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

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	

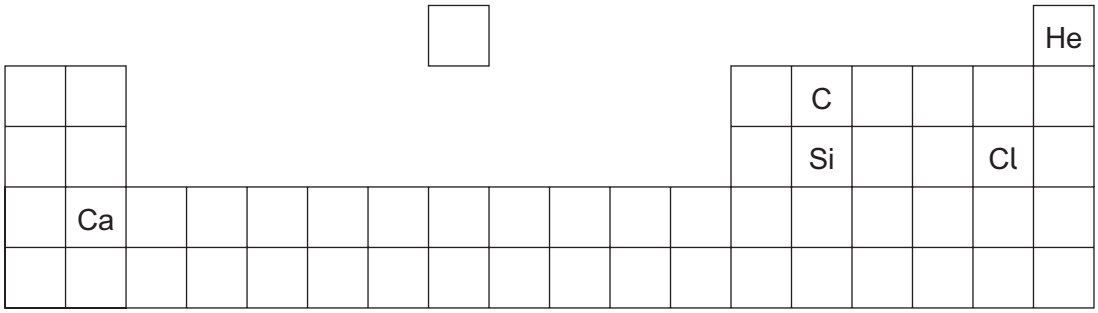
Information
- The maximum mark for this paper is 100.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.

Do not write outside the box

0 1 Elements are arranged in the periodic table.

Figure 1 shows the position of five elements in the periodic table.

Figure 1



0 1 . 1 Which element in **Figure 1** is a metal?

[1 mark]

Tick (✓) **one** box.

C ☐ Ca ☐ Cl ☐ He ☐ Si ☐

0 1 . 2 Which element in **Figure 1** is a halogen?

[1 mark]

Tick (✓) **one** box.

C ☐ Ca ☐ Cl ☐ He ☐ Si ☐

Do not write outside the box

0 1 . 3 Which element in **Figure 1** forms fullerenes?

[1 mark]

Tick (✓) **one** box.

C ☐ Ca ☐ Cl ☐ He ☐ Si ☐

0 1 . 4 Which element in **Figure 1** has atoms with a stable arrangement of electrons?

[1 mark]

Tick (✓) **one** box.

C ☐ Ca ☐ Cl ☐ He ☐ Si ☐

0 1 . 5 Which **two** elements in **Figure 1** have atoms with the same number of electrons in their outer shell?

[1 mark]

_____ and _____

Question 1 continues on the next page

Figure 2 shows some of the elements in Group 1 of the periodic table.

Figure 2

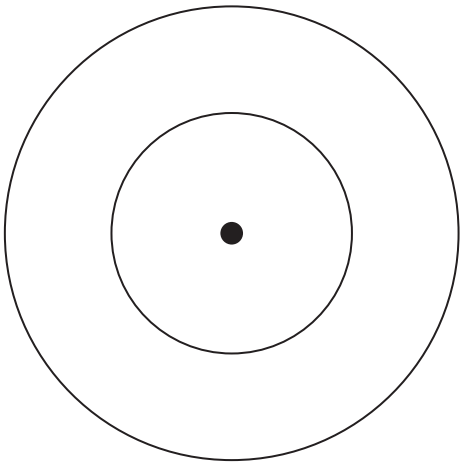
7 **Li** lithium 3
23 **Na** sodium 11
39 **K** potassium 19
85 **Rb** rubidium 37

0 1 . 6 An atom of lithium has 3 electrons.

Complete **Figure 3** to show the electronic structure of lithium.

[1 mark]

Figure 3



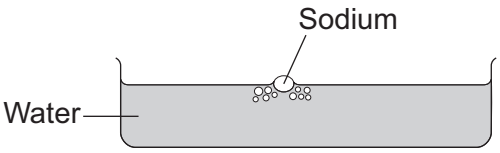
0 1 . 7 Which of the Group 1 elements in **Figure 2** is the most reactive?

[1 mark]

_____

0 1 . 8 **Figure 4** shows sodium reacting with water.

Figure 4



Give **two** observations that can be made when sodium reacts with water.

[2 marks]

1 _____

_____

2 _____

_____

0 1 . 9 Sodium reacts with water to produce an alkaline solution.

What is the name of the alkaline solution produced?

[1 mark]

Tick (✓) **one** box.

