Please write clearly in block capitals.

Centre number		Candidate number	

Surname ______________________

Forename(s) ______________________

Candidate signature ______________________
I declare this is my own work.

GCSE CHEMISTRY

F

Foundation Tier Paper 1

Thursday 14 May 2020 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.
- 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	
10	
TOTAL	

Do not write outside the box

0 1 This question is about the elements in Group 7 of the periodic table.

Table 1 shows the melting points and boiling points of some of the elements.

Table 1

Element	**Melting point in °C**	**Boiling point in °C**
Fluorine	–220	–188
Chlorine	–101	–35
Bromine	–7	59

0 1 . 1 What is the state of bromine at 100 °C?

Use **Table 1**.

[1 mark]

Tick (✓) **one** box.

Gas ☐

Liquid ☐

Solid ☐

Do not write outside the box

0 1 . 2 What temperature does chlorine gas condense at to form a liquid?

Use **Table 1**.

[1 mark]

Temperature = ____________________ °C

0 1 . 3 Complete the sentences.

[2 marks]

Going down Group 7 the melting points ________________________.

This is because the size of the molecules increases so the

intermolecular forces ________________________.

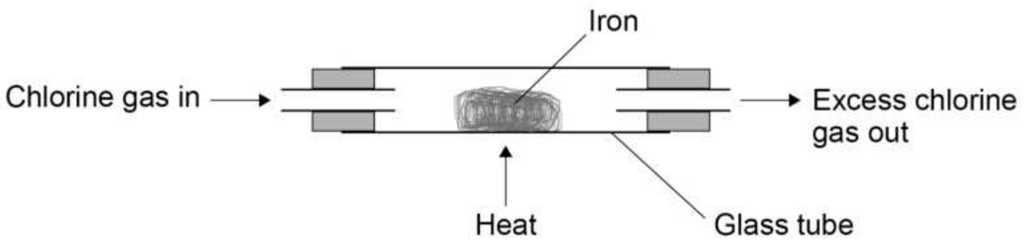
Question 1 continues on the next page

Do not write outside the box

A teacher investigated the reaction of iron with chlorine.

Figure 1 shows the apparatus used.

Figure 1



0 1 . 4 Why did the teacher do the investigation in a fume cupboard?

[1 mark]

Tick (✓) **one** box.

Chlorine gas is coloured. ☐

Chlorine gas is flammable. ☐

Chlorine gas is toxic. ☐

Do not write outside the box

0 1 . 5 The word equation for the reaction is:

iron + chlorine → iron chloride

Iron chloride is a solid.

The teacher weighed the glass tube and contents:

- before the reaction
- after the reaction.

What happened to the mass of the glass tube and contents during the reaction?

Give **one** reason for your answer.

[2 marks]

The mass of the glass tube and contents ______________________________.

Reason ____

____

Question 1 continues on the next page

Do not write outside the box

The teacher repeated the investigation with bromine gas and with iodine gas.

Table 2 shows the results.

Table 2

Element	**Observation**
Chlorine	Iron burns vigorously with an orange glow
Bromine	Iron burns with an orange glow
Iodine	Iron slowly turns darker

0 1 . 6 Fluorine is above chlorine in Group 7.

Predict what you would observe when fluorine gas reacts with iron.

Use **Table 2**.

[1 mark]

____

____

0 1 . 7 Balance the equation for the reaction between iron and bromine.

[1 mark]

$$2Fe + \_\_\_\_\_ Br_2 \rightarrow 2FeBr_3$$

0 1 . 8 Calculate the relative formula mass (M_r) of $FeBr_3$

Relative atomic masses (A_r): Fe = 56 Br = 80

[2 marks]

____

____

Relative formula mass (M_r) = ____________

11

Do not write outside the box

0 2 This question is about models of the atom.

0 2 . 1 Atoms were first thought to be tiny spheres that could not be divided.

Which particle was discovered to change this model of the atom?

[1 mark]

Tick (✓) **one** box.

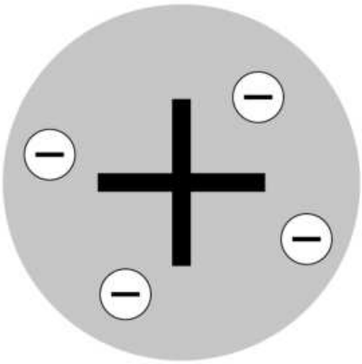
Electron ☐

Neutron ☐

Proton ☐

0 2 . 2 **Figure 2** shows another model of the atom.

