AQA

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: SYNERGY

F

Foundation Tier Paper 3 Physical Sciences

Friday 7 June 2024 Afternoon Time allowed: 1 hour 45 minutes

Materials

For this paper you must have:
- a ruler
- a protractor
- a scientific calculator
- the periodic table (enclosed)
- 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.
- 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	
8	
9	
10	
TOTAL	

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.

Do not write outside the box

0 1 This question is about the periodic table and the elements in Group 0.

0 1 . 1 Complete the sentence.

Choose the answer from the box.

[1 mark]

atomic number	**mass number**	**neutron number**

The elements in the periodic table are arranged in

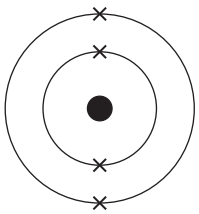
order of _____.

Do not write outside the box

0 1 . 2 Which electronic structure represents an atom of an element in Group 0?

[1 mark]

Tick (✓) **one** box.



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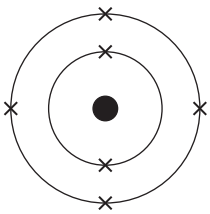

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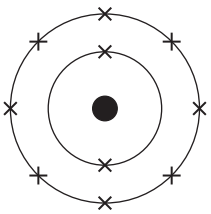

☐

0 1 . 3 Which is a property of the elements in Group 0?

[1 mark]

Tick (✓) **one** box.

Are unreactive ☐

Conduct electricity ☐

Consist of molecules ☐

Question 1 continues on the next page

Table 1 shows the relative atomic masses (A_r) and the boiling points of some elements in Group 0.

Table 1

Element	Relative atomic mass (A_r)	Boiling point in °C
Helium	4	−269
Neon	20	−246
Z	40	**X**
Krypton	84	−153
Xenon	131	−108

0 1 . 4 What is the state of the elements in Group 0 at room temperature?

Use **Table 1**.

[1 mark]

_____

0 1 . 5 Complete the sentence.

Use **Table 1**.

[1 mark]

The boiling points of elements in Group 0 increase as the

relative atomic masses _____.

Do not write outside the box

0 1 . 6 What is value **X** in **Table 1**?

[1 mark]

Tick (✓) **one** box.

−100 °C ☐

−131 °C ☐

−186 °C ☐

−252 °C ☐

0 1 . 7 Identify element **Z** in **Table 1**.

Use the periodic table.

[1 mark]

_____

7

Turn over for the next question

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There are no questions printed on this page

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ANSWER IN THE SPACES PROVIDED

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0 2 This question is about hydrocarbons.

0 2 . 1 Name the **two** elements in a hydrocarbon.

[2 marks]

1 _____

2 _____

0 2 . 2 Which **two** of the following substances are hydrocarbons?

[2 marks]

Tick (✓) **two** boxes.

Ammonia ☐

Ethene ☐

Graphite ☐

Methane ☐

Steam ☐

Question 2 continues on the next page

C_6H_{14} is a hydrocarbon.

C_6H_{14} can be broken down into smaller molecules.

0 2 . 3 Complete the equation for the breakdown of C_6H_{14} into smaller molecules.

[1 mark]

$$C_6H_{14} \longrightarrow C_4H_{10} + C\_\_\_ H\_\_\_$$

0 2 . 4 What is the name of the process that breaks down C_6H_{14} into smaller molecules?

[1 mark]

Tick (✓) **one** box.

Cracking ☐

Distillation ☐

Neutralisation ☐

Do not write outside the box

0 2 . 5 How does the boiling point of C_6H_{14} compare with the boiling point of C_4H_{10}?

Give **one** reason for your answer.

[2 marks]

Tick (✓) **one** box.

C_6H_{14} has a lower boiling point. ☐

C_6H_{14} and C_4H_{10} have the same boiling point. ☐

C_6H_{14} has a higher boiling point. ☐

Reason _____

_____

The complete combustion of C_6H_{14} produces water and **one** other product.

0 2 . 6 Name the **other** product of the complete combustion of C_6H_{14}

Do **not** refer to water in your answer.

[1 mark]

_____

0 2 . 7 The formula of water is H_2O

Calculate the relative formula mass (M_r) of water.

Relative atomic masses (A_r): H = 1 O = 16

[2 marks]

_____

_____

_____

M_r = _____

11

0 3 **Figure 1** shows two people wearing inflatable bodysuits.

The bodysuits are made of soft plastic and are inflated with air.

The inflatable bodysuits allow the two people to collide with each other safely.

Figure 1

The two people run towards each other before colliding and coming to a stop.

Do not write outside the box

People wearing bodysuits take more time to stop during a collision than people not wearing bodysuits.

0 3 . 1 How does wearing bodysuits affect the deceleration of the people during the collision?

[1 mark]

Tick (✓) **one** box.

The deceleration is less. ☐

The deceleration is the same. ☐

The deceleration is greater. ☐

0 3 . 2 How does wearing bodysuits affect the impact force experienced by each person during the collision?

[1 mark]

Tick (✓) **one** box.

