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

Higher Tier Paper 1

H

Thursday 14 May 2020 Morning Time allowed: 1 hour 45 minutes

Materials

For this paper you must have:
- a ruler
- a 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	

Do not write outside the box

0 1 This question is about structure and bonding.

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

[2 marks]

Tick (✓) **two** boxes.

Diamond ☐

Magnesium ☐

Poly(ethene) ☐

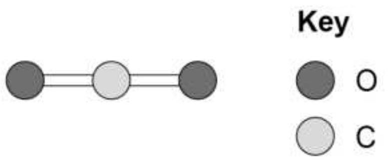
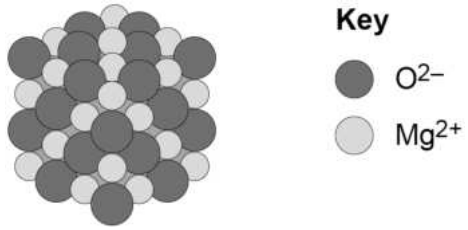
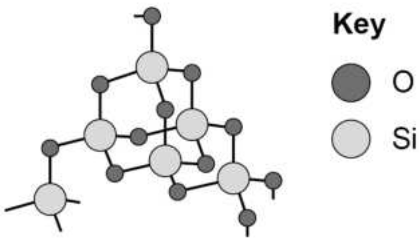
Sodium chloride ☐

Water ☐

0 1 . 2 **Table 1** shows the structures of three compounds.

Diagrams not to scale

Table 1

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]

8

Turn over for the next question

Do not write outside the box

0 2 This question is about metals and the reactivity series.

0 2 . 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 2 . 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]

Do not write outside the box

0 2 . 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 2 continues on the next page

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0 2 . 4 Metal **M** has two isotopes.

Table 2 shows the mass numbers and percentage abundances of the isotopes.

Table 2

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

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Turn over for the next question

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0 3 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:

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

0 3 . 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 3 shows the student's results.

Table 3

	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 3** in your answer.

[2 marks]

Do not write outside the box

0 3 . 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.

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

[1 mark]

0 3 . 4 Suggest why the student warmed the silver iodide.

[1 mark]

Question 3 continues on the next page

Do not write outside the box

0 3 . 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) = ____________ %

0 3 . 6 Give **one** reason why reactions with a high atom economy are used in industry.

[1 mark]

10

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0 4 This question is about electrolysis.

A student investigated the electrolysis of copper chromate solution.

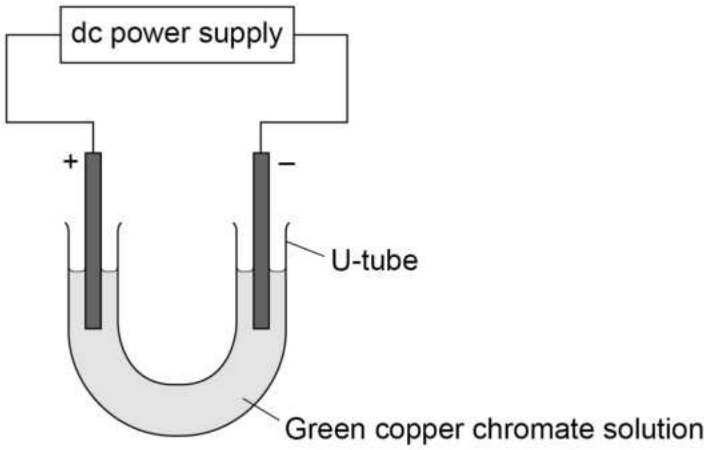
Copper chromate solution is green.

Copper chromate contains:

- blue coloured Cu^{2+} ions
- yellow coloured CrO_4^{2-} ions.

Figure 1 shows the apparatus used.

Figure 1



The student switched the power supply on.

The student observed the changes at each electrode.

Table 4 shows the student's observations.

Table 4

Changes at positive electrode	Changes at negative electrode
Solution turned yellow Bubbles formed at the electrode	Solution turned blue Solid formed on the electrode

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0 4 . 1 Explain why the colour changed at the positive electrode.

