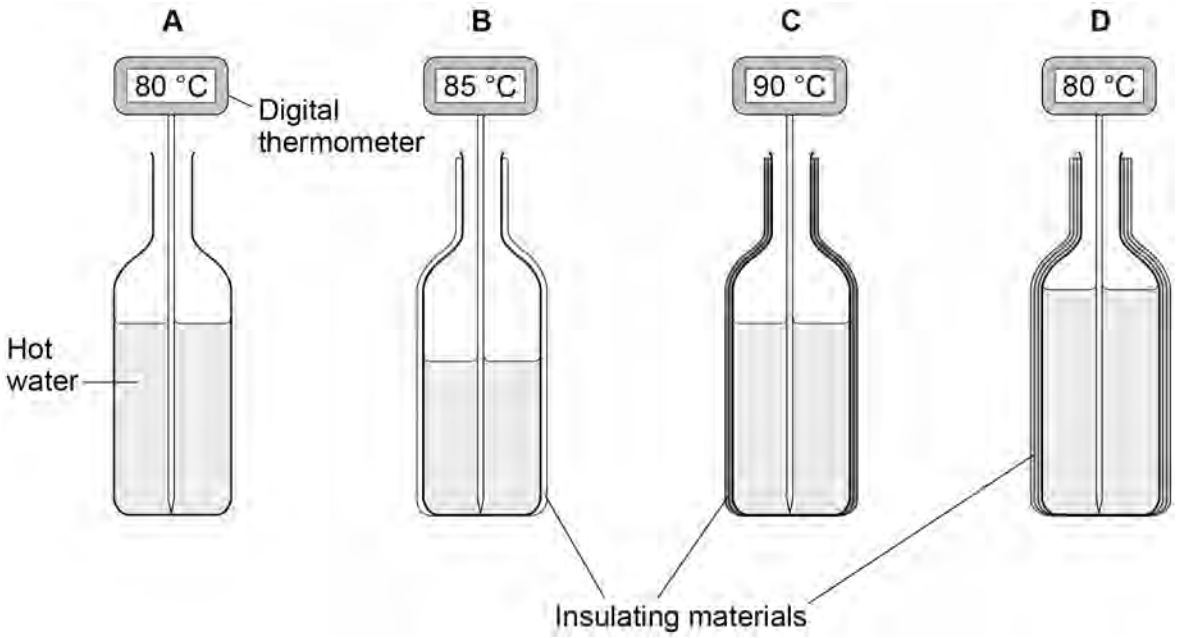
Table 4

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 6 is 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.

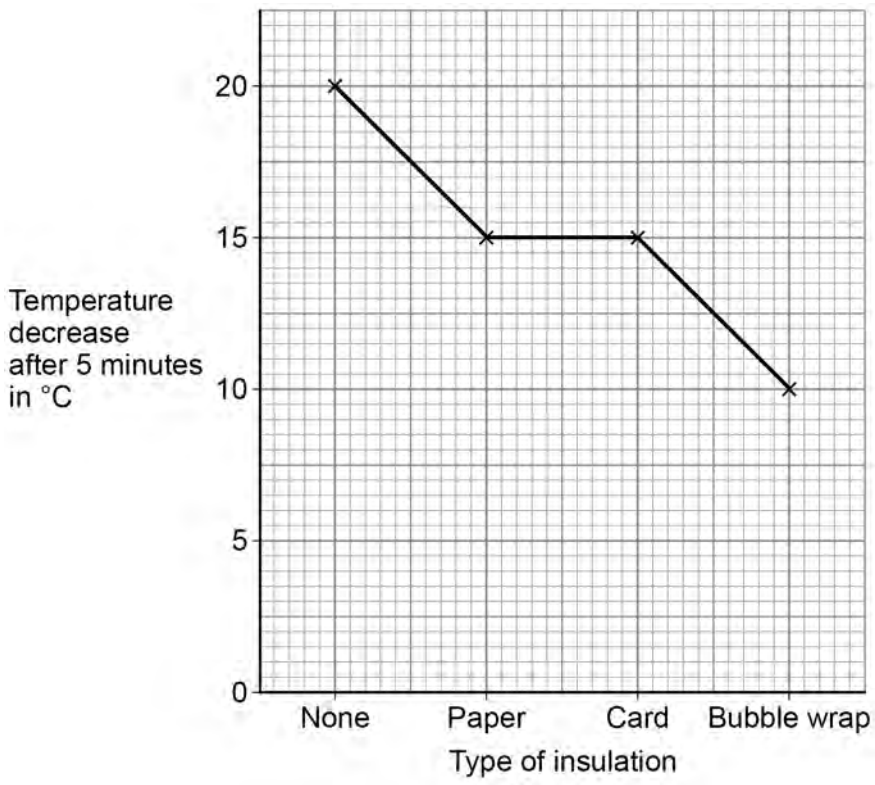
Use **Figure 6** and **Table 4**.