The impact force is less. ☐

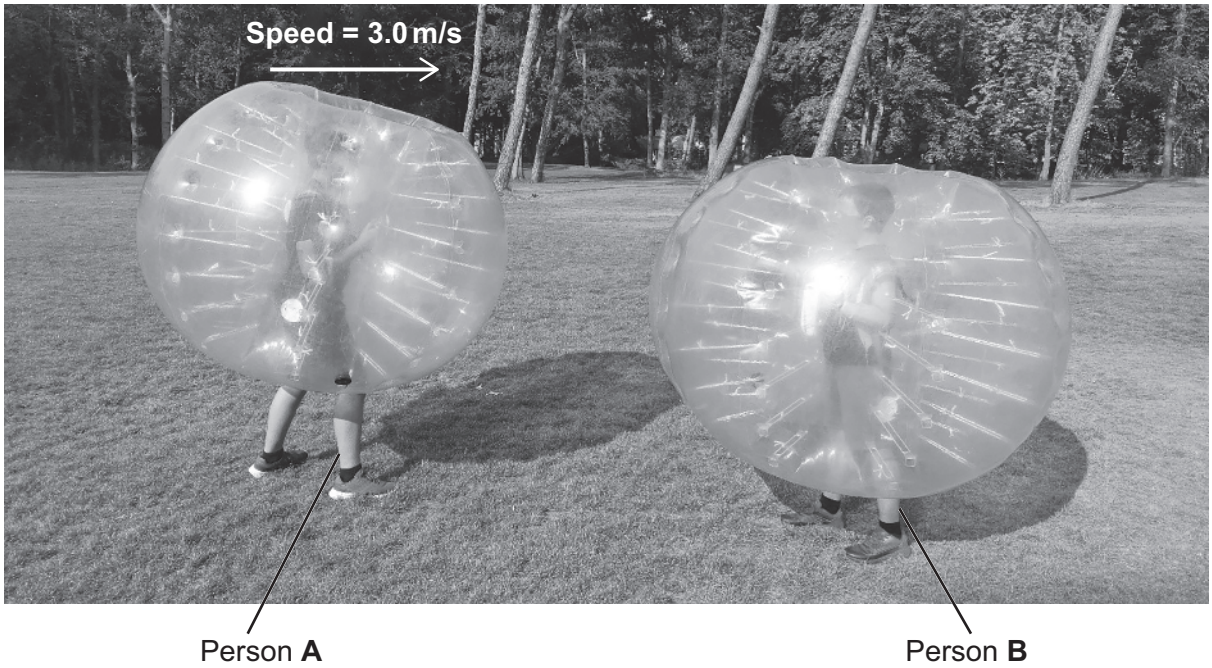
The impact force is the same. ☐

The impact force is greater. ☐

Question 3 continues on the next page

Figure 2 shows person **A** about to collide with person **B**.

Figure 2



0 3 . 3 Person **A** has a mass of 60 kg.

Person **A** moves with a speed of 3.0 m/s.

Calculate the kinetic energy of person **A**.

Use the equation:

$$\text{kinetic energy} = 0.5 \times \text{mass} \times (\text{speed})^2$$

[2 marks]

Kinetic energy = _____ J

Do not write outside the box

0 3 . 4 After the collision, person **B** has 45 J of kinetic energy.

Person **B** has a mass of 40 kg.

Calculate the speed of person **B** after the collision.

Use the equation:

$$\text{speed} = \sqrt{\frac{2 \times \text{kinetic energy}}{\text{mass}}}$$

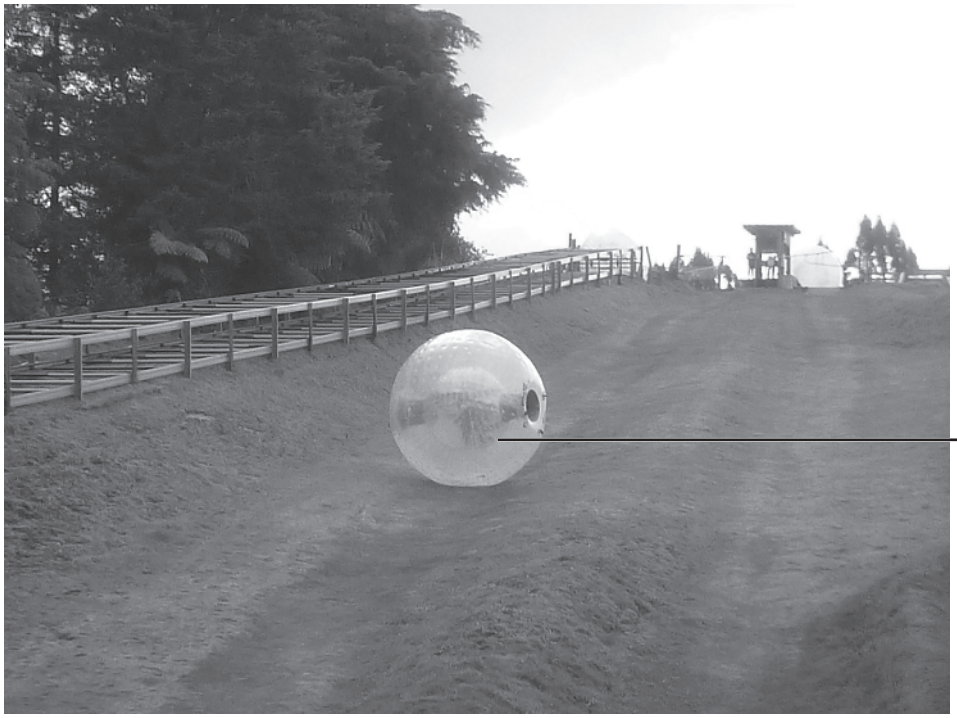
[2 marks]

Speed = _____ m/s

Question 3 continues on the next page

Figure 3 shows a person in an inflatable sphere rolling down a hill.