Sodium chloride solution ☐

Sodium hydroxide solution ☐

Sodium sulfate solution ☐

10

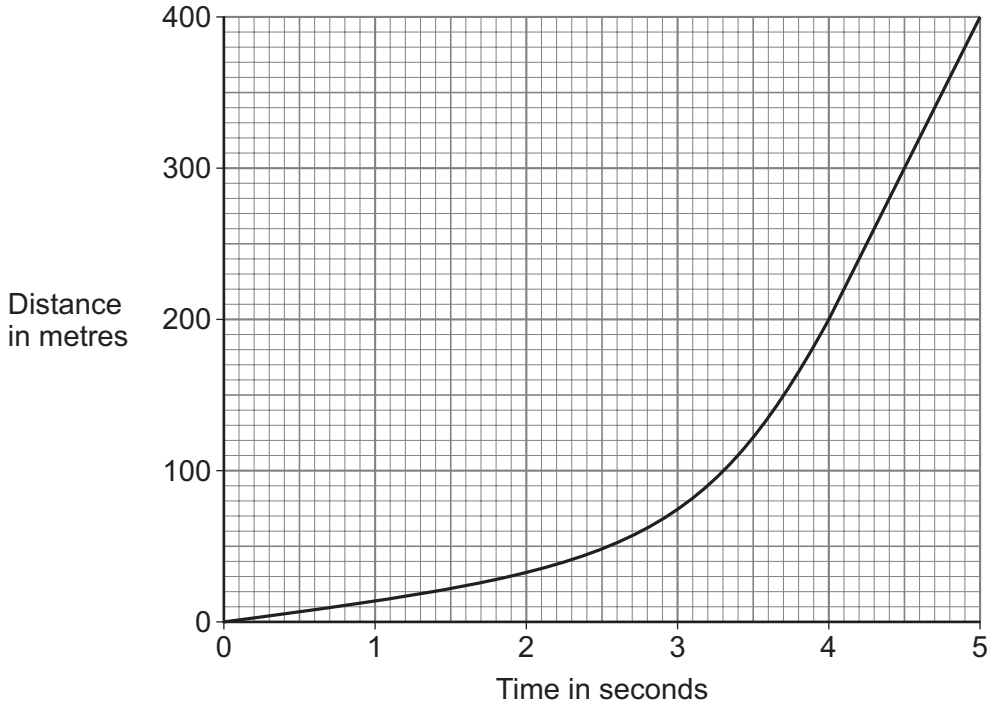
0 2 Two drivers race their cars in a straight line over a distance of 400 metres.

Figure 5 shows the cars.

Figure 5

Figure 6 shows a distance-time graph for one car in the race.

Figure 6



Do not write outside the box

0 2 . 1 When was the car travelling at a constant speed?

Give a reason for your answer.

[2 marks]

Tick (✓) **one** box.

Between 2 seconds and 3 seconds ☐

Between 3 seconds and 4 seconds ☐

Between 4 seconds and 5 seconds ☐

Reason _____

_____

0 2 . 2 The two horizontal forces acting on the car were a driving force and air resistance.

How did the driving force compare with the air resistance when the car moved at a constant speed?

Give a reason for your answer.

[2 marks]

Tick (✓) **one** box.

The driving force was less than air resistance. ☐

The driving force was the same size as air resistance. ☐

The driving force was greater than air resistance. ☐

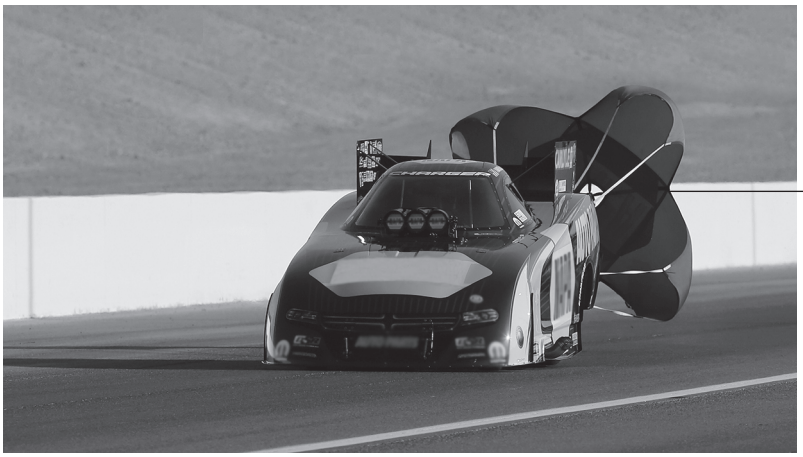
Reason _____

_____

At the end of the race, the driver applies the brakes and opens a parachute to decelerate the car.

Figure 7 shows one of the cars at the end of the race.

Figure 7



0 2 . 3 Complete the sentence.

Choose the answer from the box.

[1 mark]

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

When the driver applies the brakes, the friction in the

brakes _____.

0 2 . 4 Complete the sentence.

Choose the answer from the box.

[1 mark]

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

When the parachute opens, the air resistance acting on

the parachute _____.

Do not write outside the box

0 2 . 5 Complete the sentence.

Choose the answer from the box.

[1 mark]

decrease	**stay the same**	**increase**

Applying the brakes and opening the parachute causes the velocity of the car to _____.

