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

**H**

Higher Tier Paper 1

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.

| For Examiner's Use | |
|---|---|
| Question | Mark |
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |
| 7 | |
| 8 | |
| 9 | |
| **TOTAL** | |

**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.

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**0 1** This question is about structure and bonding.

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

**[2 marks]**

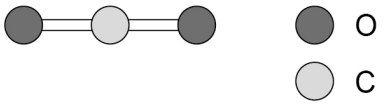
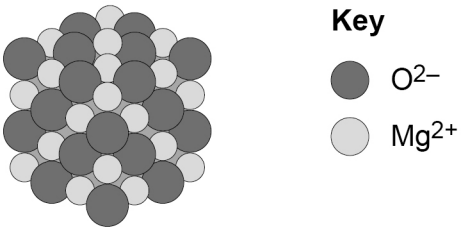
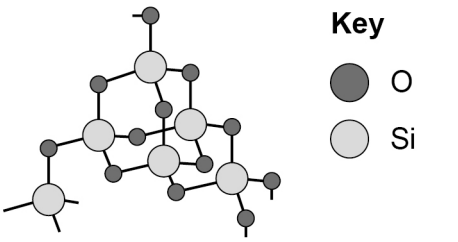
Tick (✓) **two** boxes.

- Diamond ☐
- Magnesium ☐
- Poly(ethene) ☐
- Sodium chloride ☐
- Water ☐

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

**Table 1**

**Diagrams not to scale**

| Compound | Structure |
|---|---|
| Carbon dioxide |   |
| Magnesium oxide |   |
| Silicon dioxide |   |

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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

*Do not write outside the box*

**Turn over for the next question**

**DO NOT WRITE ON THIS PAGE**
**ANSWER IN THE SPACES PROVIDED**

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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**

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**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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**Turn over for the next question**

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**ANSWER IN THE SPACES PROVIDED**

**0 4** This question is about electrolysis.

A student investigated the electrolysis of copper chromate solution.

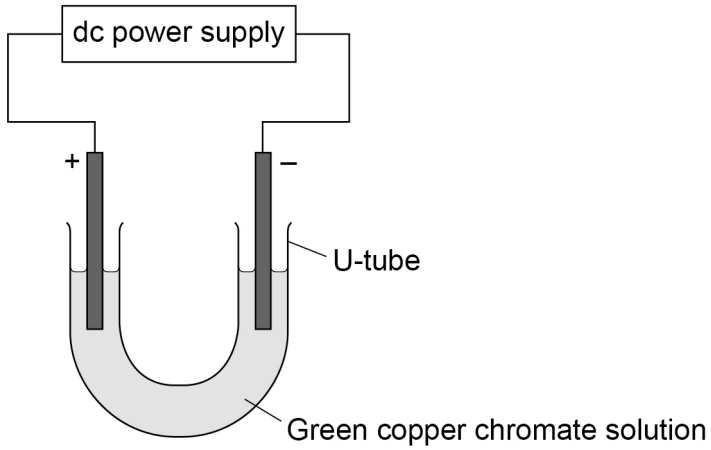
Copper chromate solution is green.

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<br>Bubbles formed at the electrode | Solution turned blue<br>Solid formed on the electrode |

*Do not write outside the box*

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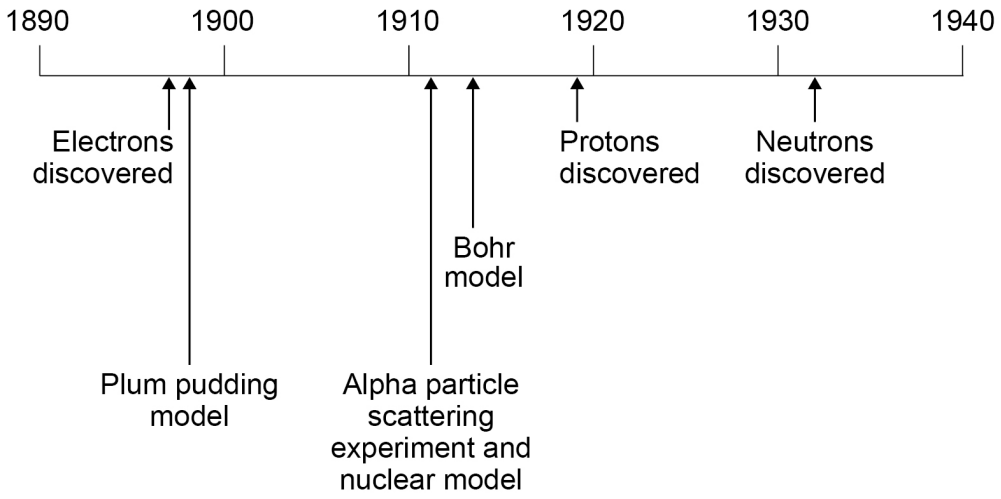
**0 5** This question is about the development of scientific theories.

