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

Monday 9 June 2025 Morning 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 **Figure 1** shows a rugby player running with a rugby ball.

Figure 1

Use the Physics Equations Sheet to answer questions **01.1** and **01.2**.

0 1 . 1 Which equation links distance (s), speed (v) and time (t)?

[1 mark]

Tick (✓) **one** box.

$s = v \times t$ ☐ $s = \frac{v}{t}$ ☐ $s = \frac{t}{v}$ ☐

0 1 . 2 The rugby player travels a distance of 44 m in a time of 5.0 s.

Calculate the mean speed of the rugby player.

[3 marks]

Mean speed = _____ m/s

The rugby player collides with another player and stops.

Use the Physics Equations Sheet to answer questions **01.3** and **01.4**.

0 1 . 3 Which equation links acceleration (a), change in velocity (Δv) and time (t)?

[1 mark]

Tick (✓) **one** box.

$a = \Delta v \times t$ ☐

$a = \frac{\Delta v}{t}$ ☐

$a = \frac{t}{\Delta v}$ ☐

0 1 . 4 The velocity of the rugby player changes from 6.0 m/s to 0.0 m/s in a time of 400 ms.

Calculate the deceleration of the rugby player.

[3 marks]

Deceleration = _____ m/s^2

Question 1 continues on the next page

Figure 2 shows a rugby player wearing a 'mouthguard'.

Figure 2

Mouthguards reduce the risk of injury when rugby players collide.

A mouthguard has been invented that transmits data about the deceleration of a rugby player's head during a collision.

A deceleration of 540 m/s^2 or more automatically alerts the team doctor at the side of the rugby pitch.

Use the Physics Equations Sheet to answer questions **01.5** and **01.6**.

0 1 . 5 Which equation links acceleration (a), mass (m) and resultant force (F)?

[1 mark]

Tick (✓) **one** box.

$F = m \times a$ ☐

$F = \frac{m}{a}$ ☐

$F = \frac{a}{m}$ ☐

Do not write outside the box

0 1 . 6 The mass of a rugby player's head is 3500 g.

During a collision the rugby player's head has a deceleration of 540 m/s^2.

Calculate the resultant force on the rugby player's head.

[3 marks]

Resultant force = _____ N

0 1 . 7 Give **one** advantage of using the new mouthguard when playing rugby compared with a mouthguard that does not transmit data.

[1 mark]

13

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 Metals are found in the Earth's crust as the metal itself or as a metal compound.

0 2 . 1 Why is gold found in the Earth as the metal itself?

[1 mark]

_____

_____

0 2 . 2 Iron is extracted from iron oxide using carbon.

The word equation for the reaction is:

iron oxide + carbon ⟶ iron + carbon dioxide

Which substance is oxidised during the reaction?

Give **one** reason for your answer.

Answer in terms of oxygen.

[2 marks]

Substance oxidised _____

Reason _____

_____

Question 2 continues on the next page

Aluminium is extracted from aluminium oxide by electrolysis.

The electrolyte is a molten mixture of aluminium oxide and cryolite.

0 2 . 3 Aluminium **cannot** be extracted from aluminium oxide using carbon.

Give **one** reason why.

[1 mark]

_____

_____

0 2 . 4 Give **two** reasons why large amounts of energy are needed for the electrolysis of aluminium oxide.

[2 marks]

1 _____

_____

2 _____

_____

Do not write outside the box

0 2 . 5 Recycling aluminium needs less energy than extracting new aluminium.

Table 1 shows the energy needed for 1 kg of aluminium to be:

- extracted
- recycled.

Table 1

	Aluminium extracted	**Aluminium recycled**
Energy in MJ	162	11

Calculate the percentage **decrease** in energy needed when aluminium is recycled instead of extracted.

Give your answer to 2 significant figures.

[4 marks]

Percentage decrease in energy (2 significant figures) = _____ %

10

Turn over for the next question

0 3 This question is about forms of carbon.

0 3 . 1 A carbon nanotube has:

- a length of 2 mm
- a diameter of 0.8 nm.

Calculate the simplest length to diameter ratio of the nanotube.

