AQA

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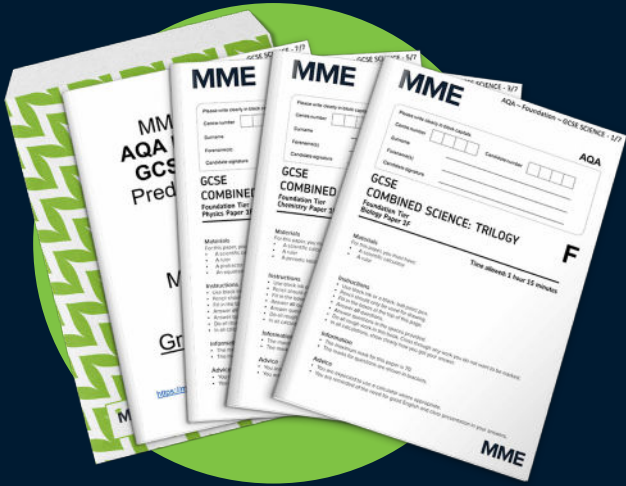
Information
- The maximum mark for this paper is 100.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.

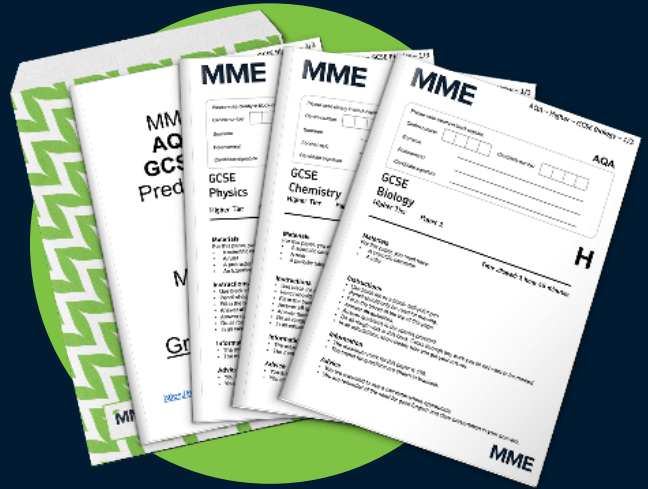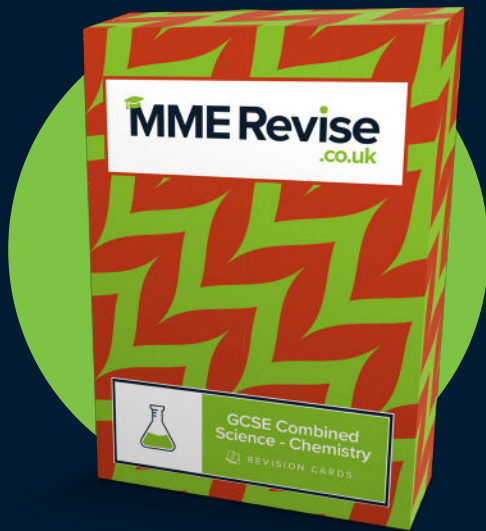| For Examiner's Use	
Question	Mark
1	
2	
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7	
8	
TOTAL	

MME.

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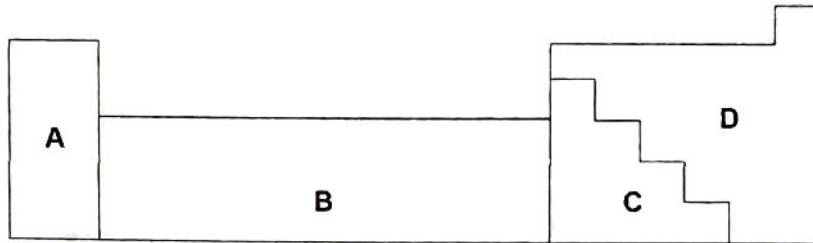Revision Cards**

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0 1 This question is about metals and non-metals.

Figure 1 shows an outline of part of the periodic table.

Figure 1

0 1 . 1 Element **Q** is a dull solid with a melting point of 44 °C.

Element **Q** does not conduct electricity.

