AQA

Please write clearly in block capitals.

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

Surname _____

Forename(s) _____

Candidate signature _____

I declare this is my own work.

GCSE PHYSICS

H

Higher 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	
TOTAL	

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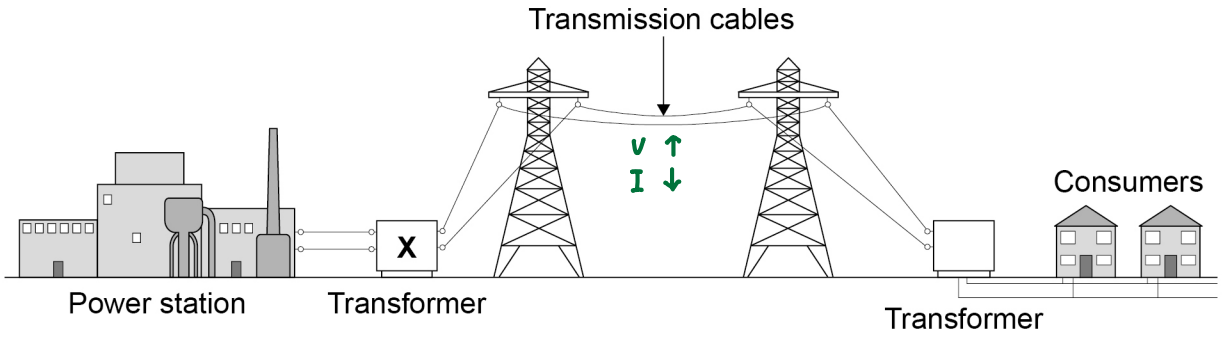
Answer **all** questions in the spaces provided.

0 1 **Figure 1** shows how the National Grid connects a power station to consumers.

Figure 1



0 1 . 1 Complete the sentences.

[2 marks]

Transformer **X** causes the potential difference to Increase .

Transformer **X** causes the current to Decrease .

Use the Physics Equations Sheet to answer questions **01.2** and **01.3**.

0 1 . 2 Which equation links current (I), power (P) and resistance (R)?

[1 mark]

Tick (✓) **one** box.

power = (current)^2 × resistance $P = I^2 R$

$P = \frac{I}{R}$ ☐

$P = \frac{I}{R^2}$ ☐

$P = I^2 R$ ☑

$P = IR$ ☐

Do not write outside the box

0 1 . 3 A transmission cable has a power loss of 1.60×10^9 W. P

The current in the cable is 2000 A. I

Calculate the resistance of the cable. R

[3 marks]

$P = 1.60 \times 10^9$ W (J/s) $\quad P = I^2R$

$I = 2000$ A $\quad I^2R = P$

$R = ?$ $\quad R = \frac{P}{I^2} = \frac{1.60 \times 10^9}{2000^2}$

$= 400\ \Omega$

Resistance = 400 Ω

Use the Physics Equations Sheet to answer questions **01.4** and **01.5**.

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

efficiency = useful power output / total power input **[1 mark]**

Efficiency = Useful power output / Total power input

0 1 . 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]

Efficiency = Useful energy output / Total energy input

Useful energy output = Total energy input × Efficiency

$= 34.2\ GJ \times 0.992$

$= 33.9$ GJ

Useful energy output = 33.9 GJ

10

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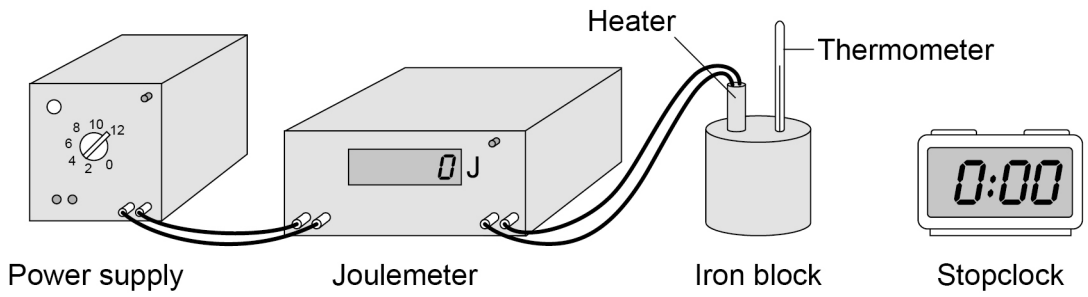
0 2 **Figure 2** shows the equipment a student used to determine the specific heat capacity of iron.

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

Figure 2



0 2 . 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 that the thermometer temperature was the same as the temperature of the iron block.