[2 marks]

0 4 . 2 The gas produced at the positive electrode was oxygen.

The oxygen was produced from hydroxide ions.

Name the substance in the solution that provides the hydroxide ions.

[1 mark]

0 4 . 3 Describe how the solid forms at the negative electrode.

[3 marks]

0 4 . 4 The student repeated the investigation using potassium iodide solution instead of copper chromate solution.

Name the product at each electrode when potassium iodide solution is electrolysed.

[2 marks]

Negative electrode ______

Positive electrode ______

8

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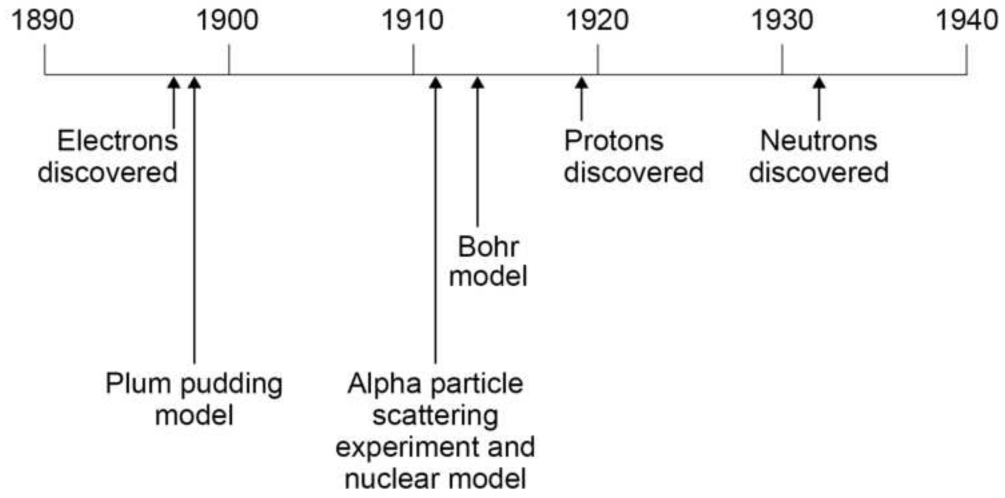
0 5 This question is about the development of scientific theories.

Figure 2 shows a timeline of some important steps in the development of the model of the atom.

Figure 2



0 5 . 1 The plum pudding model did not have a nucleus.

Describe **three** other differences between the nuclear model of the atom and the plum pudding model.

[3 marks]

1 ______________________________

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2 ______________________________

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3 ______________________________

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Do not write outside the box

0 5 . 2 Niels Bohr adapted the nuclear model.

Describe the change that Bohr made to the nuclear model.

[2 marks]

0 5 . 3 Mendeleev published his periodic table in 1869.

Mendeleev arranged the elements in order of atomic weight.

Mendeleev then reversed the order of some pairs of elements.

A student suggested Mendeleev's reason for reversing the order was to arrange the elements in order of atomic number.

Explain why the student's suggestion **cannot** be correct.

Use **Figure 2**.

[2 marks]

0 5 . 4 Give the correct reason why Mendeleev reversed the order of some pairs of elements.

[1 mark]

8

0 6 This question is about displacement reactions.

0 6 . 1 The displacement reaction between aluminium and iron oxide has a high activation energy.

What is meant by 'activation energy'?

[1 mark]

____

____

0 6 . 2 A mixture contains 1.00 kg of aluminium and 3.00 kg of iron oxide.

The equation for the reaction is:

$$2\,Al + Fe_2O_3 \rightarrow 2\,Fe + Al_2O_3$$

Show that aluminium is the limiting reactant.

Relative atomic masses (A_r): O = 16 Al = 27 Fe = 56

[4 marks]

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Magnesium displaces zinc from zinc sulfate solution.

0 6 . 3 Complete the ionic equation for the reaction.

You should include state symbols.