[4 marks]

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 _____

Reason _____

_____

_____

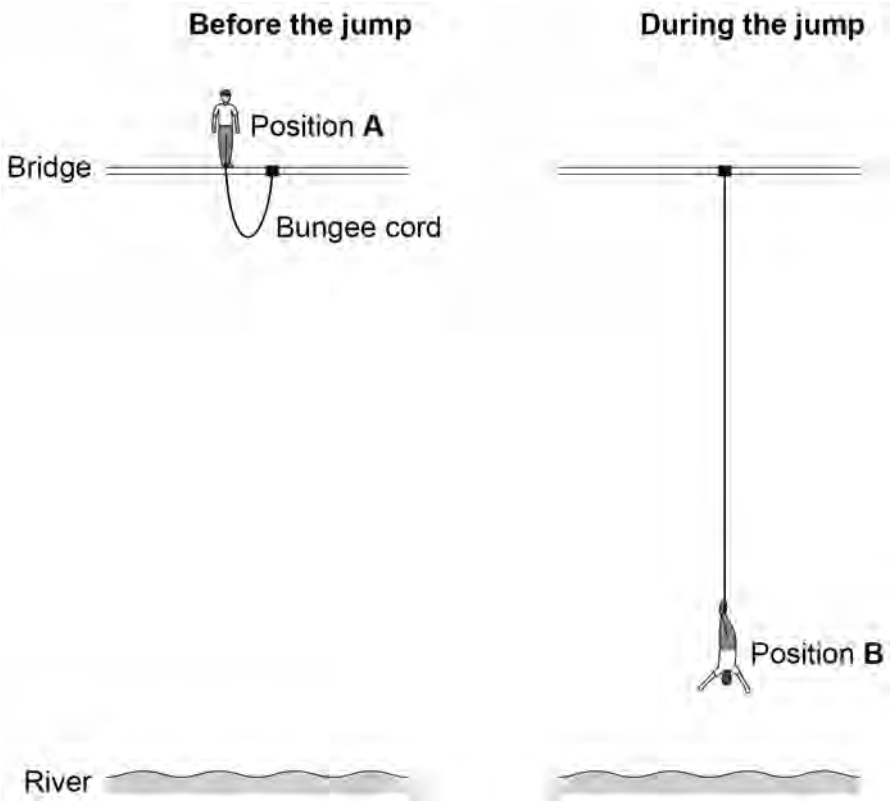
9

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 × extension^2

[2 marks]

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]

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 _____

Reason _____

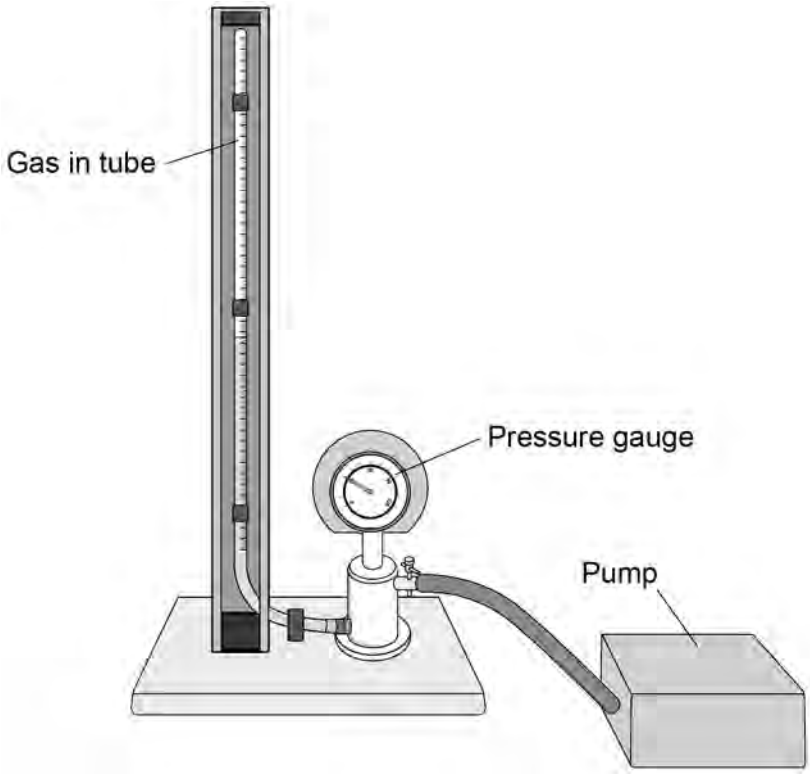
8

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 _____.

