Please write clearly in block capitals.

Centre number						Candidate number				

Surname ______________________________

Forename(s) ______________________________

Candidate signature ______________________________

I declare this is my own work.

GCSE CHEMISTRY

H

Higher Tier Paper 1

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.
- In all calculations, show clearly how you work out your answer.

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.

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 carbon and its compounds.

Fullerenes are molecules of carbon atoms.

The first fullerene to be discovered was Buckminsterfullerene (C_{60}).

0 1 . 1 What shape is a Buckminsterfullerene molecule?

[1 mark]

____

0 1 . 2 Give **one** use of a fullerene.

[1 mark]

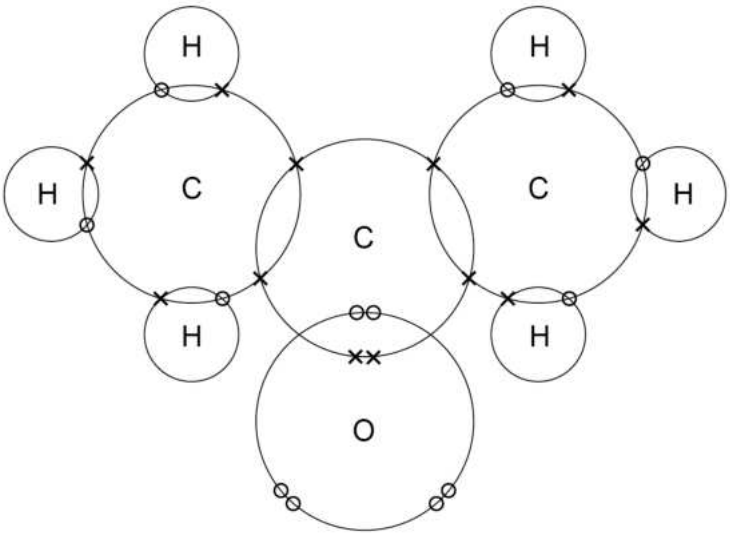
____

____

Propanone is a compound of carbon, hydrogen and oxygen.

Figure 1 shows the dot and cross diagram for a propanone molecule.

Figure 1



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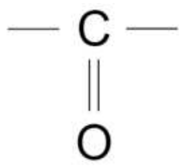
0 1 . 3 Complete **Figure 2** to show a propanone molecule.

Use a line to represent each single bond.

Use **Figure 1**.

[1 mark]

Figure 2



0 1 . 4 Determine the molecular formula of propanone.

Use **Figure 1**.

[1 mark]

Molecular formula = ____________________

0 1 . 5 Propanone is a liquid with a low boiling point.

Why does propanone have a low boiling point?

[1 mark]

Tick (✓) **one** box.

The covalent bonds are strong. ☐

The covalent bonds are weak. ☐

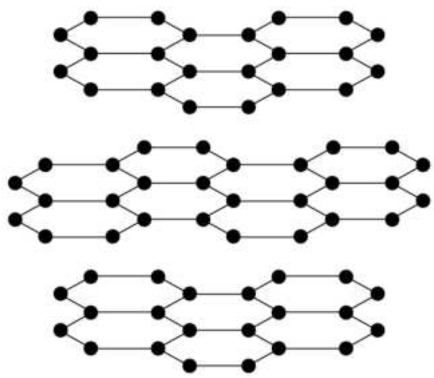
The intermolecular forces are strong. ☐

The intermolecular forces are weak. ☐

Do not write outside the box

0 1 . 6 **Figure 3** represents the structure of graphite.

Figure 3



Explain why graphite is:

- a good electrical conductor
- soft and slippery.

You should answer in terms of structure and bonding.

[6 marks]

11

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Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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0 2 This question is about atomic structure and the periodic table.

Gallium (Ga) is an element that has two isotopes.

0 2 . 1 Give the meaning of 'isotopes'.

You should answer in terms of subatomic particles.

[2 marks]

0 2 . 2 **Table 1** shows the mass numbers and percentage abundances of the isotopes of gallium.

Table 1

Mass number	Percentage abundance (%)
69	60
71	40

Calculate the relative atomic mass (A_r) of gallium.

Give your answer to 1 decimal place.

[2 marks]

Relative atomic mass (1 decimal place) = ____________

Do not write outside the box

Gallium (Ga) is in Group 3 of the modern periodic table.