Figure 3



0 3 . 5 Describe how the gravitational potential energy **and** kinetic energy of the person vary as the sphere rolls down the hill.

[2 marks]

0 3 . 6 Suggest **two** factors that affect the maximum speed of the person as the sphere reaches the bottom of the hill.

[2 marks]

1 _____

2 _____

10

Do not write outside the box

0 4 This question is about life cycle assessments (LCAs).

LCAs assess the environmental impact of a product.

0 4 . 1 An LCA has four stages.

Complete the sentences.

Choose answers from the box.

[2 marks]

disposed of	**extracted**	**manufactured**	**packaged**

The first stage of an LCA assesses how raw materials

are _____.

The final stage of an LCA assesses how the product

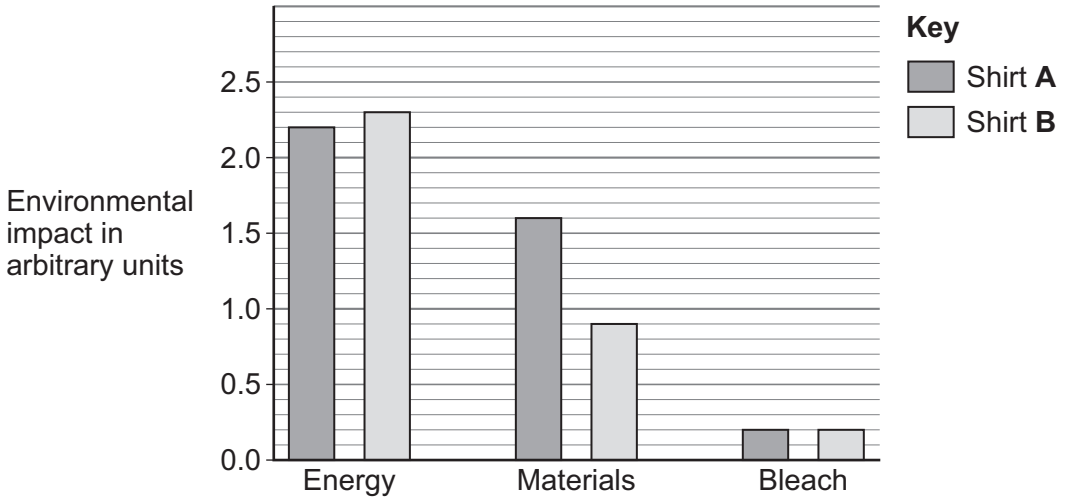
is _____.

Question 4 continues on the next page

Do not write outside the box

Figure 4 shows the environmental impact of the use of energy, materials and bleach during the production of two different shirts.

Figure 4



0 4 . 2 Draw **one** line from each statement to the cause of the environmental impact.

Use **Figure 4**.

[2 marks]

Statement	Cause of the environmental impact
Has the greatest environmental impact for both shirts	Energy
Has the biggest difference in environmental impact between the two shirts	Materials
	Bleach

Do not write outside the box

0 4 . 3 The total environmental impact of producing shirt **A** is 4.0 arbitrary units.

Determine the percentage of the total environmental impact of producing shirt **A** that is caused by **energy** use.

You should:

- give the environmental impact caused by energy use for shirt **A**
- calculate the percentage of the total environmental impact caused by energy use for shirt **A**.

Use **Figure 4**.

[3 marks]

Environmental impact = _____ arbitrary units

Percentage = _____ %

0 4 . 4 LCAs should be peer reviewed by independent scientists.

Give **one** reason why the peer review should be independent.

[1 mark]

8

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0 5 Energy resources are renewable or non-renewable.

0 5 . 1 Which **two** of the following energy resources are renewable?

[2 marks]

Tick (✓) **two** boxes.

Biofuel ☐

Coal ☐

Nuclear ☐

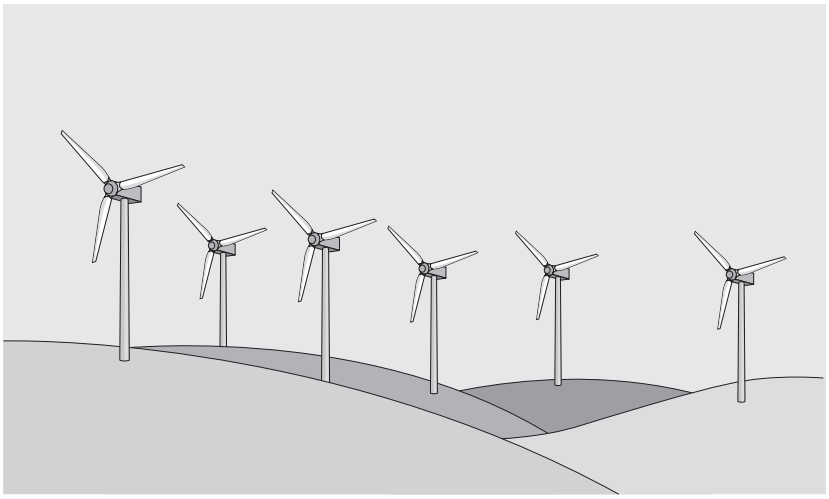
Oil ☐

Wind ☐

Do not write outside the box

0 5 . 2 **Figure 5** shows wind turbines in the countryside.

