Please write clearly in block capitals.

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

Surname _____

Forename(s) _____

Candidate signature _____

I declare this is my own work.

GCSE
PHYSICS

Higher Tier Paper 1

H

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 againstyour 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 ofthe 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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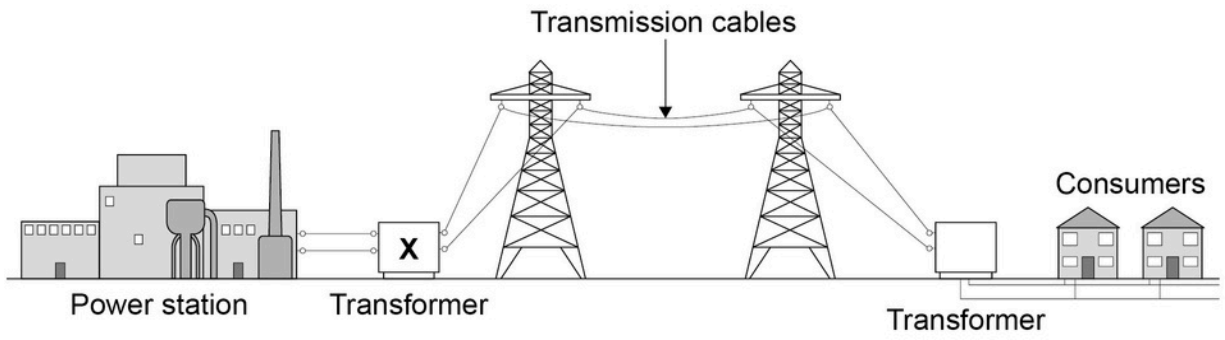
Answer all questions in the spaces provided.

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.

$P = \frac{I}{R}$ ☐

$P = \frac{I}{R^2}$ ☐

$P = I^2R$ ✓

$P = RI^2$ ☐

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0 1 . 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]

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

$R = \frac{1.69 \times 10^9}{2000^2}$

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.

[1 mark]

efficiency = useful energy output / total energy 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]

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

$= 0.992 \times 34.2$

Useful energy output = 33.9 GJ

10

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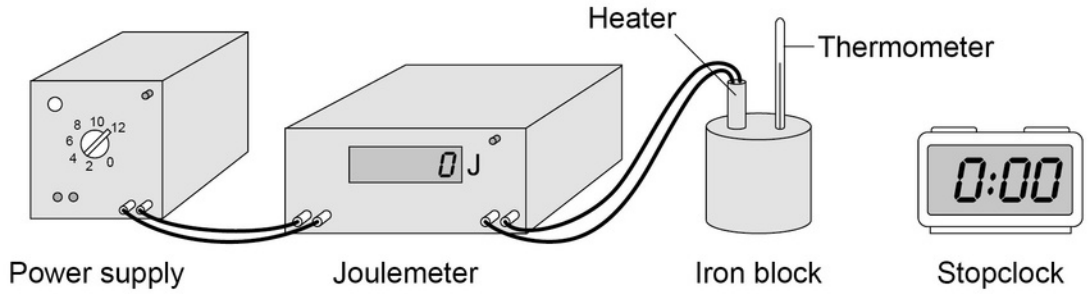
0 2 Figure 2 shows the equipment a student used to determine the specific heat capacity of iron.

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.

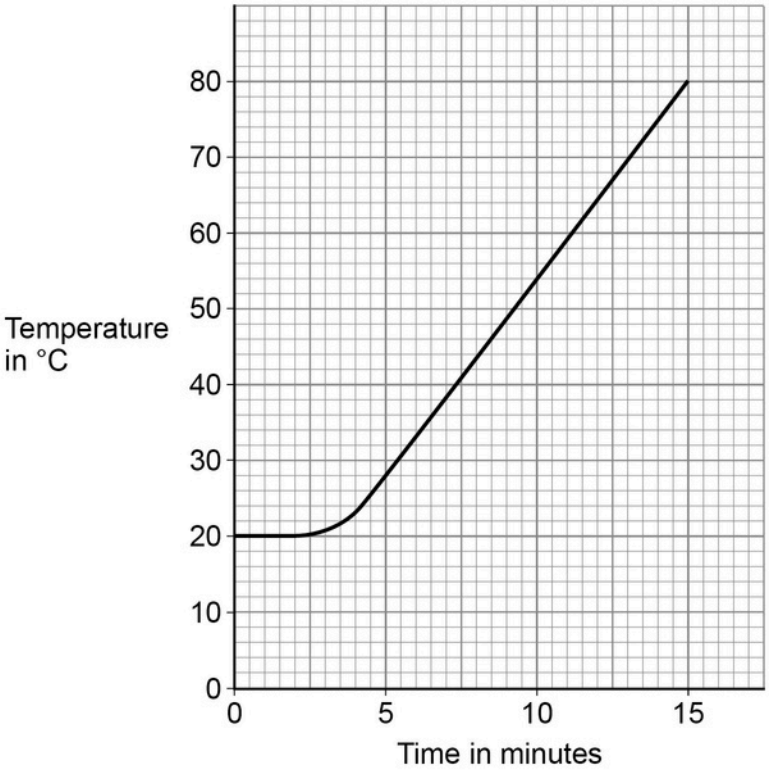
[1 mark]

