



Please write clearly in block capitals.

Centre number

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Candidate number

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Surname

Forename(s)

Candidate signature

I declare this is my own work.

student solutions

GCSE CHEMISTRY

Higher Tier Paper 1

H

Monday 18 May 2026

Morning

Time allowed: 1 hour 45 minutes

Materials

For this paper you must have:

- a ruler
- a scientific calculator
- the periodic table (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.

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.
- In all calculations, show clearly how you work out your answer.
- You are reminded of the need for good English and clear presentation in your answers.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
TOTAL	



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0 1

This question is about nanoparticles and their uses.

0 1 . 1

Nanoparticles are structures that are 1 to 100 nm in size.

What is the size of 1 nm in metres?

[1 mark]

Tick (✓) **one** box. $1 \times 10^{-3} \text{ m}$ ☐ $1 \times 10^{-6} \text{ m}$ ☐ $1 \times 10^{-9} \text{ m}$ ☒ $1 \times 10^{-12} \text{ m}$ ☐



01.2

Figure 1 shows food packed in plastic film.

Figure 1



A new technology is to add nanoparticles to plastic film used for food packaging.

Nanoparticles of substances such as silver can kill bacteria.

Suggest **one** advantage and **one** disadvantage of using nanoparticles in plastic film for food packaging.

[2 marks]

Advantage Large surface Area to volume ratio so
less amount needed as compared to coarse particles

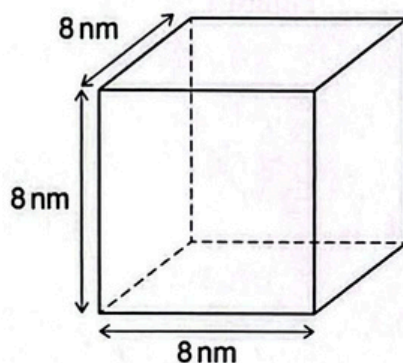
Disadvantage metal is precious so may be very
expensive / dangerous due to food contamination

Turn over ►



Figure 2 shows a cubic nanoparticle.

Figure 2



0 1 . 3

Calculate:

- the surface area of the cubic nanoparticle
- the volume of the cubic nanoparticle
- the simplest whole number surface area to volume ratio of the cubic nanoparticle.

Use Figure 2.

[5 marks]

$$\text{Surface Area} = 6(8^2) = 384 \text{ nm}^2$$

$$\text{Volume} = 8^3 = 512 \text{ nm}^3$$

$$\text{Surface area} = 384 \text{ nm}^2$$

$$\text{Volume} = 512 \text{ nm}^3$$

$$\text{Ratio} = \frac{384}{512} = \frac{3}{4}$$

$$\Rightarrow 3 : 4$$

$$\text{Surface area : volume ratio} = 3 : 4$$





0 1 . 4

The surface area to volume ratio increases when the cubic nanoparticle is split in half.

Why does the surface area to volume ratio increase?

Use **Figure 2**.

[1 mark]

Tick (✓) **one** box.

The total surface area increases and the total volume stays the same.

☒

The total surface area increases and the total volume decreases.

☐

The total surface area stays the same and the total volume decreases.

☐

9

Turn over for the next question

Turn over ►



0 2

Magnesium reacts with hydrochloric acid to produce hydrogen and one other substance.

0 2

1

Complete the word equation for the reaction.

[1 mark]

magnesium + hydrochloric acid $\rightarrow$ magnesium chloride + hydrogen

0 2

2

Magnesium is added to hydrochloric acid in an open beaker.

Explain what happens to the total mass of the beaker and contents during the reaction.

[3 marks]

- Magnesium chloride solid is formed as well as hydrogen gas.
- Since it is an open beaker, the hydrogen gas escapes
- Therefore there is a decrease in total mass compared to mass before.



A scientist investigated how the temperature change for the reaction varied with the mass of magnesium added.

This is the method used.

1. Add 20 cm³ of hydrochloric acid to an insulated cup.
2. Measure the temperature of the hydrochloric acid.
3. Add 0.01 g of magnesium to the hydrochloric acid.
4. Stir the reaction mixture.
5. Record the highest temperature reached.
6. Repeat steps 1 to 5 with different masses of magnesium.