0 2 . 6 Why may it be dangerous for a car to have a very large deceleration?

[1 mark]

Tick (✓) **one** box.

The car engine may overheat. ☐

The car will stop in a short distance. ☐

The driver may lose control of the car. ☐

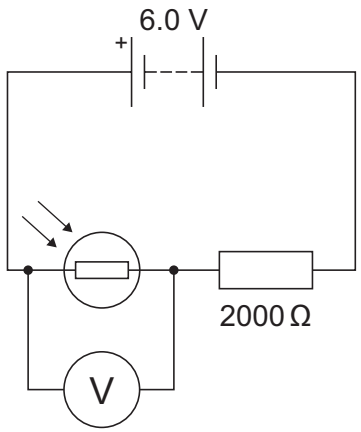
8

Turn over for the next question

0 3 A student investigated how the resistance of a light dependent resistor (LDR) varied with light intensity.

Figure 8 shows the circuit used.

Figure 8



0 3 . 1 The student connected cells together to make the battery.

How many 1.5 V cells did the student use to make the 6.0 V battery?

[1 mark]

Tick (✓) **one** box.

2 cells ☐ 3 cells ☐ 4 cells ☐

Do not write outside the box

0 3 . 2 When the potential difference across the LDR was 3.0 V, the resistance of the LDR was 2000 Ω.

Calculate the current in the LDR.

Use the equation:

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

[2 marks]

Current = _____ A

0 3 . 3 The resistor and the LDR were connected in series.

How does the potential difference across the battery compare with the total potential difference across the resistor and LDR?

[1 mark]

Tick (✓) **one** box.

The potential difference across the battery is less. ☐

The potential difference across the battery is the same. ☐

The potential difference across the battery is greater. ☐

Question 3 continues on the next page

Do not write outside the box

0 3 . 4 The potential difference across the battery was 6.0 V.

The potential difference across the LDR was 3.0 V.

How should the student calculate the potential difference across the resistor?

[1 mark]

Tick (✓) **one** box.

6.0 V + 3.0 V ☐

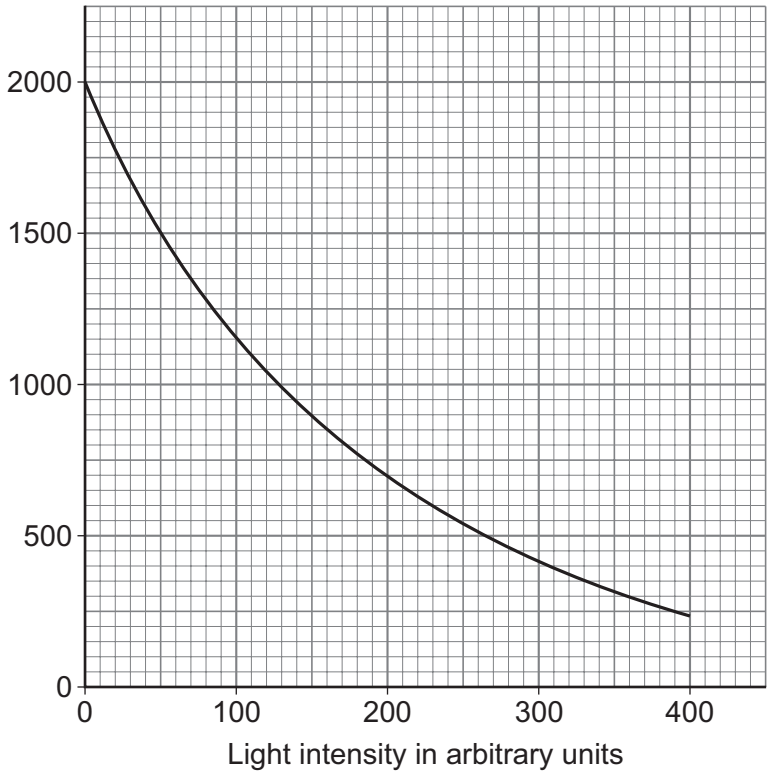
6.0 V − 3.0 V ☐

$\frac{6.0\ \text{V}}{3.0\ \text{V}}$ ☐

The student plotted a graph to show how the resistance of the LDR varied with light intensity.

Figure 9 shows the results.

Figure 9



Do not write outside the box

0 3 . 5 What was the resistance of the LDR when the light intensity was 50 arbitrary units?

[1 mark]

Resistance = _____ ohms

0 3 . 6 Which **two** conclusions can the student make from **Figure 9**?

[2 marks]

Tick (✓) **two** boxes.

Resistance and light intensity have a non-linear relationship. ☐

Resistance and light intensity have a positive correlation. ☐

Resistance decreases as light intensity increases. ☐

Resistance is directly proportional to light intensity. ☐

Resistance is not affected by light intensity. ☐

0 3 . 7 LDRs are often used in control circuits.

