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

H

Higher 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	
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 Enzymes are large molecules and biological catalysts.

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

[1 mark]

_____

0 1 . 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. ☐

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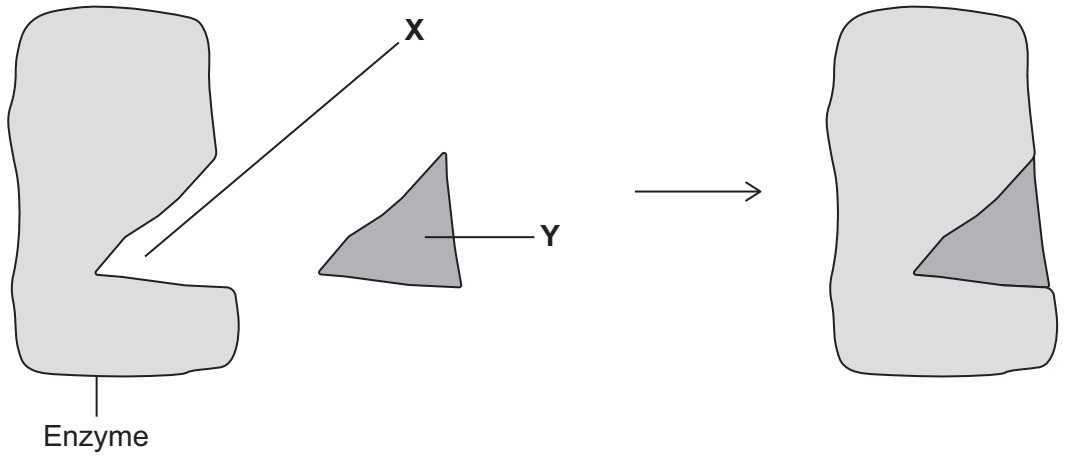
Figure 1 shows a model of enzyme action.

Figure 1



0 1 . 3 Name **X** and **Y** in **Figure 1**.

[2 marks]

X _____

Y _____

0 1 . 4 Name the model shown in **Figure 1**.

[1 mark]

_____

Question 1 continues on the next page

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 1 . 5 Explain why the solutions are all placed in the same water bath.

[2 marks]

_____

_____

_____

_____

0 1 . 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 1 shows the results.

Table 1

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 1 . 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 1 . 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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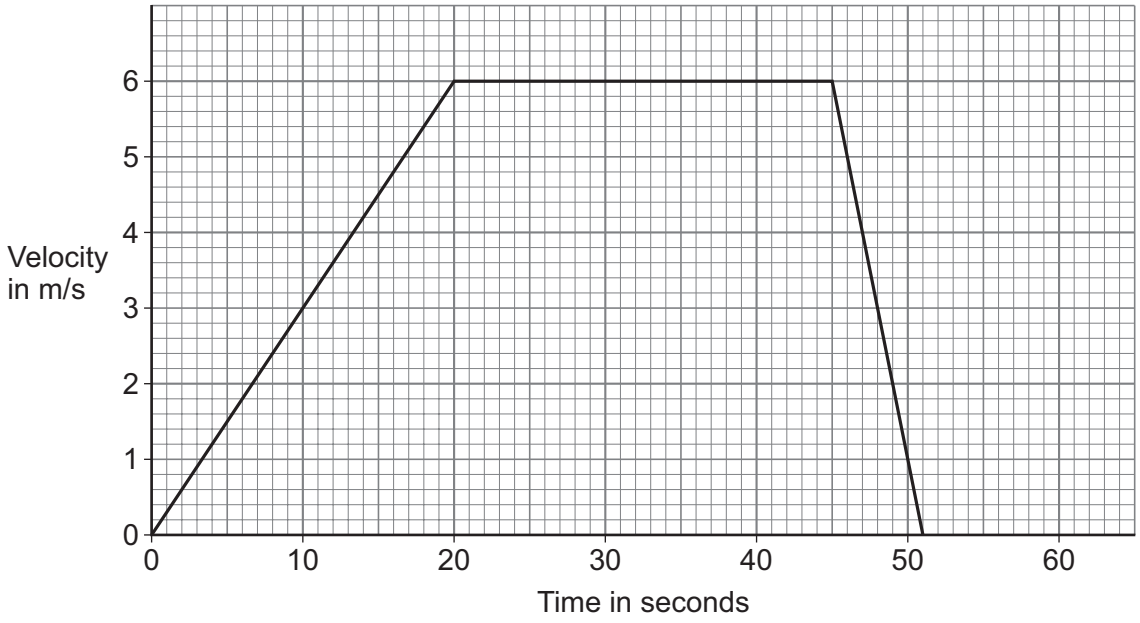
0 2 **Figure 2** shows a velocity–time graph for a remote-controlled car.

