AQA

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 = -35 °C

0 1 . 3 Complete the sentences.

[2 marks]

Going down Group 7 the melting points increase.

This is because the size of the molecules increases so the intermolecular forces increase.

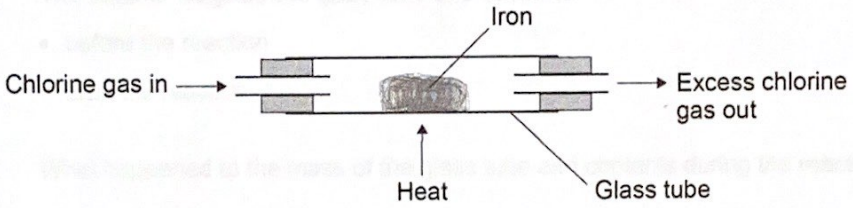
Question 1 continues on the next page

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 increased.

Reason Chlorine atoms are now part of the solid iron chloride.

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]

Burns very vigorously

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

[1 mark]

$2Fe + \underline{3} Br_2 \rightarrow 2FeBr_3$

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

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

[2 marks]

$56 + (80 \times 3) = 296$

Relative formula mass (M_r) = 296

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?

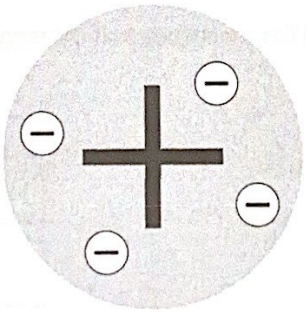
[1 mark]

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]

plum pudding

Do not write outside the box

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 protons.

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

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

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.

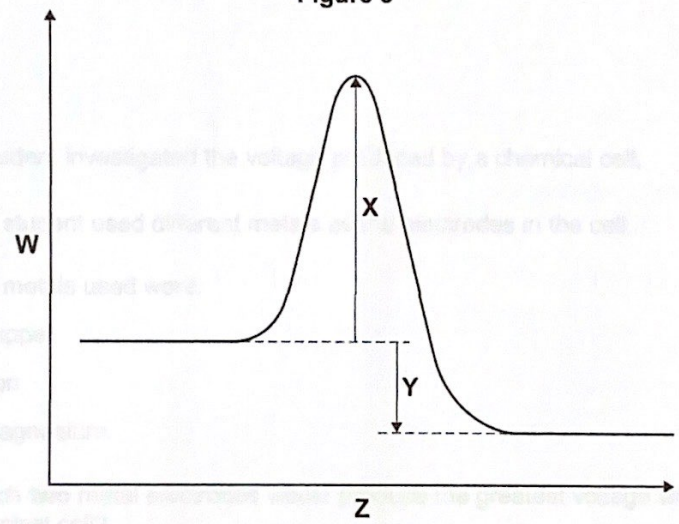
0 3 . 1 Complete the word equation for the reaction.

[1 mark]

hydrogen + oxygen → water

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 Energy

X Activation energy

Y Overall energy change.

Z progress of reaction

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 magnesium and copper

Reason they have the largest difference in reactivity.

8

Do not write outside the box

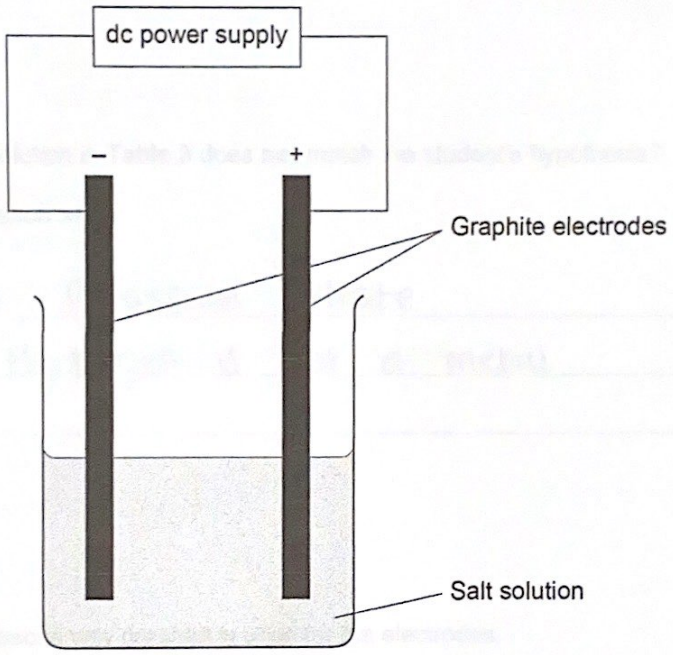
0 4 This question is about electrolysis.