Which circuit would need an LDR?

[1 mark]

Tick (✓) **one** box.

A circuit to monitor the temperature of an oven. ☐

A circuit to keep the contents of a fridge cold. ☐

A circuit to switch lights on at night. ☐

9

0 4 Lithium reacts with chlorine to produce lithium chloride.

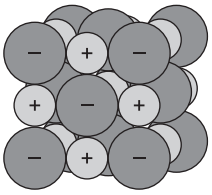
0 4 . 1 **Figure 10** shows models of chlorine and of lithium chloride.

Figure 10

Chlorine

Cl — Cl

Lithium chloride



Draw **one** line from each substance to the type of bonding in the substance.

[2 marks]

Substance	Type of bonding
Chlorine	Covalent
Lithium chloride	Ionic
	Metallic

Lithium chloride can also be produced by reacting lithium carbonate with an acid.

0 4 . 2 Which acid reacts with lithium carbonate to produce lithium chloride?

[1 mark]

Tick (✓) **one** box.

Hydrochloric acid ☐

Nitric acid ☐

Sulfuric acid ☐

0 4 . 3 What type of substance is lithium chloride?

[1 mark]

Tick (✓) **one** box.

Acid ☐

Alkali ☐

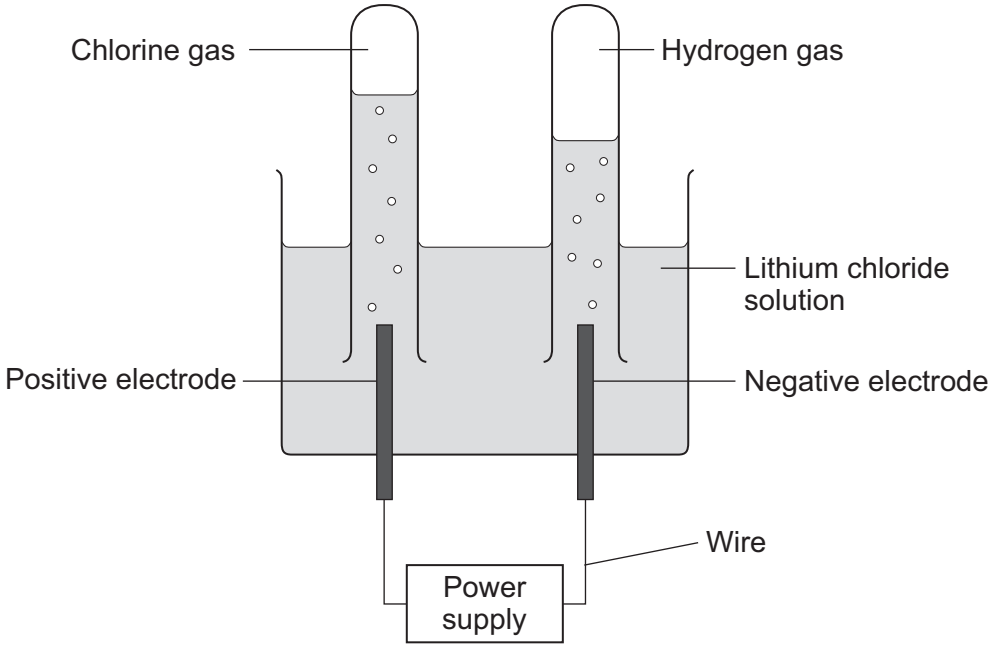
Salt ☐

Question 4 continues on the next page

Do not write outside the box

Figure 11 shows the electrolysis of lithium chloride solution.

Figure 11



0 4 . 4 Lithium chloride solution contains Li^+ ions and Cl^- ions.

Chloride ions move to the positive electrode to produce chlorine.

Explain why chloride ions move to the positive electrode.

[2 marks]

Do not write outside the box

0 4 . 5 Complete the sentences.

Choose answers from the box.

[2 marks]

atoms	**electrons**	**ions**	**molecules**

When the power supply is switched on, charge flows through the circuit.

Charge is carried through the wires by _____.

Charge is carried through the lithium chloride solution by _____.

Question 4 continues on the next page

Hydrogen gas and chlorine gas are produced during the electrolysis of lithium chloride solution.

0 4 . 6 Draw **one** line from each gas to the result of the test for that gas.

[2 marks]

Gas	Result of the test
	A 'pop' sound with a burning splint
Chlorine	Damp litmus paper is bleached and turns white
Hydrogen	Glowing splint relights
	Limewater goes cloudy

0 4 . 7 Why is hydrogen gas produced at the negative electrode?

[1 mark]

Tick (✓) **one** box.