Figure 5



What are **two** effects on the environment of using wind turbines to generate electricity?

[2 marks]

Tick (✓) **two** boxes.

Some birds are killed by wind turbines. ☐

There is no fuel cost when using wind turbines. ☐

Wind is an unreliable energy resource. ☐

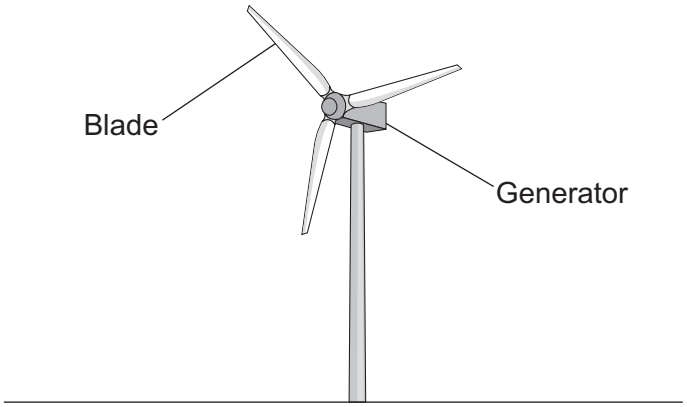
Wind turbines generate lots of electricity in windy conditions. ☐

Wind turbines produce low frequency noise. ☐

Question 5 continues on the next page

Figure 6 shows a wind turbine.

Figure 6



0 5 . 3 The useful power output of the generator in the wind turbine is 144 000 W.

The efficiency of the wind turbine is 0.30

Calculate the total power input to the wind turbine.

Use the equation:

$$\text{total power input} = \frac{\text{useful power output}}{\text{efficiency}}$$

[2 marks]

Total power input = _____ W

Do not write outside the box

Use the Physics Equations Sheet to answer Questions **05.4** and **05.5**.

0 5 . 4 Which equation links current, potential difference and power?

[1 mark]

Tick (✓) **one** box.

power = potential difference × current ☐

$$\text{power} = \frac{\text{potential difference}}{\text{current}}$$ ☐

$$\text{power} = \frac{\text{current}}{\text{potential difference}}$$ ☐

0 5 . 5 The power output of the generator in the wind turbine is 144 000 W.

The potential difference across the generator is 960 V.

Calculate the current in the generator.

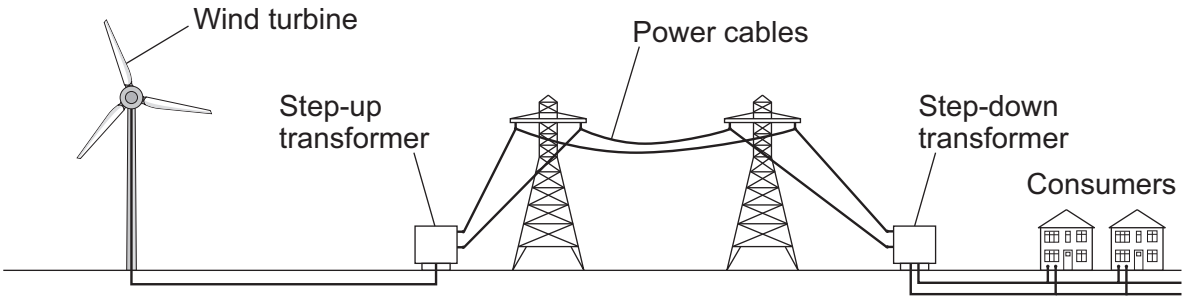
[3 marks]

Current = _____ A

Question 5 continues on the next page

Figure 7 shows how the National Grid links the wind turbine to consumers.

Figure 7



0 5 . 6 The step-up transformer increases the potential difference and decreases the current.

What effect does decreasing the current have on the energy loss from the power cables?

[1 mark]

Tick (✓) **one** box.

The energy loss decreases. ☐

The energy loss is not affected. ☐

The energy loss increases. ☐

Do not write outside the box

0 5 . 7 What is the function of the step-down transformer in **Figure 7**?

[1 mark]

Tick (✓) **one** box.

To decrease the current. ☐

To decrease the potential difference. ☐

To decrease the power input. ☐

12

Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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0 6 This question is about the elements magnesium, oxygen and lithium.

0 6 . 1 What is the type of bonding in magnesium?

[1 mark]

Tick (✓) **one** box.

Covalent ☐

Ionic ☐

Metallic ☐

0 6 . 2 What is the type of bonding in oxygen?

[1 mark]

Tick (✓) **one** box.