[2 marks]

$$Mg(s) + Zn^{2+}(aq) \rightarrow \_\_\_\_\_\_\_\_\_\_ + \_\_\_\_\_\_\_\_\_\_$$

0 6 . 4 Explain why the reaction between magnesium atoms and zinc ions is both oxidation and reduction.

[2 marks]

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9

Turn over for the next question

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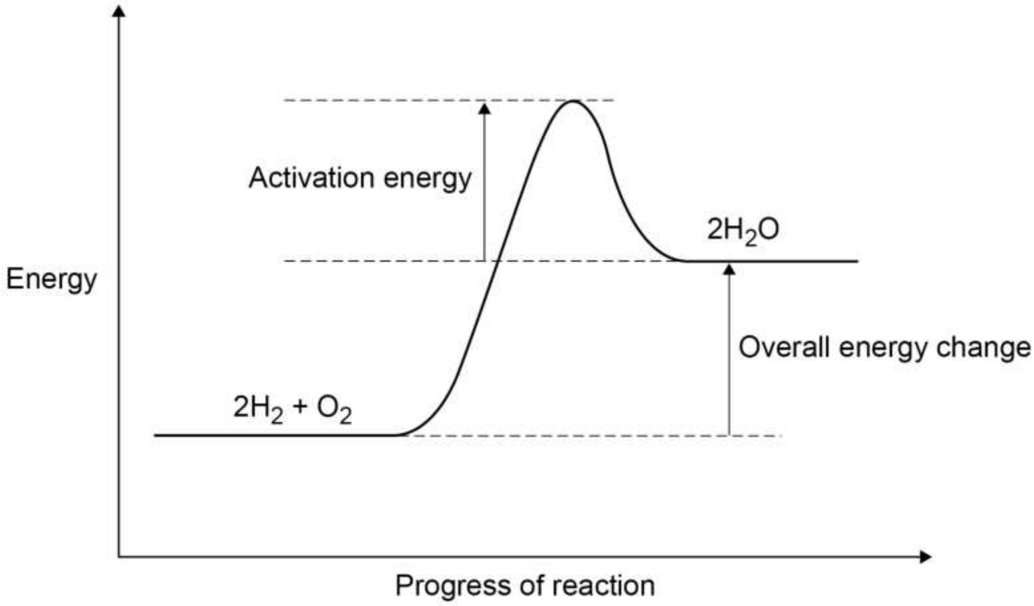
0 7 The reaction between hydrogen and oxygen releases energy.

0 7 . 1 A student drew a reaction profile for the reaction between hydrogen and oxygen.

Figure 3 shows the student's reaction profile.

Figure 3



The student made **two** errors when drawing the reaction profile.

Describe the **two** errors.

[2 marks]

1 ____

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2 ____

____

Do not write outside the box

0 7 . 2 The reaction between hydrogen and oxygen in a hydrogen fuel cell is used to produce electricity.

Hydrogen fuel cells and rechargeable cells are used to power some cars.

Give **two** advantages of using hydrogen fuel cells instead of using rechargeable cells to power cars.

[2 marks]

1 ____

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2 ____

____

0 7 . 3 Reactions occur at the positive electrode and at the negative electrode in a hydrogen fuel cell.

Write a half equation for **one** of these reactions.

[1 mark]

____

Question 7 continues on the next page

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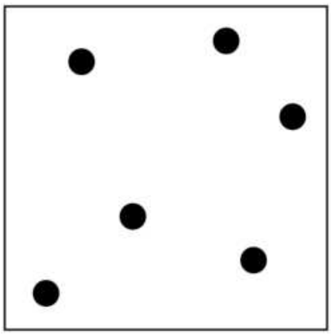
0 7 . 4 The three states of matter can be represented by a simple particle model.

Figure 4 shows a simple particle model for hydrogen gas.

Figure 4



Give **two** limitations of this simple particle model for hydrogen gas.

[2 marks]

1 ____

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2 ____

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0 7 . 5 The hydrogen gas needed to power a car for 400 km would occupy a large volume.

Suggest **one** way that this volume can be reduced.