Figure 2



What is the name of this model of the atom?

[1 mark]

____

0 2 . 3 A scientist fired particles at gold atoms.

Some of these particles were scattered.

The results led to a different model of the atom.

Which type of particle was fired at the gold atoms?

[1 mark]

Tick (✓) **one** box.

Alpha ☐

Electron ☐

Neutron ☐

Proton ☐

0 2 . 4 Which scientist first suggested that electrons orbit the nucleus at specific distances?

[1 mark]

Tick (✓) **one** box.

Bohr ☐

Chadwick ☐

Mendeleev ☐

Do not write outside the box

0 2 . 5 The model of the atom used today has three subatomic particles:

- electrons
- neutrons
- protons.

Complete the sentences.

[3 marks]

Atoms of the same element have the same atomic number because they have the same number of ____________________.

Atoms of the same element can have different mass numbers because they have different numbers of ____________________.

Atoms have no overall charge because they have the same number of ____________________ and ____________________.

0 2 . 6 The radius of a nucleus is approximately 1×10^{-14} m

The radius of an atom is approximately 1×10^{-10} m

A teacher uses a ball of radius 1 cm to represent the nucleus.

What could represent the atom on the same scale?

[1 mark]

Tick (✓) **one** box.

A ball of radius 10 cm ☐

A sports arena of radius 100 m ☐

An island of radius 10 km ☐

A planet of radius 1000 km ☐

8

Do not write outside the box

0 3 This question is about chemical reactions and energy.

Hydrogen reacts with oxygen to produce water.

This reaction releases energy.

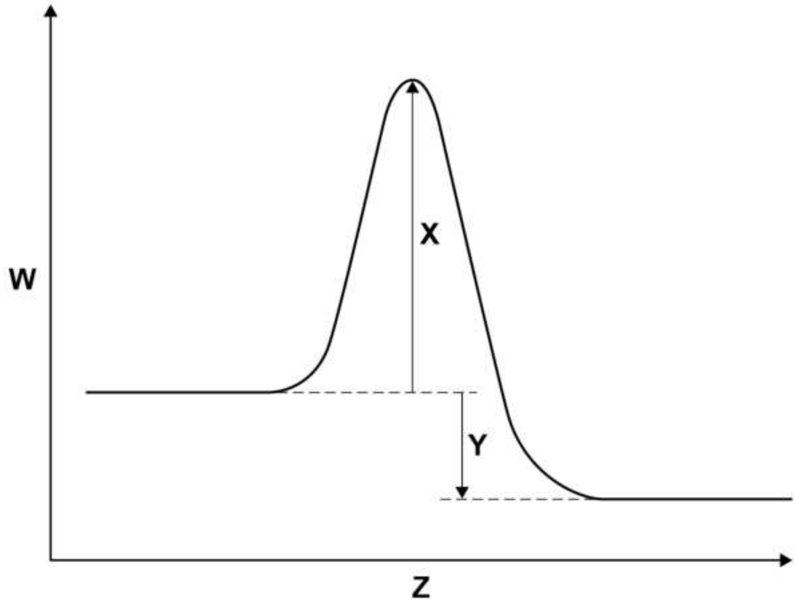
0 3 . 1 Complete the word equation for the reaction.

[1 mark]

hydrogen + oxygen → ____________

0 3 . 2 **Figure 3** shows a reaction profile for the reaction between hydrogen and oxygen.

Figure 3



What do the labels **W**, **X**, **Y** and **Z** represent?

Choose answers from the box.

[4 marks]

activation energy	**energy**	**overall energy change**
products	**progress of reaction**	**reactants**

W ____________________

X ____________________

Y ____________________

Z ____________________

Do not write outside the box

0 3 . 3 The reaction between hydrogen and oxygen is used in a hydrogen fuel cell.

What is the reason for using this reaction in a fuel cell?

[1 mark]

Tick (✓) **one** box.

To produce a change of state ☐

To produce a potential difference ☐

To produce a temperature change ☐

0 3 . 4 A student investigated the voltage produced by a chemical cell.