Which section of the periodic table in **Figure 1** is most likely to contain element **Q**?

[1 mark]

Tick (✓) **one** box.

A ☐   B ☐   C ☐   D ☑

0 1 . 2 Element **R** forms ions of formula R^{2+} and R^{3+}

Which section of the periodic table in **Figure 1** is most likely to contain element **R**?

[1 mark]

Tick (✓) **one** box.

A ☐   B ☑   C ☐   D ☐

0 1 . 3 Give **two** differences between the physical properties of the elements in Group 1 and those of the transition elements.

[2 marks]

1 Group 1 elements have lower densities.

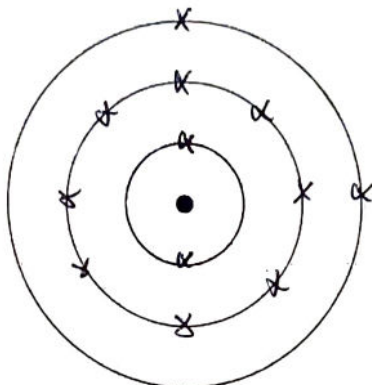2 Group 1 elements have lower melting points

0 1 . 4 Complete **Figure 2** to show the electronic structure of an aluminium atom.

Use the periodic table.

[1 mark]

Figure 2

0 1 . 5 Aluminium is a metal.

Describe how metals conduct electricity.

Answer in terms of electrons.

[3 marks]

Metals have delocalised electrons.
These electrons carry electrical
charge. They move through
the metal, conducting electricity.

0 1 . 6 Name the type of bonding in compounds formed between metals and non-metals.

[1 mark]

Ionic

Turn over ▶

0 1 . 7 Magnesium oxide is a compound formed from the metal magnesium and the non-metal oxygen.

Describe what happens when a magnesium atom reacts with an oxygen atom.

You should refer to electrons in your answer.

[4 marks]

The Magnesium atom loses electrons.
The Oxygen atom gains electrons.
Two electrons are transferred between
the atoms. Magnesium ions and
Oxide ions are formed.

13

0 2   Sodium carbonate reacts with hydrochloric acid in an exothermic reaction.

The equation for the reaction is:

$$Na_2CO_3(s) + 2HCl(aq) \rightarrow 2NaCl(aq) + CO_2(g) + H_2O(l)$$

A student investigated the effect of changing the mass of sodium carbonate powder on the highest temperature reached by the reaction mixture.

0 2 . 1   Plan a method to investigate the effect of changing the mass of sodium carbonate powder on the highest temperature reached.
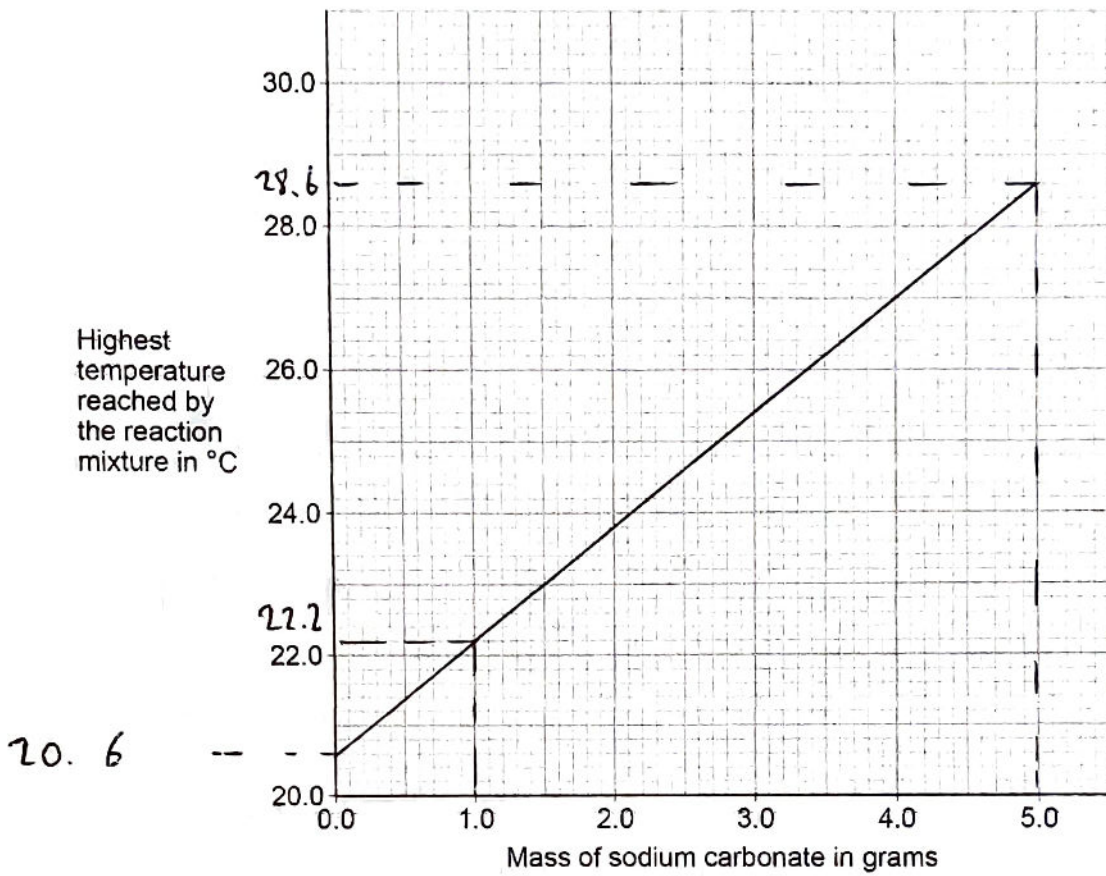
[6 marks]