1 000 000 nm = 1 mm

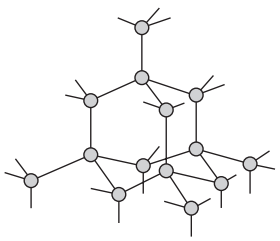
[3 marks]

Length to diameter ratio = _____ : 1

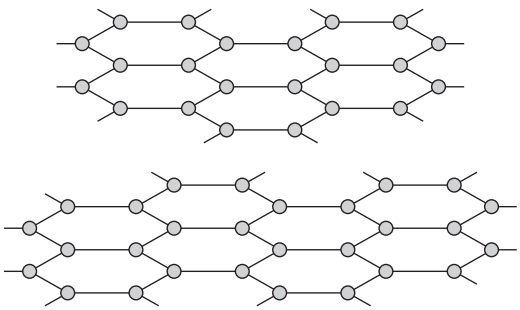
0 3 . 2 **Figure 3** represents the structure of diamond and of graphite.

Figure 3

Diamond



Graphite



Key

○ Carbon atom

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Compare the structure and bonding of diamond with the structure and bonding of graphite.

[6 marks]

Extra space

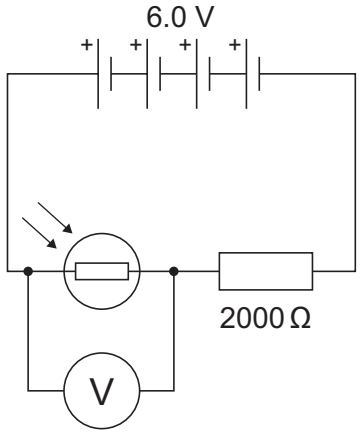
9

Turn over for the next question

0 4 A student investigated how the resistance of a light dependent resistor (LDR) varies with light intensity.

Figure 4 shows the circuit.

Figure 4



0 4 . 1 The potential difference across the battery was 6.0 V.

Determine the potential difference across each cell.

[1 mark]

_____

_____

Potential difference across each cell = _____ V

Do not write outside the box

0 4 . 2 When the LDR was in a dark room, the reading on the voltmeter was 3.0 V.

What was the resistance of the LDR?

Give a reason for your answer.

[2 marks]

Tick (✓) **one** box.

1000 Ω ☐ 2000 Ω ☐ 4000 Ω ☐

Reason _____

_____

_____

0 4 . 3 The student directed a bright light onto the LDR in the circuit.

Explain why the reading on the voltmeter decreased.

[3 marks]

_____

_____

_____

_____

_____

_____

_____

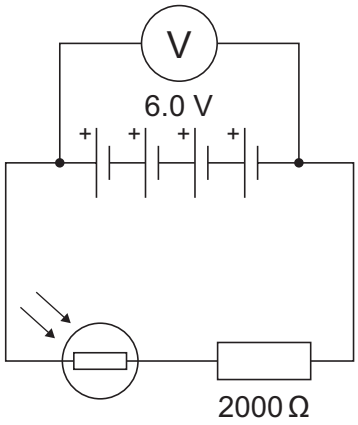
Question 4 continues on the next page

Do not write outside the box

0 4 . 4 Another student set the circuit up incorrectly.

Figure 5 shows the incorrect circuit.

Figure 5



The student placed the circuit in a dark room and then directed a bright light onto the LDR.

Explain what the reading on the voltmeter would be.

[2 marks]

8

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Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

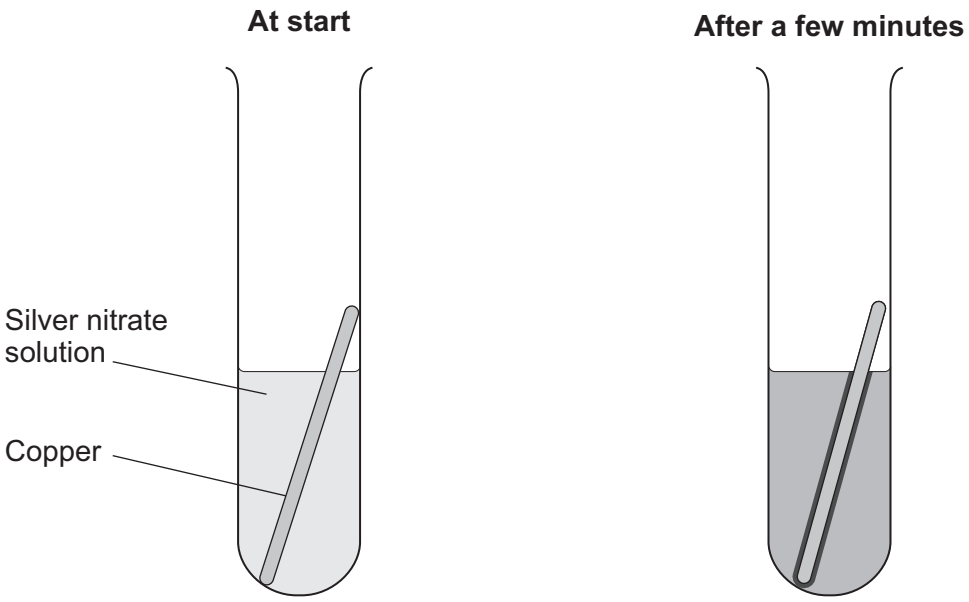
0 5 This question is about metals and metal compounds.