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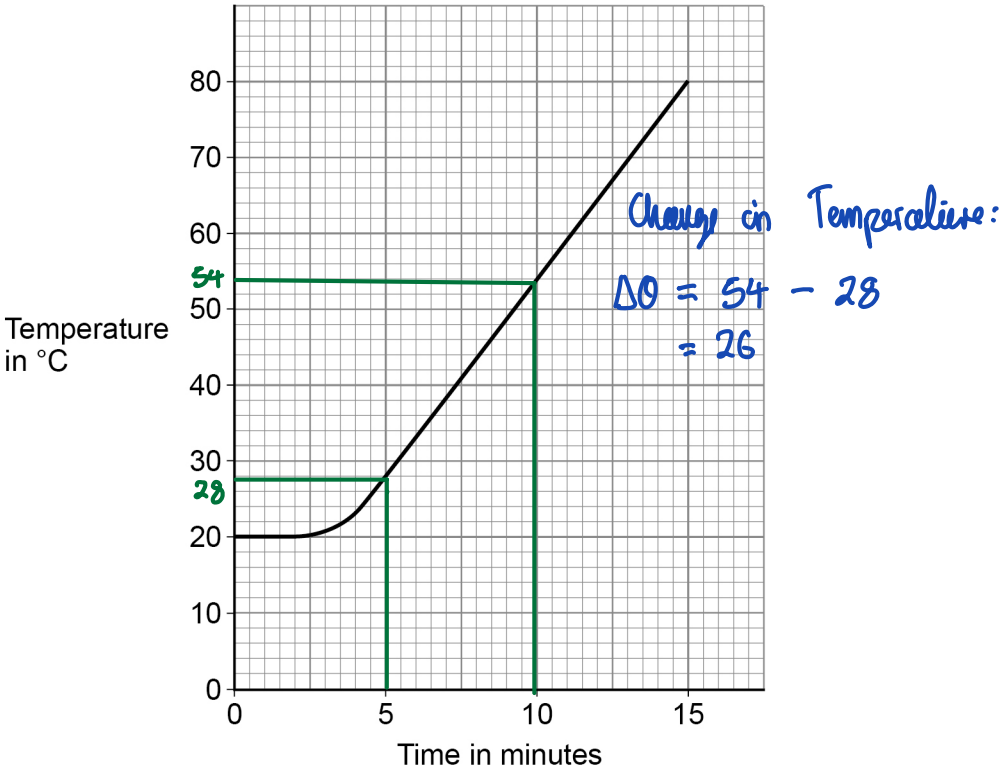
0 2 . 2 **Figure 3** shows how the temperature changed after the power supply was switched on.

Figure 3



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

The mass of the iron block was 2.0 kg. m

Calculate the specific heat capacity of iron. c = ?

Use information from **Figure 3** and the Physics Equations Sheet.

[4 marks]

change in thermal energy = mass × specific heat capacity × temperature change | $\Delta E = m\ c\ \Delta\theta$

ΔE = m c ΔΘ

ΔE = 26 000 J

m c ΔΘ = ΔE

m = 2.0 kg

$c = \frac{\Delta E}{m\ \Delta\theta}$

c = ?

ΔΘ = 54 − 28 = 26°C

$c = \frac{26\,000\ J}{2.0\ kg \times 26\ °C}$

c = 500 J/kg °C

Specific heat capacity = 500 J/kg °C

Do not write outside the box

0 2 . 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

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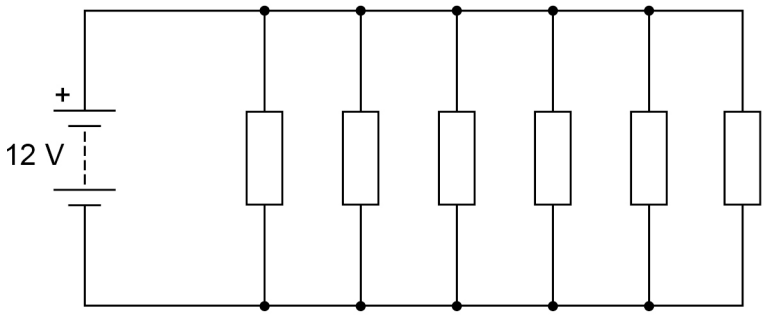
0 3 **Figure 4** shows an electrical circuit used to heat the windscreen of a car.

Each resistor in the circuit represents a heating element.

Figure 4



0 3 . 1 The 12 V battery supplies direct potential difference.

What is meant by 'direct potential difference'?

[1 mark]

Polarity of the potential difference does not change.

Use the Physics Equations Sheet to answer questions **03.2** and **03.3**.

0 3 . 2 Which equation links charge flow (Q), energy (E) and potential difference (V)?

