| Candidate Name | Centre Number | | | | | Candidate Number | | | | |
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**GCSE CHEMISTRY**

**COMPONENT 2**

**Applications in Chemistry**

**HIGHER TIER**

**SAMPLE PAPER**

**(1 hour 15 minutes)**

| | For Examiner's use only | | |
|---|---|---|---|
| | **Question** | **Maximum Mark** | **Mark Awarded** |
| **Section A** | **1** | **15** | |
| **Section B** | **2** | **7** | |
| | **3** | **8** | |
| | **4** | **7** | |
| | **5** | **7** | |
| | **6** | **10** | |
| | **7** | **6** | |
| | **Total** | **60** | |

## ADDITIONAL MATERIALS

In addition to this examination paper you will need a resource booklet, a calculator and a ruler.

## INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen. Do not use correction fluid.
Write your name, centre number and candidate number in the spaces at the top of this page.
Answer **all** questions.
Write your answers in the spaces provided in this booklet.

## INFORMATION FOR CANDIDATES

This paper is in two sections, Section **A** and Section **B**.

Section **A**: 15 marks. Read the article in the resource booklet carefully then answer **all** questions. You are advised to spend about 25 minutes on this section.

Section **B**: 45 marks. Answer **all** questions. You are advised to spend about 50 minutes on this section.

The number of marks is given in brackets at the end of each question or part-question.

The assessment of the quality of extended response (QER) will take place in question **7**.

## SECTION A

*Read the article in the resource booklet and answer* **all** *the questions that follow.*

1. (a) Describe the bonding between carbon atoms in diamond.
Include a dot and cross diagram in your answer. [3]
*Details of the structure of diamond are not required.*

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(b) (i) Explain why graphene is a good conductor of electricity. [2]

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(ii) Explain why graphite is soft and slippery and can act as a lubricant. [2]

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(iii) Diamond is a very dense allotrope of carbon because the carbon atoms are tightly packed. Calculate the volume of the cube containing carbon atoms in **Diagram 2**. Give the unit. [1]

volume = ……..

(c) Determine the molecular formula of the fullerene identified using mass spectroscopy in the article.
*Show your working.*

[2]

molecular formula …….

(d) (i) Calculate the specific strength of Kevlar (**Table 1**) and use this value to **estimate** the breaking length. [3]

specific strength ……. kN m/kg

breaking length ……. km

(ii) Explain why carbon nanotubes may eventually replace materials like steel and aluminium in the manufacture of power lines. [2]

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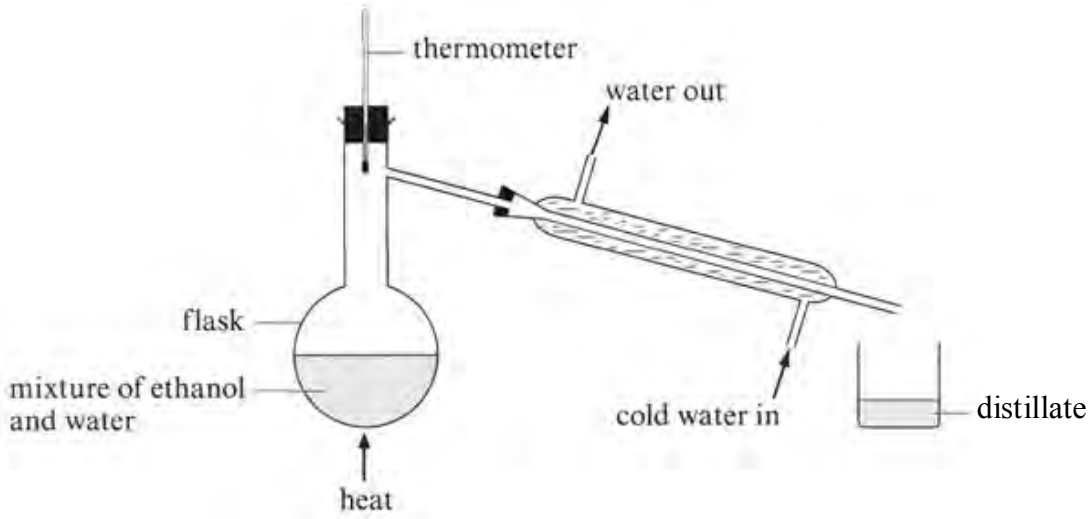
15

**SECTION B**

*Answer* **all** *questions*.