First measure the volume of the hydrochloric acid with a measuring cylinder. Then pour the acid into a polystyrene cup and use a thermometer to measure initial temperature. Next add a known mass of of sodium carbonate, stir the acid and sodium carbonate. With the thermometer measure the temperature of the mixture and note down the highest temperature. Repeat the previous steps with different masses of sodium carbonate. Finally, repeat the whole investigation with the same starting temperature, volume and concentration of hydrochloric acid.

Figure 3 shows a line of best fit drawn through the student's results.

Figure 3

20. 6

0 2 . 2 Determine the gradient of the line of best fit in **Figure 3**.

Use the equation:

$$\text{Gradient} = \frac{\text{Change in highest temperature}}{\text{Change in mass}}$$

Give the unit.

[5 marks]

using Figure 3: Change in : 28.6 - 22.2
highest temperature = 6.4

Change in mass: 5.0 - 1.0 = 4.0

Gradient = Change in highest temperature = 6.4
           Change in mass   4.0

= 1.6 °C/g

Gradient = _____1.6_____ Unit ___°C/g___

0 2 . 3 The initial temperature of the reaction mixture is where the line of best fit would meet the *y*-axis.

Determine the initial temperature of the reaction mixture.

Show your working on **Figure 3**.

[2 marks]

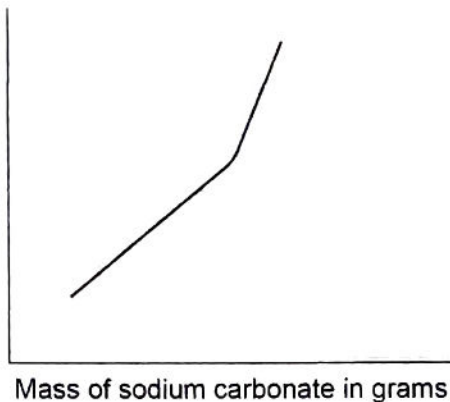Initial temperature of the reaction mixture = ___20.6___ °C

0 2 . 4 Another student repeated the investigation but added sodium carbonate until the sodium carbonate was in excess.

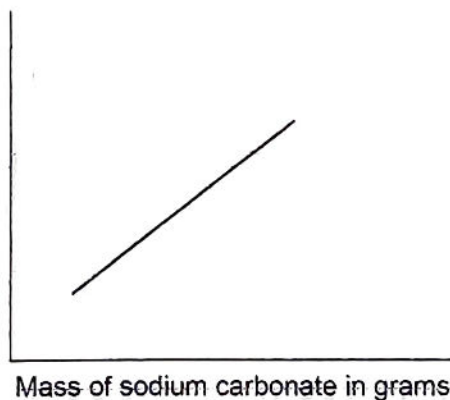Which sketch graph shows the results obtained when sodium carbonate was added until in excess?