Covalent ☐

Ionic ☐

Metallic ☐

Question 6 continues on the next page

Do not write outside the box

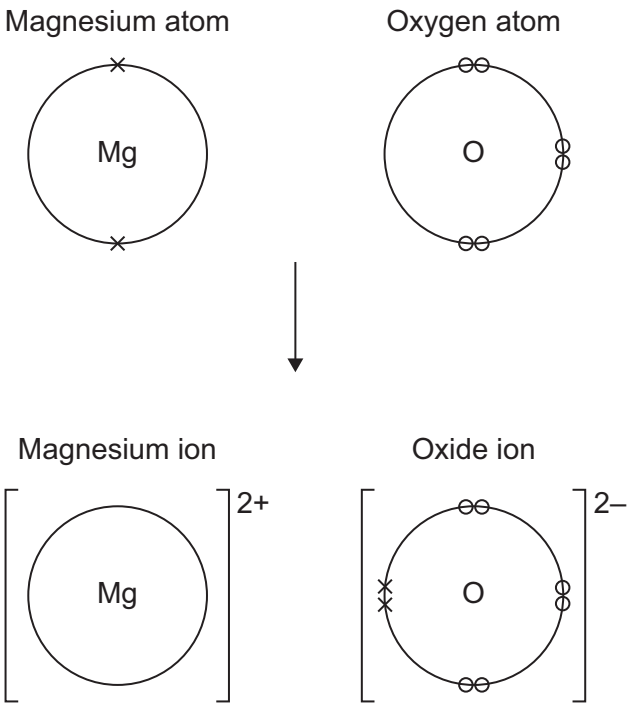
0 6 . 3 Magnesium atoms react with oxygen atoms to produce magnesium oxide.

Magnesium oxide contains magnesium ions and oxide ions.

Figure 8 shows the electronic structure of the atoms and the ions.

Only the outer shell electrons are shown.

Figure 8



Describe what happens when a magnesium atom reacts with an oxygen atom to produce a magnesium ion and an oxide ion.

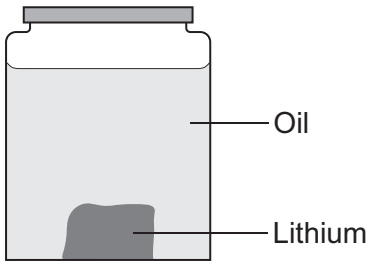
Answer in terms of electrons.

[4 marks]

Lithium is an element in Group 1 of the periodic table.

0 6 . 4 **Figure 9** shows a piece of lithium stored in oil.

Figure 9



Suggest why lithium is stored in oil.

[1 mark]

Question 6 continues on the next page

A teacher reacted 0.5 g of lithium with oxygen.

The teacher measured the mass of lithium oxide produced.

The teacher repeated the experiment with different masses of lithium.

Table 2 shows the results.

Table 2

Mass of lithium reacted in grams	Mass of lithium oxide produced in grams
0.5	1.0
1.0	2.1
1.5	3.1
2.0	4.2
2.5	5.2

0 6 . 5 Describe the relationship between the mass of lithium reacted and the mass of lithium oxide produced.

[1 mark]

Do not write outside the box

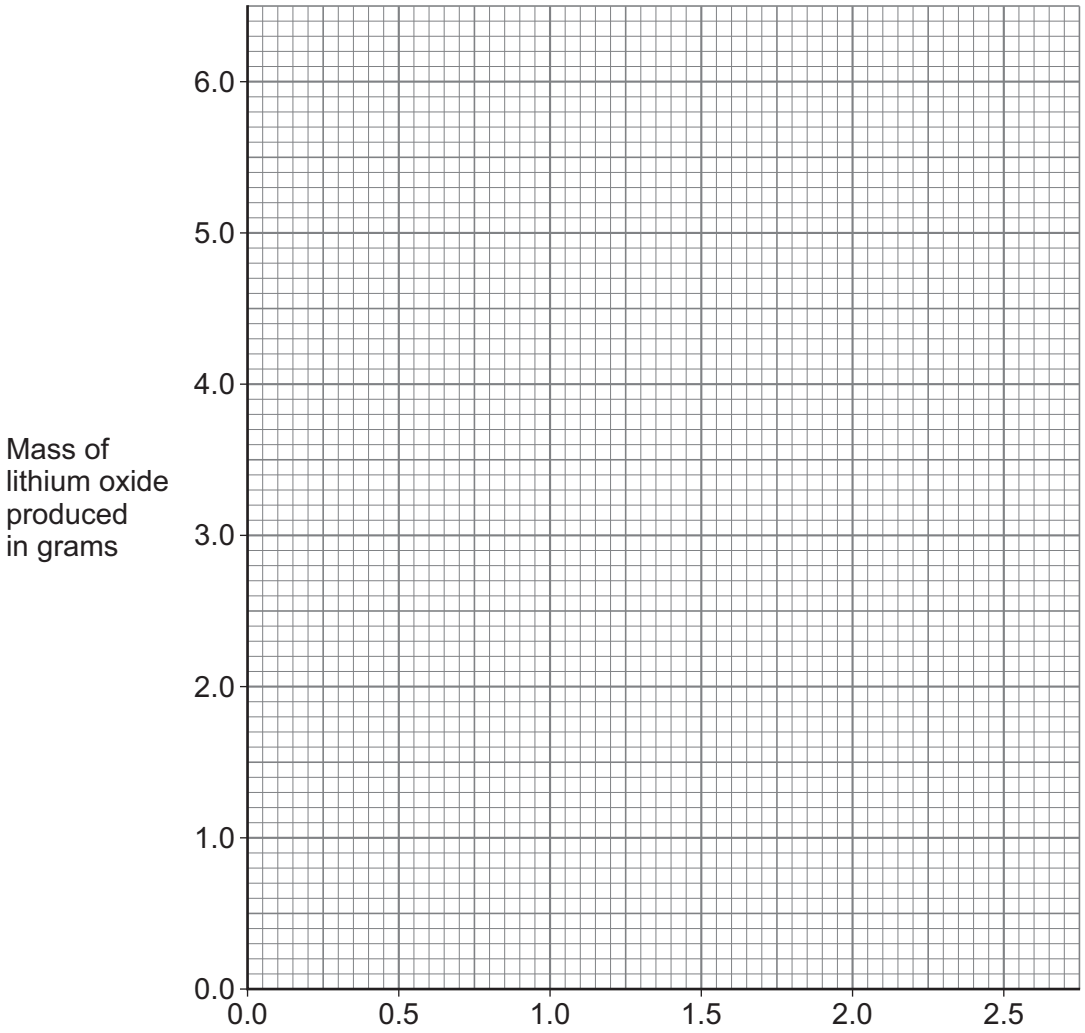
0 6 . 6 Complete **Figure 10**.