0 2 3

Give **two** control variables in this investigation.

[2 marks]

1. Volume of hydrochloric acid.
2. Concentration of hydrochloric acid.

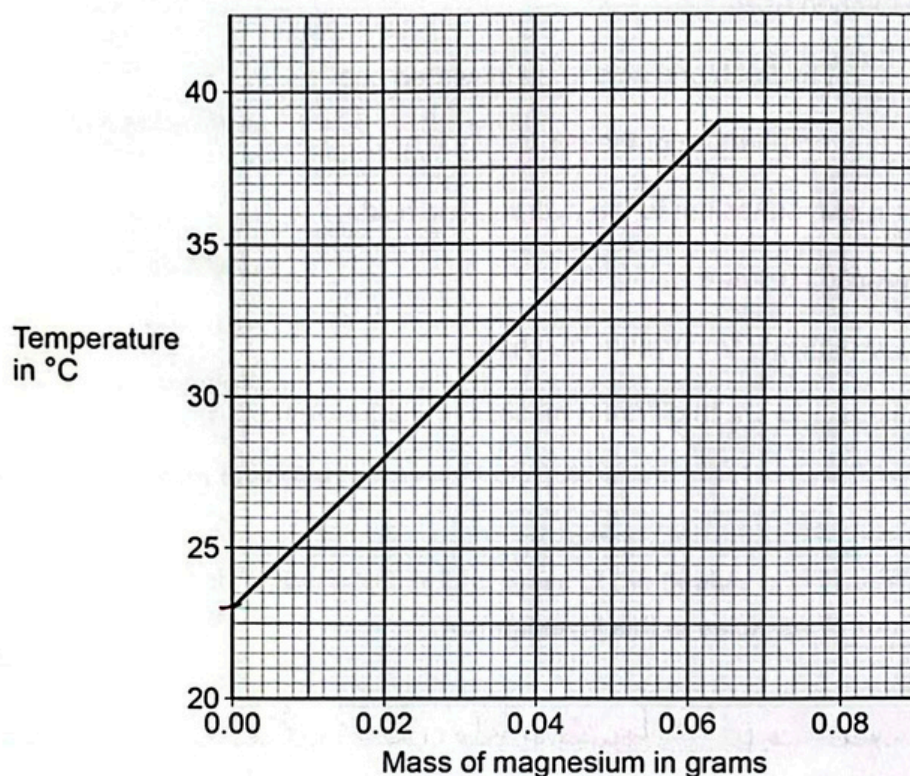
Question 2 continues on the next page

Turn over ►



0 2 . 4 Figure 3 shows the results.

Figure 3



Determine the temperature change per gram of magnesium added, up to the point where the reaction is complete.

[4 marks]

$$(0.00, 23) \quad (0.06, 38)$$

$$\frac{\Delta y}{\Delta x} = \frac{38 - 23}{0.06 - 0.00} = \frac{15}{0.06} = 250 \text{ } ^\circ\text{C/g}$$

Temperature change per gram = 250 °C/g

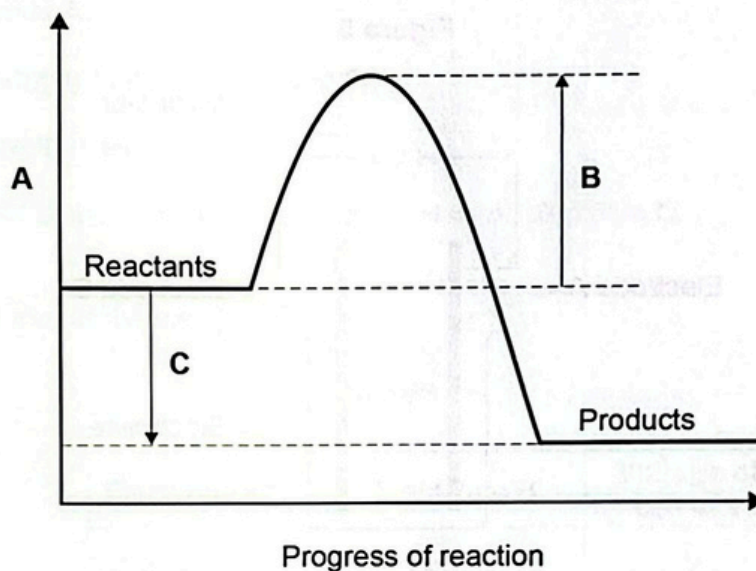




0 2 . 5

Figure 4 shows the reaction profile for the reaction of magnesium with hydrochloric acid.