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 solid produced

Observation if gas produced at the positive electrode bubbles of gas

Do not write outside the box

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 Potassium nitrate

Reason Hydrogen is not a metal

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

[2 marks]

1 Graphite conducts electricity

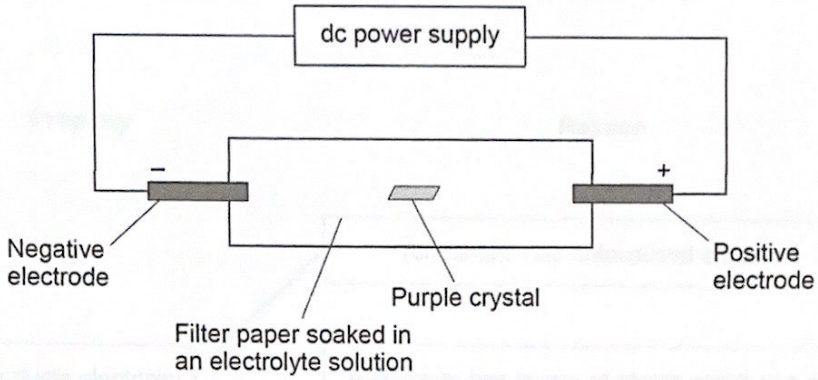
2 Graphite is inert

Do not write outside the box

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 The electrode attracts ions of the opposite charge

8

Do not write outside the box

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
Conducts electricity	Aluminium has delocalised electrons
	Aluminium has layers of atoms which can slide
High melting point	Aluminium has strong metallic bonds
	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]

A mixture of metals

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]

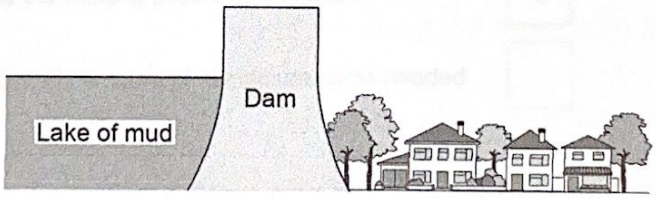
Bauxite contains a variable percentage of aluminium.

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 There is a potential danger of the dam bursting

2 Toxic substances could leak from the mud to the environment

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]

3 x Na
1 x Al
6 x F

Number of atoms = 10

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 oxygen.

This product reacts with the positive electrode because the positive electrode is made of carbon.

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]

$\frac{25}{100} \times 300\,000 = 75\,000$

$= 7.5 \times 10^4$

Maximum mass (in standard form) = 7.5×10^4 kg

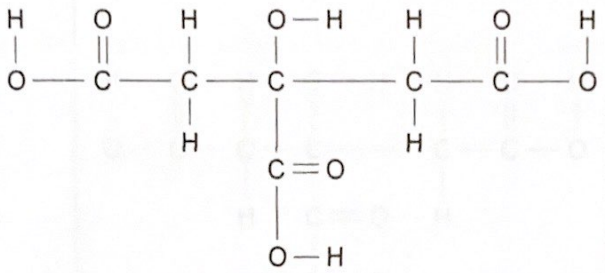
13

Do not write outside the box

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]

$C_6H_{\underline{8}}O_{\underline{7}}$

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

[1 mark]

Tick (✓) **one** box.