A teacher demonstrated the reaction of copper with silver nitrate.

Figure 6 shows the apparatus:

- at the start
- after a few minutes.

Figure 6



The word equation for the reaction is:

copper + silver nitrate ⟶ copper nitrate + silver

Do not write outside the box

0 5 . 1 Silver ions are reduced to silver atoms in the reaction.

What is meant by 'reduced' in this reaction?

[1 mark]

0 5 . 2 Complete the ionic equation for the reaction between copper and silver nitrate solution.

You should balance the equation.

[2 marks]

$$\quad + \quad Ag^{+} \longrightarrow \quad Cu^{2+} \; +$$

0 5 . 3 Copper nitrate is made up of Cu^{2+} ions and NO_3^- ions.

What is the formula of copper nitrate?

[1 mark]

Tick (✓) **one** box.

- $CuNO_3$ ☐
- $Cu(NO_3)_2$ ☐
- Cu_2NO_3 ☐
- $Cu_2(NO_3)_3$ ☐

0 5 . 4 **Figure 7** shows the order of reactivity for three metals.

Figure 7

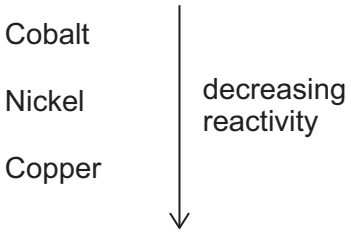


Table 2 shows the colours of three metal nitrate solutions.

Table 2

Metal nitrate	**Colour of metal nitrate solution**
Cobalt nitrate	Pink
Nickel nitrate	Green
Copper nitrate	Blue

The teacher added an excess of each metal to each metal nitrate solution.

Complete **Table 3** to show the **colours** of the resultant solutions.

[3 marks]

Table 3

Metal	**Metal nitrate solution**		
	Cobalt nitrate	Nickel nitrate	Copper nitrate
Cobalt			
Nickel			
Copper			

Do not write outside the box

0 5 . 5 Copper is a good conductor of electricity.

Explain how copper conducts electricity.

[3 marks]

0 5 . 6 Pure copper is too soft for many uses.

Copper is mixed with other metals to make copper alloys.

Explain why copper alloys are harder than pure copper.

[3 marks]

13

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There are no questions printed on this page

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ANSWER IN THE SPACES PROVIDED

Do not write outside the box

0 6 Two drivers raced their cars in a straight line over a distance of 400 metres.

Figure 8 shows the cars.

Figure 8

0 6 . 1 At the start of the race, one car accelerated from rest at 25 m/s^2.

The car moved 32 m while accelerating.

Calculate the final velocity of the car.

Use the Physics Equations Sheet.

[3 marks]

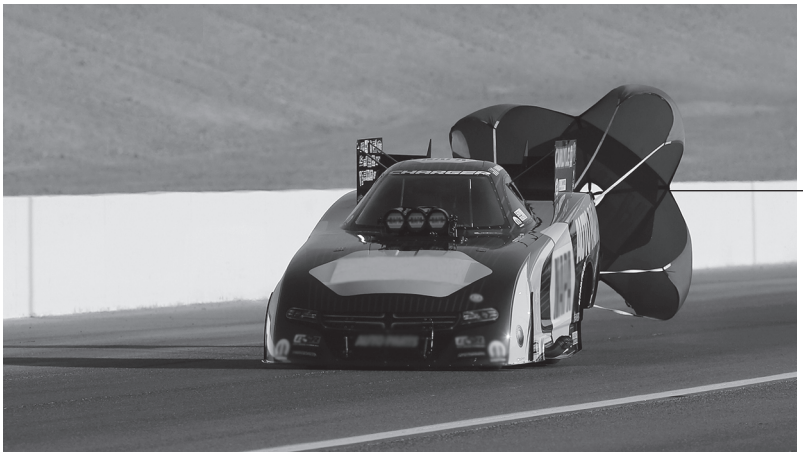
Final velocity = _____ m/s

Turn over ▶

At the end of the race, each driver applied the brakes and opened a parachute to decelerate the car.