Hydrogen is less reactive than lithium. ☐

Hydrogen has the same reactivity as lithium. ☐

Hydrogen is more reactive than lithium. ☐

Do not write outside the box

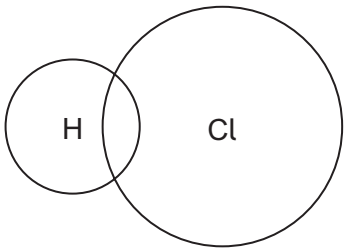
0 4 . 8 Hydrogen reacts with chlorine to produce hydrogen chloride.

- A hydrogen atom has 1 electron in the outer shell.
- A chlorine atom has 7 electrons in the outer shell.

Complete the dot and cross diagram for a hydrogen chloride molecule.

Use the symbols O and X to represent electrons.

[2 marks]



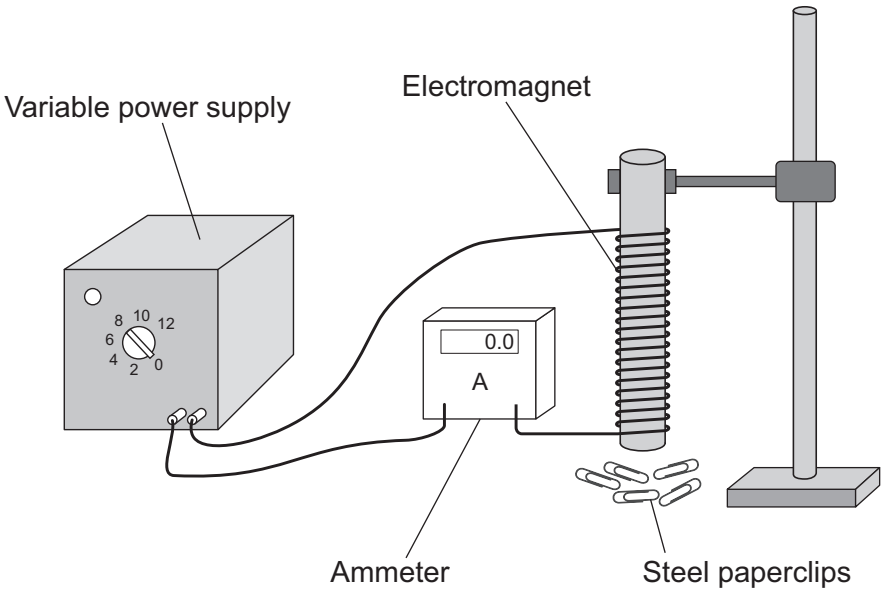
13

Turn over for the next question

0 5 A student used an electromagnet to investigate magnetism.

Figure 12 shows the apparatus.

Figure 12



Do not write outside the box

This is the method used.

1. Turn on the power supply.
2. Record the current on the ammeter.
3. Count the number of paperclips picked up by the electromagnet.
4. Turn off the power supply to release the paperclips.
5. Adjust the power supply and repeat steps 1 to 4 for different values of current.

0 5 . 1 Draw the circuit symbol for an ammeter in the space below.

[1 mark]

Question 5 continues on the next page

Table 1 shows the results.

Table 1

Current in amps	Number of paperclips picked up
0.0	0
1.0	5
2.0	17
3.0	33
4.0	53
5.0	76

Do not write outside the box

0 5 . 2 Complete **Figure 13**.

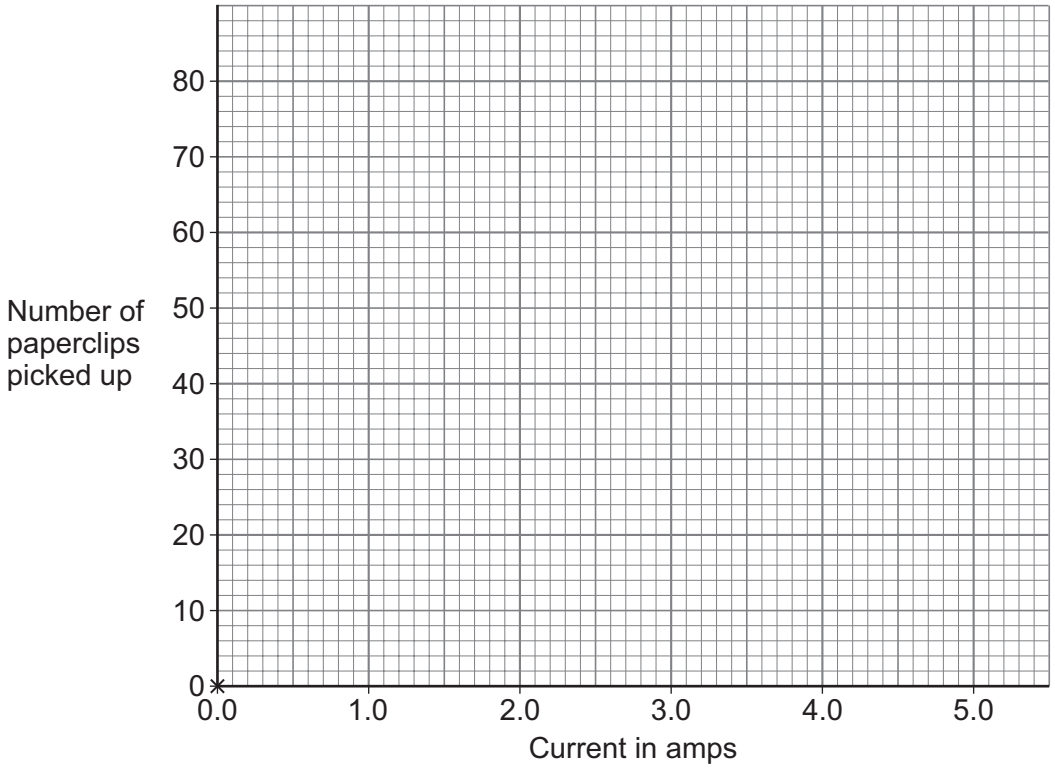
[3 marks]