[1 mark]

Tick (✓) **one** box.

energy transferred = charge flow × potential difference | $E = Q\,V$

$E = \frac{V}{Q}$ ☐

$E = QV$ ☑

$E = \frac{Q}{V}$ ☐

$E = \frac{V^2}{Q}$ ☐

Do not write outside the box

0 3 . 3 Calculate the charge flow through the 12 V battery when the battery transfers 5010 J of energy. **[3 marks]**

$E = 5010\ J$

$Q = ?$

$V = 12\ V$

$E = QV$

$QV = E$

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

$Q = 417.5\ C$

Charge flow = 417.5 C

0 3 . 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.

thermal energy for a change of state = mass × specific latent heat | $E = mL$ **[3 marks]**

$E = 5010\ J$

$m = 0.015\ kg$

$L = ?$

$E = mL$

$mL = E$

$L = \frac{E}{m} = \frac{5010\ J}{0.015\ kg}$

$L = 334000\ J/kg$

Specific latent heat of fusion of water = 334 000 J/kg

Do not write outside the box

0 3 . 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 arranged in a regular pattern
Particles in a liquid are arranged randomly

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 the potential energy of the particles increases.

So, 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 particles.

14

Turn over for the next question

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0 4 A remote village in the UK uses a hydroelectric generator to provide electricity.

0 4 . 1 In one day, 2 500 000 kg of water passes through the hydroelectric generator.

The change in gravitational potential energy of the water is 367.5 MJ.

gravitational field strength = 9.8 N/kg

Calculate the mean change in vertical height of the water as it moves through the hydroelectric generator.

Use the Physics Equations Sheet.

gravitational potential energy = mass × gravitational field strength × height | $E_p = m\,g\,h$ **[4 marks]**

$E_p = 367.5\ \text{MJ} = 367.5 \times 10^6\ \text{J}$

$m = 2\,500\,000\ \text{kg}$

$g = 9.8\ \text{N/kg}$

$h = ?$

$E_p = mgh$

$mgh = E_p$

$h = \dfrac{E_p}{mg}$

$= \dfrac{367.5 \times 10^6\ \text{J}}{2\,500\,000\ \text{kg}\ 9.8\ \text{N/kg}} = 15\ \text{m}$

Mean change in vertical height = 15 m

Do not write outside the box

0 4 . 2 The generator transfers 3.0 kW of electrical power.

Calculate the time taken for the generator to transfer 2.16×10^7 J of energy.

Use the Physics Equations Sheet. power = $\frac{\text{energy transferred}}{\text{time}}$ $P = \frac{E}{t}$

Give your answer in standard form.

[5 marks]

$P = 3.0\ \text{kW} = 3.0 \times 10^3\ \text{W}$

$E = 2.16 \times 10^7\ \text{J}$

$t = ?$

$P = \frac{E}{t}$

$t = \frac{E}{P}$

$t = \frac{2.16 \times 10^7\ \text{J}}{3.0 \times 10^3\ \text{W}}$

$t = 7200\ \text{s} = 7.2 \times 10^3\ \text{s}$

Time taken (in standard form) = 7.2×10^3 s

Question 4 continues on the next page

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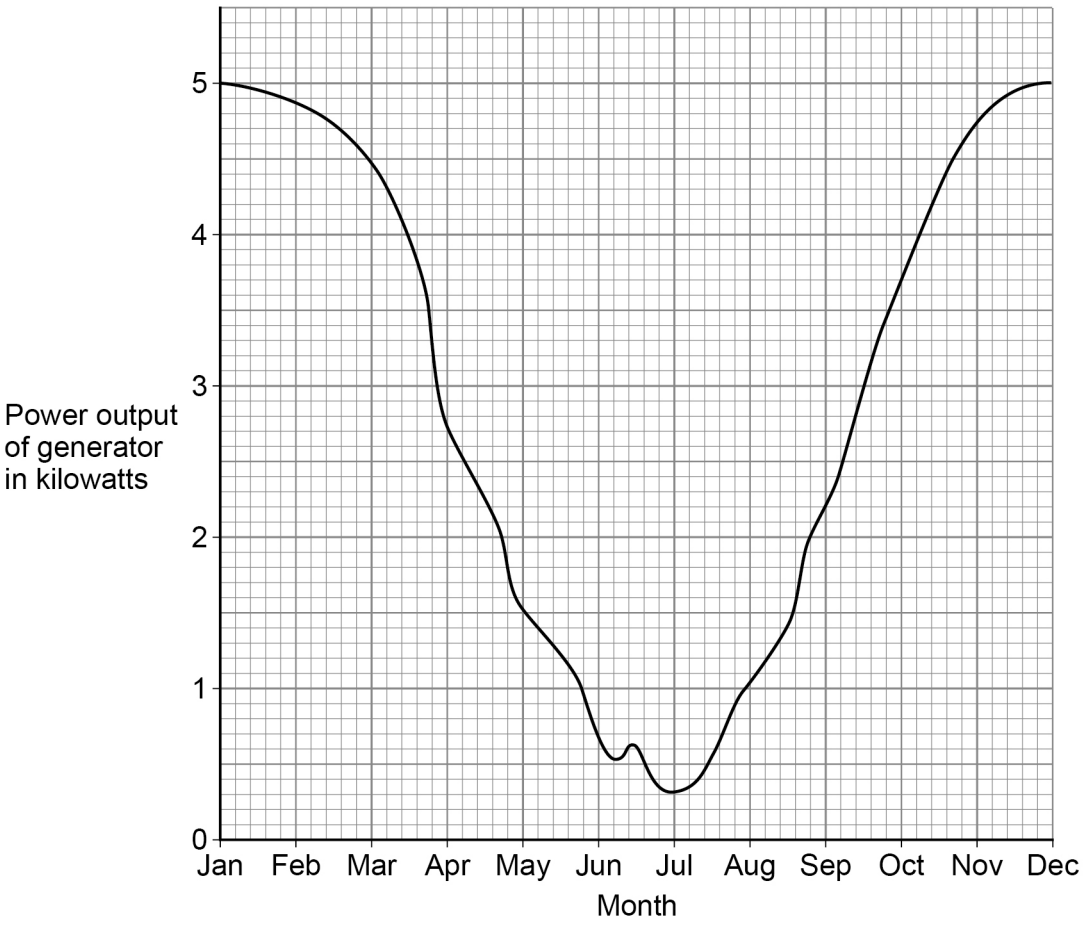
0 4 . 3 **Figure 5** shows how the power output of the generator varied during one year.