[1 mark]

Tick (✓) **one** box.

A
Highest temperature reached by the reaction mixture in °C

Mass of sodium carbonate in grams

☐

B
Highest temperature reached by the reaction mixture in °C

Mass of sodium carbonate in grams

☐

C
Highest temperature reached by the reaction mixture in °C

Mass of sodium carbonate in grams

☑

Figure 4 shows a reaction profile for the reaction of sodium carbonate with hydrochloric acid.

Figure 4

Progress of reaction

| 0 2 | . | 5 | What do labels **X** and **Y** represent on **Figure 4**?

[2 marks]

X ___Energy___

Y ___Energy Change___

| 0 2 | . | 6 | How does the reaction profile show that the reaction is exothermic?

Use **Figure 4**.

[1 mark]

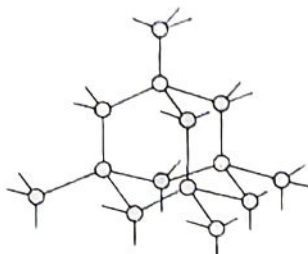The level of products is below the level of reactonts.

17

0 3 This question is about different forms of carbon.

Figure 5 represents the structure of diamond.

Figure 5

Key
O Carbon atom

0 3 . 1 Describe the structure and bonding of diamond.

[3 marks]

Diamond is a giant structure.
It contains covalent bonds.
Each atom has four bonds.

0 3 . 2 Explain why diamond has a very high melting point.

[3 marks]

Covalent bonds are strong.
Diamond has many covalent bonds
that must be broken when
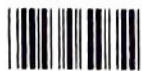it is heated. A lot of energy
is required.

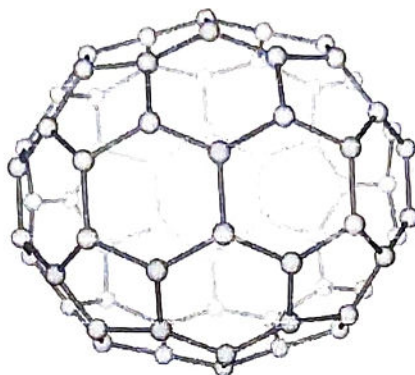**Figure 6** represents the molecule C_{70}

Figure 6

0 3 . 3 What is the name of this type of molecule?

[1 mark]

Tick (✓) **one** box.

Fullerene ☑

Graphene ☐

Nanotube ☐

Polymer ☐

0 3 . 4 Molecules such as C_{70} can be used in medicine to move drugs around the body.

Suggest **one** reason why the C_{70} molecule is suitable for this use.

[1 mark]

C_{70} is hollow.

Turn over ▶

0 3 . 5 Calculate the number of C_{70} molecules that can be made from one mole of carbon atoms.

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

[3 marks]

moles of C_{70} molecules = $\dfrac{1}{70}$ = $0.0\dot{1}4285\dot{7}$

molecules = $0.0\dot{1}4285\dot{7} \times 6.02 \times 10^{23}$

= 8.6×10^{21}
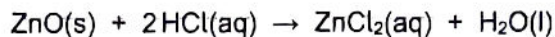
Number of molecules = 8.6×10^{21}

11

0 4 This question is about zinc and compounds of zinc.

A student produces pure crystals of zinc chloride by reacting zinc oxide with hydrochloric acid.

The equation for the reaction is:

$$ZnO(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2O(l)$$

0 4 . 1 The student adds zinc oxide to hydrochloric acid until the zinc oxide is in excess.

Give **one** observation that the student could make to show that the zinc oxide is in excess.

[1 mark]

If there is Zinc oxide solid remaining.

0 4 . 2 Why is excess zinc oxide used rather than excess hydrochloric acid?

[1 mark]

The excess Zinc oxide can be filtered off

0 4 . 3 Name **one other** compound that the student could add to hydrochloric acid to produce zinc chloride.

