Please write clearly in block capitals.

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

Surname _____

Forename(s) _____

Candidate signature _____

I declare this is my own work.

GCSE
COMBINED SCIENCE: TRILOGY

F

Foundation Tier
Physics Paper 1F

Wednesday 22 May 2024 Morning Time allowed: 1 hour 15 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.
- 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).
- Do all rough work in this book. Cross through any work you do not want to be marked.
- In all calculations, show clearly how you work out your answer.

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

Information
- The maximum mark for this paper is 70.
- 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.

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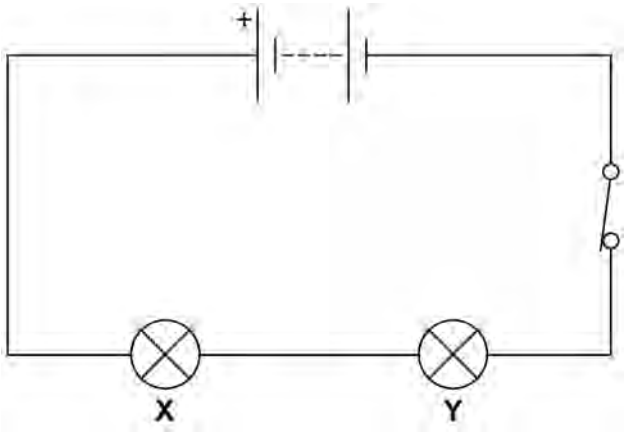
0 1 **Figure 1** shows a circuit diagram. The circuit contains a battery and two lamps, **X** and **Y**.

Figure 1



0 1 . 1 How does the current in lamp **X** compare with the current in lamp **Y**?

[1 mark]

Tick (✓) **one** box.

The current in lamp **X** is smaller. ☐

The current in both lamps is the same. ☐

The current in lamp **X** is greater. ☐

0 1 . 2 Lamp **X** and lamp **Y** are **not** identical.

The potential difference across the battery is 4.5 V.

The potential difference across lamp **X** is 1.5 V.

Calculate the potential difference across lamp **Y**.

[1 mark]

Potential difference across lamp **Y** = _____ V

Do not write outside the box

The current in lamp **X** is 1.2 A.

The potential difference across lamp **X** is 1.5 V.

0 1 . 3 Calculate the power of lamp **X**.

Use the equation:

power = potential difference × current

[2 marks]

Power = _____ W

0 1 . 4 Calculate the resistance of lamp **X**.

Use the equation:

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

[2 marks]

Resistance = _____ Ω

Question 1 continues on the next page

Do not write outside the box

0 1 . 5 The current in lamp **X** is 1.2 A.

Calculate the charge flow through lamp **X** in 40 seconds.

Use the equation:

charge flow = current × time

[2 marks]

Charge flow = _____ C

0 1 . 6 The switch can be used to turn the lamps on and off.

Immediately after the lamps are switched on, the resistance of each lamp increases.

Why does the resistance of each lamp increase?

[1 mark]

Tick (✓) **one** box.

The current in the battery decreases. ☐

The potential difference across each lamp decreases. ☐

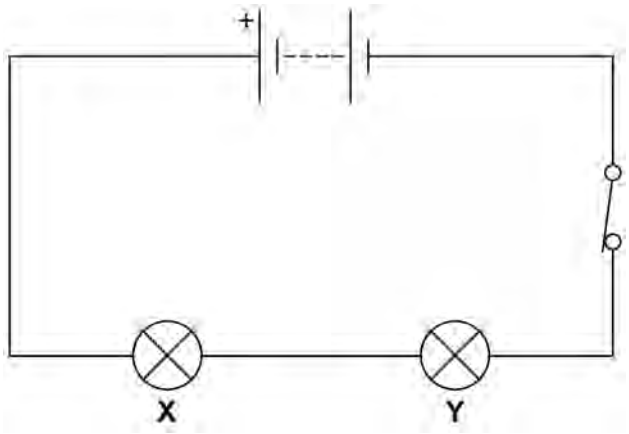
The power of the battery increases. ☐

The temperature of each lamp increases. ☐

Do not write outside the box

Figure 1 is repeated below.