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

Do not write outside the box

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.

The mass of the iron block was 2.0 kg.

Calculate the specific heat capacity of iron.

Use information from Figure 3 and the Physics Equations Sheet.

[4 marks]

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

$26,000 = 20 \times c \times 26$

$c = \frac{26,000}{20 \times 26}$

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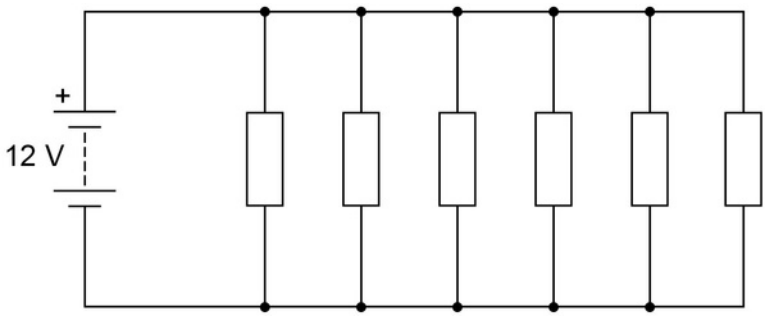
0 3 Figure 4 shows an electrical circuit used to heat the windscreen of a car.

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 doesn't 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.

$E = \frac{V}{Q}$ ☐

$E = QV$ ☑

$E = \frac{Q}{V}$ ☐

$E = \frac{V^2}{Q}$ ☐

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]

$5010 = Q \times 12$

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

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.

[3 marks]

$5010 = 0.015 \times L$

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

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 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

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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.

[4 marks]

$E_p = 367,500,000$

$367000000 = 2500000 \times 9.8 \times h$

$h = \frac{367000000}{2500000 \times 9.8}$

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 × 107 J of energy.

Use the Physics Equations Sheet.

Give your answer in standard form.

[5 marks]