Figure 9 shows one of the cars at the end of the race.

Figure 9



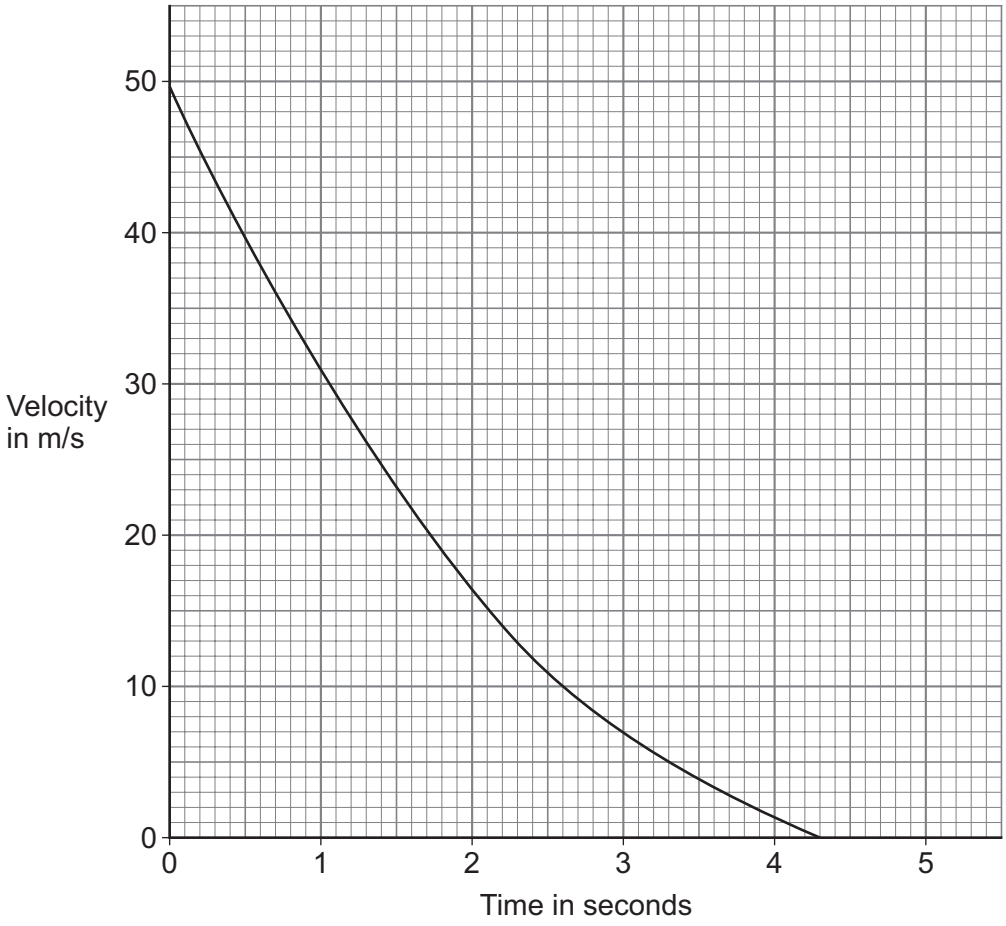
0 6 . 2 Explain how opening the parachute affects the deceleration of the car.

[3 marks]

Do not write outside the box

0 6 . 3 **Figure 10** shows how the velocity of one car changed as the car decelerated.

Figure 10



Determine the deceleration of the car at 2.5 seconds.