0 2 . 3 Give the numbers of electrons and neutrons in an atom of the isotope $^{69}_{31}Ga$

[2 marks]

Number of electrons ____________________

Number of neutrons ____________________

0 2 . 4 What is the most likely formula of a gallium ion?

[1 mark]

Tick (✓) **one** box.

Ga^{+} ☐

Ga^{-} ☐

Ga^{3+} ☐

Ga^{3-} ☐

0 2 . 5 Gallium was discovered six years after Mendeleev published his periodic table.

Give **two** reasons why the discovery of gallium helped Mendeleev's periodic table to become accepted.

[2 marks]

1 ____

____

2 ____

____

9

Do not write outside the box

0 3 This question is about the extraction of metals.

Element **R** is extracted from its oxide by reduction with hydrogen.

The equation for the reaction is:

$$3H_2 + \mathbf{R}O_3 \rightarrow \mathbf{R} + 3H_2O$$

0 3 . 1 The sum of the relative formula masses (M_r) of the reactants ($3H_2$ + $\mathbf{R}O_3$) is 150

Calculate the relative atomic mass (A_r) of **R**.

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

[2 marks]

Relative atomic mass (A_r) of **R** = ____________________

0 3 . 2 Identify element **R**.

You should use:

- your answer to **question 03.1**
- the periodic table.

[1 mark]

Identity of **R** = ____________________

Do not write outside the box

0 3 . 3 Carbon is used to extract tin (Sn) from tin oxide (SnO_2).

The equation for the reaction is:

$$SnO_2 + C \rightarrow Sn + CO_2$$

Calculate the percentage atom economy for extracting tin in this reaction.

Relative atomic masses (A_r): C = 12 O = 16 Sn = 119

[3 marks]

Percentage atom economy = ________________ %

Question 3 continues on the next page

0 3 . 4 Tungsten (W) is a metal.

Tungsten is extracted from tungsten oxide (WO_3).

All other solid products from the extraction method must be separated from the tungsten.

Table 2 shows information about three possible methods to extract tungsten from tungsten oxide.

Table 2

Method	Reactant	Relative cost of reactant	Products
1	Carbon	Low	Tungsten solid Carbon dioxide gas Tungsten carbide solid
2	Hydrogen	High	Tungsten solid Water vapour
3	Iron	Low	Tungsten solid Iron oxide solid

Evaluate the three possible methods for extracting tungsten from tungsten oxide.

[4 marks]

10

Do not write outside the box

0 4 This question is about Group 1 elements.

0 4 . 1 Give **two** observations you could make when a small piece of potassium is added to water.

[2 marks]

1 ____________________

____

2 ____________________

____

0 4 . 2 Complete the equation for the reaction of potassium with water.

You should balance the equation.

[2 marks]

$$K \; + \; H_2O \; \rightarrow \; \quad + \quad$$

0 4 . 3 Explain why the reactivity of elements changes going down Group 1.

[4 marks]

____

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Sodium reacts with oxygen to produce the ionic compound sodium oxide.

Oxygen is a Group 6 element.

0 4 . 4 Draw a dot and cross diagram to show what happens when atoms of sodium and oxygen react to produce sodium oxide.

[4 marks]

Diagram

Do not write outside the box

0 4 . 5 Why is oxygen described as being reduced in the reaction between sodium and oxygen?

[1 mark]

0 4 . 6 Explain why sodium oxide has a high melting point.

[3 marks]

16

Turn over for the next question

Do not write outside the box

0 5 This question is about salts.

0 5 . 1 Name the salt produced by the neutralisation of hydrochloric acid with potassium hydroxide.

[1 mark]

____

0 5 . 2 Write an ionic equation for the neutralisation of hydrochloric acid with potassium hydroxide.

[1 mark]

________ + ________ → ______________

0 5 . 3 Soluble salts can be produced by reacting dilute hydrochloric acid with an insoluble solid.

Copper, copper carbonate and copper oxide are insoluble solids.

Which of these insoluble solids can be used to make a copper salt by reacting the solid with dilute hydrochloric acid?

[1 mark]

Tick (✓) **one** box.

Copper and copper carbonate only ☐

Copper and copper oxide only ☐

Copper carbonate and copper oxide only ☐

Copper, copper carbonate and copper oxide ☐

A student makes crystals of magnesium sulfate.

This is the method used.