You should:

- label the *x*-axis
- plot the data from **Table 2**
- draw a line of best fit.

[4 marks]

Figure 10



Question 6 continues on the next page

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0 6 . 7 The teacher did the experiment four times using 0.25 g of lithium.

Table 3 shows the results.

Table 3

Mass of lithium reacted in grams	Mass of lithium oxide produced in grams				
	Test 1	Test 2	Test 3	Test 4	Mean
0.25	0.52	0.53	0.49	0.50	**X**

Calculate mean value **X** in **Table 3**.

[2 marks]

X = _____ g

14

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Turn over for the next question

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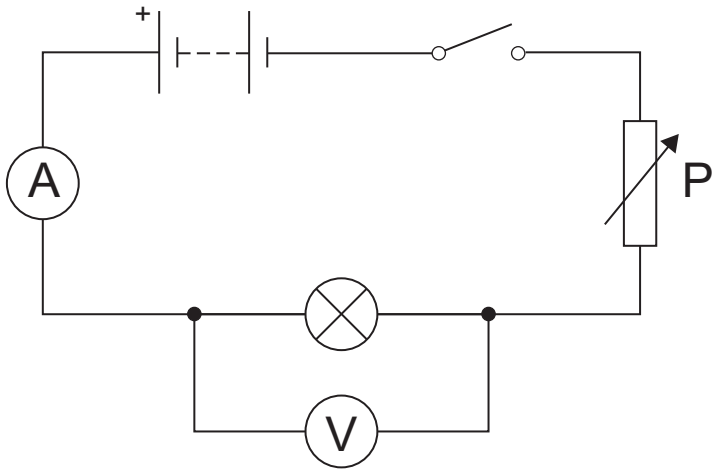
0 7 A student investigated how the current in a filament lamp varies with the potential difference across the filament lamp.

Figure 11 shows the circuit used.

Figure 11



0 7 . 1 What is component **P**?

[1 mark]

Tick (✓) **one** box.

A battery ☐

A variable resistor ☐

An open switch ☐

Do not write outside the box

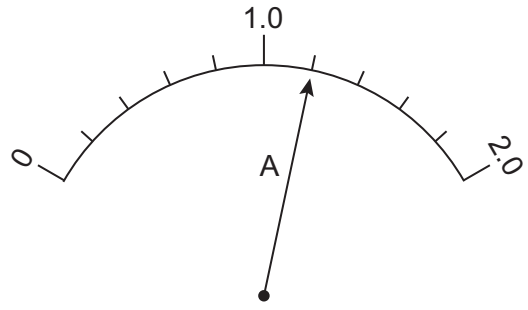
0 7 . 2 The student measured different values of potential difference and the corresponding values of current for the filament lamp.

Describe how the student could use the circuit in **Figure 11** to make these measurements.

[4 marks]

0 7 . 3 **Figure 12** shows the reading on the ammeter at one point in the investigation.

Figure 12



What is the reading on the ammeter?

[1 mark]

Ammeter reading = _____ A

Question 7 continues on the next page

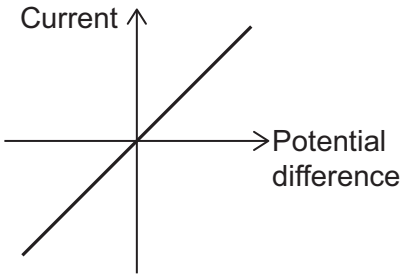
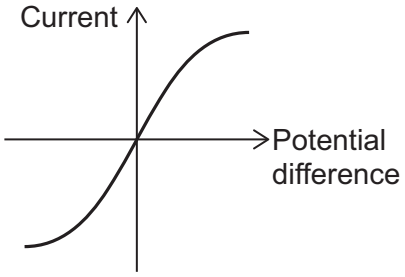
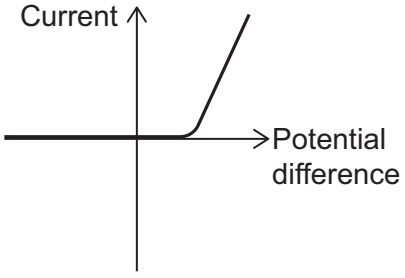
Do not write outside the box

0 7 . 4 The student repeated the investigation for two other components.