The student used different metals as the electrodes in the cell.

The metals used were:

- copper
- iron
- magnesium.

Which **two** metal electrodes would produce the greatest voltage when used in the chemical cell?

Give **one** reason for your answer.

[2 marks]

Metals ____________________ and ____________________

Reason ____

____

8

Do not write outside the box

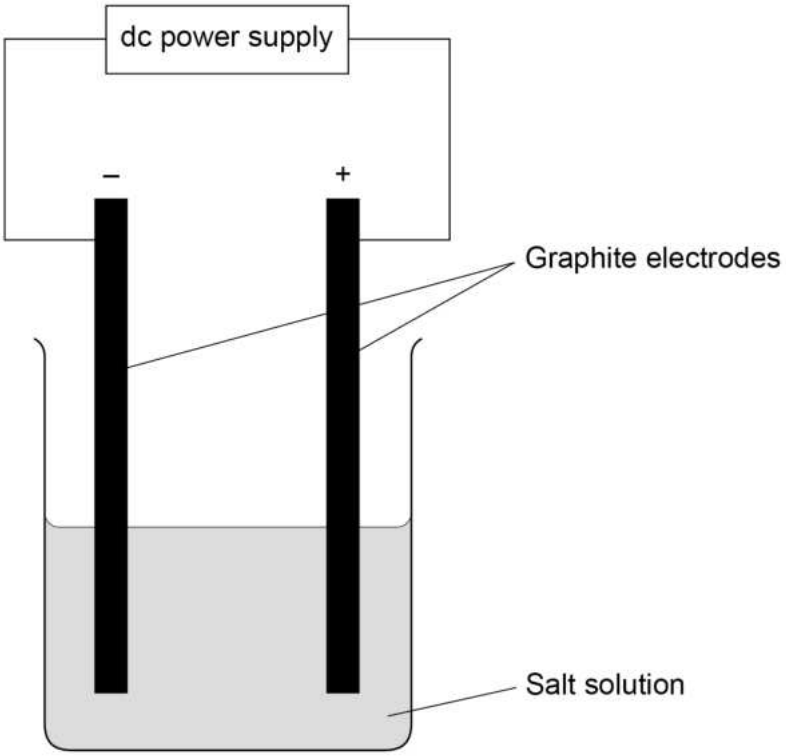
0 4 This question is about electrolysis.

A student investigated the hypothesis:

'The electrolysis of a salt solution produces a metal at the negative electrode and a gas at the positive electrode.'

Figure 4 shows the apparatus used.

Figure 4



0 4 . 1 What observation would be made at each electrode if the hypothesis is correct?

[2 marks]

Observation if metal produced at the negative electrode ____________________

____

Observation if gas produced at the positive electrode ____________________

____

Table 3 shows the student's results.

Table 3

Salt solution	**Product at the negative electrode**	**Product at the positive electrode**
Copper chloride	Copper	Chlorine
Potassium nitrate	Hydrogen	Oxygen
Silver nitrate	Silver	Oxygen

0 4 . 2 Which salt solution in **Table 3** does **not** match the student's hypothesis?

Give **one** reason why.

[2 marks]

Salt solution ____

Reason ____

____

0 4 . 3 Give **two** reasons why graphite is used for the electrodes.

[2 marks]

1 ____

____

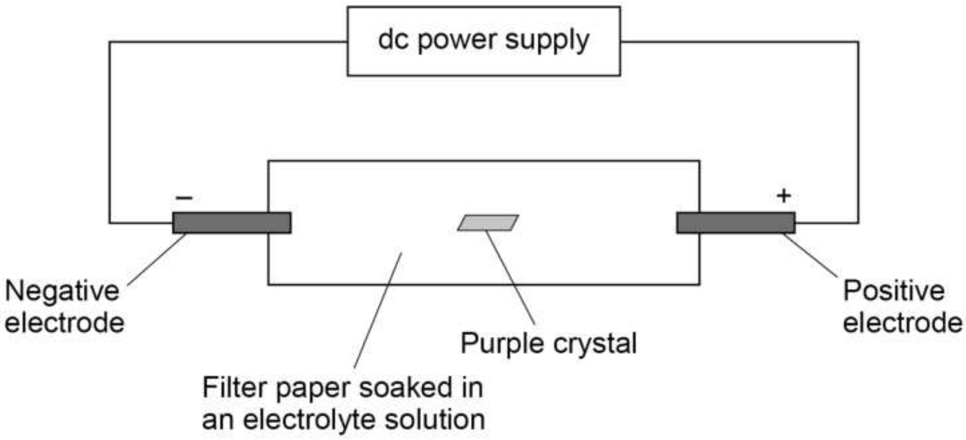
2 ____

____

A different student investigated what happens during electrolysis.