Figure 1



0 1 . 7 Lamp **Y** breaks.

What happens to lamp **X**?

Give a reason for your answer.

[2 marks]

Tick (✓) **one** box.

Lamp **X** gets brighter. ☐

Lamp **X** stays the same brightness. ☐

Lamp **X** no longer emits light. ☐

Reason _____

_____

11

Turn over for the next question

Do not write outside the box

0 2 **Figure 2** shows an outdoor swimming pool.

The water in the swimming pool comes from the sea.

Figure 2

The water in the pool is heated using a geothermal energy resource.

0 2 . 1 Which of the following describes a geothermal energy resource?

[1 mark]

Tick (✓) **one** box.

A non-renewable energy resource with high carbon emissions. ☐

A non-renewable energy resource with low running costs. ☐

A renewable energy resource that uses hot rocks underground. ☐

A renewable energy resource that uses the tides. ☐

Do not write outside the box

0 2 . 2 15 kg of seawater is heated before it is added to the pool.

specific heat capacity of seawater = 3800 J/kg °C

Calculate the change in thermal energy of 15 kg of seawater when its temperature is increased by 9.0 °C.

Use the equation:

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

[2 marks]

Change in thermal energy = _____ J

0 2 . 3 The energy transferred from 1.0 m^2 of the surface of the pool to the air is 80 J each second.

The surface area of the pool is 120 m^2.

Calculate the energy transferred from the whole surface of the pool to the air each second.

[1 mark]

Energy transferred each second = _____ J

Question 2 continues on the next page

Do not write outside the box

0 2 . 4 Which of the following units is the same as 1 J/s?

[1 mark]

Tick (✓) **one** box.

1 N ☐

1 Pa ☐

1 W ☐

0 2 . 5 The pool is above sea level.

5.0 kg of water is pumped from sea level into the pool.

The water gains 196 J of gravitational potential energy.

gravitational field strength = 9.8 N/kg

Calculate the height of the pool above sea level.

Use the equation:

$$\text{height} = \frac{\text{gravitational potential energy}}{\text{mass} \times \text{gravitational field strength}}$$

[2 marks]

Height = _____ m

Do not write outside the box

0 2 . 6 The water in some swimming pools is heated by burning fossil fuels.

Explain **one** environmental **disadvantage** of burning fossil fuels.

[2 marks]

9

Turn over for the next question

Do not write outside the box

0 3 Some people used to think that radioactive substances had health benefits.

100 years ago, a company made toothpaste containing the radioactive isotopes radium-228 and radium-226.

Figure 3 shows the symbols for these isotopes.

Figure 3

$^{228}_{88}Ra$ $^{226}_{88}Ra$

0 3 . 1 How are atoms of radium-228 different from atoms of radium-226?

[1 mark]

Tick (✓) **one** box.

Radium-228 atoms have one more neutron and one more proton. ☐

Radium-228 atoms have two more neutrons and two more protons. ☐

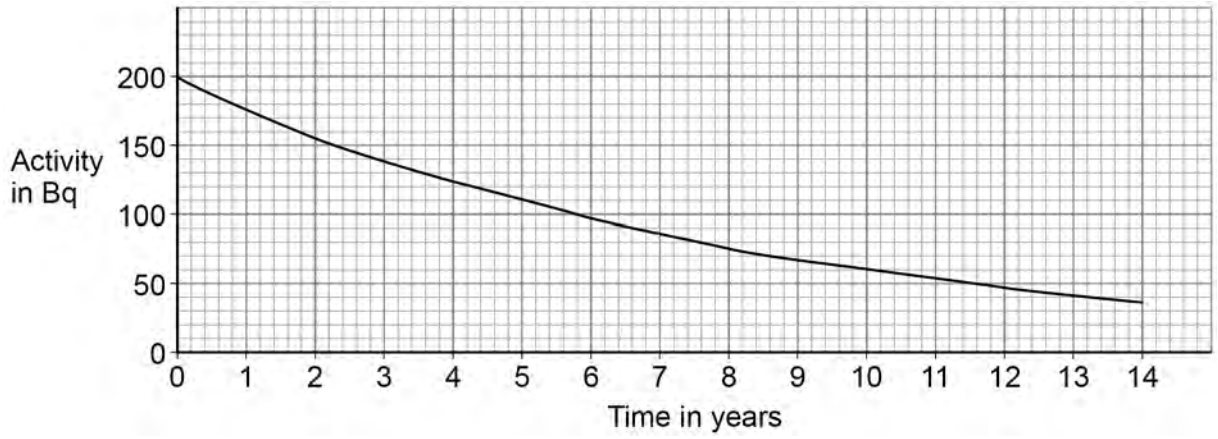
Radium-228 atoms have two more neutrons. ☐