[1 mark]

Zinc Carbonate

0 4 . 4 Describe how the student should obtain crystals of zinc chloride from a solution of zinc chloride.

[2 marks]

Heat the Zinc chloride Solution until the crystallisation point is reached. The Solution should be left to Crystallise.
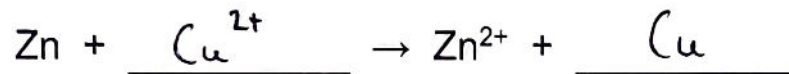
Turn over ▶

Zinc chloride is also produced in a displacement reaction between zinc and copper chloride solution.

The equation for the reaction is:

$$Zn + CuCl_2 \rightarrow ZnCl_2 + Cu$$

0 4 . 5 Complete the ionic equation for this reaction.

[1 mark]

$$Zn + \underline{\quad Cu^{2+} \quad} \rightarrow Zn^{2+} + \underline{\quad Cu \quad}$$

0 4 . 6 Why is zinc described as being oxidised in this reaction?

[1 mark]

Zinc atoms lose 2 electrons

0 4 . 7 Zinc and copper can be used with another substance to produce electricity.

Complete **Figure 7** to show how zinc, copper and another substance can be used to light a lamp.
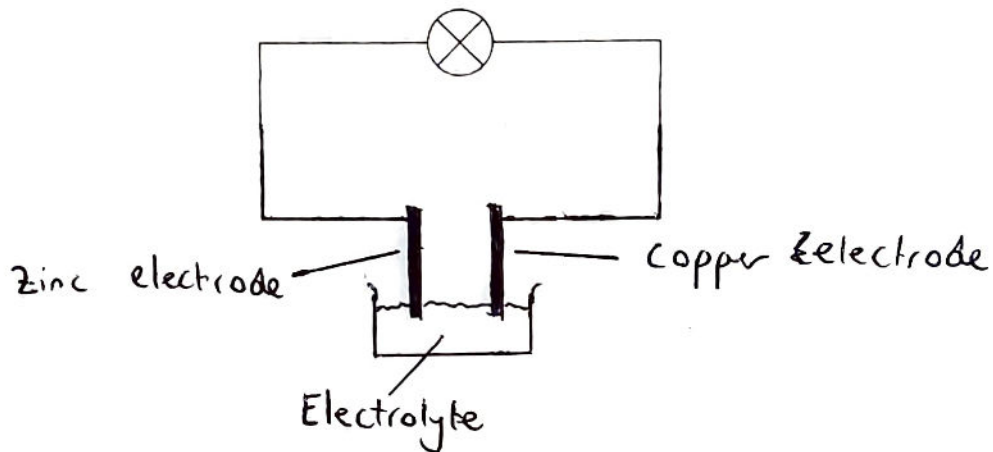
Label:

- zinc
- copper
- the other substance used.

The symbol ──⊗── represents the lamp.

[3 marks]

Figure 7

Zinc electrode

Copper Eelectrode

Electrolyte

Turn over for the next question

10

0 5 This question is about groups in the periodic table.

The elements in Group 1 become more reactive going down the group.

Rubidium is below potassium in Group 1.

0 5 . 1 Rubidium and potassium are added to water.

Predict **one** observation you would see that shows that rubidium is more reactive than potassium.

[1 mark]

There would be more vigorous bubbling for rubidium

0 5 . 2 Explain why rubidium is more reactive than potassium.

[3 marks]

Rubidium's outer shell is further from the nucleus. This means there is less attraction between the nucleus and the outer electron in rubidium. Therefore the outer electron is more easily lost, so rubidium is more reactive.

0 5 . 3 Complete the equation for the reaction of rubidium with water.

You should balance the equation.

[3 marks]

$$2Rb + 2H_2O \rightarrow 2RbOH + H_2$$

The noble gases are in Group 0.

0 5 . 4 Which is a correct statement about the noble gases?

[1 mark]

Tick (✓) **one** box.

The noble gases all have atoms with eight electrons in the outer shell. ☐

The noble gases have boiling points that increase going down the group. ☑

The noble gases have molecules with two atoms. ☐

The noble gases react with metals to form ionic compounds. ☐

0 5 . 5 **Table 1** shows information about the three isotopes of neon.