You should:

- plot the data from **Table 1**
- draw a line of best fit.

The first point has been plotted for you.

Figure 13



Question 5 continues on the next page

0 5 . 3 The student repeated the investigation using an electromagnet with half as many turns of wire.

How does using fewer turns of wire affect the number of paperclips picked up, for the same value of current?

[1 mark]

Tick (✓) **one** box.

Fewer paperclips will be picked up. ☐

The same number of paperclips will be picked up. ☐

More paperclips will be picked up. ☐

Do not write outside the box

Electromagnets are used in recycling centres to move magnetic materials.

0 5 . 4 Which **two** of the following materials are magnetic?

[2 marks]

Tick (✓) **two** boxes.

- Cobalt ☐
- Copper ☐
- Lead ☐
- Magnesium ☐
- Nickel ☐

0 5 . 5 Why is an electromagnet more useful than a permanent magnet in a recycling centre?

[1 mark]

_____

_____

8

Turn over for the next question

Do not write outside the box

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 This question is about temperature changes.

A student investigated the temperature changes as solids are dissolved in water.

This is the method used.

1. Measure 100 cm^3 of water into a polystyrene cup.
2. Measure the temperature of the water.
3. Add 5.0 g of solid copper sulfate to the water.
4. Stir the mixture until all the copper sulfate has dissolved.
5. Measure the highest temperature reached by the mixture.
6. Repeat steps 1 to 5 with solid lithium chloride.

0 6 . 1 Draw **one** line from each measurement to the piece of equipment used to make the measurement.

[2 marks]

Measurement	**Piece of equipment**
	Balance
100 cm^3 of water	Measuring cylinder
5.0 g of solid	Ruler
	Thermometer

Question 6 continues on the next page

Table 2 shows the highest temperature reached for each solid when dissolved in water.

Table 2

	Copper sulfate	**Lithium chloride**
Highest temperature reached in °C	21	24

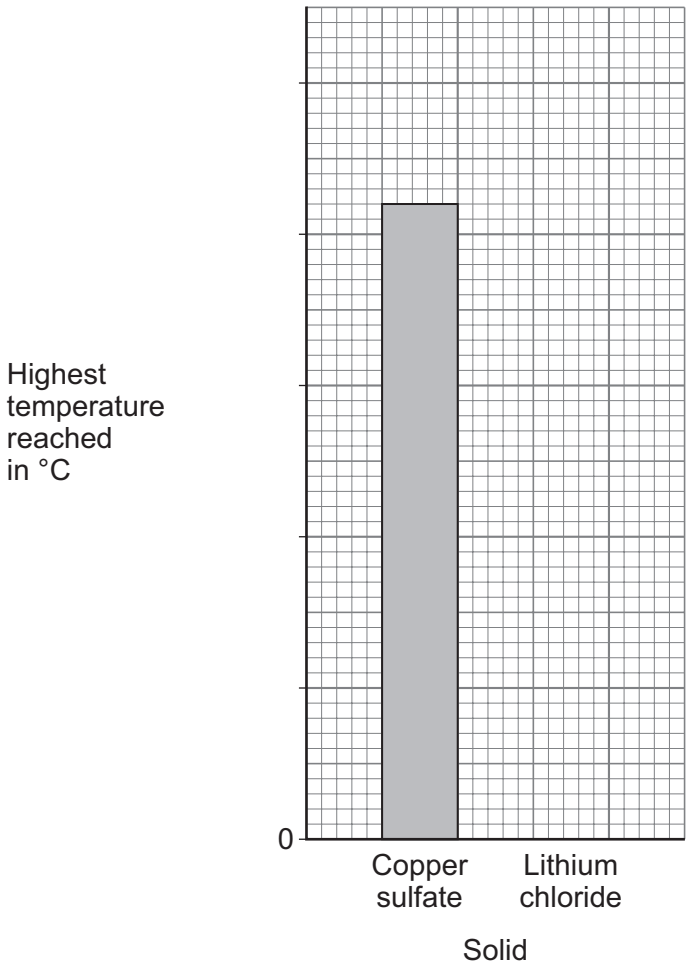
0 6 . 2 Complete **Figure 14**.