Radium-228 atoms have two more protons. ☐

Do not write outside the box

0 3 . 2 **Figure 4** shows how the activity of a sample of radium-228 changed over time.

Figure 4



What is the approximate half-life of radium-228?

[1 mark]

Tick (✓) **one** box.

6 years ☐

7 years ☐

14 years ☐

100 years ☐

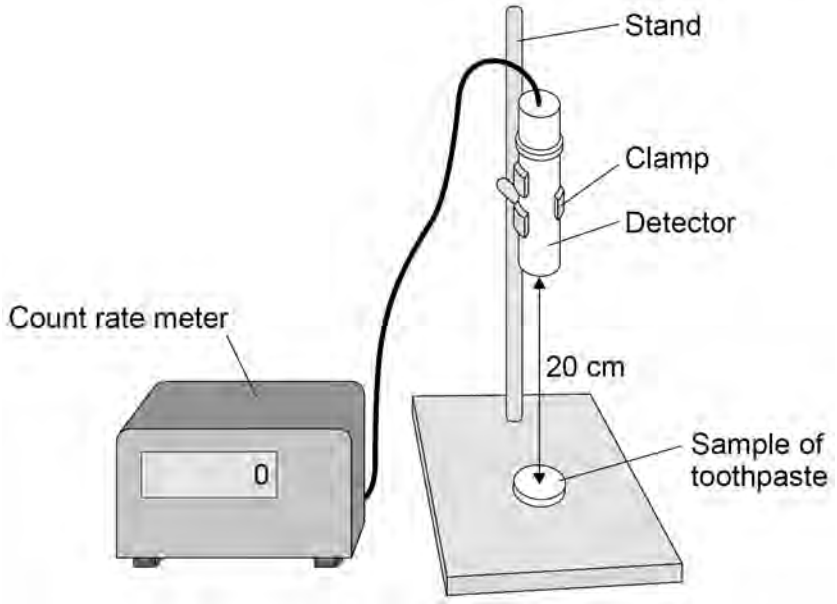
Question 3 continues on the next page

Do not write outside the box

A scientist investigated whether the toothpaste in four tubes of the 100-year-old toothpaste is equally radioactive.

Figure 5 shows the equipment used.

Figure 5



0 3 . 3 When the equipment was arranged as shown in **Figure 5**, it was **not** possible to detect alpha particles from the toothpaste.

Suggest how the scientist adjusted the equipment to detect alpha particles from the toothpaste.

[1 mark]

Do not write outside the box

0 3 . 4 The scientist adjusted the equipment and determined the activity of the toothpaste from each tube.

Table 1 shows the results.

Table 1

Tube	Activity in Bq
A	3150
B	2940
C	3180
D	3050

What was the range of activities shown in **Table 1**?

[1 mark]

From _____ Bq to _____ Bq

0 3 . 5 What was the independent variable in the investigation?

[1 mark]

Tick (✓) **one** box.

The activity of the toothpaste ☐

The mass of toothpaste used ☐

The temperature of the toothpaste ☐

The tube of toothpaste used ☐

Question 3 continues on the next page

Turn over ►

Do not write outside the box

0 3 . 6 What was the dependent variable in the investigation?

[1 mark]

Tick (✓) **one** box.

The activity of the toothpaste ☐

The mass of toothpaste used ☐

The temperature of the toothpaste ☐

The tube of toothpaste used ☐

0 3 . 7 When the toothpaste was new, it caused a risk to health because of the nuclear radiation emitted.