Figure 5 shows the apparatus.

Figure 5



The purple crystal contained:

- colourless positive ions
- purple coloured negative ions.

The purple crystal dissolved in the electrolyte solution.

0 4 . 4 What happens to the purple coloured ions?

Give **one** reason for your answer.

[2 marks]

Tick (✓) **one** box.

The ions do not move. ☐

The ions move towards the negative electrode. ☐

The ions move towards the positive electrode. ☐

Reason ____

____

8

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Turn over for the next question

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0 5 This question is about aluminium.

0 5 . 1 Aluminium is a metal.

Draw **one** line from each property of aluminium to the correct reason for that property.

[2 marks]

Property	**Reason**
	Aluminium has delocalised electrons
Conducts electricity	Aluminium has layers of atoms which can slide
	Aluminium has strong metallic bonds
High melting point	Aluminium has weak intermolecular forces
	Aluminium has a random arrangement of atoms

0 5 . 2 Aluminium can be used to make alloys.

What is meant by an 'alloy'?

[1 mark]

___

___

Do not write outside the box

Aluminium is extracted from bauxite.

Bauxite is a mixture which contains aluminium oxide.

0 5 . 3 Bauxite contains between 15% and 25% aluminium.

Aluminium oxide always contains 53% aluminium.

How does this show that bauxite is a mixture and **not** a compound?

[1 mark]

____

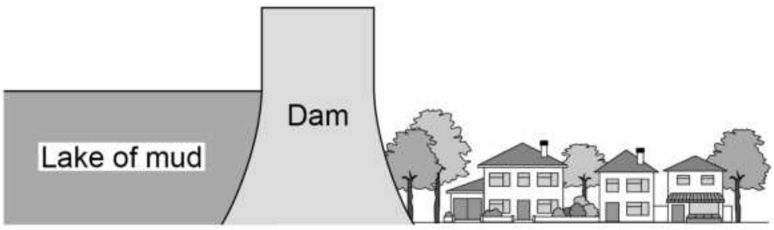
____

0 5 . 4 The waste material from the bauxite is stored in lakes of mud.

The lakes of mud are held in place by dams.

Figure 6 shows one of these lakes.

Figure 6



Suggest **two** possible problems with storing the waste material in lakes of mud.

[2 marks]

1 ____

____

2 ____

____

Turn over ►

Do not write outside the box

Aluminium is extracted by electrolysis.

The aluminium oxide is mixed with cryolite and melted.

The mixture is then electrolysed.

0 5 . 5 The formula of cryolite is Na_3AlF_6

Give the total number of atoms in the formula.

[1 mark]

Number of atoms = ____________________

0 5 . 6 What is the reason for adding cryolite to the aluminium oxide?

[1 mark]

Tick (✓) **one** box.

To increase the amount of aluminium extracted ☐

To lower the melting point of the mixture ☐

To reduce the amount of aluminium oxide needed ☐

Do not write outside the box

0 5 . 7 Complete the sentences.

Choose answers from the box.

[2 marks]

aluminium	**carbon**	**fluorine**
oxygen	**sodium**	

When the molten aluminium oxide and cryolite mixture is electrolysed the product

at the positive electrode is ________________________ .

This product reacts with the positive electrode because the positive electrode is

made of ________________________ .

0 5 . 8 A sample of bauxite contains 25% aluminium.

Calculate the maximum mass of aluminium that can be extracted from 300 000 kg of the sample of bauxite.

Give your answer in standard form.