Figure 5



A solar power system is installed in the remote village in addition to the hydroelectric generator.

Explain why this improves the reliability of the electricity supply to the village.

Use information from **Figure 5**.

[2 marks]

In the summer the power output from the hydroelectric generator is lower, but the solar power output would be greater.
So less variation in total power output, which improves the reliability of the supply.

11

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0 5 Some isotopes emit nuclear radiation.

0 5 . 1 Carbon-14 and carbon-12 are isotopes of carbon.

Compare the structure of an atom of carbon-14 with the structure of an atom of carbon-12.

[3 marks]

Similarities: Same number of protons (atomic number)
Same number of electrons

Differences: Different number of neutrons
(Different mass number)

0 5 . 2 Carbon-14 is a radioactive isotope.

Carbon-14 has a half-life of 5700 years.

What does 'a half-life of 5700 years' mean?

[1 mark]

The time it takes for the number of nuclei in a radioactive sample to halve, is 5700 years.

Question 5 continues on the next page

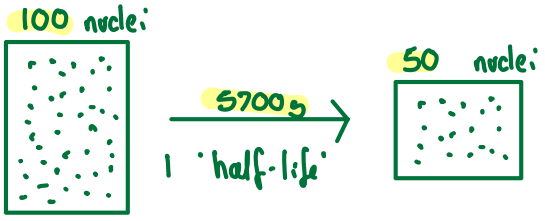

Table 1 gives the half-life of some other radioactive isotopes.

Table 1

Isotope	Half-life in seconds
Nitrogen-18	0.62
Nitrogen-17	4.17
Fluorine-17	64.37
Fluorine-18	6584.34

0 5 . 3 A sample of fluorine-17 has an activity that is one quarter of its original activity.

Calculate the age of the sample of fluorine-17.

[2 marks]

F-17 $\xrightarrow{64.37s}$ $\frac{1}{2}$ F-17 $\xrightarrow{64.37s}$ $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$ F-17

Takes 2 half-lives to reduce to $\frac{1}{4}$

$\therefore$ time = $2 \times 64.37s = 128.74s$

Age = 128.74 s

0 5 . 4 All of the isotopes in **Table 1** emit beta radiation.

Explain which isotope would cause the biggest risk to a person's health based only on the half-life of each isotope.

[3 marks]

The shorter the half-life, the quicker the decay, the more radiation emitted.

Nitrogen-18 has the shortest half-life, so greatest activity (decays per second, Bq)

So greatest dose of radiation absorbed per second.

Do not write outside the box

0 5 . 5 People who work in the nuclear power industry need to be aware of irradiation and contamination.

Describe the difference between irradiation and contamination.

[2 marks]

Irradiation is the exposure of a person/object to radiation

Contamination is the unwanted presence of radioactive material on a person or object.

0 5 . 6 Give **one** health risk to a person working close to a source of nuclear radiation.

[1 mark]

Cancer

0 5 . 7 Workers in nuclear power stations are monitored to check the radiation they emit.

A worker stands 1 cm away from a radiation detector.

The amount of radiation the worker emits is recorded.

Explain why the worker needs to stand close to the radiation detector.

[2 marks]

Some radioactive materials emit alpha radiation, which has a very short range in air.

Do not write outside the box

0 5 . 8 Workers in the nuclear power industry are exposed to nuclear radiation.

Pilots on aircraft are exposed to cosmic radiation from space.

daily dose caused by working in a nuclear power station = 0.00050 mSv

hourly dose from cosmic rays to a pilot while flying = 0.0030 mSv

Calculate the number of days it takes for a nuclear power station worker to receive the same dose as a pilot flying for 24 hours.