What happened to the risk to health from the toothpaste after 100 years?

[1 mark]

0 3 . 8 Which property makes nuclear radiation hazardous?

[1 mark]

Tick (✓) **one** box.

Nuclear radiation is ionising. ☐

Nuclear radiation is penetrating. ☐

Nuclear radiation is too small to see. ☐

Nuclear radiation makes objects radioactive. ☐

8

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Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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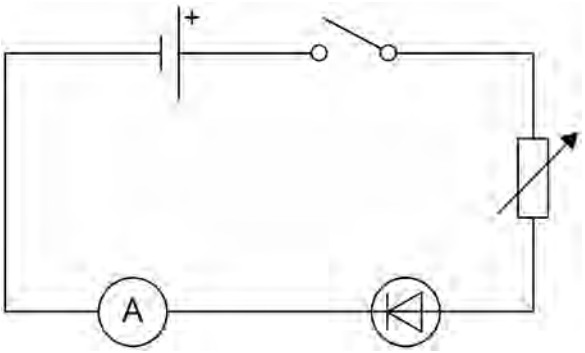
0 4 A student investigated how the current in a diode varies with the potential difference across the diode.

Figure 6 shows an incomplete diagram of the circuit used.

Figure 6



0 4 . 1 The student measured the potential difference across the diode.

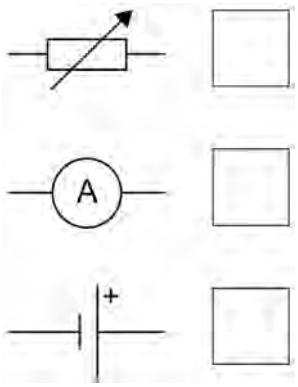
Complete **Figure 6** by adding the symbol for a voltmeter in the correct position.

[2 marks]

0 4 . 2 Which component should the student adjust to change the potential difference across the diode?

[1 mark]

Tick (✓) **one** box.



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The student measured the current three times for each value of potential difference.

0 4 . 3 Complete the sentence.

Choose the answer from the box.

[1 mark]

random	**systematic**	**zero**

When the potential difference was 1.50 V the current measurements varied between 0.95 A and 1.08 A. This was caused by _____ errors.

0 4 . 4 For one value of potential difference, the measurements of current were:

0.27 A 0.32 A 0.31 A

Calculate the mean current.

[2 marks]

_____

_____

_____

Mean current = _____ A

Question 4 continues on the next page

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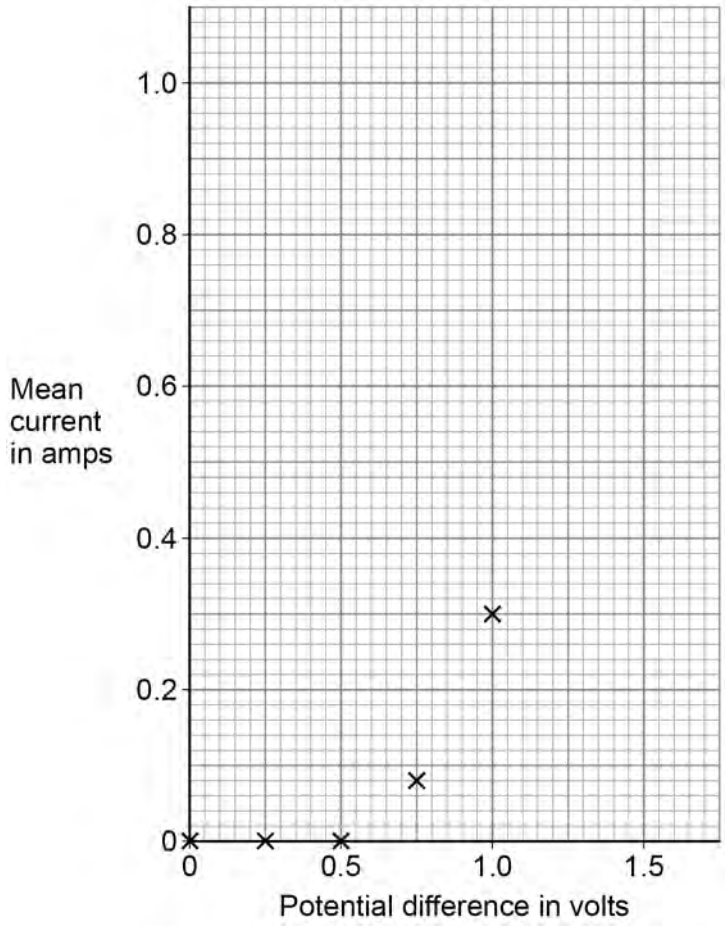
Figure 7 shows some of the results.