Figure 4



What do labels A, B and C represent on Figure 4?

[3 marks]

A Energy

B Activation Energy

C Overall energy change.

13

Turn over for the next question

Turn over ►

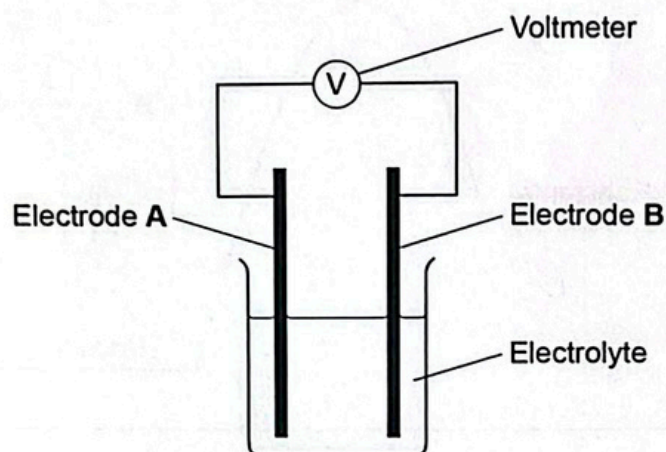


0 3

This question is about chemical cells.

Figure 5 shows a simple cell.

Figure 5



0 3 . 1

Which combination of electrodes and electrolyte would produce a voltage in the cell represented by Figure 5?

[1 mark]

Tick (✓) one box.

Electrode A	Electrode B	Electrolyte
Copper	Copper	Sodium chloride solution
Copper	Zinc	Sodium chloride solution
Copper	Zinc	Water
Zinc	Zinc	Water

☐
☒
☐
☐


03.2

A student investigated the voltage produced by different cells.

This is the method used.

1. Set up a cell as shown in **Figure 5**, using magnesium metal as electrode **A**.
2. Use copper metal as electrode **B**.
3. Record the cell voltage.
4. Repeat steps 1 to 3 using different metals as electrode **B**.

Table 1 shows the results.

Table 1

Electrode A	Electrode B	Voltage of the cell in volts
Magnesium	Copper	2.71
Magnesium	Silver	3.17
Magnesium	Tin	2.23
Magnesium	Zinc	1.61

Write the five metals, copper, magnesium, silver, tin and zinc in order of reactivity.

Justify your answer.

[2 marks]

Most reactive Magnesium

Zinc

Tin

Copper

Least reactive Silver

Justification the bigger the difference in reactivity
the bigger voltage, magnesium produces a voltage with all so
most reactive.

Turn over ►



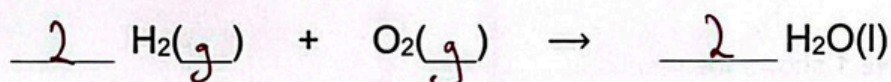
0 3 . 3 A hydrogen fuel cell is supplied with hydrogen and oxygen.

Complete the equation for the overall reaction in the hydrogen fuel cell.

You should:

- balance the equation
- write in the missing state symbols.

[2 marks]



0 3 . 4 Table 2 shows data about two methods of powering electric cars.

Table 2

	Hydrogen fuel cell	Rechargeable lithium-ion battery
Cost of refuelling or recharging in pence per mile	20	3 to 20
Distance travelled before refuelling or recharging in miles	300 to 400	150 to 300
Time taken to refuel or recharge in minutes	5	20 to 60

Evaluate the use of a hydrogen fuel cell instead of a lithium battery in an electric car.