2. The diagram shows the apparatus which can be used to separate a mixture of ethanol and water. Ethanol has a boiling point of 78 °C.




(a) Explain how the mixture is separated. [4]

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(b) Compound **X** has a boiling point of 75 °C.

(i) Suggest why this method would not be very effective in separating compound **X** and ethanol. [2]

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(ii) Suggest how you could adapt the method to improve the separation of compound **X** and ethanol. [1]

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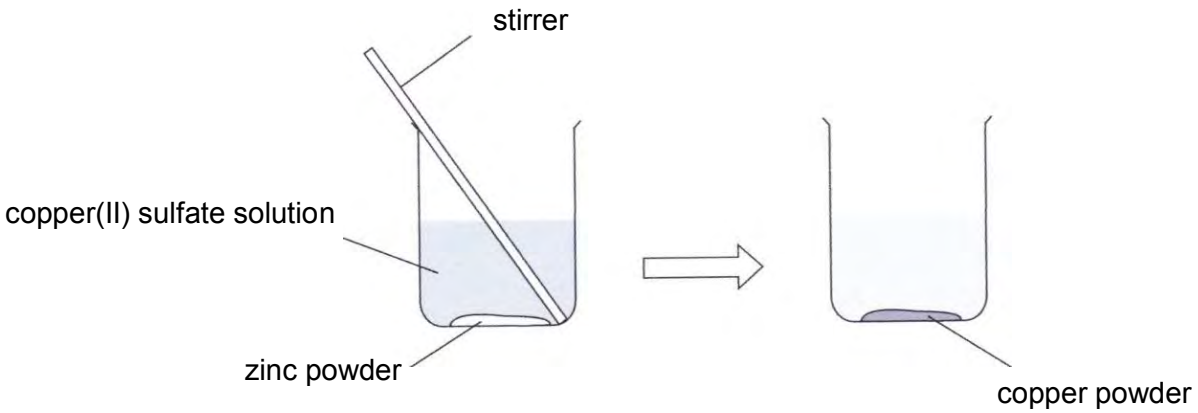
3. Three students individually investigated the mass of copper formed when four different masses of zinc powder were added to 50 $cm^3$ of copper(II) sulfate solution.