You should:

- use a suitable scale for the *y*-axis
- plot the data for lithium chloride from **Table 2** as a bar chart.

[2 marks]

Figure 14



Do not write outside the box

0 6 . 3 Before solid copper sulfate was added, the temperature of the water was 17 °C.

How do the results in **Table 2** show that the process was exothermic?

[1 mark]

_____

_____

0 6 . 4 The student used a different method to measure the temperature change when solid calcium chloride dissolved in water.

The student did four tests.

Table 3 shows the results.

Table 3

	Test 1	**Test 2**	**Test 3**	**Test 4**	**Mean**
Temperature change in °C	5.8	6.3	5.9	6.4	**X**

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

[2 marks]

_____

_____

_____

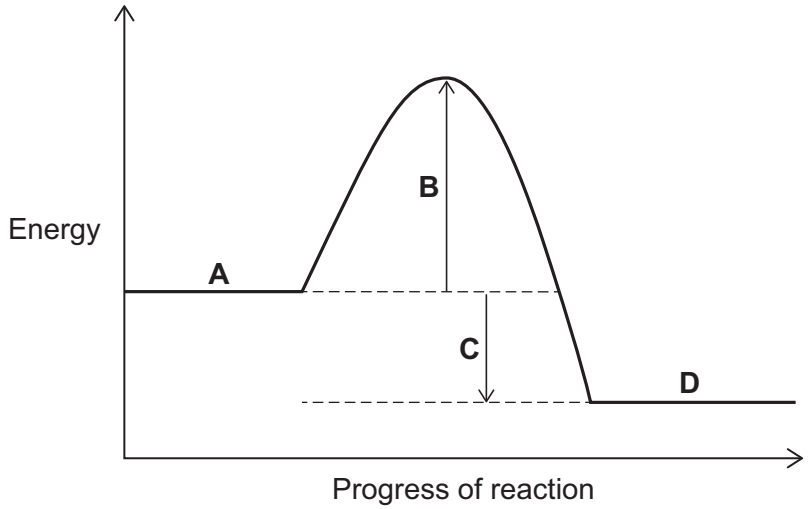
X = _____ °C

Question 6 continues on the next page

Do not write outside the box

Figure 15 shows a reaction profile.

Figure 15



0 6 . 5 Which label on **Figure 15** represents the products?

[1 mark]

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

0 6 . 6 Which label on **Figure 15** represents the activation energy?

[1 mark]

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

0 6 . 7 Which label on **Figure 15** represents the overall energy change?

[1 mark]

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

10

Do not write outside the box

Turn over for the next question

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

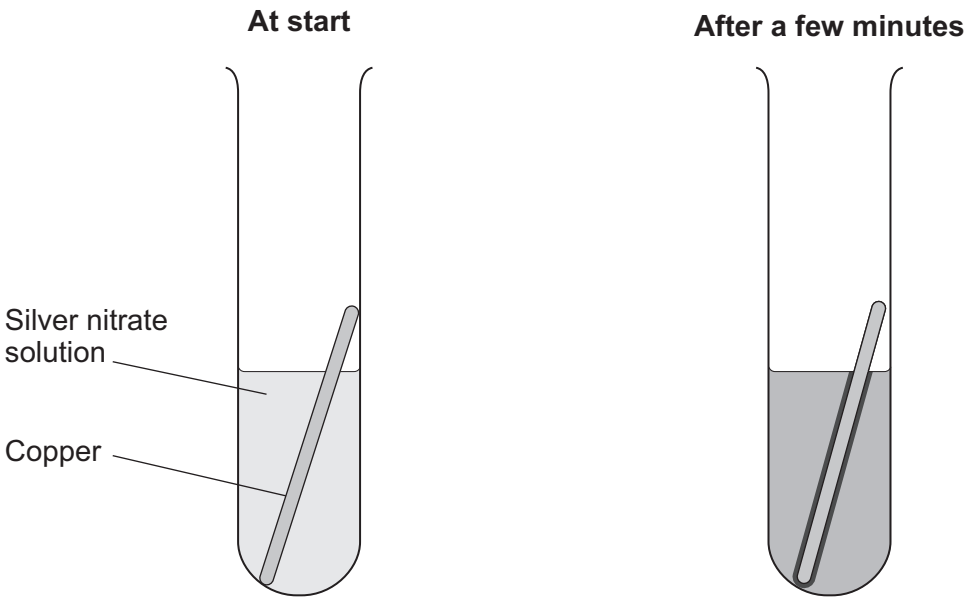
0 7 This question is about copper and copper compounds.