Figure 2



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

Use the Physics Equations Sheet.

[2 marks]

Distance = _____ m

0 2 . 3 How does the deceleration of the car compare with the acceleration of the car?

Use **Figure 2**.

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 2 continues on the next page

Do not write outside the box

0 2 . 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

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0 3 A student investigated the reaction between citric acid powder and sodium hydrogen carbonate solution.

The temperature of the reaction mixture decreased.

0 3 . 1 Plan a method to investigate how changing the mass of citric acid affects the lowest temperature reached by the mixture.

[6 marks]

Question 3 continues on the next page

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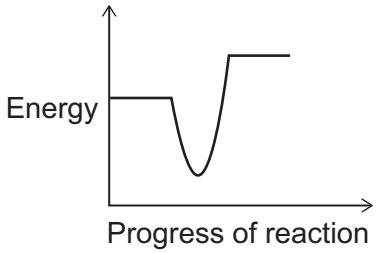
0 3 . 2 The reaction between citric acid and sodium hydrogen carbonate is endothermic.

Which reaction profile represents an endothermic reaction?

[1 mark]

Tick (✓) **one** box.



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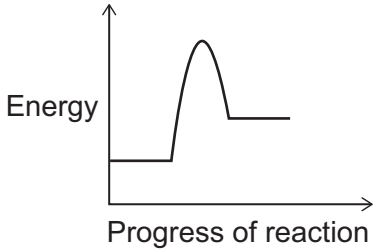

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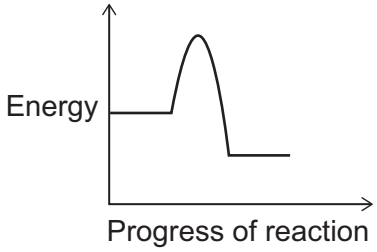

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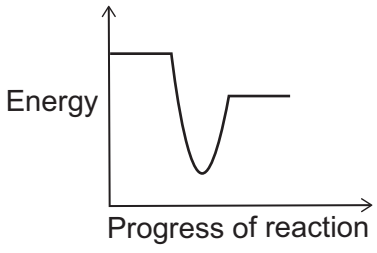

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0 3 . 3 Explain why the rate of reaction is greater when powder is used instead of larger lumps.

Refer to surface area and collisions in your answer.

[2 marks]

_____

_____

_____

_____

9

Turn over for the next question

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

LCAs assess the environmental impact of different processes during the life cycle of a product.

Table 2 shows values for the environmental impact of three processes during the production of two shirts.

Table 2

Process	**Environmental impact in equivalent units**	
	Shirt **A**	Shirt **B**
Use of materials	1.58	0.87
Use of energy	2.21	2.30
Use of bleach	0.26	0.26

0 4 . 1 The environmental impacts were measured in different units.

The measurements were converted to values with the same units.

These units are known as equivalent units.

Give **one** reason why **equivalent units** are used in LCAs.

[1 mark]

_____

_____

Do not write outside the box

0 4 . 2 Evaluate the environmental impact of producing shirt **A** compared with producing shirt **B**.

Use **Table 2**.

Use calculations in your answer.

[4 marks]

0 4 . 3 Peer reviews are used to check LCAs.

Why should an independent scientist be used to peer review an LCA?

[1 mark]

Question 4 continues on the next page

Do not write outside the box

0 4 . 4 Some LCAs assess the environmental impact of metal extraction.

Name the **biological** methods of metal extraction that use:

- bacteria
- plants.