[3 marks]

____

____

____

____

____

Maximum mass (in standard form) = ________________________ kg

13

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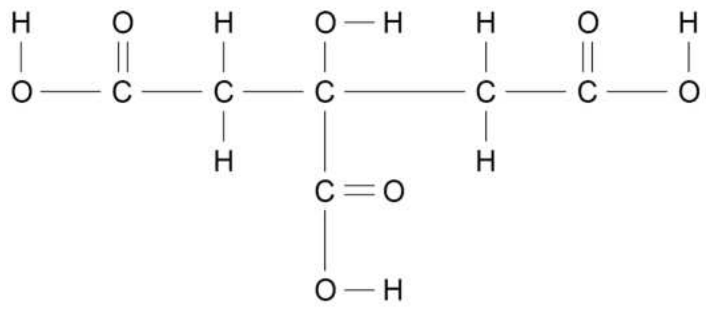
0 6 This question is about citric acid.

Figure 7 represents one molecule of citric acid.

Figure 7



0 6 . 1 Complete the molecular formula of citric acid.

Use **Figure 7**.

[1 mark]

C_6H __ O __

0 6 . 2 What type of bonding is shown in **Figure 7**?

[1 mark]

Tick (✓) **one** box.

Covalent ☐

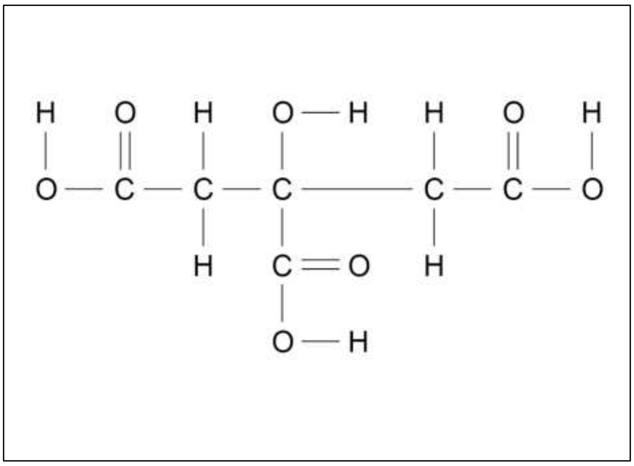
Ionic ☐

Metallic ☐

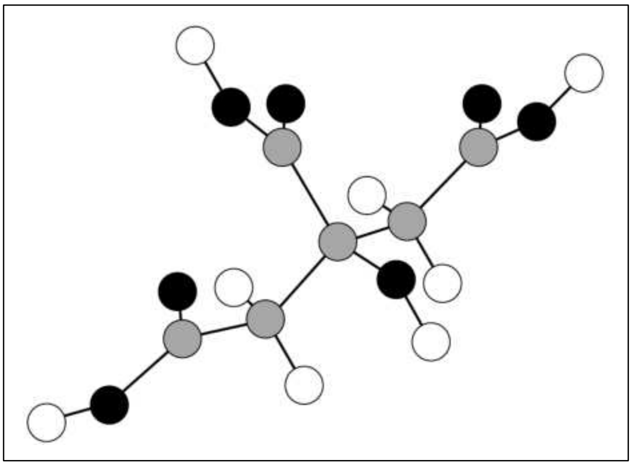
0 6 . 3 **Figure 8** shows two representations of one molecule of citric acid, **A** and **B**.

Figure 8

A



B



Give **two** advantages of representation **A** compared with representation **B**.

[2 marks]

Advantages of **A**:

1 ____

____

2 ____

____

A student investigated the temperature change during the reaction between citric acid and sodium hydrogencarbonate solution.

Citric acid is a solid.

This is the method used.

1. Pour 25 cm^3 of sodium hydrogencarbonate solution into a polystyrene cup.
2. Measure the temperature of the sodium hydrogencarbonate solution.
3. Add 0.25 g of citric acid to the cup.
4. Stir the solution.
5. Measure the temperature of the solution.
6. Repeat steps 3 to 5 until a total of 2.00 g of citric acid has been added.

Table 4 shows some of the student's results.

Table 4

Mass of citric acid added in g	**Temperature of solution in °C**
0.00	22.6
0.25	22.2
0.50	21.8
0.75	21.4
1.00	21.0
1.25	20.6

0 6 . 4 How do the results in **Table 4** show that the reaction is endothermic?

[1 mark]

Do not write outside the box

0 6 . 5 Three of the student's results are plotted on **Figure 9**.

A line of best fit for these points is drawn.