[3 marks]

Pilots dose in 24 hr = 24 × 0·0030 mSv

= 0·072 mSv

N° of days for worker to receive 0·072 mSv dose

$$= \frac{0{\cdot}072 \text{ mSv}}{0{\cdot}00050 \text{ mSv/day}} = 144 \text{ days}$$

Number of days = 144

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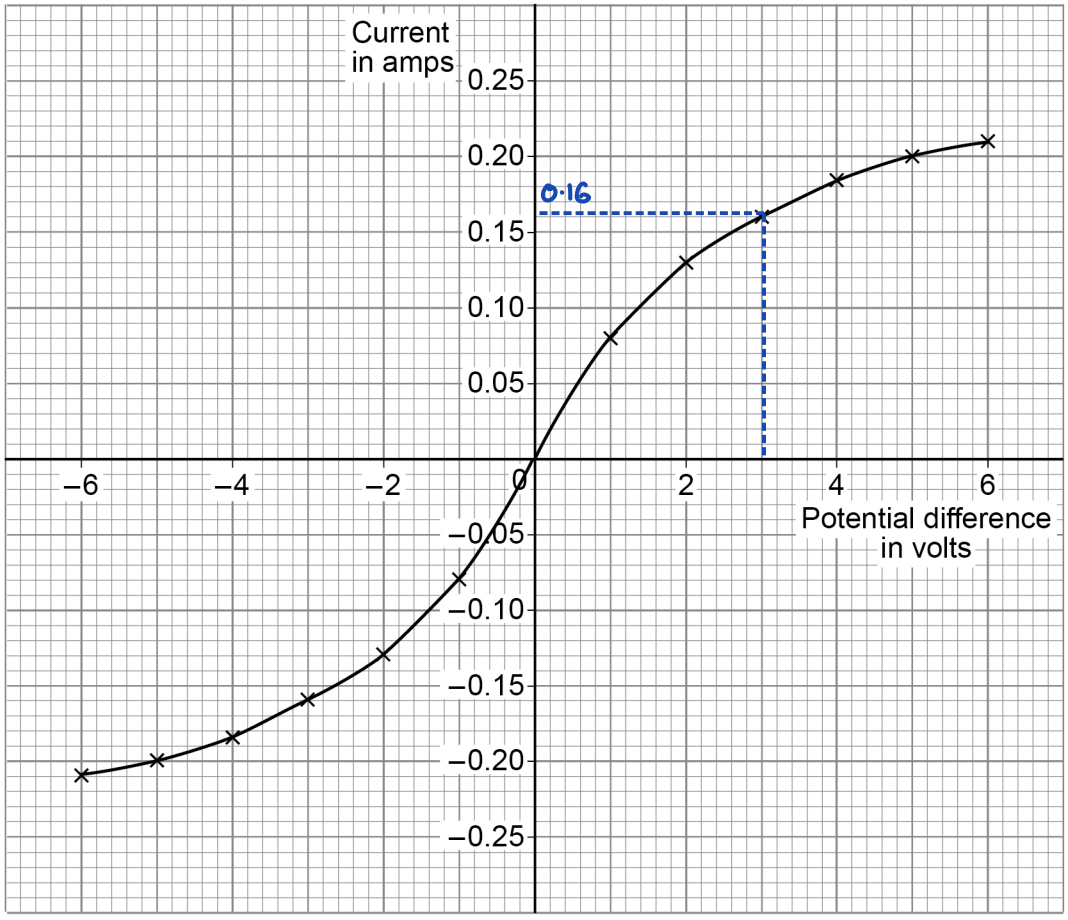
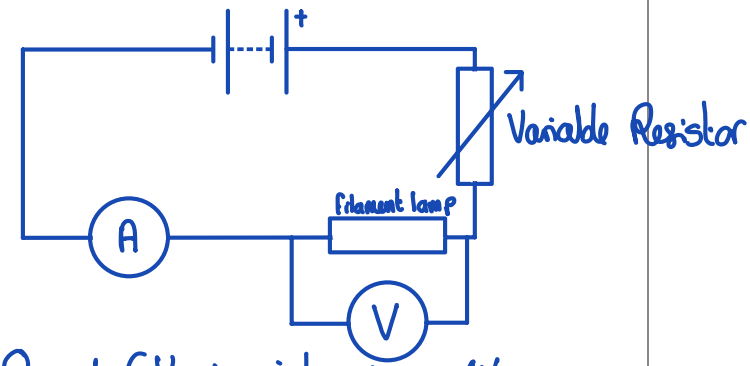
0 6 A student investigated how the current in a filament lamp varies with the potential difference across the filament lamp.

Figure 6 shows the results.