[2 marks]

Bacteria _____

Plants _____

8

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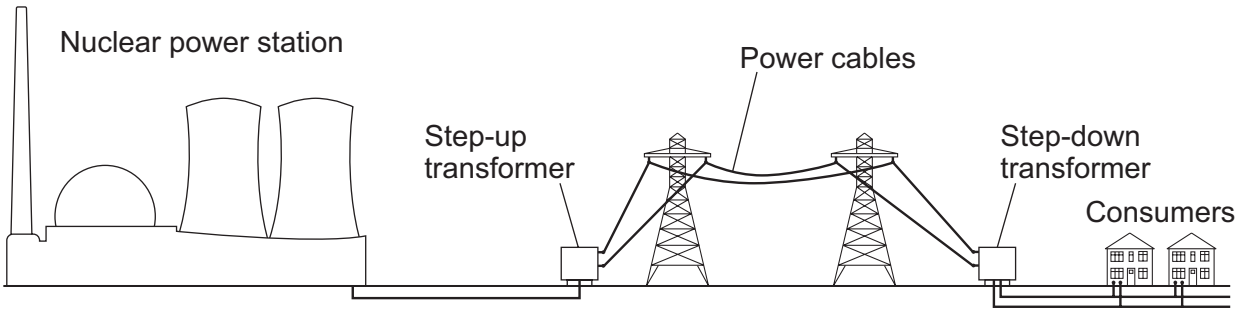
0 5 **Figure 3** shows how the National Grid links a nuclear power station to consumers.

Figure 3



0 5 . 1 Explain why step-up transformers are used in the National Grid.

[4 marks]

0 5 . 2 Explain why step-down transformers are used in the National Grid.

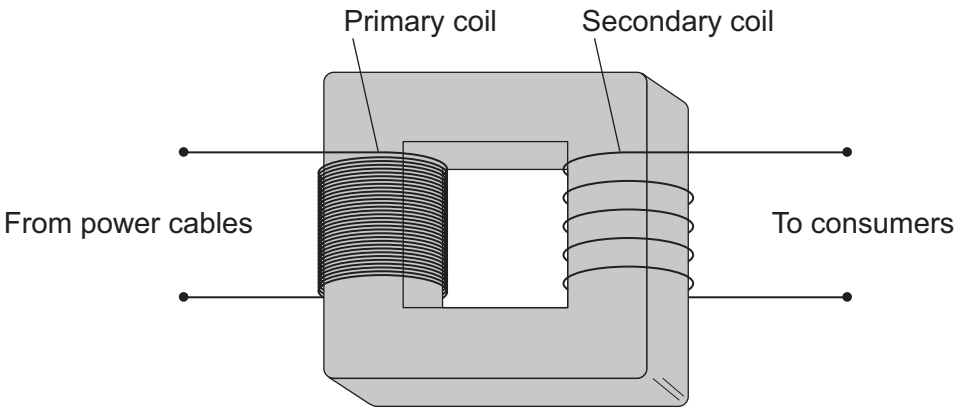
[2 marks]

Question 5 continues on the next page

Turn over ▶

0 5 . 3 **Figure 4** shows a transformer.

Figure 4



The potential difference across the primary coil is 345 kV.

The potential difference across the secondary coil is 230 V.

The current in the primary coil is 0.060 A.

Calculate the current in the secondary coil.

Use the Physics Equations Sheet.

[4 marks]

Current = _____ A

Do not write outside the box

0 5 . 4 Nuclear power stations and coal power stations have an environmental impact.

Compare the environmental impact of generating electricity using these two types of power station.

[4 marks]

14

Turn over for the next question

Do not write outside the box

0 6 This question is about groups in the periodic table.

0 6 . 1 What name is given to the Group 0 elements?

[1 mark]

_____

0 6 . 2 Explain the reactivity of the Group 0 elements.

[2 marks]

_____

_____

_____

_____

0 6 . 3 Describe the relationship between relative atomic mass and boiling point for the elements in Group 0.

[1 mark]

_____

_____

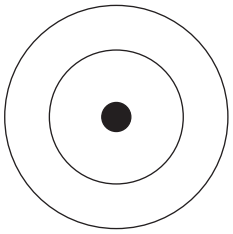
Do not write outside the box

0 6 . 4 Fluorine is an element in Group 7.