[1 mark]

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0 7 . 6 The energy needed for a car powered by a hydrogen fuel cell to travel 100 km is 58 megajoules (MJ).

The energy released when 1 mole of hydrogen gas reacts with oxygen is 290 kJ

The volume of 1 mole of a gas at room temperature and pressure is 24 dm^3

Calculate the volume of hydrogen gas at room temperature and pressure needed for the car to travel 100 km

[4 marks]

Volume of hydrogen gas = ____________________ dm^3

12

Turn over for the next question

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0 8 This question is about the halogens.

Table 5 shows the melting points and boiling points of some halogens.

Table 5

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

0 8 . 1 What is the state of bromine at 0 °C **and** at 100 °C?

[1 mark]

Tick (✓) **one** box.

State at 0 °C	**State at 100 °C**	
Gas	Gas	☐
Gas	Liquid	☐
Liquid	Gas	☐
Liquid	Liquid	☐
Solid	Gas	☐
Solid	Liquid	☐

Do not write outside the box

0 8 . 2 Explain the trend in boiling points of the halogens shown in **Table 5**.

[4 marks]

0 8 . 3 Why is it **not** correct to say that the boiling point of a single bromine molecule is 59 °C?

[1 mark]

Question 8 continues on the next page

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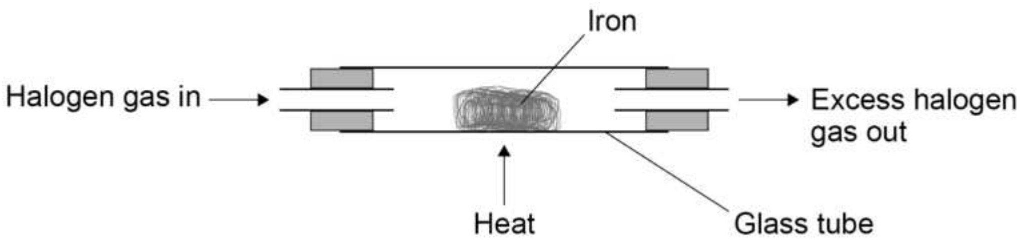
Iron reacts with each of the halogens in their gaseous form.

Figure 5 shows the apparatus used.

Figure 5



0 8 . 4 Give **one** reason why this experiment should be done in a fume cupboard.

[1 mark]

____

____

0 8 . 5 Explain why the reactivity of the halogens decreases going down the group.

[3 marks]

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0 8 . 6 A teacher investigated the reaction of iron with chlorine using the apparatus in **Figure 5**.

The word equation for the reaction is:

iron + chlorine → iron chloride

The teacher weighed:

- the glass tube
- the glass tube and iron before the reaction
- the glass tube and iron chloride after the reaction.

Table 6 shows the teacher's results.

Table 6

	Mass in g
Glass tube	51.56
Glass tube and iron	56.04
Glass tube and iron chloride	64.56

Calculate the simplest whole number ratio of:

moles of iron atoms : moles of chlorine atoms

Determine the balanced equation for the reaction.

Relative atomic masses (A_r): Cl = 35.5 Fe = 56

[6 marks]

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Moles of iron atoms : moles of chlorine atoms = ______________ : ______________

Equation for the reaction ____

16

0 9 This question is about citric acid ($C_6H_8O_7$).

Citric acid is a solid.