Covalent ☑

Ionic ☐

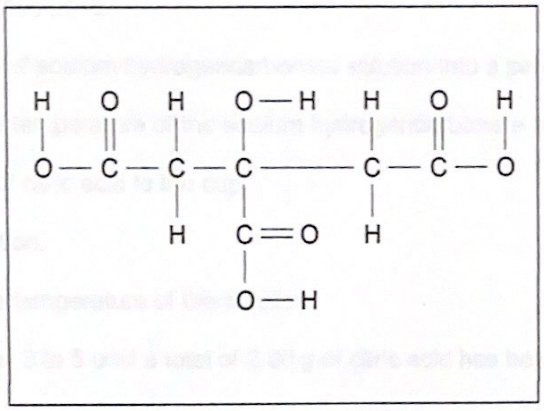
Metallic ☐

Do not write outside the box

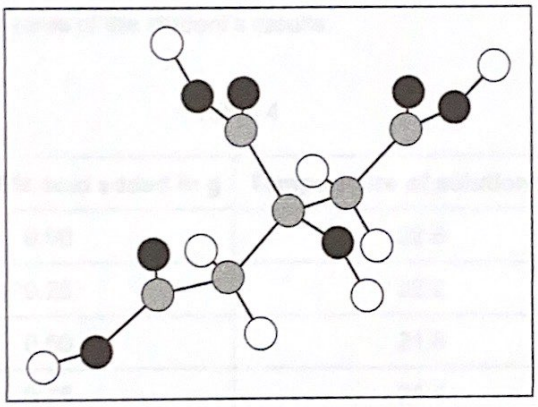
0 6 . 3 **Figure 8** shows two representations of one molecule of citric acid, **A** and **B**.

Figure 8

A



B



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

[2 marks]

Advantages of **A**:

1 Shows which atom is which element

2 Shows whether the bonds are double ~~and~~ or single

Turn over ▶

Do not write outside the box

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]

The temperature decreases throughout the reaction

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.

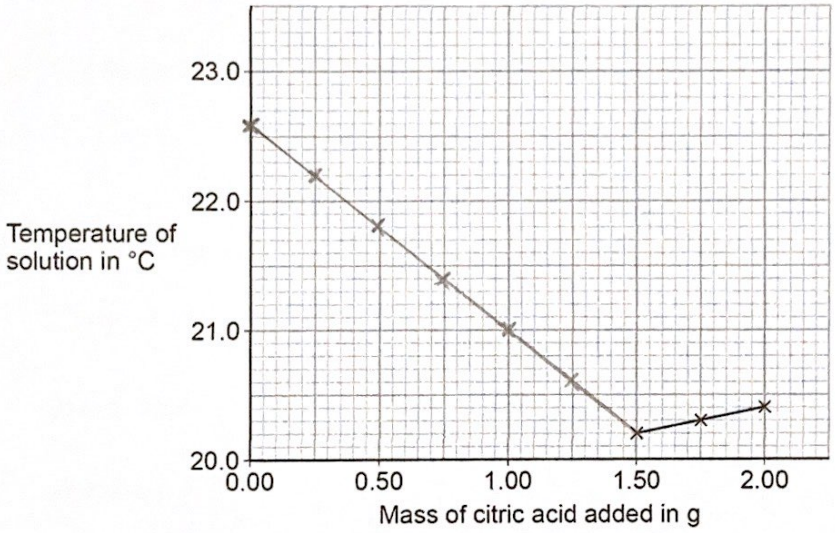
Complete **Figure 9**.

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]

22.6 - 20.2 = 2.4

Overall temperature change = 2.4 °C

Turn over ▶

Do not write outside the box

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]

magnesium bromide

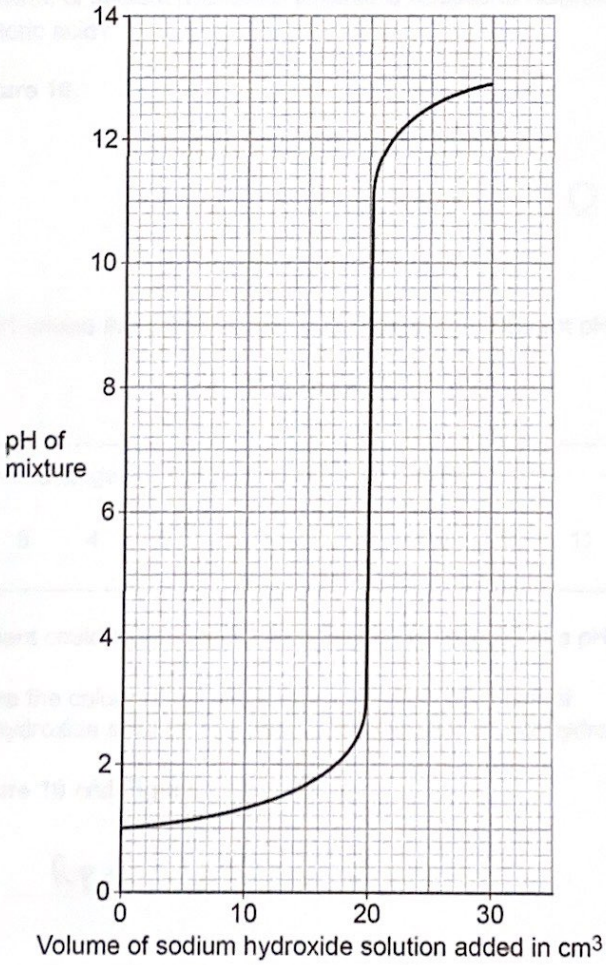
A student investigated how pH changes during a titration.