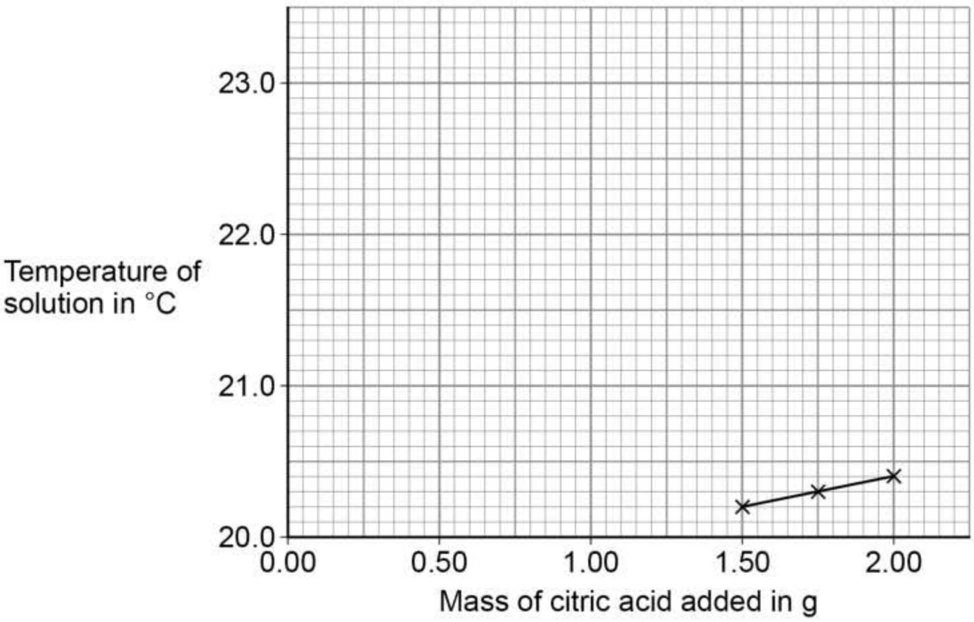
Complete **Figure 9**.

You should:

- plot the data from **Table 4** on **Figure 9**
- draw a line of best fit through the points you have plotted
- extend your line of best fit to meet the line of best fit already drawn on **Figure 9**.

[4 marks]

Figure 9



0 6 . 6 Determine the overall temperature change for the reaction.

Use **Figure 9**.

[2 marks]

____

____

Overall temperature change = ____________ °C

Turn over ►

0 6 . 7 What is the dependent variable in this investigation?

[1 mark]

Tick (✓) **one** box.

Mass of citric acid ☐

Temperature of solution ☐

Volume of solution ☐

12

Do not write outside the box

0 7 This question is about acids, bases and salts.

Zinc nitrate is a salt.

A student produces zinc nitrate using an acid and a base.

0 7 . 1 Which acid should the student use to produce zinc nitrate?

[1 mark]

Tick (✓) **one** box.

Hydrochloric acid ☐

Nitric acid ☐

Sulfuric acid ☐

0 7 . 2 Which is a base the student could use to produce zinc nitrate?

[1 mark]

Tick (✓) **one** box.

Zinc chloride ☐

Zinc oxide ☐

Zinc sulfate ☐

0 7 . 3 Name the salt with the formula $MgBr_2$

[1 mark]