Table 1

Mass number	Percentage abundance (%)
20	90.48
21	0.27
22	9.25

Calculate the relative atomic mass (A_r) of neon.

Give your answer to 3 significant figures.

[3 marks]

$$\frac{(90.48 \times 20) + (0.27 \times 21) + (9.25 \times 22)}{100}$$

$$= 20.1877$$

$$= 20.2 \quad (\text{to 3 significant figures})$$

Relative atomic mass (3 significant figures) = _20.2_
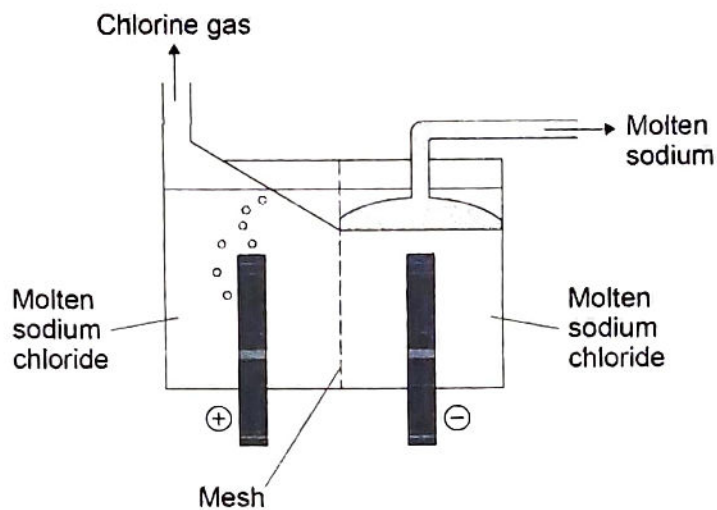
11

Turn over ▶

0 6 This question is about electrolysis.

Molten sodium chloride is electrolysed in an industrial process to produce sodium.

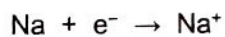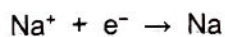**Figure 8** shows a simplified version of the electrolysis cell used.

Figure 8

0 6 . 1 Which is the correct half equation for the production of sodium?

[1 mark]

Tick (✓) **one** box.

Na + e⁻ → Na⁺ ☐

Na → Na⁺ + e⁻ ☐

Na⁺ + e⁻ → Na ☑

Na⁺ → Na + e⁻ ☐

A mesh is used to keep the products of the electrolysis apart.

0 6 . 2 Suggest **one** reason why the products of the electrolysis must be kept apart.

[1 mark]

So the products do not react

0 6 . 3 Which type of particle passes through the mesh in the electrolysis of molten sodium chloride?

[1 mark]

Tick (✓) **one** box.

Atom ☐

Electron ☐

Ion ☑

Molecule ☐

Question 6 continues on the next page

Turn over ▶

Aqueous sodium chloride solution is electrolysed in a different industrial process.

Two gases and an alkaline solution are produced.

0 6 . 4 Which **two** ions are present in aqueous sodium chloride solution in addition to sodium ions and chloride ions?

[2 marks]

1 H^+ ions

2 OH^- ions

0 6 . 5 Name the alkaline solution produced.

[1 mark]

Sodium Hydroxide

0 6 . 6 Explain how the alkaline solution is produced.

You should refer to the processes at the electrodes.

[3 marks]

Sodium ions and hydroxide ions are left in the solution. This is because hydrogen ions are discharged at the negative electrode to form hydrogen. Chloride ions are discharged at the positive electrode to form chlorine.
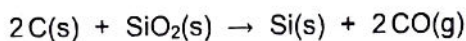
9

0 7 This question is about silicon and compounds of silicon.

0 7 . 1 The reactivity series sometimes includes non-metals such as carbon, hydrogen and silicon.

Silicon can be extracted by reducing silicon dioxide with different substances.

The equation for one possible reaction is:

$$2C(s) + SiO_2(s) \rightarrow Si(s) + 2CO(g)$$

Explain what this reaction shows about the position of silicon in the reactivity series.

[2 marks]

Silicon is less reactive than carbon. This is because carbon displaces silicon from silicon dioxide.