3kW = 3000W

$3000 = \frac{2.16 \times 10^7}{t}$

$t = \frac{2.16 \times 10^7}{3000} = 7200$

7.2×10^3

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

Question 4 continues on the next page

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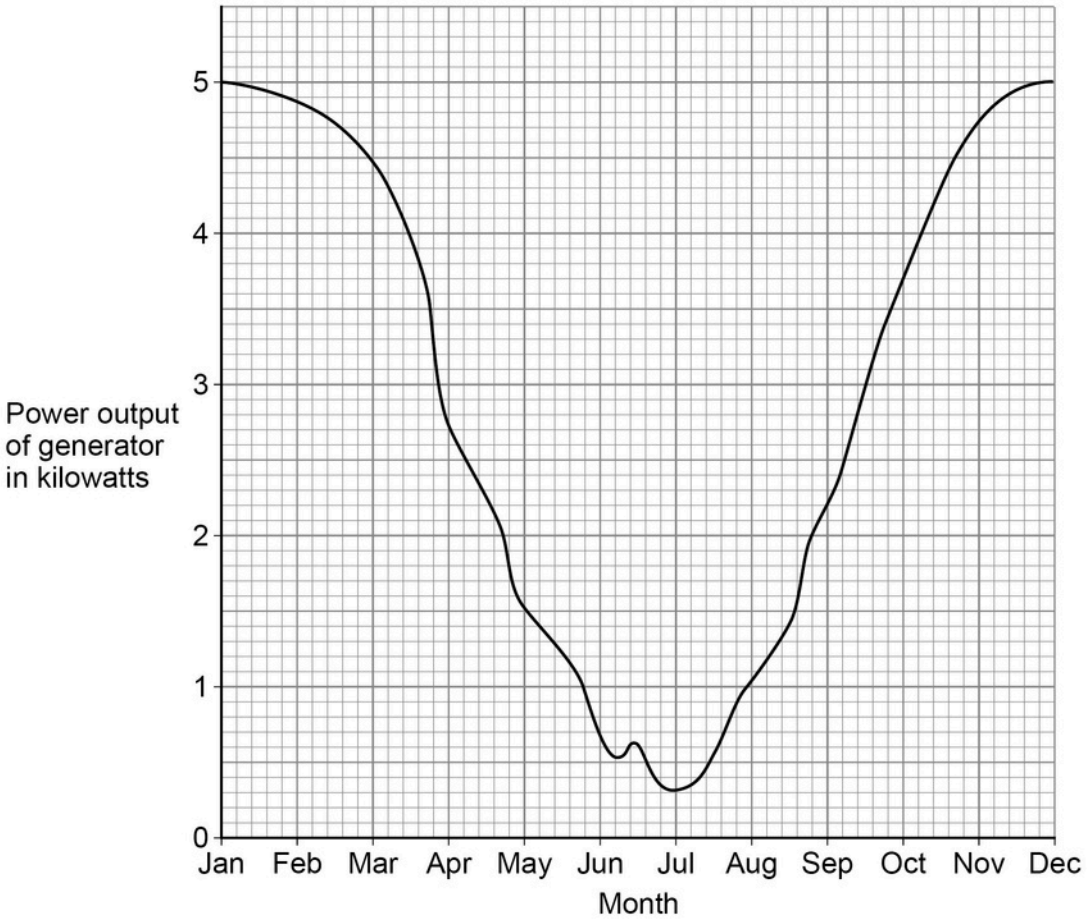
0 4 . 3 Figure 5 shows how the power output of the generator varied during one year.

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 protonsDifference: • different number of neutrons

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 s ample) to halve (is 5700 years)

Question 5 continues on the next page

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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]

2 half lives

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]

Nitrogen-18 : greatest activity (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 an object to radiation.

Co ntamination is the unwanted presence of radioactive material / ato ms on an object.

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

[1 mark]

Cancer / Tumours

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 hours = 0.072

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

Number of days = 144

17

Turn over for the next question

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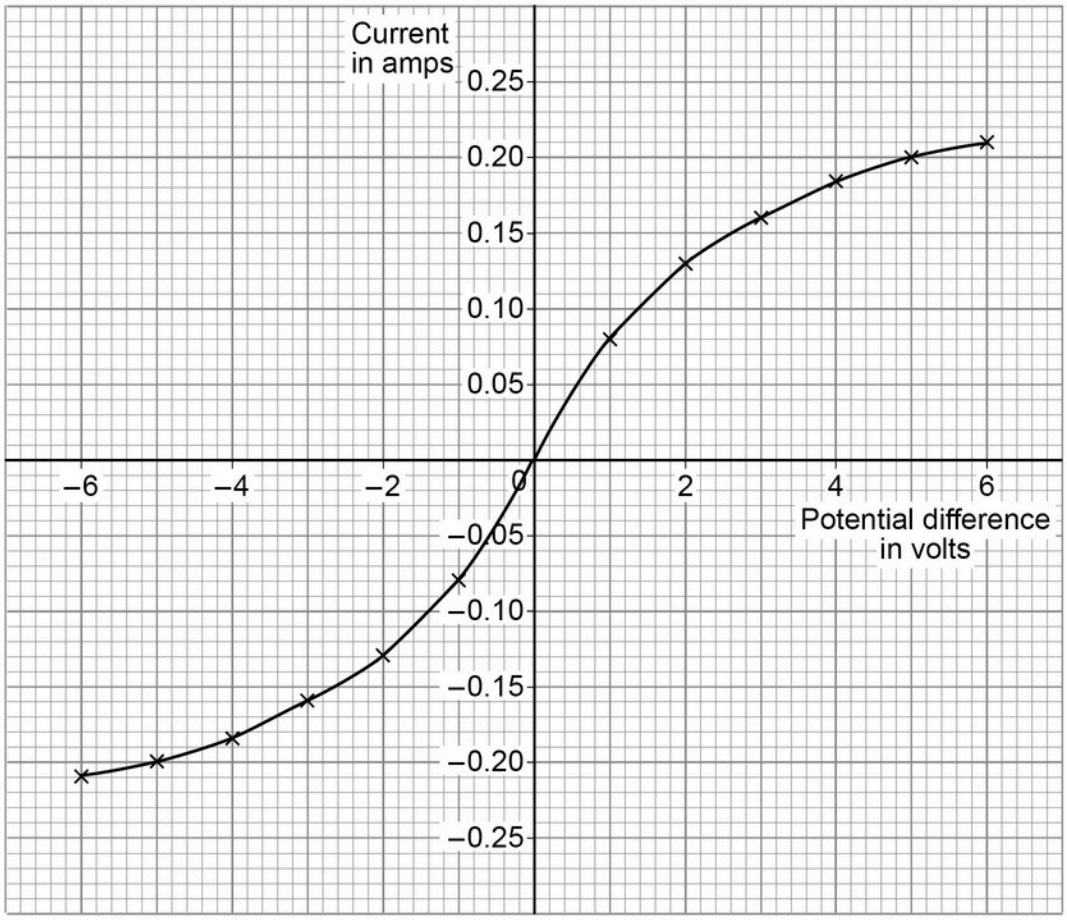
0 6 A student investigated how the current in a filament lamp varies with the potential difference across the filament lamp.
Figure 6 shows the results.