Figure 7



0 4 . 5 **Table 2** shows the results when the potential difference was greater than 1.00 V.

Table 2

Potential difference in volts	Mean current in amps
1.25	0.60
1.50	1.00

Complete **Figure 7**.

You should:

- plot the results from **Table 2**
- draw a line of best fit.

[2 marks]

Do not write outside the box

0 4 . 6 Complete the sentence.

Choose the answer from the box.

[1 mark]

directly proportional	**inversely proportional**	**non-linear**

Figure 7 shows that the relationship between potential difference and current for the diode is _____.

0 4 . 7 The student adjusted the circuit so that the current in the diode was 1.00 A.

The student then reversed the connections to the diode.

What happened to the current in the diode when the connections were reversed?

[1 mark]

Tick (✓) **one** box.

The current decreased to 0.00 A. ☐

The current remained at 1.00 A. ☐

The current increased to 2.00 A. ☐

10

Turn over for the next question

Do not write outside the box

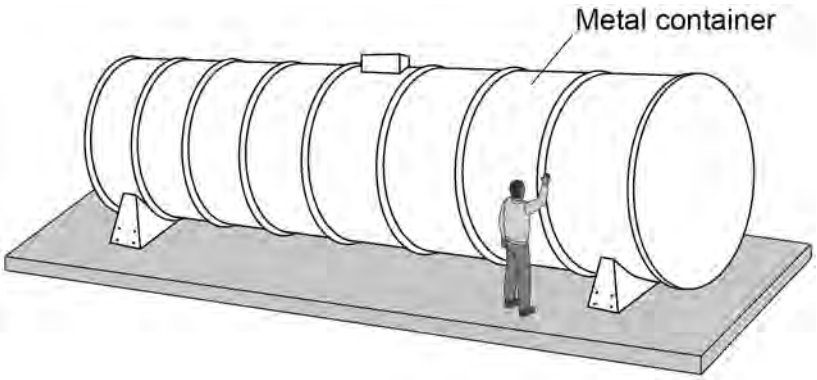
0 5 Data-storage computers get very hot.

Scientists investigated using the sea to cool data-storage computers.

The computers were set up inside a large metal container.

Figure 8 shows the metal container before it was lowered into the sea.

Figure 8



0 5 . 1 Why is the container made of metal?

[1 mark]

Tick (✓) **one** box.

Metal has a high thermal conductivity. ☐

Metal is a good thermal insulator. ☐

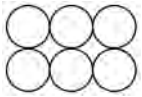
Metal is a poor conductor of thermal energy. ☐

Do not write outside the box

0 5 . 2 The walls of the container are solid.

Figure 9 shows an arrangement of six particles in a solid.

Figure 9



The air inside the container is a gas.

Draw an arrangement of six particles in a gas in the box below.

[1 mark]

0 5 . 3 How does the air in the container exert pressure on the container?

[1 mark]

Tick (✓) **one** box.

Air particles absorb energy from the container. ☐

Air particles collide with the walls of the container. ☐

Air particles expand to fill the container. ☐

Question 5 continues on the next page

Do not write outside the box

0 5 . 4 As the container is lowered into the sea, the temperature of the air in the container decreases.

Complete the sentence.

Choose the answer from the box.

[1 mark]

decreases	**stays the same**	**increases**

When the temperature of the air in the container decreases, the average speed of the air particles _____.

0 5 . 5 After the temperature of the air in the container had decreased, the computers were switched on.