**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 _____

_____

_____

2 _____

_____

_____

3 _____

_____

_____

*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**

*Do not write outside the box*

**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]**

**9**

**Turn over for the next question**

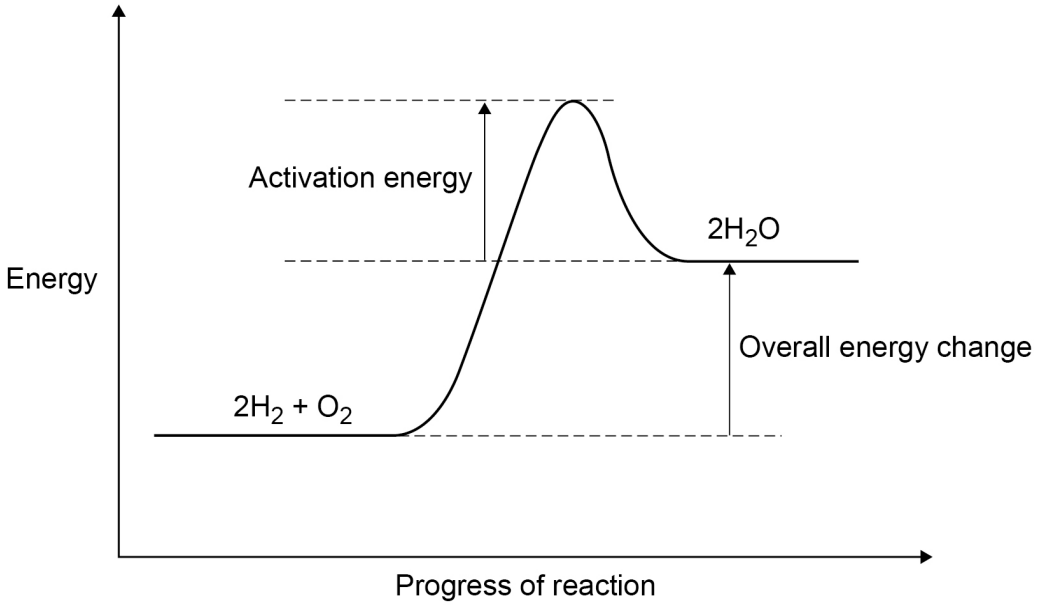
*Do not write outside the box*

**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 _____

_____

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 _____

_____

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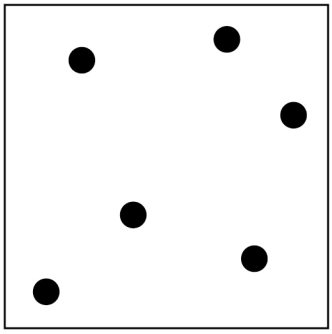
**0 7 . 4** The three states of matter can be represented by a simple particle model.

**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 _____

_____

2 _____

_____

**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]**

_____

_____

*Do not write outside the box*

**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**

*Do not write outside the box*

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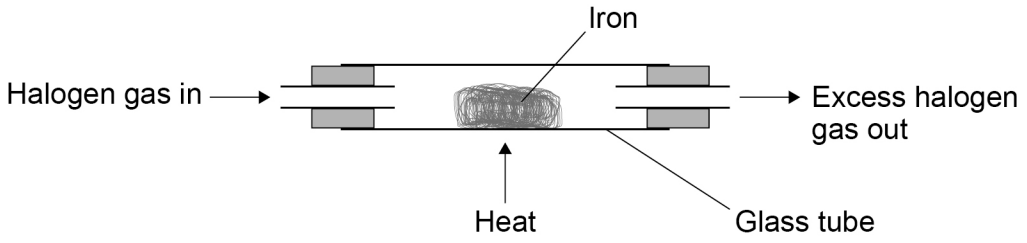
Iron reacts with each of the halogens in their gaseous form.

**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]**

Do not write outside the box

**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]**

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

Equation for the reaction _____

16

**Turn over ►**

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**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.

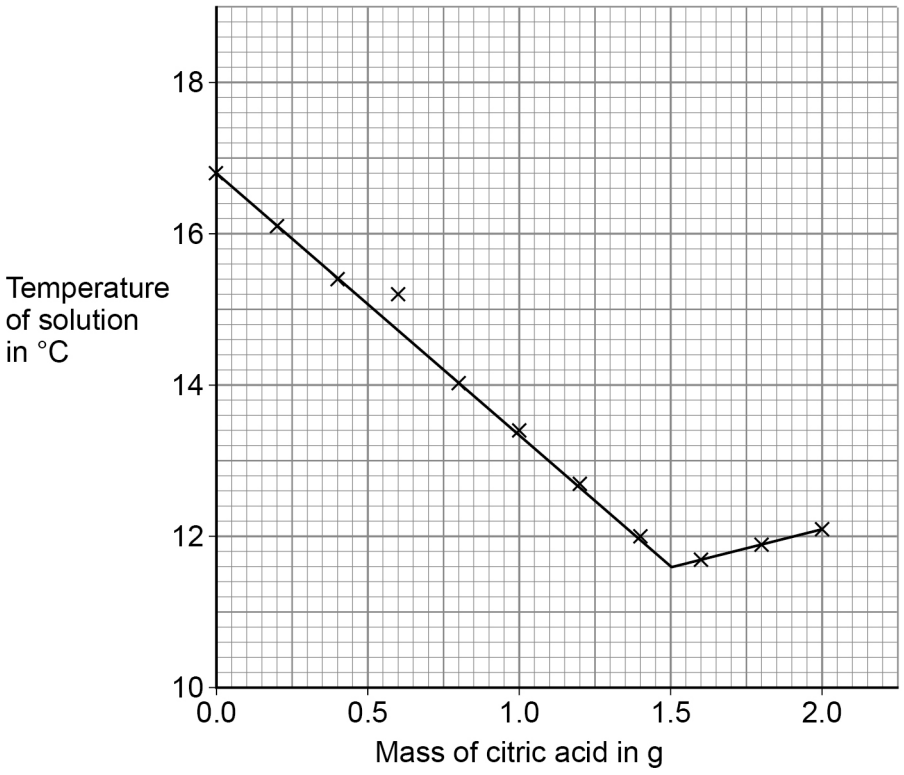
5. Measure the temperature of the solution.

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 _____

_____

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]**

_____

_____

_____

_____

_____

_____

Concentration = _____ $mol/dm^3$

**18**

**END OF QUESTIONS**

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**ANSWER IN THE SPACES PROVIDED**

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| Question number | **Additional page, if required.**<br>**Write the question numbers in the left-hand margin.** |
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