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 _____.

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 cm^3
300	10
200	15
150	20
120	25
100	30

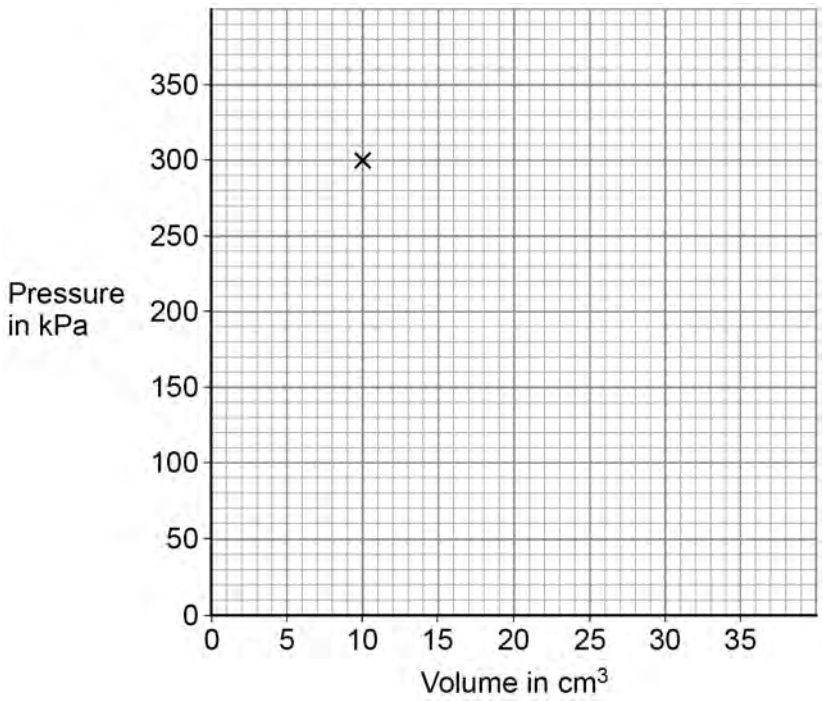
Complete **Figure 10**. The first point has been plotted for you.

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]

Constant = _____ kPa cm^3

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.

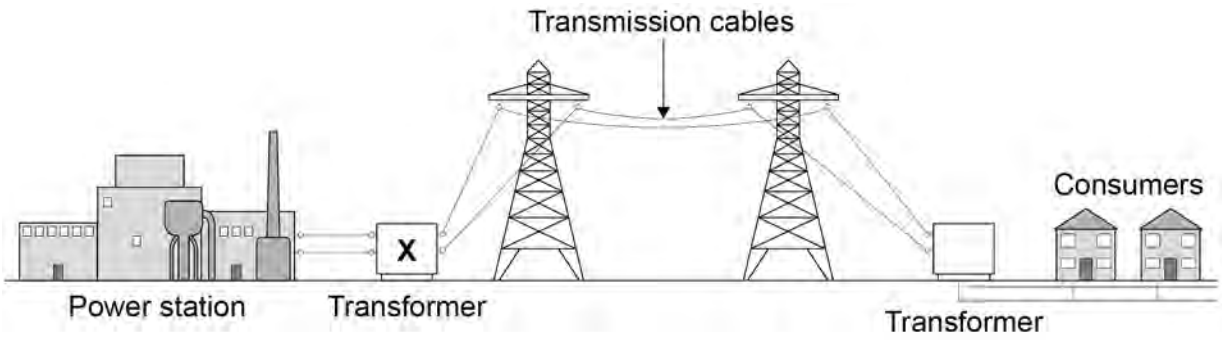
Quantity	Decreases	Stays the same	Increases
Mean time between collisions of the particles with the tube			
Mean distance between the particles			
Mean speed of the particles			

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 _____ .

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.

$P = \frac{I}{R}$ ☐

$P = \frac{I}{R^2}$ ☐

$P = I^2 R$ ☐

$P = IR$ ☐

Do not write outside the box

0 8 . 3 A transmission cable has a power loss of 1.60×10^9 W.

The current in the cable is 2000 A.

Calculate the resistance of the cable.