[3 marks]

- Hydrogen fuel cells allow greater distance travelled before re-fuelling (350 vs 200)
- Hydrogen fuel cells allow for faster refuelling 5 mins vs 60 mins
- Rechargeable cells are cheaper to refuel per mile.
- Overall hydrogen fuel cells are the best.



Turn over for the next question

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outside the
box

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ANSWER IN THE SPACES PROVIDED

Turn over ►



0 4

The elements in Group 7 of the periodic table are known as the halogens.

0 4 . 1

Describe the trend in melting point of the elements in Group 7.

[1 mark]

increases

0 4 . 2

Name the type of bonding in a compound of iodine with a non-metal.

[1 mark]

covalent

0 4 . 3

Give **one** reason why all halogens have similar reactions.

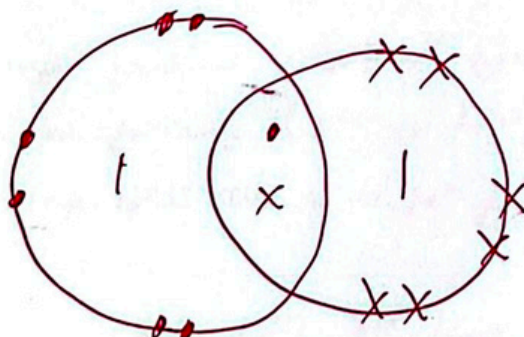
[1 mark]

Because they all have same amount of
electrons in outer shell.

0 4 . 4

Draw a dot and cross diagram for an iodine molecule (I_2).Show the **outer** shell electrons **only**.

[2 marks]



0 4 . 5

Explain the trend in reactivity of the elements going down Group 7.

[4 marks]

- reactivity decreases as you go down group
- Because the outer shell electrons become further from nucleus
- Thus, less electrostatic attraction between the nucleus and outer shell electron.
- So gaining an electron is more difficult.

Allow: Electron becomes larger ~~to~~ for MP2

Extra space ~~all~~ None shielding between the outer electron and nucleus. for MP3.

9

Turn over for the next question

Turn over ►





0 5

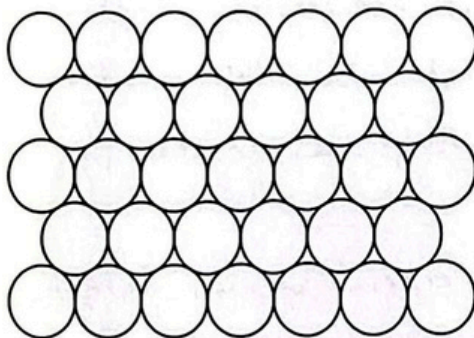
Chemists use theories of structure to explain the properties of materials.

0 5

1

Figure 6 represents the structure of a metal.

Figure 6



Describe the structure of a metal.

[2 marks]

Metals consist of giant structures of atoms arranged in uniform/regular pattern surrounded by a sea of electrons.

0 5

2

Explain why silicon dioxide has a very high melting point.

[3 marks]

Silicon dioxide is a giant covalent structure many covalent bonds needed to break requires a lot of energy to break.



Diamond and graphite are both forms of carbon.

0 5 . 3

Describe **two** differences in the **structures** of diamond and graphite.

[2 marks]

- 1 Each carbon atom makes 4 other covalent (in diamond) bonds but graphite only makes 3.
- 2 Has ~~weak~~ layers held by weak inter-molecular forces.

0 5 . 4

Describe **two** differences in the **properties** of diamond and graphite.

[2 marks]

- 1 Diamond is harder
- 2 Graphite conducts electricity but diamond doesn't.

0 5 . 5

Name the type of carbon molecule that can have a spherical shape.

[1 mark]

Fullerenes

10

Turn over for the next question

Turn over ►



0 6

This question is about the periodic table.

0 6 . 1

How were the elements ordered in early periodic tables?

[1 mark]

~~Based on Atomic~~ Based on Atomic Mass.

0 6 . 2

Mendeleev developed an early version of the periodic table.