Figure 6



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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]

- Ammeter in series with filament lamp
- Current measured with an ammeter
- Voltmeter in parallel with filament lamp
- P.d. measured with a voltmeter
- Variable resistor (or variable power pack or variable number of cells) used to vary current in and p.d. across filament lamp
- Range of p.d. of 0 to 6 V
- Interval of p.d. of 1 V
- Reverse connections to power supply to obtain negative values
- Take repeat readings and calculate a mean
- Discard anomalies

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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]

$3.0 = 0.16 \times R$

$R = \frac{3.0}{0.16}$

Resistance = 18.72 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]

$t = 1800\text{s}$

$Q = 0.21 \times 1800$
$= 378$

$E = 378 \times 6.0$

Energy transferred = 2268 J

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

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

Explain why the student is not correct.

[2 marks]

For the power to quadruple the current and the p.d. would both need to double.
But the current doesn't double because the resistance of the filament lamp increases

16

Turn over for the next question

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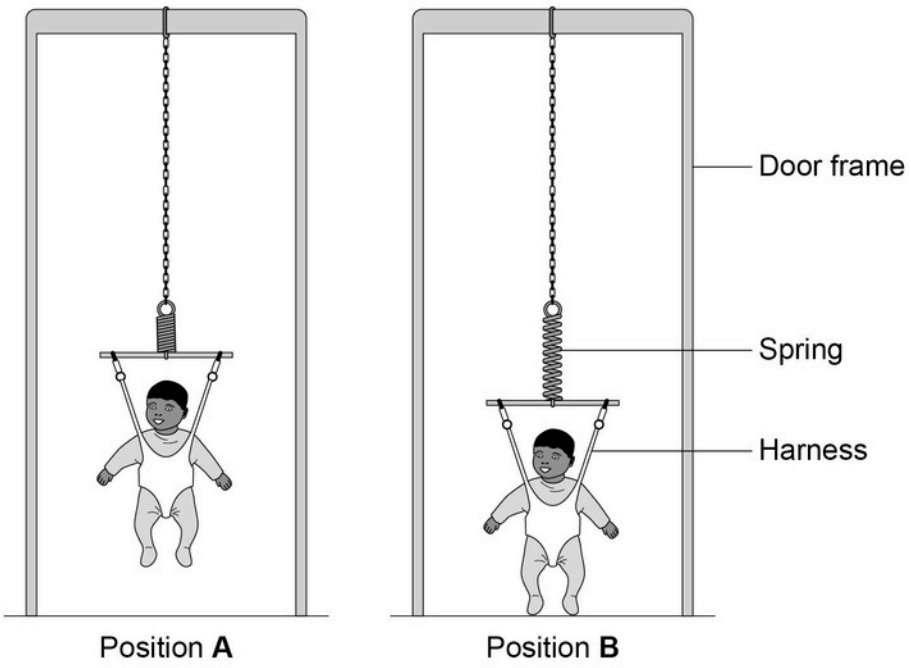
0 7 A baby bouncer is a harness attached to a spring that hangs from a door frame.

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 become permanently extended

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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.
As the baby moves down this is transferred to kinetic energy of the baby and then elastic potential energy of the spring
in position B all the energy is elastic potential energy

0 7 . 3 In one position the extension of the spring is 8.0 cm.

The elastic potential energy stored by the spring is 4.0 J.

Calculate the spring constant of the spring.

Use the Physics Equations Sheet.