0 7 . 2 Aluminium also reduces silicon dioxide.

Carbon is used rather than aluminium to reduce silicon dioxide because carbon is cheaper than aluminium.

Carbon can be obtained by heating coal.

Aluminium is obtained from aluminium oxide.

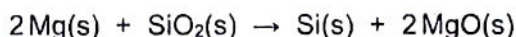Explain why aluminium is more expensive than carbon.

[2 marks]

More energy is needed to obtain aluminium because aluminium is obtained by electrolysis

Turn over ▶

Magnesium also reduces silicon dioxide.

The equation for the reaction is:

$$2\,Mg(s) \; + \; SiO_2(s) \; \rightarrow \; Si(s) \; + \; 2\,MgO(s)$$

0 7 . 3 Give **one** reason why the products are difficult to separate if magnesium is used to reduce silicon dioxide.

[1 mark]

Both   products   are   solid

0 7 . 4 Calculate the minimum mass in grams of magnesium needed to completely reduce 1.2 kg of silicon dioxide.

Relative atomic masses (A_r):   O = 16   Mg = 24   Si = 28

[5 marks]

M_r of SiO_2 = $\underset{(Si)}{28}$ + $\underset{(O_2)}{(2 \times 16)}$ = 60

1.2 kg = 1.2 × 1000 = 1200 g

number of moles of SiO_2 = $\dfrac{1200}{60}$ = 20

Number of moles of Mg = 20 × 2 = 40

Mass of Mg = moles × mass = 40 × 24 = 960
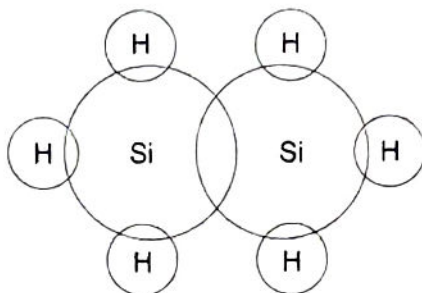
Minimum mass of magnesium = _____960_____ g

Si_2H_6 is a covalent compound of silicon and hydrogen.

| 0 | 7 | . | 5 |

Complete **Figure 9** to show the outer shell electrons in a molecule of Si_2H_6

[1 mark]

Figure 9

| 0 | 7 | . | 6 |

Si_2H_6 reacts with oxygen.

The equation for the reaction is:

$$2\,Si_2H_6(g) \; + \; 7\,O_2(g) \; \rightarrow \; 4\,SiO_2(s) \; + \; 6\,H_2O(g)$$

30 cm³ of Si_2H_6 is reacted with 150 cm³ (an excess) of oxygen.

Calculate the total volume of gases present after the reaction.

All volumes of gases are measured at the same temperature and pressure.

[4 marks]

Volume of Oxygen for 30 cm³ Si_2H_6
= 3.5 × 30
= 105 cm³

Volume of excess oxygen = 150 - 105 = 45 cm³

Volume of Water Vapor = 3 × 30 = 90 cm³
Volume of gases = 45 + 90 = 135 cm³

Volume of gases = _135_ cm³

15

Turn over ▶

Do not write outside the box

0 8 This question is about acids and alkalis.

0 8 . 1 Explain why the pH of an acid depends on:

- the strength of the acid
- the concentration of the acid.

[4 marks]

Firstly, we know that the pH depends on the hydrogen ion (H^+) concentration. The higher the concentration of H^+ ions, the lower the pH. In terms of the strength of the acid, the stronger an acid, the greater the ionisation in an aqueous solution. This means that the stronger the acid, the lower the pH. A more concentrated acid has more acid in the same volume. So therefore the higher the concentration of the acid the lower the pH.

0 8 . 2 A student titrated 25.00 cm³ of hydrochloric acid with 0.100 mol/dm³ barium hydroxide solution.

Table 2 shows the results.

Table 2

Titration number	1	2	3	4	5
Volume of barium hydroxide solution used in cm³	23.90	23.45	23.55	23.55	23.45

The student calculated the volume of barium hydroxide solution to be used in the titration calculation as 23.50 cm³.

Explain why the student used a volume of 23.50 cm³ of barium hydroxide solution in the titration calculation.