Complete **Figure 5** to represent the electronic structure of fluorine.

[1 mark]

Figure 5



0 6 . 5 Which is a correct statement about the elements in Group 7?

[1 mark]

Tick (✓) **one** box.

The elements in Group 7 consist of single, non-bonded atoms. ☐

The elements in Group 7 react with non-metals to form covalent compounds. ☐

The melting points of the elements in Group 7 decrease going down the group. ☐

The reactivity of the elements in Group 7 increases going down the group. ☐

Question 6 continues on the next page

Do not write outside the box

The elements in Group 1 react with water.

0 6 . 6 Give **two** observations you would see when a small piece of lithium is added to water.

[2 marks]

1 _____

_____

2 _____

_____

0 6 . 7 Lithium reacts with water less vigorously than sodium reacts with water.

Explain why lithium is less reactive than sodium.

[3 marks]

_____

_____

_____

_____

_____

_____

_____

_____

Do not write outside the box

0 6 . 8 Complete the equation for the reaction of lithium with water.

You should balance the equation.

[3 marks]

14

$$Li \quad + \quad H_2O \quad \longrightarrow \quad +$$

Turn over for the next question

Do not write outside the box

0 7 Magnesium reacts with oxygen to form magnesium oxide.

0 7 . 1 Describe what happens when a magnesium atom reacts with an oxygen atom to produce magnesium oxide.

[4 marks]

A student reacted different masses of magnesium with oxygen.

The student determined the mass of magnesium oxide produced.

Table 3 shows the results.

Table 3

Mass of magnesium reacted in grams	Mass of magnesium oxide produced in grams
0.08	0.12
0.17	0.25
0.24	0.38
0.33	0.54
0.42	0.67
0.49	0.81

Do not write outside the box

0 7 . 2 Complete **Figure 6**.

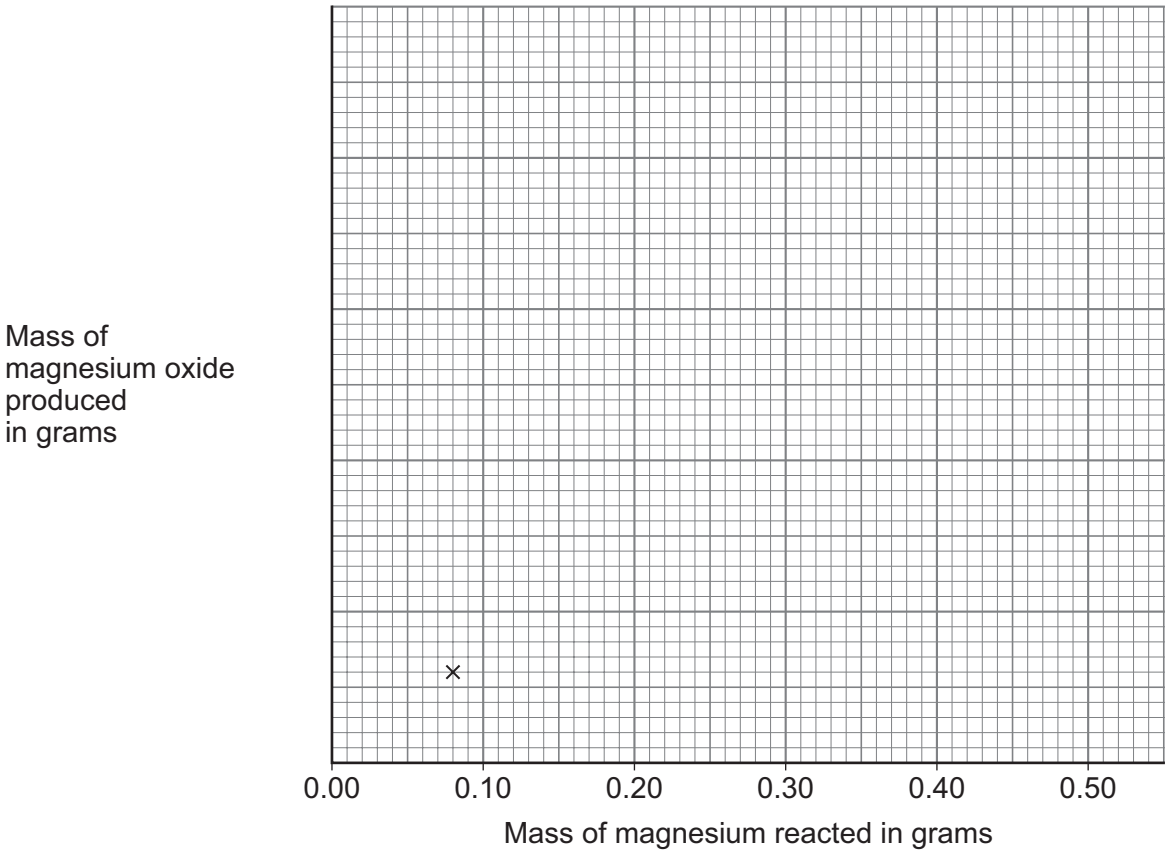
You should:

- use a suitable scale for the *y*-axis
- plot the data from **Table 3**.

The first point has been plotted for you.

[3 marks]

Figure 6



0 7 . 3 The student's results **cannot** be used to show that the method gives precise measurements.

Give **one** reason why.

[1 mark]

_____

_____

8

Turn over ▶

Do not write outside the box

0 8 **Figure 7** shows two people wearing inflatable bodysuits.

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

The bodysuits reduce the chance of injury in a collision.

Figure 7

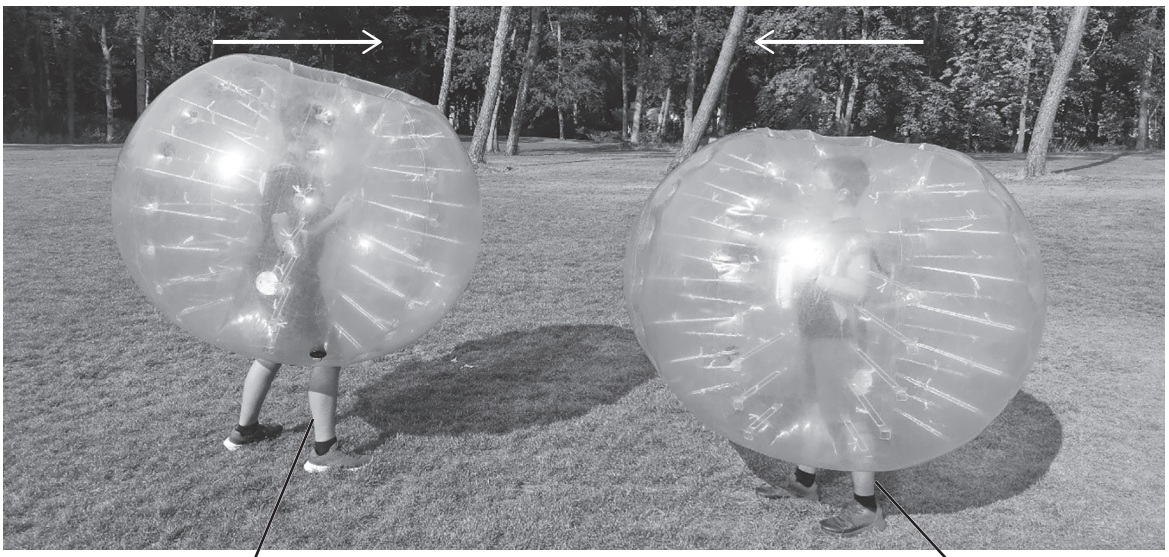
0 8 . 1 Explain how wearing a bodysuit reduces the chance of injury in a collision.

[3 marks]

Do not write outside the box

0 8 . 2 **Figure 8** shows person **A** about to collide with person **B**.

Figure 8



The arrows show the direction in which each person is moving.

The velocity of person **A** is +2.0 m/s.

The two people collide and stop.

Calculate the velocity of person **B** before the collision.

Use the Physics Equations Sheet.