The student plotted a graph of current against potential difference for each component.

Draw **one** line from each component to the correct graph.

[3 marks]

Component	Graph
Diode	
Filament lamp	
Resistor (at constant temperature)	

9

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Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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0 8 Enzymes are large molecules and biological catalysts.

0 8 . 1 What type of molecule is an enzyme?

[1 mark]

_____

0 8 . 2 A catalyst changes the rate of a chemical reaction.

What happens to the mass of a catalyst during a chemical reaction?

[1 mark]

Tick (✓) **one** box.

The mass of the catalyst decreases. ☐

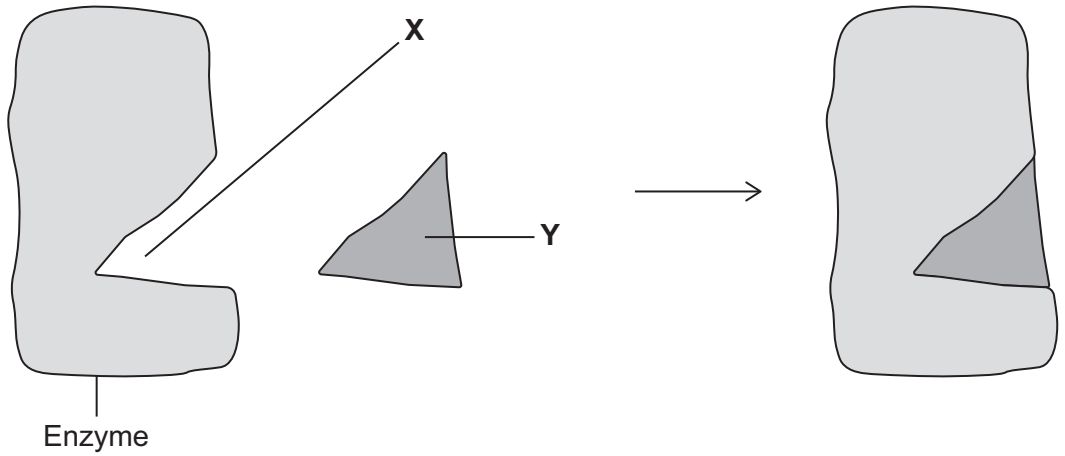
The mass of the catalyst stays the same. ☐

The mass of the catalyst increases. ☐

Do not write outside the box

Figure 13 shows a model of enzyme action.

Figure 13



0 8 . 3 Name **X** and **Y** in **Figure 13**.

[2 marks]

X _____

Y _____

0 8 . 4 Name the model shown in **Figure 13**.

[1 mark]

_____

Question 8 continues on the next page

Do not write outside the box

Amylase is an enzyme that breaks down starch.

A student investigated how changing the pH affected the activity of amylase.

This is the method used.

1. Heat a test tube containing 2 cm^3 of amylase solution at pH 5.0 in a water bath at 35 °C.
2. Heat a test tube containing 2 cm^3 of starch solution in the same water bath.
3. Transfer the amylase solution into the test tube of starch solution and mix.
4. After 30 seconds remove a drop of the amylase–starch mixture and test the drop for starch.
5. Repeat step 4 until no starch is detected.
6. Record the total time taken for no starch to be detected.
7. Repeat steps 1 to 6 using amylase solution at different pH values.

0 8 . 5 Explain why the solutions are all placed in the same water bath.

[2 marks]

0 8 . 6 Describe the test for starch.

Give the result of the test if starch is present.

[2 marks]

Test _____

Result _____

Do not write outside the box

Table 4 shows the results.

Table 4

pH	Time taken for no starch to be detected in seconds
5.0	120
5.5	120
6.0	90
6.5	90
7.0	60
7.5	60
8.0	90
8.5	120

0 8 . 7 Which range of pH values had the fastest rate of reaction?

[1 mark]

Tick (✓) **one** box.

pH 5.0 to pH 5.5 ☐

pH 6.0 to pH 6.5 ☐

pH 7.0 to pH 7.5 ☐

pH 8.0 to pH 8.5 ☐

0 8 . 8 How could the method be improved to obtain a more accurate pH value for the fastest rate of reaction?