1. Add sulfuric acid to a beaker.
2. Warm the sulfuric acid.
3. Add a spatula of magnesium oxide to the beaker.
4. Stir the mixture.
5. Repeat steps 3 and 4 until there is magnesium oxide remaining in the beaker.
6. Filter the mixture.
7. Evaporate the filtrate gently until crystals start to form.
8. Leave the solution to finish crystallising.

0 5 . 4 Give **one** reason for:

- step 2
- step 5
- step 6.

[3 marks]

Step 2 ____

Step 5 ____

Step 6 ____

0 5 . 5 How should the filtrate be evaporated gently in **step 7**?

[1 mark]

Do not write outside the box

0 5 . 6 Iron chloride is produced by heating iron in chlorine gas.

The equation for the reaction is:

$$2\,Fe + 3\,Cl_2 \rightarrow 2\,FeCl_3$$

Calculate the volume of chlorine needed to react with 14 g of iron.

You should calculate:

- the number of moles of iron used
- the number of moles of chlorine that react with 14 g of iron
- the volume of chlorine needed.

Relative atomic mass (A_r): Fe = 56

The volume of 1 mole of gas = 24 dm^3

[3 marks]

Volume of chlorine = ______________________ dm^3

10

Do not write outside the box

0 6 This question is about metals.

0 6 . 1 **Table 3** shows information about four substances.

Table 3

Substance	Melting point in °C	Boiling point in °C	Does it conduct electricity in the solid state?	Does it conduct electricity in the liquid state?
A	–117	79	No	No
B	801	1413	No	Yes
C	1535	2750	Yes	Yes
D	1610	2230	No	No

Which substance could be a metal?

[1 mark]

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

0 6 . 2 Explain why alloys are harder than pure metals.

[3 marks]

____

____

____

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____

Turn over ►

Do not write outside the box

0 6 . 3 A student wants to compare the reactivity of an unknown metal, **Q**, with that of zinc.

Both metals are more reactive than silver.

The student is provided with:

- silver nitrate solution
- metal **Q** powder
- zinc powder
- a thermometer
- normal laboratory equipment.

No other chemicals are available.

Describe a method the student could use to compare the reactivity of metal **Q** with that of zinc.

Your method should give valid results.

[4 marks]

8

0 7 This question is about chemical reactions and electricity.

0 7 . 1 Electrolysis and chemical cells both involve chemical reactions and electricity.

Explain the difference between the processes in electrolysis and in a chemical cell.

[2 marks]

____

____

____

____

0 7 . 2 A teacher demonstrates the electrolysis of molten lead bromide.

Bromine is produced at the positive electrode.

Complete the half equation for the production of bromine.

You should balance the half equation.

[2 marks]

$$Br^{-} \rightarrow \quad\quad + $$

0 7 . 3 Two aqueous salt solutions are electrolysed using inert electrodes.

Complete **Table 4** to show the product at each electrode.

[3 marks]

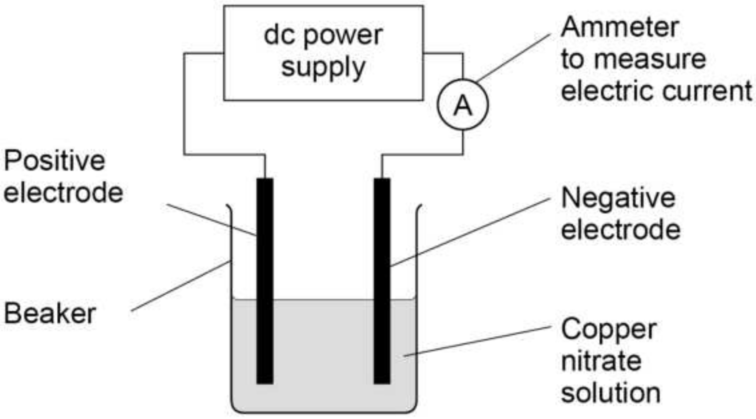
Table 4

Salt solution	**Product at positive electrode**	**Product at negative electrode**
Copper nitrate		copper
Potassium iodide		

Some students investigated the electrolysis of copper nitrate solution using inert electrodes.

Figure 4 shows the apparatus.

Figure 4



The students investigated how the mass of copper produced at the negative electrode varied with:

- time
- current.

This is the method used.