[5 marks]

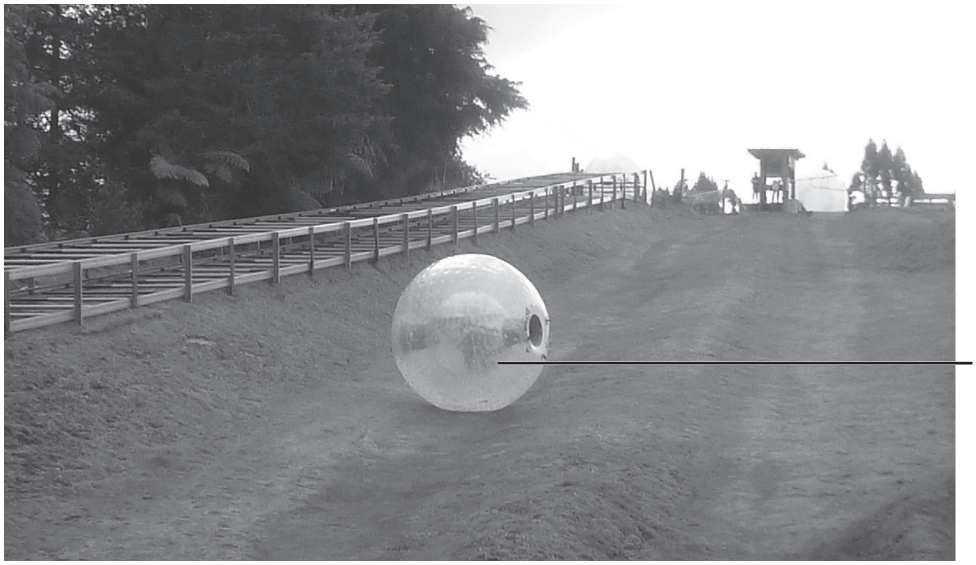
Velocity = _____ m/s

Turn over ▶

Do not write outside the box

0 8 . 3 **Figure 9** shows a person in an inflatable sphere rolling down a hill.

Figure 9



The total mass of the person and sphere is 80 kg.

The sphere moves through a vertical height of 6.4 m.

gravitational field strength = 9.8 N/kg

Calculate the maximum possible speed of the sphere at the bottom of the hill.

Use the Physics Equations Sheet.

[5 marks]

Maximum speed = _____ m/s

Do not write outside the box

0 8 . 4 The actual speed of the sphere at the bottom of the hill is much less than the maximum possible speed.

Explain why.

[2 marks]

15

Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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0 9 This question is about hydrocarbons.

Hexane (C_6H_{14}) and pentane (C_5H_{12}) are hydrocarbons in the same homologous series.

0 9 . 1 Give the name of the homologous series that includes hexane and pentane.

[1 mark]

_____

0 9 . 2 Give the general formula of the homologous series that includes hexane and pentane.

[1 mark]

_____

0 9 . 3 Explain why the boiling point of hexane is higher than the boiling point of pentane.

[3 marks]

_____

_____

_____

_____

_____

_____

Question 9 continues on the next page

Do not write outside the box

0 9 . 4 Complete the equation for the cracking of hexane (C_6H_{14}) into **ethene** and one **other** molecule.

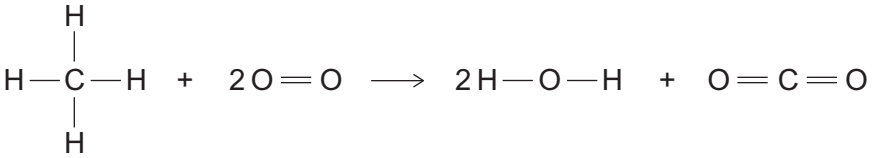
[2 marks]

$$C_6H_{14} \longrightarrow C\_\_\_H\_\_\_ + C\_\_\_H\_\_\_$$

0 9 . 5 Methane undergoes complete combustion with oxygen.

Figure 10 represents the equation for the reaction.

Figure 10



The energy released forming the new bonds is 814 kJ/mol greater than the energy needed to break the existing bonds.

Table 4 shows some bond energy values.

Table 4

Bond	Bond energy in kJ/mol
C — H	**Y**
O = O	498
O — H	464
C = O	803

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Calculate value **Y** in **Table 4**.

[5 marks]

Y = _____ kJ/mol

12

END OF QUESTIONS

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