Figure 6



Variable number of cells or Variable resistor used to vary current in and p.d. across filament lamp
p.d. = 0 to 6V



Vary cell voltage between 0 and 6V in intervals of 1V
Reverse connections to power supply to obtain negative values
Take repeat readings and calculate a mean.
Discard anomalies and plot measured current vs V

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0 6 . 1 Describe a method the student could use to obtain these results.

You should include a circuit diagram.

[6 marks]

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0 6 . 2 Determine the resistance of the filament lamp when the potential difference across it is +3.0 V.

Use the Physics Equations Sheet.

Use **Figure 6** on page 18.

[3 marks]

From graph, at $V = +3.0$, $I = 0.16\ A$

potential difference = current × resistance	$V = I R$

$V = IR$

$R = \frac{V}{I} = \frac{3.0\ V}{0.16\ A} = 18.75\ \Omega$

Resistance = 18.75 Ω

0 6 . 3 The current in the lamp is 0.21 A when the potential difference across the lamp is 6.0 V.

Calculate the energy transferred by the filament lamp in 30 minutes.

Use the Physics Equations Sheet.

[5 marks]

$I = 0.21\ A$ E transferred in 30 min

$V = 6.0\ V$

$t = 30 \times 60 = 1800\ s$

charge flow = current × time	$Q = I t$

$Q = It = 0.21\ A \times 1800\ s = 378\ C$

energy transferred = charge flow × potential difference	$E = Q V$

$E = Q V$

$= 378\ C \times 6.0\ V$

$= 2268\ J$

Energy transferred = 2268 J

Do not write outside the box

0 6 . 4 The power output of the lamp is 1.0 W when the potential difference across the lamp is 5.0 V.

1W → 4W = x4

A student predicts that the power output would be 4.0 W if the potential difference was doubled. V5.0 → x2

Explain why the student is **not** correct.

power = potential difference × current	$P = VI$

[2 marks]

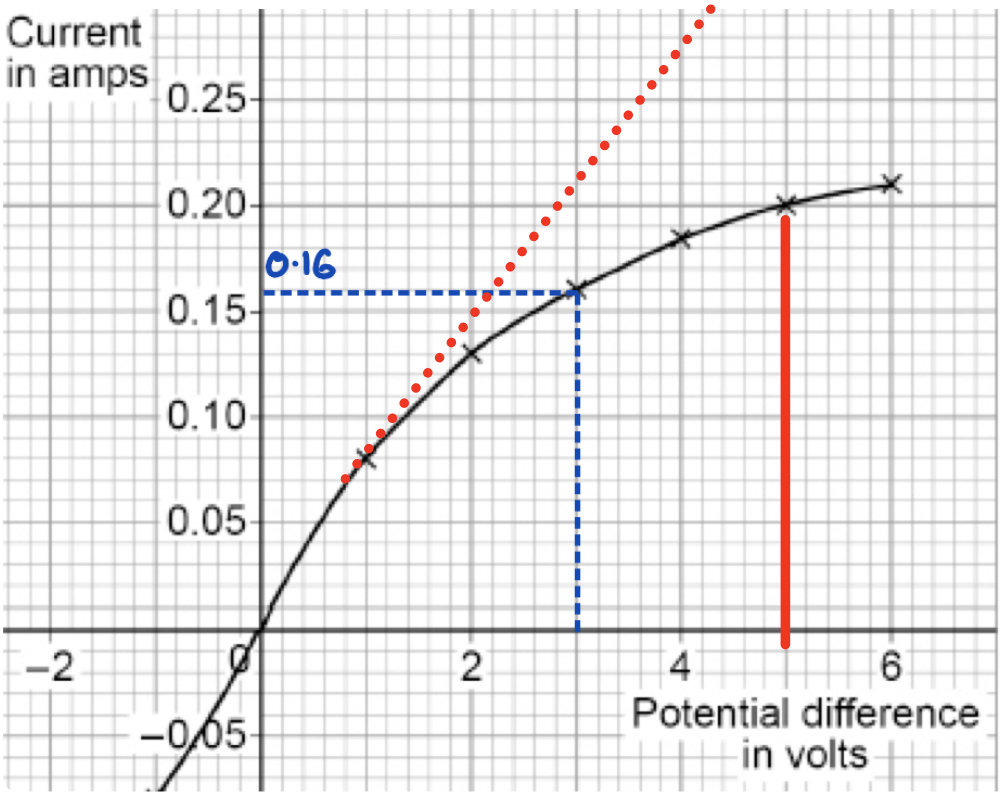
$P = VI$

$4P = 2V \cdot 2I$

For the Power to quadruple both the current and the voltage would need to double BOT. the current does not double because the resistance of the filament increases.