[4 marks]

$e = 0.080$ m

$4.0 = \frac{1}{2} \times k \times (0.080)^2$

$k = \frac{4.0 \times 2}{(0.080)^2}$

Spring constant = 1250 N/m

8

Turn over for the next question

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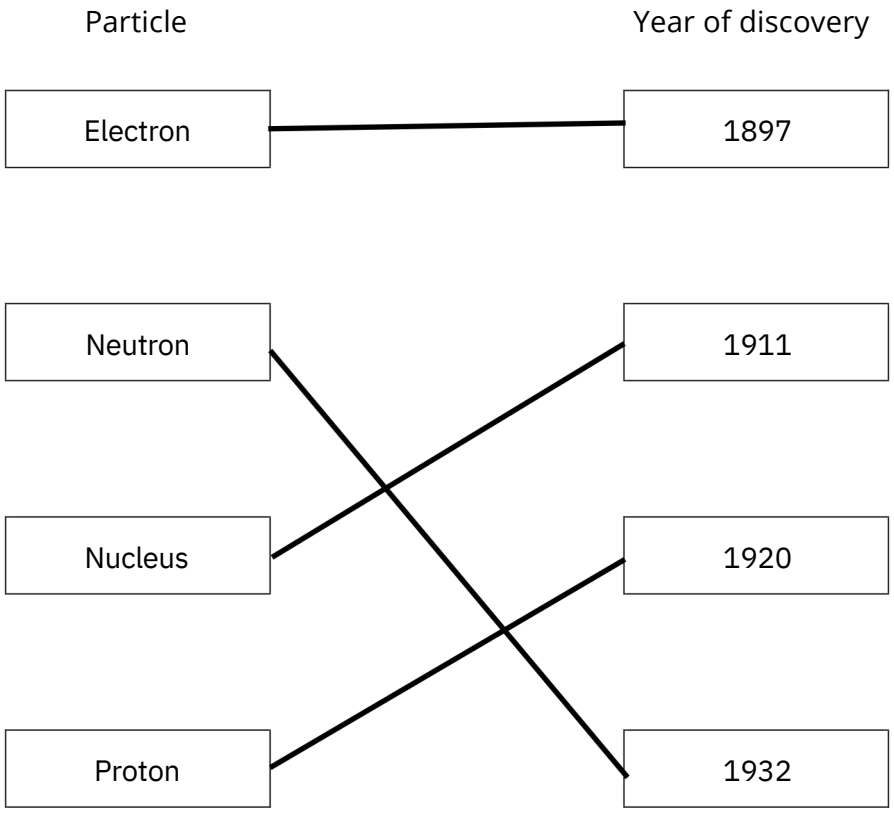
0 8 Scientists developed new models of the atom as new particles were discovered.

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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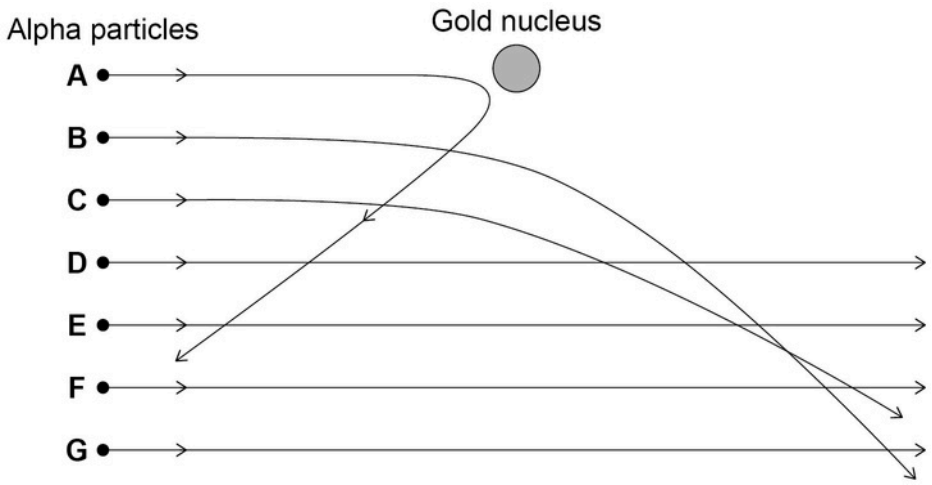
The nucleus was discovered using an alpha particle scattering experiment.

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 (gold) nucleus have 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?

Tick (✓) one box. [1 mark]

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 e nergy from electromagnetic radiation.
T o 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]

More air particles in the tyre
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 more collisions with tyre walls per second and greater force in each collision.
Greater mean force per square metre causes greater pressure on wall of tyre.

7

END OF QUESTIONS

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