1. Weigh the negative electrode.
2. Set up the apparatus shown in **Figure 4**.
3. Adjust the power supply until the ammeter shows a current of 0.3 A
4. Switch off the power supply after 5 minutes.
5. Rinse the negative electrode with water and allow to dry.
6. Reweigh the negative electrode.
7. Repeat steps 1 to 6 for different times.
8. Repeat steps 1 to 7 at different currents.

Do not write outside the box

0 7 . 4 Some of the copper produced did not stick to the negative electrode but fell to the bottom of the beaker.

Suggest how the students could find the total mass of copper produced.

[4 marks]

Question 7 continues on the next page

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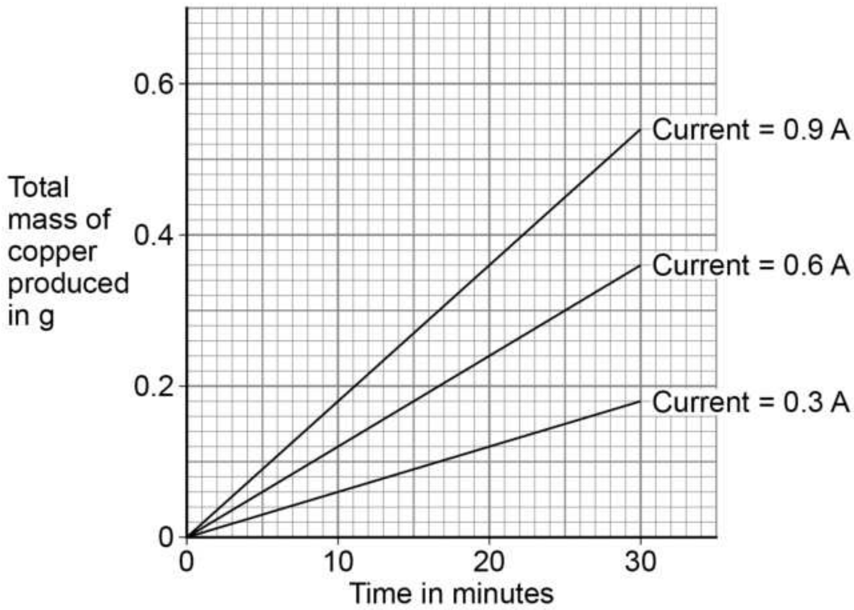
The students plotted their results on a graph.

Figure 5 shows the graph.

Figure 5



A student correctly concluded that the total mass of copper produced is directly proportional both to the time and to the current.

0 7 . 5 How do the results in **Figure 5** support the conclusion that the total mass of copper produced is directly proportional to the time?

[1 mark]

0 7 . 6 How do the results in **Figure 5** support the conclusion that the total mass of copper produced is directly proportional to the current?

Use data from **Figure 5** in your answer.

[1 mark]

Do not write outside the box

0 7 . 7 Copper nitrate solution is blue.

Suggest why the blue colour of the copper nitrate solution fades during the electrolysis.

[1 mark]

0 7 . 8 Determine the number of atoms of copper produced when copper nitrate solution is electrolysed for 20 minutes at a current of 0.6 A

Give your answer to 3 significant figures.

Use **Figure 5**.

Relative atomic mass (A_r): Cu = 63.5

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

[3 marks]

Number of atoms (3 significant figures) = ____________

17

Turn over for the next question

0 8 This question is about the reaction between hydrogen sulfide (H_2S) and oxygen.

The equation for the reaction is:

$$2\,H_2S(g) + 3\,O_2(g) \rightarrow 2\,H_2O(g) + 2\,SO_2(g)$$

0 8 . 1 What does $H_2O(g)$ represent?

[1 mark]

____

0 8 . 2 Calculate the volume of oxygen required to react with 50 cm^3 of hydrogen sulfide.

[1 mark]

____

____

Volume = ____________________ cm^3

0 8 . 3 **Figure 6** shows part of the reaction profile for the reaction.

The reaction is exothermic.