[3 marks]

Deceleration = _____ m/s^2

9

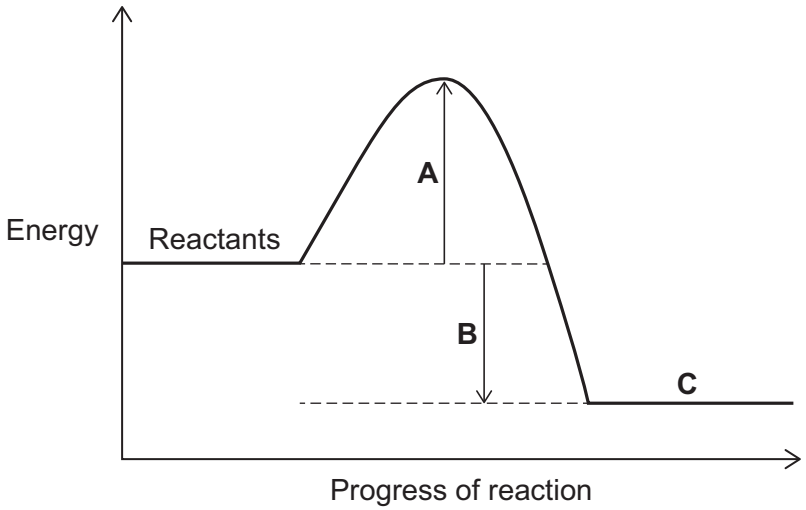
Turn over ▶

0 7 The elements in Group 1 of the periodic table are called the alkali metals.

Lithium reacts with chlorine to produce lithium chloride.

Figure 11 shows the reaction profile for the reaction between lithium and chlorine.

Figure 11



0 7 . 1 What do labels **A**, **B** and **C** on **Figure 11** represent?

[3 marks]

A _____

B _____

C _____

0 7 . 2 What type of reaction does the reaction profile in **Figure 11** represent?

[1 mark]

_____

Do not write outside the box

0 7 . 3 Describe what happens when a lithium atom reacts with a chlorine atom.

Answer in terms of electrons.

[4 marks]

Extra space

0 7 . 4 Explain the trend in the reactivity of the Group 1 metals.

[4 marks]

Extra space

12

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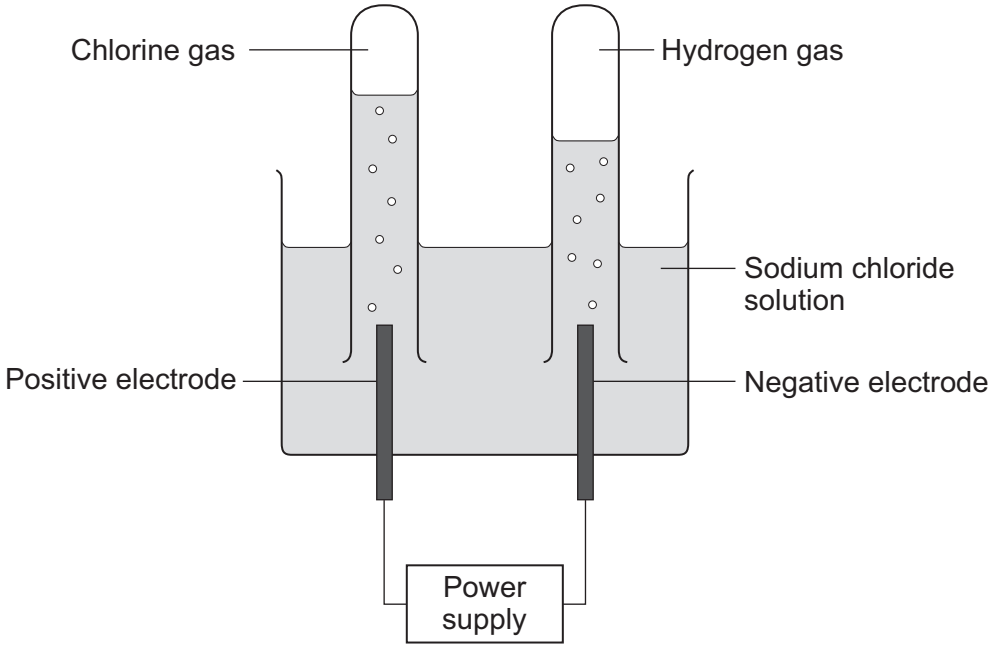
0 8 An aqueous solution of sodium chloride can be electrolysed.

Figure 12 shows the apparatus.

Figure 12



0 8 . 1 The electrodes in **Figure 12** are made of graphite.

Graphite is a good conductor of electricity.

Give **one** other reason why graphite electrodes are used.