[3 marks]

Resistance = _____ 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]

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]

Useful energy output = _____ GJ

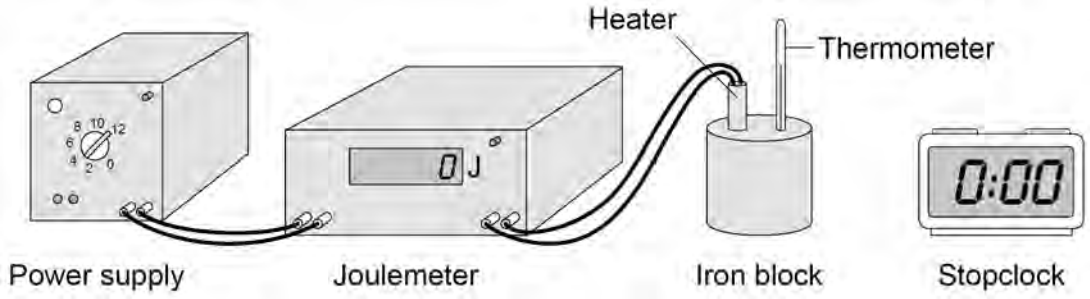
10

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.

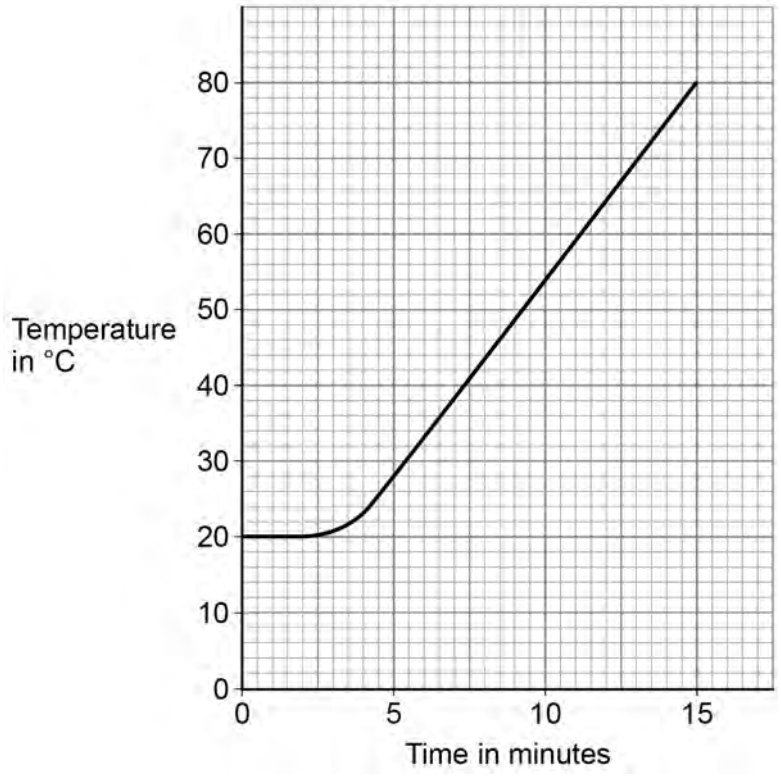
Suggest why.

[1 mark]

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]

Specific heat capacity = _____ 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. ☐

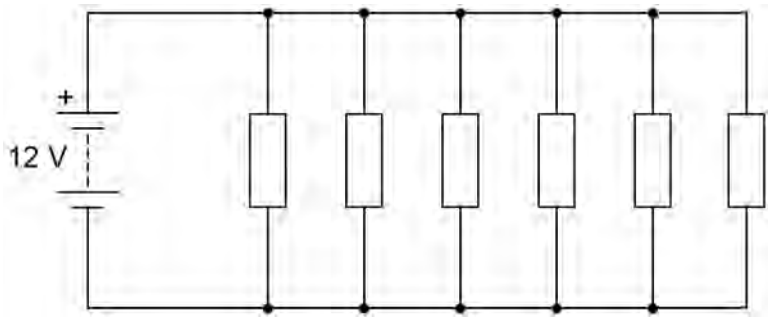
7

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]

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.

$E = \frac{V}{Q}$ ☐

$E = QV$ ☐

$E = \frac{Q}{V}$ ☐

$E = \frac{V^2}{Q}$ ☐

Turn over ►

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]

Charge flow = _____ 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]

Specific latent heat of fusion of water = _____ 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]

14

END OF QUESTIONS

There are no questions printed on this page

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ANSWER IN THE SPACES PROVIDED

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Question number	**Additional page, if required.** **Write the question numbers in the left-hand margin.**

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