The computers caused the temperature of the air to then increase.

Describe how the air pressure in the container changed as the temperature decreased and then increased.

[2 marks]

Do not write outside the box

0 5 . 6 The container has a length of 12 m.

The container has a cross-sectional area of 7.5 m^2.

Calculate the volume of the container.

Use the equation:

volume = length × cross-sectional area

[1 mark]

Volume = _____ m^3

Use the Physics Equations Sheet to answer questions **05.7** and **05.8**.

0 5 . 7 Write down the equation that links density (ρ), mass (m) and volume (V).

[1 mark]

0 5 . 8 The average density of the container and its contents is 1100 kg/m^3.

Calculate the mass of the container and its contents.

Use your answer to Question **05.6**

[3 marks]

Mass = _____ kg

11

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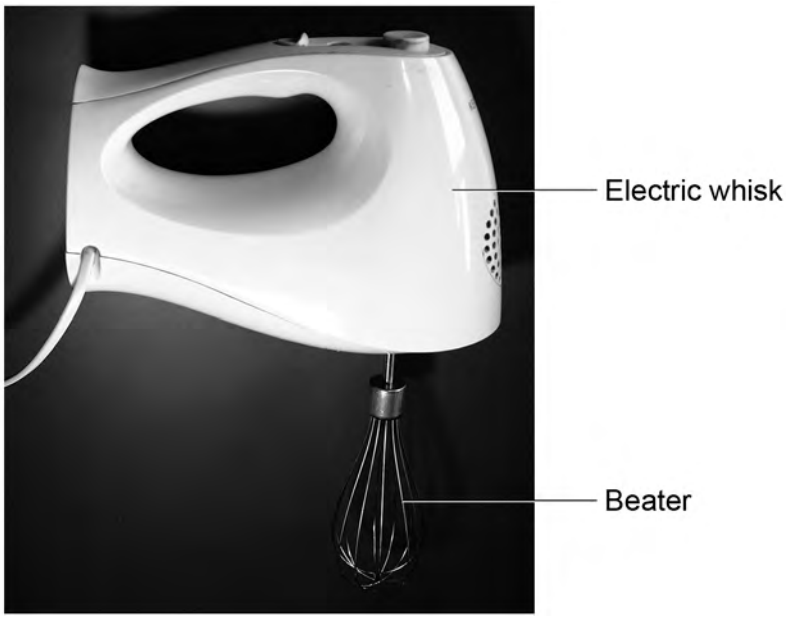
0 6 **Figure 10** shows an electric whisk that plugs into the mains electricity supply.

The whisk can mix food by spinning a beater.

Figure 10



0 6 . 1 Give **two** energy stores that increase when the whisk is switched on.

[2 marks]

1 _____

_____

2 _____

_____

Do not write outside the box

Use the Physics Equations Sheet to answer questions **06.2** and **06.3**.

0 6 . 2 Work is done by the whisk when it is used to mix food.

Write down the equation that links power (*P*), time (*t*) and work done (*W*).

[1 mark]

0 6 . 3 The power output of the whisk is 92 W.

Calculate the time for the whisk to do 23 000 J of work.

[3 marks]

Time = _____ s

Question 6 continues on the next page

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Use the Physics Equations Sheet to answer questions **06.4** and **06.5**.

0 6 . 4 Which equation links current (I), power (P) and resistance (R)?

[1 mark]

Tick (✓) **one** box.

$P = \frac{I}{R^2}$ ☐

$P = I R^2$ ☐

$P = \frac{I^2}{R}$ ☐

$P = I^2 R$ ☐

0 6 . 5 The current in the whisk is 500 mA.

The resistance of the whisk is 640 Ω.

Calculate the power of the whisk.

[3 marks]

Power = _____ W

Do not write outside the box

The whisk has several settings that allow the beater to spin at different speeds.

A faster beater speed needs a greater power input from the mains electricity supply.

0 6 . 6 What is the potential difference between the live wire and neutral wire in the mains electricity supply?

[1 mark]

_____ V

0 6 . 7 Changing the beater speed does **not** change the potential difference between the live wire and neutral wire.