A teacher demonstrated the reaction of copper with silver nitrate.

Figure 16 shows the apparatus:

- at the start
- after a few minutes.

Figure 16



The word equation for the reaction is:

copper + silver nitrate ⟶ copper nitrate + silver

colourless solution — blue solution

Do not write outside the box

0 7 . 1 What type of reaction happens between copper and silver nitrate?

[1 mark]

Tick (✓) **one** box.

Combustion ☐

Displacement ☐

Neutralisation ☐

0 7 . 2 Give **two** observations that can be made when copper reacts with silver nitrate solution.

Use **Figure 16** and the word equation.

[2 marks]

1 _____

_____

2 _____

_____

0 7 . 3 Copper reacted with silver nitrate solution.

The teacher then added copper to nickel nitrate solution.

Copper did **not** react with nickel nitrate solution.

Write the order of reactivity for copper, nickel and silver.

[1 mark]

Most reactive _____

_____

Least reactive _____

Question 7 continues on the next page

A student reacted solid copper oxide with nitric acid to produce a solution of copper nitrate.

This is the method used.

1. Add 25 cm^3 of nitric acid to a beaker.
2. Warm the nitric acid.
3. Add solid copper oxide to the nitric acid.
4. Stir the mixture.
5. Repeat steps 3 and 4 until solid copper oxide is in excess.

0 7 . 4 Give **one** safety precaution the student should use.

[1 mark]

0 7 . 5 The nitric acid was warmed in step 2 of the method.

Suggest how the reaction was affected by warming the nitric acid.

[1 mark]

Do not write outside the box

0 7 . 6 After the reaction finished, the beaker contained a mixture of solid copper oxide and copper nitrate solution.

Describe a method to obtain pure, dry copper nitrate crystals from the mixture.

[4 marks]

Extra space

10

Turn over for the next question

Do not write outside the box

0 8 **Figure 17** shows a rugby player running with a rugby ball.

Figure 17

Use the Physics Equations Sheet to answer questions **08.1** and **08.2**.

0 8 . 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 8 . 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

Do not write outside the box

The rugby player collides with another player and stops.

Use the Physics Equations Sheet to answer questions **08.3** and **08.4**.

0 8 . 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 8 . 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 8 continues on the next page

Figure 18 shows a rugby player wearing a 'mouthguard'.

Figure 18

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 **08.5** and **08.6**.

0 8 . 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 8 . 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 8 . 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

Do not write outside the box

There are no questions printed on this page

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ANSWER IN THE SPACES PROVIDED

Do not write outside the box

0 9 Metals are found in the Earth's crust as the metal itself or as a metal compound.

0 9 . 1 Why is gold found in the Earth as the metal itself?

[1 mark]

_____

_____

0 9 . 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 9 continues on the next page

Do not write outside the box

Aluminium is extracted from aluminium oxide by electrolysis.

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

0 9 . 3 Aluminium **cannot** be extracted from aluminium oxide using carbon.

Give **one** reason why.

[1 mark]

_____

_____

0 9 . 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 9 . 5 Recycling aluminium needs less energy than extracting new aluminium.

Table 4 shows the energy needed for 1 kg of aluminium to be:

- extracted
- recycled.

Table 4

	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

Do not write outside the box

1 0 This question is about forms of carbon.

1 0 . 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

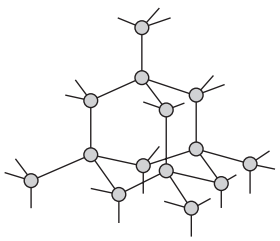
[3 marks]

Length to diameter ratio = _____ : 1

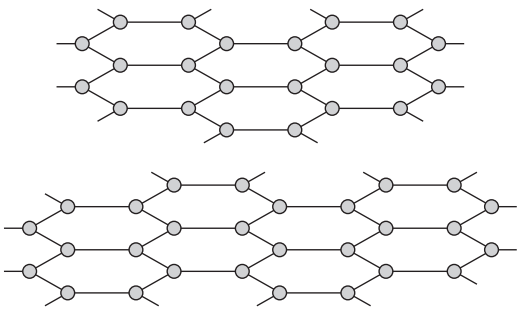
1 0 . 2 **Figure 19** represents the structure of diamond and of graphite.

Figure 19

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

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.**