Mendeleev changed the order of some elements from their positions in earlier versions of the periodic table.

Give **one** reason why Mendeleev changed the order of some elements.

[1 mark]

To place elements in groups of
with correlating properties.

Some elements in the periodic table have two or more isotopes.

0 6 . 3

Define the term 'isotopes'.

Answer in terms of subatomic particles.

[2 marks]

Same element, protons, electrons

Different amount of neutrons.



0 6 4 Magnesium has three isotopes.

Table 3 shows information about the isotopes.

Table 3

Mass number	Percentage abundance (%)
24	78.6
25	10.1
26	11.3

Calculate the relative atomic mass (A_r) of magnesium.

Give your answer to 3 significant figures.

[3 marks]

$$A_r = \frac{(24 \times 78.6) + (25 \times 10.1) + (26 \times 11.3)}{100}$$

$$A_r = 24.3$$

Relative atomic mass (A_r) (3 significant figures) = 24.3

Question 6 continues on the next page

Turn over ►



0 6 5

Sodium reacts with oxygen to produce sodium oxide.

Describe what happens to sodium atoms and to oxygen atoms when sodium oxide is produced.

[4 marks]

Sodium loses 1 electron each forming (Na^+) ions.

Oxygen atoms gain 2 electrons from sodium forming (O^{2-}) ions.

The oppositely charged atoms attract to form an ionic bond.

As opposite charges attract so each oxygen ~~atom~~ ion (O^{2-}) bonds to two (Na^+) ions.

Extra space



Table 4 shows information about the properties of some metals.

Table 4

Metal	Melting point in °C	Density in g/cm ³	Appearance of the metal chloride
A	98	0.97	White crystals
B	1455	8.90	Green crystals
C	660	2.70	White crystals
D	232	7.29	White crystals

0 6 . 6

Which metal in Table 4 could be useful as a catalyst?

Justify your answer.

[2 marks]

Metal B

Justification makes a coloured compound.

0 6 . 7

Which metal in Table 4 is likely to be the most reactive with water?

Justify your answer.

[2 marks]

Metal A

Justification low melting point.

15

Turn over ►



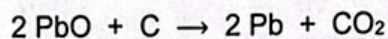
0 7

Lead is a metal in Group 4 of the periodic table.

Oxides of lead include PbO, PbO₂ and Pb₃O₄

The lead oxide PbO reacts with carbon when heated.

The equation for this reaction is:



0 7 . 1

22.3 g of the lead oxide PbO is heated with 1.2 g of carbon.

Which substance is in excess?

Relative formula mass (M_r): PbO = 223

Relative atomic mass (A_r): C = 12

[1 mark]

Tick (✓) **one** box.

Carbon is in excess

☒

Lead oxide is in excess

☐

Neither substance is in excess

☐

0 7 . 2 The lead oxide PbO contains Pb^{2+} and O^{2-} ions.

Explain why the lead oxide PbO is reduced in this reaction with carbon.

Answer in terms of electrons.

[2 marks]

Reduction is gain of electrons
Lead (Pb) gained 2 electrons.

0 7 . 3 Lead forms Pb^{2+} ions and Pb^{4+} ions.

What is the ratio of the numbers of ions in the lead oxide Pb_3O_4 ?

[1 mark]

Tick (✓) one box.

1 Pb^{2+} : 2 Pb^{4+} : 4 O^{2-}

☐

2 Pb^{2+} : 1 Pb^{4+} : 4 O^{2-}

☒

3 Pb^{2+} : 4 O^{2-}

☐

3 Pb^{4+} : 4 O^{2-}

☐

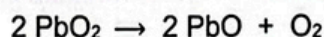
Question 7 continues on the next page

Turn over ►



0 7 . 4 The lead oxide PbO_2 decomposes when heated.

The equation for this reaction is:



9.56 g of PbO_2 was heated until the reaction was complete.

Calculate the volume of oxygen gas produced.

Give your answer in cm^3 .

Relative atomic masses (A_r): O = 16 Pb = 207

The volume of 1 mole of any gas is 24 dm^3 .