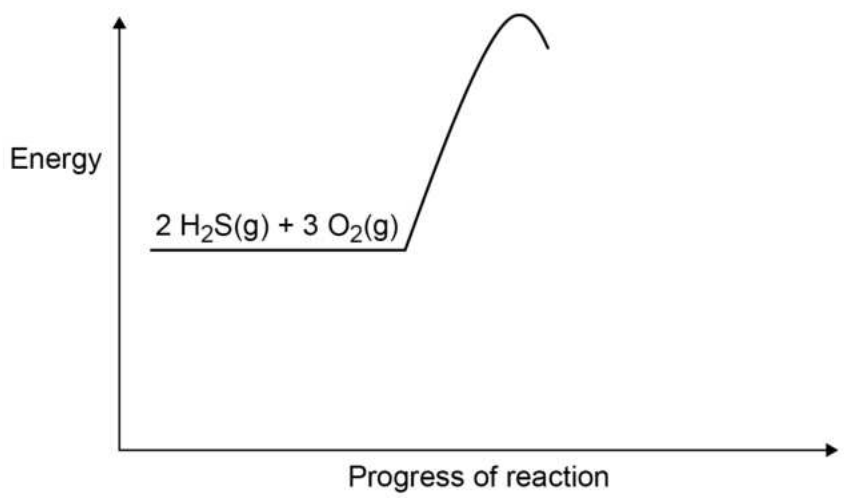
Complete **Figure 6**.

You should:

- complete the profile line
- label the activation energy
- label the overall energy change.

[3 marks]

Figure 6



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0 8 . 4 **Figure 7** shows the displayed formula equation for the reaction of hydrogen sulfide with oxygen.

Figure 7

$$2\,H{-}S{-}H \;+\; 3\,O{=}O \;\longrightarrow\; 2\,H{-}O{-}H \;+\; 2\,O{=}S{=}O$$

Table 5 shows some of the bond energies.

Table 5

Bond	H—S	O=O	H—O	S=O
Energy in kJ/mol	364	498	464	**X**

In the reaction the energy released forming new bonds is 1034 kJ/mol greater than the energy needed to break existing bonds.

Calculate the bond energy **X** for the S=O bond.

Use **Figure 7** and **Table 5.**

[5 marks]

X = ______________ kJ/mol

10

Do not write outside the box

0 9 This question is about acids.

Hydrogen chloride and ethanoic acid both dissolve in water.

All hydrogen chloride molecules ionise in water.

Approximately 1% of ethanoic acid molecules ionise in water.

0 9 . 1 A solution is made by dissolving 1 g of hydrogen chloride in 1 dm^3 of water.

Which is the correct description of this solution?

[1 mark]

Tick (✓) **one** box.

A concentrated solution of a strong acid ☐

A concentrated solution of a weak acid ☐

A dilute solution of a strong acid ☐

A dilute solution of a weak acid ☐

0 9 . 2 Which solution would have the lowest pH?

[1 mark]

Tick (✓) **one** box.

0.1 mol/dm^3 ethanoic acid solution ☐

0.1 mol/dm^3 hydrogen chloride solution ☐

1.0 mol/dm^3 ethanoic acid solution ☐

1.0 mol/dm^3 hydrogen chloride solution ☐

Do not write outside the box

A student investigated the concentration of a solution of sodium hydroxide by titration with a 0.0480 mol/dm^3 ethanedioic acid solution.

This is the method used.

1. Measure 25.0 cm^3 of the sodium hydroxide solution into a conical flask using a 25.0 cm^3 pipette.

2. Add two drops of indicator to the sodium hydroxide solution.

3. Fill a burette with the 0.0480 mol/dm^3 ethanedioic acid solution to the 0.00 cm^3 mark.

4. Add the ethanedioic acid solution to the sodium hydroxide solution until the indicator changes colour.

5. Read the burette to find the volume of the ethanedioic acid solution used.

0 9 . 3 Suggest **two** improvements to the method that would increase the accuracy of the result.

[2 marks]

1 ____

____

2 ____

____

Question 9 continues on the next page

Do not write outside the box

0 9 . 4 Ethanedioic acid is a solid at room temperature.

Calculate the mass of ethanedioic acid ($H_2C_2O_4$) needed to make 250 cm^3 of a solution with concentration 0.0480 mol/dm^3

Relative formula mass (M_r): $H_2C_2O_4$ = 90

[2 marks]

Mass = ____________________ g

0 9 . 5 The student found that 25.0 cm^3 of the sodium hydroxide solution was neutralised by 15.00 cm^3 of the 0.0480 mol/dm^3 ethanedioic acid solution.

The equation for the reaction is:

$$H_2C_2O_4 + 2NaOH \rightarrow Na_2C_2O_4 + 2H_2O$$

Calculate the concentration of the sodium hydroxide solution in mol/dm^3

[3 marks]

Concentration = ____________________ mol/dm^3

9

END OF QUESTIONS

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