16

Turn over for the next question



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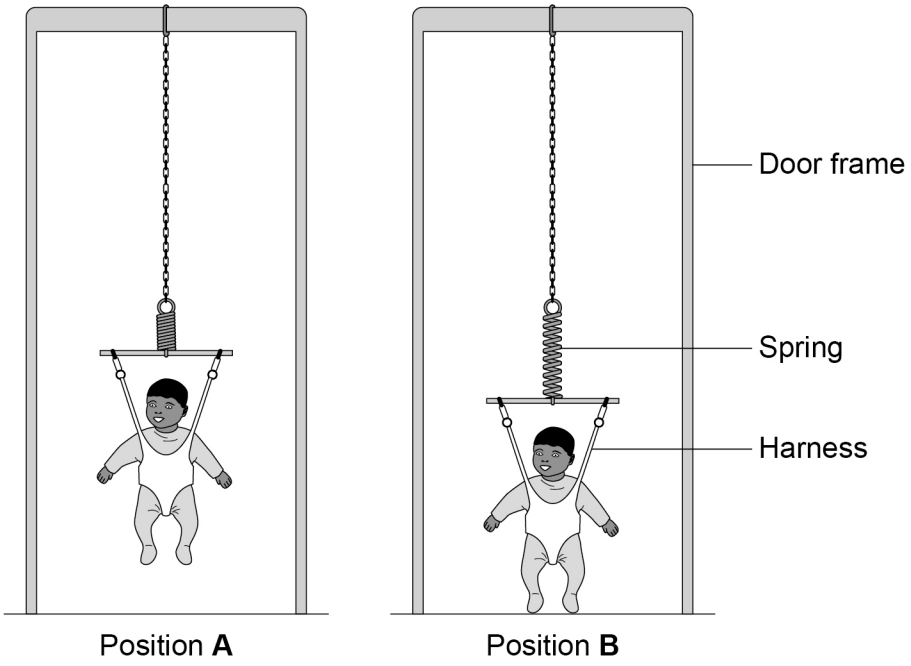
0 7 A baby bouncer is a harness attached to a spring that hangs from a door frame.

Figure 7 shows a baby in a baby bouncer in two positions.

Figure 7



0 7 . 1 The baby bouncer should not be used with babies that have a mass greater than 12 kg.

Suggest **one** reason why.

[1 mark]

Spring may be over extended leading to it becoming permanently extended.

Do not write outside the box

0 7 . 2 In positions **A** and **B** the baby is stationary.

Describe the energy transfers as the baby moves from position **A** to position **B**.

[3 marks]

In position A the baby has gravitational potential energy (E_p). As the baby moves down this is transferred to kinetic energy (E_k) of the baby and elastic potential energy of the spring (E_e). At position B, all of the energy has been transferred to elastic potential energy of the spring (E_e)

0 7 . 3 In one position the extension of the spring is 8.0 cm. $e = \frac{8}{100} = 0.08\ m$

The elastic potential energy stored by the spring is 4.0 J. $E_e = 4.0\ J$

Calculate the spring constant of the spring. $k = ?$

Use the Physics Equations Sheet.

[4 marks]

$E_e = \frac{1}{2} k e^2 = \frac{k e^2}{2} = 0.5 k e^2$

$k = \frac{2 E_e}{e^2} = \frac{E_e}{0.5 e^2}$

$k = \frac{2 \times 4.0\ J}{(0.08\ m)^2} = 1250\ N/m$

Spring constant = 1250 N/m

8

Turn over for the next question

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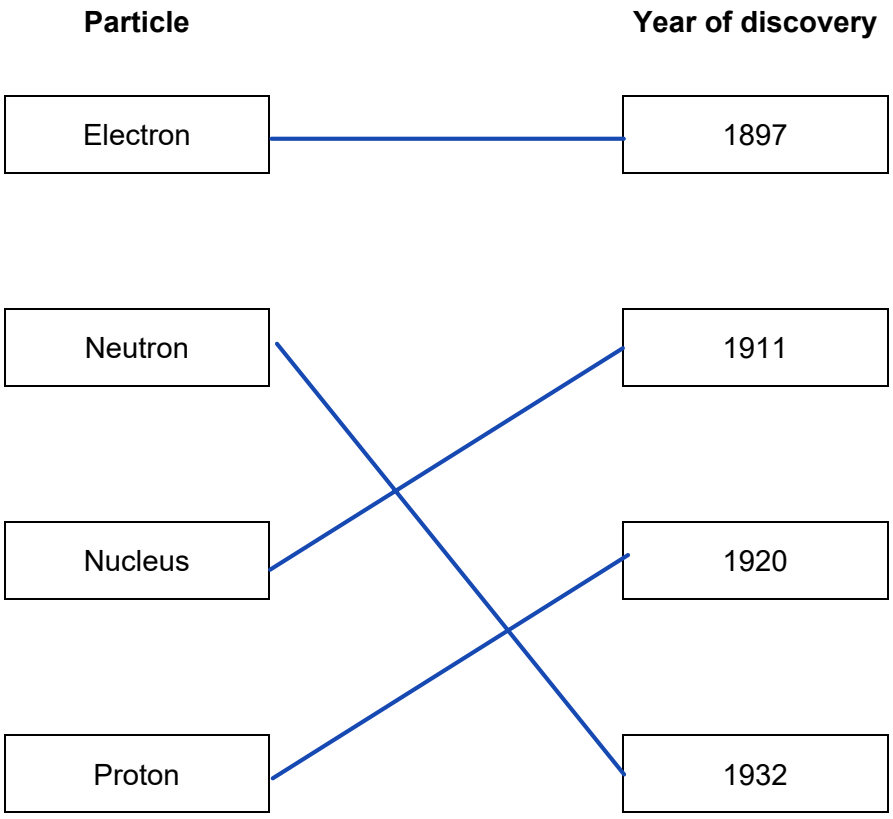
0 8 Scientists developed new models of the atom as new particles were discovered.