[5 marks]

$M_r \text{ PbO}_2 = 239$
 $\text{mols of PbO}_2 = 0.04 \text{ mol}$
 $\text{mols of O}_2 = 0.02 \text{ mol}$
 $\text{Volume of O}_2 = 0.48 \text{ dm}^3$
 $0.48 \text{ dm}^3 = 480 \text{ cm}^3$

Volume of oxygen = 480 cm^3

9



0 8

This question is about electrolysis.

Aluminium is extracted by electrolysis of a molten mixture of aluminium oxide and cryolite.

0 8

1

Explain why a mixture is used as the electrolyte.

[2 marks]

Cryolite lowers activation energy

Less energy is needed.

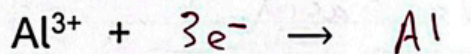
0 8

2

Aluminium oxide contains the ions Al^{3+} and O^{2-}

Complete the half equation for the reaction at the negative electrode in the electrolysis of aluminium oxide.

[2 marks]



0 8

3

An aqueous solution of potassium nitrate is electrolysed using inert electrodes.

Predict the product at each electrode.

[2 marks]

Negative electrode Hydrogen

Positive electrode Oxygen

Turn over ►



08.4

A student investigated the electrolysis of an aqueous solution of copper sulfate.

Copper sulfate contains the ions Cu^{2+} and SO_4^{2-}

The products at the electrodes were copper and oxygen.

An acidic solution was also produced.

Explain how the acidic solution is produced.

You should identify the acidic solution produced.

[5 marks]

Copper sulphate splits into Cu^{2+} , SO_4^{2-} , H^+ , OH^- ions

Copper ions are reduced at cathode to make copper solid.

Hydroxide ions are oxidised ~~at~~ at the anode to produce water + oxygen

SO_4^{2-} and H^+ attract and bond forming H_2SO_4 also known as sulphuric acid.

Extra space



0 9

This question is about the titration of a strong acid with a strong alkali.

0 9

1

What is meant by a 'strong' acid?

[2 marks]

An acid that fully ionizes
in an aqueous solution.

0 9

2

The pH of a solution changes during a titration.

Plan a titration experiment to measure the volume of barium hydroxide solution that reacts with 25.0 cm^3 of hydrochloric acid.

Your experiment should use a pH probe instead of an indicator.

[6 marks]

Pipette 25 cm^3 of HCl into conical flask

add Barium hydroxide into burette, record the initial volume

Place pH probe into flask and record the starting pH of acid

Add barium hydroxide into flask using burette

Swirl flask

Continue to add barium hydroxide over pH 7

plot graph
find volume Barium hydroxide needed to achieve pH 7 from the burette.

Extra space

Turn over ►



09.3

A student measured the pH during a titration when barium hydroxide solution was added to hydrochloric acid.

Table 5 shows the pH of the mixture at the beginning and at the end of the titration.

Table 5

Volume of barium hydroxide solution added in cm^3	0.0	18.5
pH of mixture	1	7

Explain the change in pH.

Answer in terms of ions.

[4 marks]

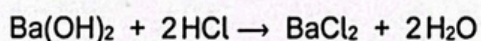
HCl has H^+ ions
 High concentration of H^+ ions to start off
 with
 But barium hydroxide provides OH^- ions
 H^+ and OH^- ions attract to ~~provide~~ produce
 H_2O
 At 18.5cm^3 of barium hydroxide there
 is equal concentration of H^+ and
 Extra space OH^- ions.



09.4

25.0 cm³ of hydrochloric acid was neutralised by
18.5 cm³ of 0.240 mol/dm³ barium hydroxide solution.

The equation for the reaction is:



Calculate the concentration of the hydrochloric acid.

[4 marks]

Mols of Barium hydroxide
= 0.00444 mol

$\text{Ba(OH)}_2 : \text{HCl} = 2 : 1$

Mols of HCl = 0.00888 mol

Volume of HCl = 0.025 dm³

Concentration of HCl = $\frac{0.00888}{0.025} = 0.355$ mol/dm³

Concentration = 0.355 mol/dm³

16

END OF QUESTIONS