The power input to the whisk changes because the current in the whisk changes.

Complete the sentence.

[1 mark]

When the beater speed increases, the current in the whisk increases because the resistance of the whisk _____.

12

Turn over for the next question

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0 7 Last century, scientists used evidence from the alpha particle scattering experiment to develop a new model of the atom.

In the experiment, alpha particles were directed towards a piece of gold foil.

0 7 . 1 What does an alpha particle consist of?

[1 mark]

0 7 . 2 A gold atom has the symbol $^{197}_{79}Au$.

How many neutrons are there in this gold atom?

[1 mark]

Number of neutrons = _____

Question 7 continues on the next page

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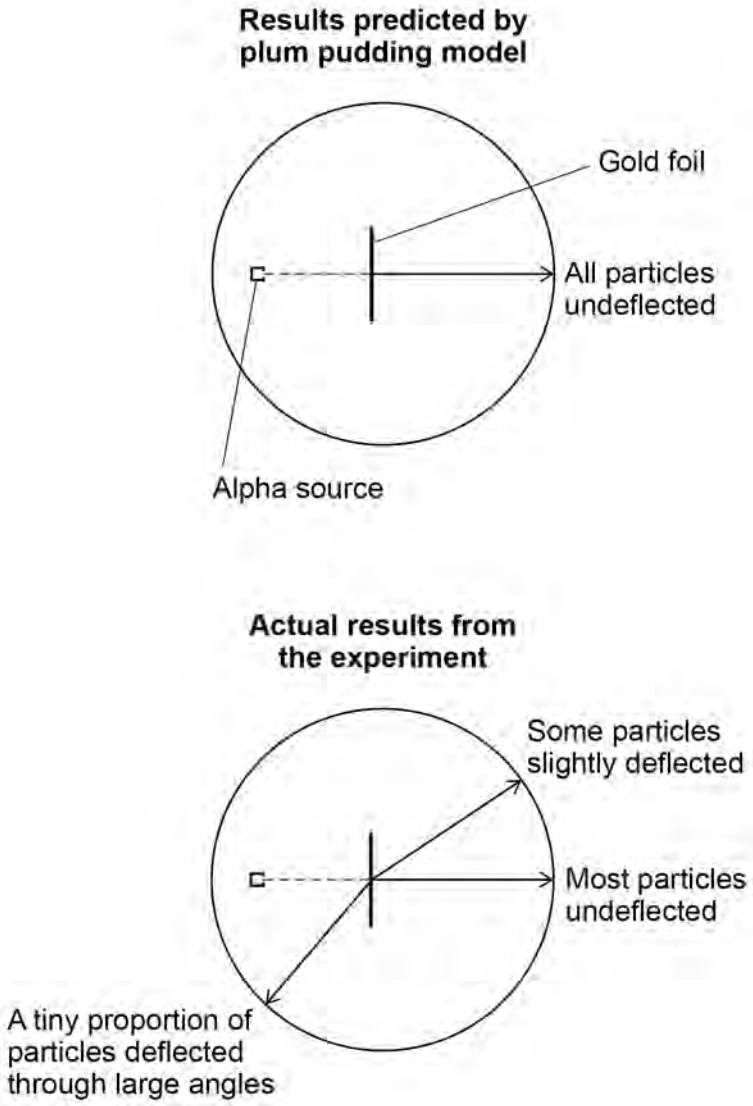
0 7 . 3 The alpha particle scattering experiment led to the plum pudding model of the atom being replaced by the nuclear model.

Figure 11 shows the results predicted by the plum pudding model and the actual results from the alpha particle scattering experiment.

Figure 11



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Describe how the actual results led to the plum pudding model of the atom being replaced by the nuclear model.

You should include details of the plum pudding model and the nuclear model of the atom.

[6 marks]

0 7 . 4 Scientists did not know that neutrons existed when they first did alpha particle scattering experiments.

Which scientist did the experiments that provided evidence that neutrons exist?

[1 mark]

Tick (✓) **one** box.

Isaac Newton ☐

James Chadwick ☐

Niels Bohr ☐

END OF QUESTIONS

9

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