0 8 . 1 Draw **one** line from each particle to the year it was discovered.

[2 marks]



Question 8 continues on the next page

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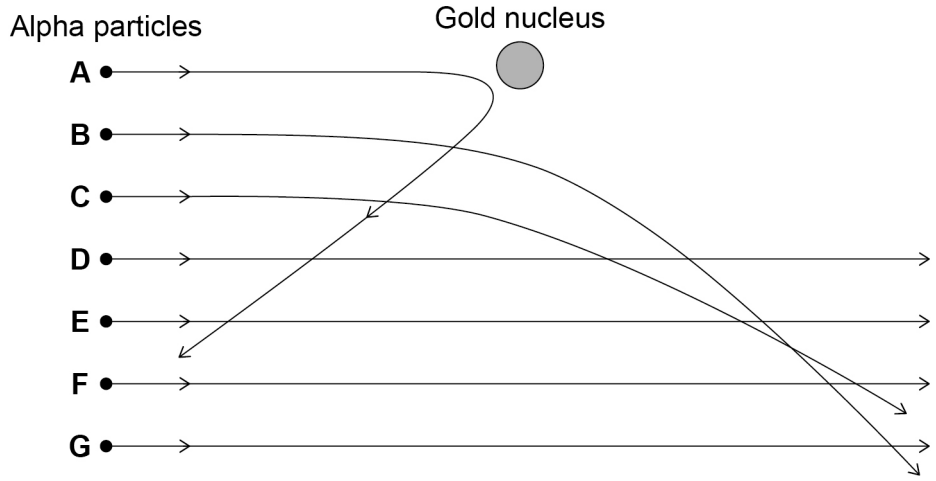
The nucleus was discovered using an alpha particle scattering experiment.

Alpha particles were directed at a sheet of gold foil.

Figure 8 shows the paths taken by seven alpha particles, **A**, **B**, **C**, **D**, **E**, **F** and **G**.

Figure 8



0 8 . 2 Explain why alpha particle **A** takes the path shown in **Figure 8**.

[2 marks]

Both the alpha particles and the nucleus have the same, positive charge.
So the alpha particle and the gold nucleus repel each other.

0 8 . 3 Explain why the path of alpha particle **B** is more tightly curved than the path of alpha particle **C**.

[2 marks]

Particle B passes closer to the nucleus, so experiences a stronger repulsive force

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0 8 . 4 What can be deduced about the atom from the paths taken by alpha particles **D**, **E**, **F** and **G** in **Figure 8**?

[1 mark]

Tick (✓) **one** box.

The atom contains a nucleus. ☐

The atom contains protons, neutrons and electrons. ☐

The atom is mostly empty space. ☑

0 8 . 5 How is the Bohr model of the atom different from the nuclear model of the atom?

[1 mark]

In the Bohr model, the electrons orbit the nucleus at specific distances, whereas in the nuclear model the electrons can orbit at a continuous range of distances.

0 8 . 6 Explain how an electron can move up and down between energy levels in an atom.

[2 marks]

To move to a higher energy level, an electron absorbs energy from electromagnetic radiation.
To move to a lower energy level, an electron emits energy in the form of electromagnetic radiation

10

Turn over for the next question

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0 9 **Figure 9** shows air being pumped into a car tyre.

Figure 9

0 9 . 1 Complete the sentence.

[1 mark]

Air particles in the tyre move quickly in random directions.

0 9 . 2 When the tyre is at the correct pressure, pumping more air into the tyre causes the pressure to increase further.

The volume and temperature of the air in the tyre do **not** change.

Explain why the pressure increases as more air is pumped into the tyre.

[2 marks]

For a constant volume, pumping more air into the tyre increases the number of air particles in the tyre. Leading to a greater number of collisions with tyre walls per second.

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0 9 . 3 The air pressure in a car tyre changes if the temperature of the air in the tyre increases.

Explain why.

[4 marks]

As temperature increases, the air particles have greater mean kinetic energy.
So there are more collisions with tyre walls per second and also greater force in each collision.
A greater mean force per square metre causes greater pressure on the wall of the tyre.

7

END OF QUESTIONS

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