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

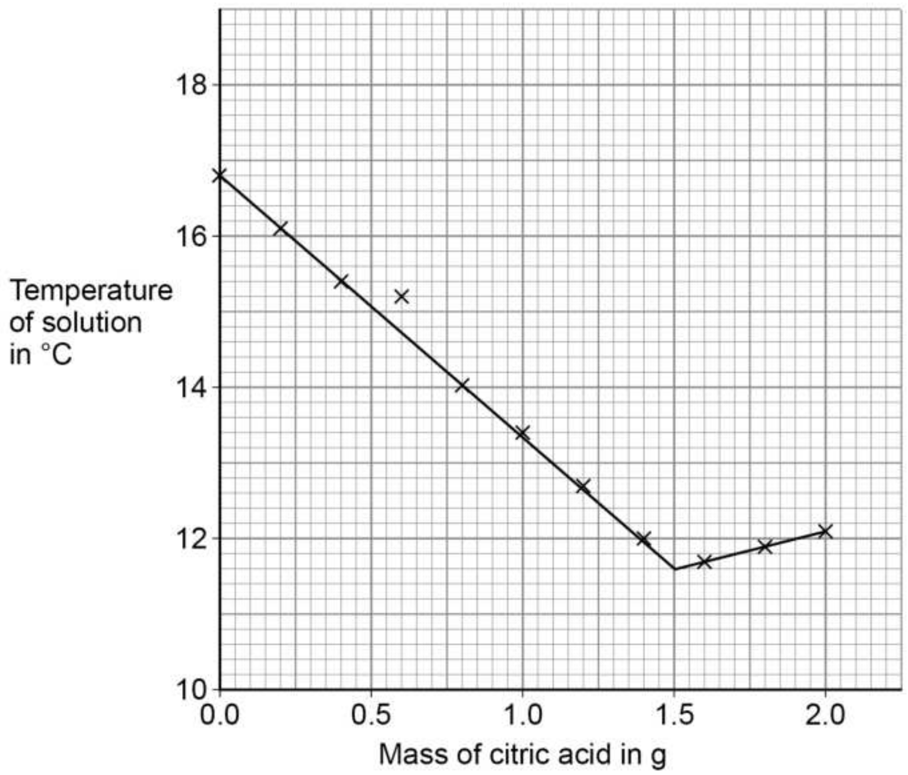
This is the method used.

1. Pour 25 cm^3 of sodium hydrogencarbonate solution into a polystyrene cup.
2. Measure the temperature of the sodium hydrogencarbonate solution.
3. Add 0.20 g of citric acid to the polystyrene 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.

The student plotted the results on a graph.

Figure 6 shows the student's graph.

Figure 6



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0 9 . 1 **Figure 6** shows an anomalous point when 0.60 g of citric acid was added. This was caused by the student making an error.

The student correctly:

- measured the mass of the citric acid
- read the thermometer
- plotted the point.

Suggest **one** reason for the anomalous point.

[1 mark]

0 9 . 2 Explain the shape of the graph in terms of the energy transfers taking place.

You should use data from **Figure 6** in your answer.

[3 marks]

0 9 . 3 A second student repeated the investigation using a metal container instead of the polystyrene cup. The container and the cup were the same size and shape.

Sketch a line on **Figure 6** to show the second student's results until 1.00 g of citric acid had been added. The starting temperature of the solution was the same.

Explain your answer.

[3 marks]

Do not write outside the box

The student used a solution of citric acid to determine the concentration of a solution of sodium hydroxide by titration.

0 9 . 4 The student made 250 cm^3 of a solution of citric acid of concentration 0.0500 mol/dm^3

Calculate the mass of citric acid ($C_6H_8O_7$) required.

Relative atomic masses (A_r): H = 1 C = 12 O = 16

[3 marks]

Mass = ____________________ g

This is part of the method the student used for the titration.

1. Measure 25.0 cm^3 of the sodium hydroxide solution into a conical flask using a pipette.
2. Add a few drops of indicator to the flask.
3. Fill a burette with citric acid solution.

0 9 . 5 Describe how the student would complete the titration.

[3 marks]

Do not write outside the box

0 9 . 6 Give **two** reasons why a burette is used for the citric acid solution.

[2 marks]

1 ____

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2 ____

____

0 9 . 7 13.3 cm^3 of 0.0500 mol/dm^3 citric acid solution was needed to neutralise 25.0 cm^3 of sodium hydroxide solution.

The equation for the reaction is:

$$3\,NaOH + C_6H_8O_7 \rightarrow C_6H_5O_7Na_3 + 3\,H_2O$$

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

[3 marks]

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____

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____

____

____

Concentration = ____________________ mol/dm^3

18

END OF QUESTIONS

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