____

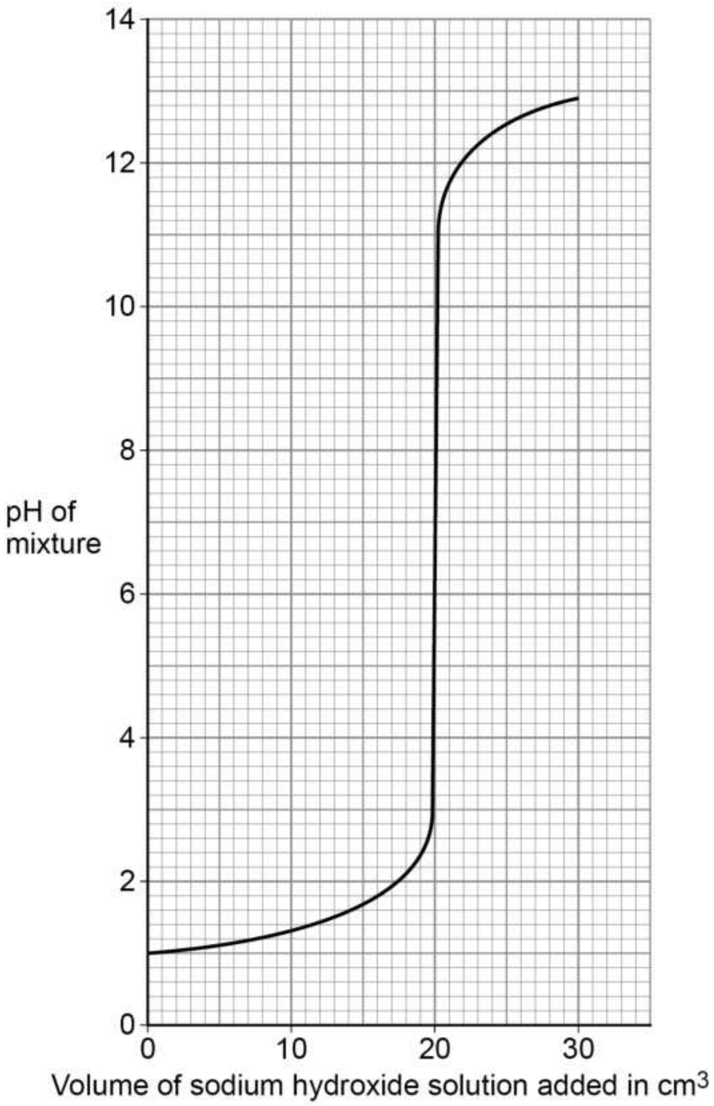
A student investigated how pH changes during a titration.

This is the method used.

1. Pour 25.0 cm^3 of hydrochloric acid into a beaker.
2. Measure the pH of the hydrochloric acid with a pH probe.
3. Add 1.0 cm^3 of sodium hydroxide solution from a burette.
4. Swirl the mixture.
5. Measure the pH of the mixture.
6. Repeat steps 3 to 5 until a total of 30.0 cm^3 of sodium hydroxide solution has been added.

Figure 10 shows the student's results.

Figure 10



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0 7 . 4 Describe how the pH of the mixture changes as sodium hydroxide solution is added to hydrochloric acid.

Use data from **Figure 10** in your answer.

[3 marks]

____

____

____

____

____

____

0 7 . 5 What volume of sodium hydroxide solution is needed to neutralise 25.0 cm^3 of hydrochloric acid?

Use **Figure 10**.

[1 mark]

Volume = ______________________ cm^3

0 7 . 6 **Figure 11** shows the colour of universal indicator at different pH values.

Figure 11

The student could have used universal indicator instead of a pH probe.

Determine the colour of universal indicator when 10.0 cm^3 of sodium hydroxide solution has been added to 25.0 cm^3 of hydrochloric acid.

Use **Figure 10** and **Figure 11**.

[1 mark]

Colour = ______________________

Turn over ►

Do not write outside the box

0 7 . 7 The student used a pipette to measure 25.0 cm^3 of hydrochloric acid.

Figure 12 shows a pipette.

Figure 12

The pipette is labelled 25.0 ± 0.06 cm^3

Calculate the percentage uncertainty in the volume measured using this pipette.

Use the equation:

$$\text{percentage uncertainty} = \frac{\text{uncertainty}}{\text{volume measured}} \times 100$$

[2 marks]

____

____

____

Percentage uncertainty = ____________________ %

0 7 . 8 Give **one** advantage of using a pipette rather than using a measuring cylinder to measure the volume of hydrochloric acid.

[1 mark]

____

____

11

Turn over for the next question

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ANSWER IN THE SPACES PROVIDED**

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0 8 This question is about structure and bonding.

0 8 . 1 Which **two** substances have intermolecular forces between particles?

[2 marks]

Tick (✓) **two** boxes.