Do **not** refer to conduction of electricity in your answer.

[1 mark]

Do not write outside the box

The electrolysis of an aqueous solution of sodium chloride produces chlorine, hydrogen and one other substance.

0 8 . 2 What is the other substance produced in the electrolysis of an aqueous solution of sodium chloride?

[1 mark]

Tick (✓) **one** box.

Hydrochloric acid ☐

Sodium ☐

Sodium hydroxide ☐

Water ☐

0 8 . 3 Write the half equation for the production of chlorine gas at the positive electrode.

[2 marks]

_____ ⟶ _____ + _____

Question 8 continues on the next page

Do not write outside the box

0 8 . 4 Hydrogen gas is produced at the negative electrode in the electrolysis of an aqueous solution of sodium chloride.

Explain why.

[4 marks]

Extra space

8

Do not write outside the box

Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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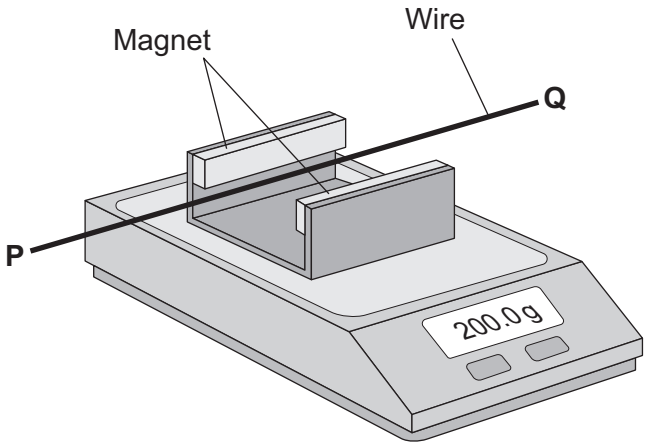
0 9 A teacher demonstrates the motor effect.

Figure 13 shows the apparatus.

Figure 13



The wire is connected to a circuit.

The part of the wire between **P** and **Q** is fixed in position and cannot move.

The teacher switches the circuit on.

When there is a current in the wire, there is an upwards magnetic force on the wire.

0 9 . 1 Explain why the reading on the balance increases when the circuit is switched on.

[2 marks]

Do not write outside the box

0 9 . 2 Give **one** way the upwards magnetic force on the wire in **Figure 13** can be increased.

[1 mark]

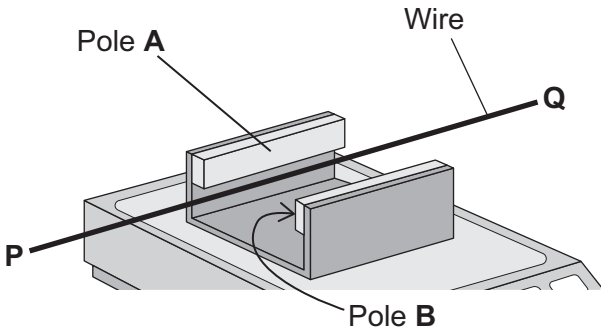
_____

_____

_____

0 9 . 3 **Figure 14** shows the wire and the magnets.

Figure 14



The direction of the current is from **P** to **Q**.

The magnetic force on the wire is upwards.

What are the names of the magnetic poles on **Figure 14**?

[1 mark]

Pole **A** _____

Pole **B** _____

Question 9 continues on the next page

Do not write outside the box

0 9 . 4 The potential difference across the wire is 2.0×10^{-3} V.

The resistance of the wire is 4.0×10^{-4} Ω.

The length of wire in the magnetic field is 6.0 cm.

The magnetic flux density between the magnets is 0.025 T.

Calculate the force exerted on the wire.

Use the Physics Equations Sheet.

[6 marks]

Force = _____ N

10

Do not write outside the box

Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

Do not write outside the box

1 0 Buckminsterfullerene is a form of carbon.

1 0 . 1 Buckminsterfullerene is a covalent molecule that consists of 60 carbon atoms.

Describe the structure of a buckminsterfullerene molecule.

[3 marks]

Do not write outside the box

1 0 . 2 Calculate the number of molecules in 9.00 g of buckminsterfullerene (C_{60}).

Relative atomic mass (A_r): C = 12

The Avogadro constant = 6.02×10^{23} per mole

[5 marks]

Number of molecules = _____

8

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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