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



Do not write outside the box

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]

From 0 to 20 cm^3 of sodium hydroxide the pH increases gradually. At 20 cm^3 the pH changes from pH 3 to pH 11. From 20 cm^3 the pH gradually increases.

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

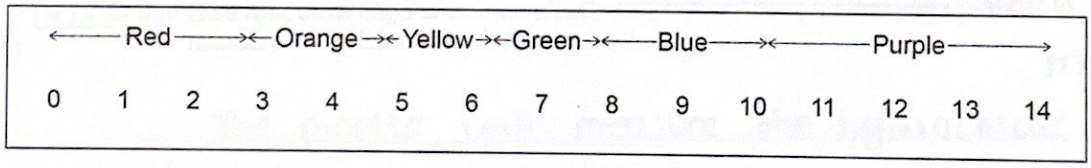
Use **Figure 10**.

[1 mark]

Volume = 20 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]

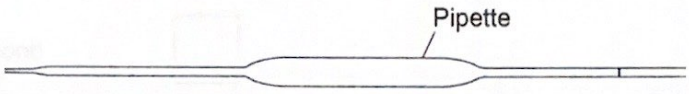
Colour = Red

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 = $\frac{0.06}{25} \times 100$

$= 0.24$

Percentage uncertainty = 0.24 %

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]

The pipette will measure the hydrochloric acid more accurately.

11

Do not write outside the box

0 8 This question is about structure and bonding.

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

[2 marks]

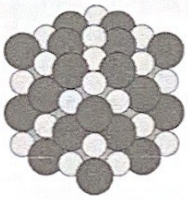
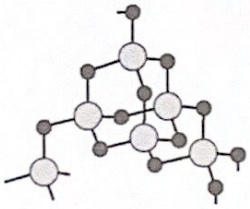
Tick (✓) **two** boxes.

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	

Do not write outside the box

Compare the structure and bonding of the three compounds:

- carbon dioxide
- magnesium oxide
- silicon dioxide.

[6 marks]

Carbon dioxide and silicon dioxide are made of ~~atoms~~ atoms, magnesium oxide is made of ions. Silicon dioxide and magnesium oxide are giant structures but carbon dioxide is small molecules with weak intermolecular forces. Carbon dioxide and silicon dioxide are formed from 2 non-metals, have covalent bonds and so share electrons between the atoms. However, magnesium oxide is formed from a metal and a non-metal so it has ionic bonds and 2 electrons are transferred ~~between~~ from magnesium to oxygen. In silicon dioxide there are only single bonds where each silicon forms 4 bonds and each oxygen forms ~~two~~ 2 bonds but in carbon dioxide the bonds are double bonds (carbon forms 2 double bonds and oxygens form 1 double bond)

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]

The grey crystals are silver and the copper nitrate compound produced is blue so the copper must displace the silver

Do not write outside the box

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]

First add the same concentration and volume of hydrochloric acid to 3 beakers and add the same mass of each metal to ~~the~~ the beakers (1 metal per beaker). Measure the temperature change from before the metals are added to after they are added. Copper will not react so will be identified by no temperature change. Magnesium and iron will both react and increase the temperature but magnesium will increase it more than iron.

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]

$$\frac{(203 \times 30) + (205 \times 70)}{100}$$

$= 204.4$

Relative atomic mass (1 decimal place) = 204.4

11

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]

Total mass before = 78.26 + 78.5 = 156.76 =
Total mass after = 108.22 + 48.54 = 156.76
so the mass of the products equals the mass of the reactants.

Do not write outside the box

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

[1 mark]

filtration

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.

10.3 Suggest **one** impurity that was removed by rinsing with water.

[1 mark]

Sodium nitrate solution

10.4 Suggest why the student warmed the silver iodide.

[1 mark]

To evaporate the water

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]

Total M_r of reactants $= 170 + 150 = 320$

% atom economy $= \frac{\text{mr of desired products}}{\text{mr of all reactants}} \times 100$

$= \frac{235}{320} \times 100 = 73.4375$

$= 73.4$

Percentage atom economy (3 significant figures) = 73.4 %

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

[1 mark]

For sustainable development

10

END OF QUESTIONS