[1 mark]

_____

_____

11

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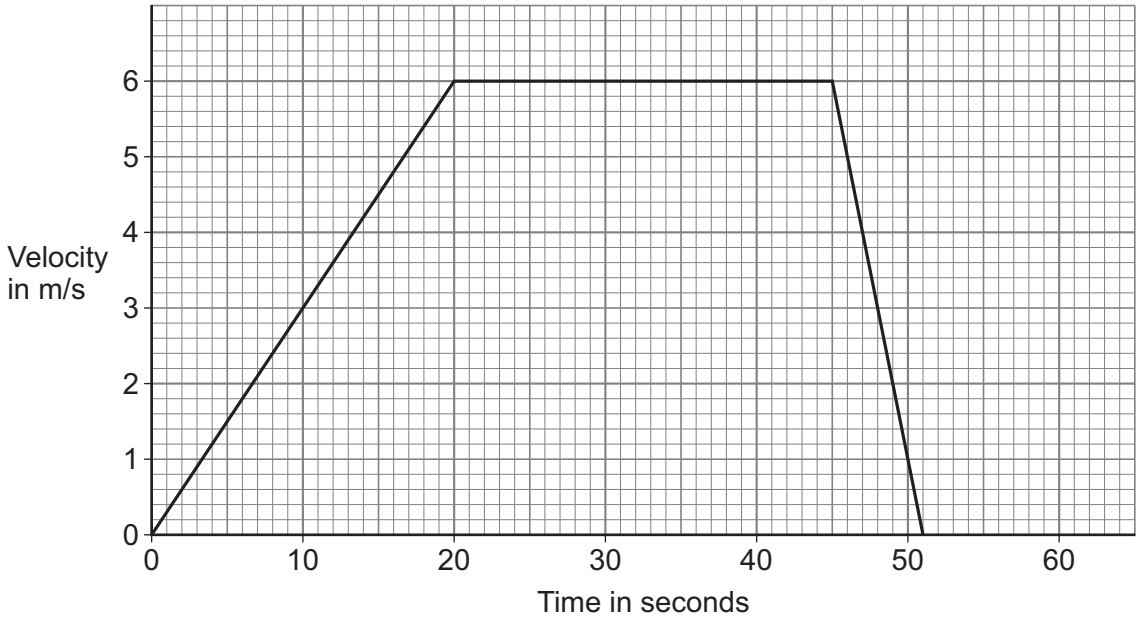
0 9 **Figure 14** shows a velocity–time graph for a remote-controlled car.

Figure 14



0 9 . 1 Determine the acceleration of the car between 0 and 20 seconds.

Use the Physics Equations Sheet.

[2 marks]

_____

_____

_____

Acceleration = _____ m/s^2

Do not write outside the box

0 9 . 2 Determine the distance travelled by the car between 20 seconds and 45 seconds.

Use the Physics Equations Sheet.

[2 marks]

Distance = _____ m

0 9 . 3 How does the deceleration of the car compare with the acceleration of the car?

Use **Figure 14**.

Give **one** reason for your answer.

[2 marks]

Tick (✓) **one** box.

The deceleration was greater than the acceleration. ☐

The deceleration was the same as the acceleration. ☐

The deceleration was less than the acceleration. ☐

Reason _____

Question 9 continues on the next page

Do not write outside the box

0 9 . 4 Another remote-controlled car travelled a distance of 80 m while accelerating from 0 m/s to 16 m/s.

Calculate the acceleration of this car.

Use the Physics Equations Sheet.

[3 marks]

Acceleration = _____ m/s^2

9

Do not write outside the box

1 0 A student investigated the reaction between citric acid powder and sodium hydrogen carbonate solution.

The temperature of the reaction mixture decreased.

1 0 . 1 Plan a method to investigate how changing the mass of citric acid affects the lowest temperature reached by the mixture.

[6 marks]

Question 10 continues on the next page

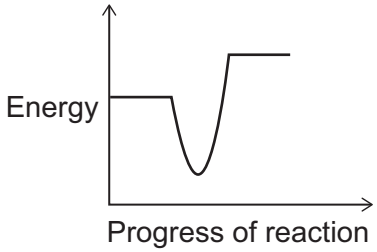
Do not write outside the box

1 0 . 2 The reaction between citric acid and sodium hydrogen carbonate is endothermic.

Which reaction profile represents an endothermic reaction?

[1 mark]

Tick (✓) **one** box.



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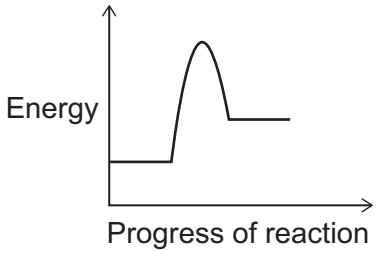

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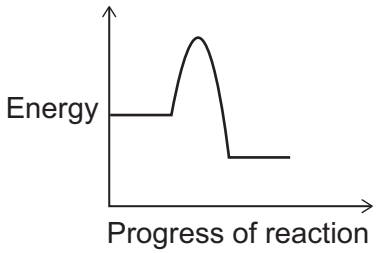

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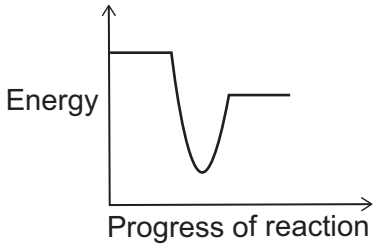

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1 0 . 3 Explain why the rate of reaction is greater when powder is used instead of larger lumps.

Refer to surface area and collisions in your answer.

[2 marks]

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9

END OF QUESTIONS

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