Diamond ☐

Magnesium ☐

Poly(ethene) ☐

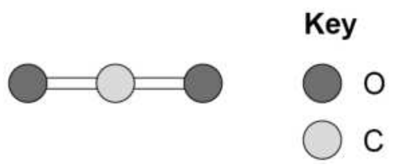
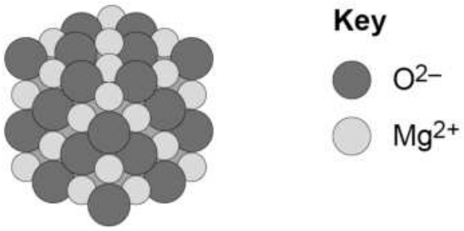
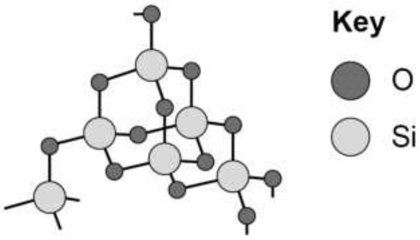
Sodium chloride ☐

Water ☐

0 8 . 2 **Table 5** shows the structures of three compounds.

Table 5

Diagrams not to scale

Compound	**Structure**
Carbon dioxide	
Magnesium oxide	
Silicon dioxide	

Compare the structure and bonding of the three compounds:

- carbon dioxide
- magnesium oxide
- silicon dioxide.

[6 marks]

8

Turn over for the next question

Do not write outside the box

0 9 This question is about metals and the reactivity series.

0 9 . 1 Which **two** statements are properties of most transition metals?

[2 marks]

Tick (✓) **two** boxes.

They are soft metals. ☐

They form colourless compounds. ☐

They form ions with different charges. ☐

They have high melting points. ☐

They have low densities. ☐

0 9 . 2 A student added copper metal to colourless silver nitrate solution.

The student observed:

- pale grey crystals forming
- the solution turning blue.

Explain how these observations show that silver is less reactive than copper.

[3 marks]

____

____

____

____

____

____

0 9 . 3 A student is given three metals, **X**, **Y** and **Z** to identify.

The metals are magnesium, iron and copper.

Plan an investigation to identify the three metals by comparing their reactions with dilute hydrochloric acid.

Your plan should give valid results.

[4 marks]

Question 9 continues on the next page

Do not write outside the box

0 9 . 4 Metal **M** has two isotopes.

Table 6 shows the mass numbers and percentage abundances of the isotopes.

Table 6

Mass number	Percentage abundance (%)
203	30
205	70

Calculate the relative atomic mass (A_r) of metal **M**.

Give your answer to 1 decimal place.

[2 marks]

Relative atomic mass (1 decimal place) = ____________________

11

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 This question is about silver iodide.

Silver iodide is produced in the reaction between silver nitrate solution and sodium iodide solution.

The equation for the reaction is:

$$AgNO_3(aq) + NaI(aq) \rightarrow AgI(s) + NaNO_3(aq)$$

1 0 . 1 A student investigated the law of conservation of mass.

This is the method used.

1. Pour silver nitrate solution into a beaker labelled **A**.
2. Pour sodium iodide solution into a beaker labelled **B**.
3. Measure the masses of both beakers and their contents.
4. Pour the solution from beaker **B** into beaker **A**.
5. Measure the masses of both beakers and their contents again.

Table 7 shows the student's results.

Table 7

	Mass before mixing in g	**Mass after mixing in g**
Beaker **A** and contents	78.26	108.22
Beaker **B** and contents	78.50	48.54

Explain how the results demonstrate the law of conservation of mass.

You should use data from **Table 7** in your answer.

[2 marks]

Do not write outside the box

1 0 . 2 Suggest how the student could separate the insoluble silver iodide from the mixture at the end of the reaction.

[1 mark]

The student purified the separated silver iodide.

This is the method used.

1. Rinse the silver iodide with distilled water.

2. Warm the silver iodide.

1 0 . 3 Suggest **one** impurity that was removed by rinsing with water.

[1 mark]

1 0 . 4 Suggest why the student warmed the silver iodide.

[1 mark]

Question 10 continues on the next page

Do not write outside the box

1 0 . 5 Calculate the percentage atom economy for the production of silver iodide in this reaction.

The equation for the reaction is:

$$AgNO_3(aq) + NaI(aq) \rightarrow AgI(s) + NaNO_3(aq)$$

Give your answer to 3 significant figures.

Relative formula masses (M_r): $AgNO_3$ = 170 NaI = 150 AgI = 235 $NaNO_3$ = 85

[4 marks]

Percentage atom economy (3 significant figures) = ____________ %

1 0 . 6 Give **one** reason why reactions with a high atom economy are used in industry.

[1 mark]

10

END OF QUESTIONS

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