[2 marks]

The mean of the titration numbers 2 to 5 volumes is calculated, 23.90 cm³ is ignored because it is an anomalous result.

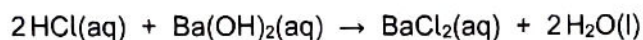IB/M/Jun22/8462/1H

0	8	.	3

25.00 cm³ of the hydrochloric acid reacted with 23.50 cm³ of the 0.100 mol/dm³ barium hydroxide solution.

The equation for the reaction is:

$$2\,HCl(aq) + Ba(OH)_2(aq) \rightarrow BaCl_2(aq) + 2\,H_2O(l)$$

Calculate the concentration of the hydrochloric acid in mol/dm³.

┌ (cm³ to dm³) **[4 marks]**

$$\text{Moles of } Ba(OH)_2 = \frac{23.50}{1000} \times 0.100 \text{ mol/dm}^3$$

$$= 0.00235 \text{ mol}$$

$$\text{Moles of } HCl = 0.00235 \times 2 = 0.00470 \text{ mol}$$

$$\text{Concentration} = 0.00470 \times \frac{1000}{25.0}$$

$$= 0.188 \text{ mol/dm}^3$$

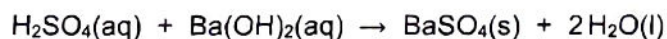Concentration of the hydrochloric acid = __0.188__ mol/dm³

Question 8 continues on the next page

Turn over ▶

Another student titrated sulfuric acid with barium hydroxide solution.

The equation for the reaction is:

$$H_2SO_4(aq) + Ba(OH)_2(aq) \rightarrow BaSO_4(s) + 2H_2O(l)$$
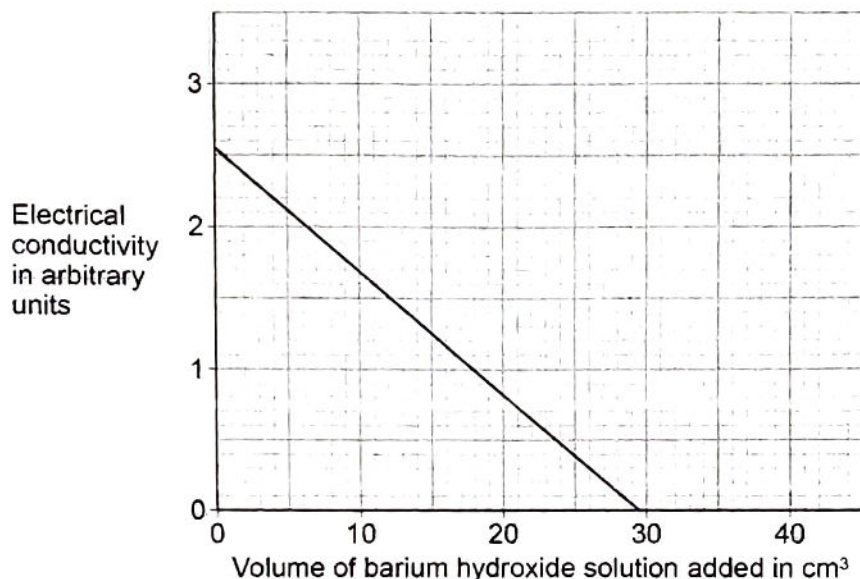
The student measured the electrical conductivity of the mixture during the titration.

The better a conductor, the higher the electrical conductivity value.

Figure 10 shows the results.

Figure 10

Volume of barium hydroxide solution added in cm³

0 8 . 4   Explain why the electrical conductivity of the mixture was zero when the sulfuric acid had just been neutralised.

Use the equation for the reaction.

Refer to ions in your answer.

[3 marks]

There are no ions that are free to move because barium sulfate is insoluble. The hydrogen ions are not free to move because they have reacted with hydroxide ions to produce water.

0 8 . 5 The student then added a further 10 cm^3 of barium hydroxide solution.

The electrical conductivity of the mixture increased.

Give **one** reason why.

[1 mark]

The mixture now contains barium ions and hydroxide ions that are free to move.

14

END OF QUESTIONS