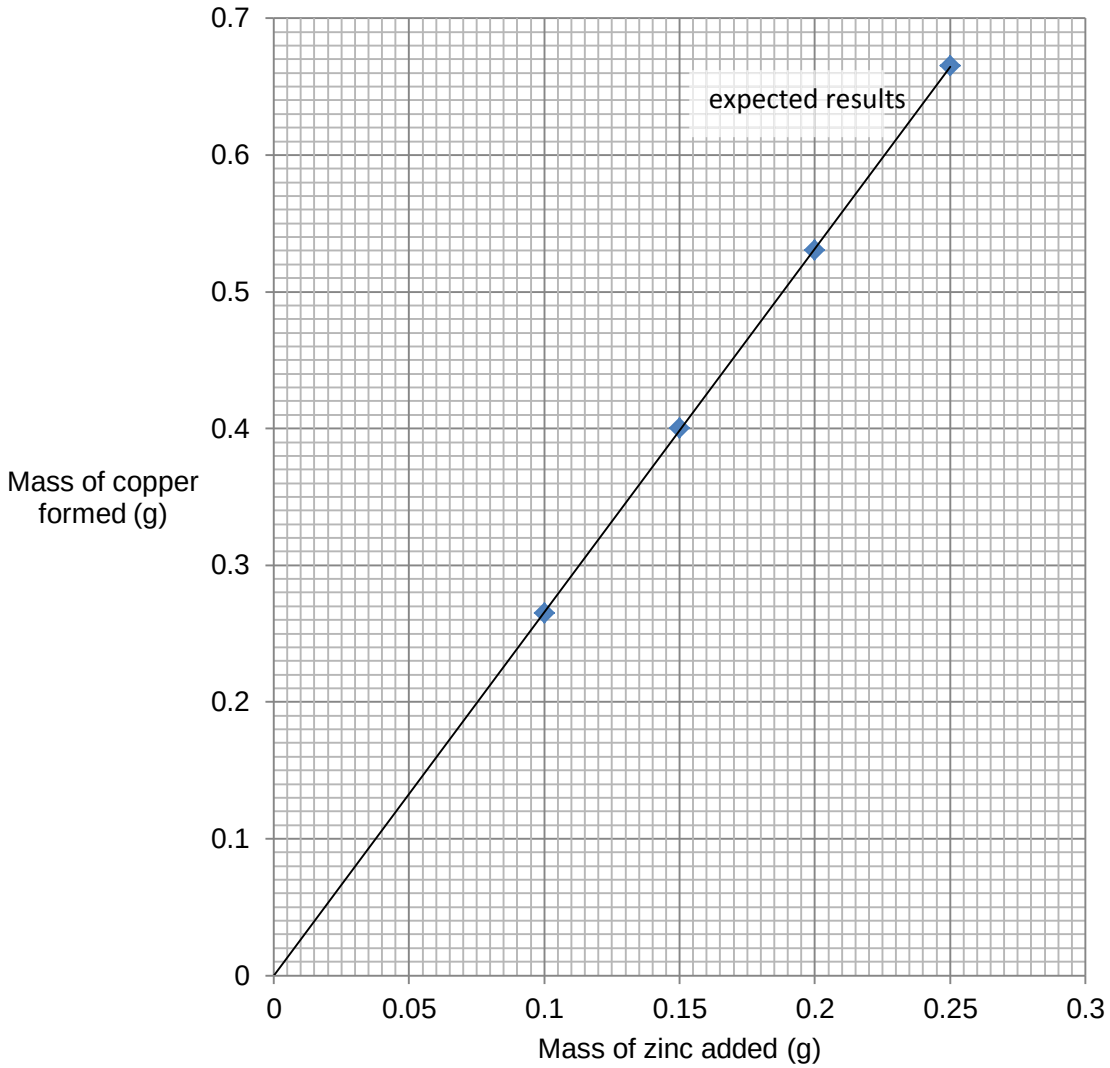

The equation for the reaction is:

$Cu^{2+}(aq) + Zn(s) \longrightarrow Cu(s) + Zn^{2+}(aq)$

The results obtained are shown in the table.

| **Mass of zinc added (g)** | **Mass of copper formed (g)** | | | |
|---|---|---|---|---|
| | **Student A** | **Student B** | **Student C** | **Mean** |
| 0.10 | 0.18 | 0.13 | 0.17 | 0.16 |
| 0.15 | 0.23 | 0.24 | 0.19 | 0.22 |
| 0.20 | 0.35 | 0.31 | 0.36 | 0.34 |
| 0.25 | 0.33 | 0.40 | 0.38 | 0.37 |

The graph on the next page shows the relationship between the mass of zinc added and the **expected** mass of copper formed.




(a) Explain whether copper ions are oxidised or reduced in this reaction. [1]

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(b) (i) Suggest a method to separate the copper powder from the solution. [1]

……..

(ii) I **On the grid above**, plot the mean mass of copper formed against the mass of zinc added in this investigation. Add a line of best fit to the graph. [2]

II Extrapolate your line of best fit on the graph to predict the mass of copper (to two decimal places) that would be formed if **0.30** g of zinc is added. [1]

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(iii) Describe the **main** difference between the graph of expected results and the one plotted using experimental results. [1]

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(iv) Suggest **two** possible reasons for the difference between the graphs. [2]

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8

4. Three groups of students used the apparatus shown in the diagram to investigate how the electric current passing through a sodium chloride solution depends on the concentration of the solution.

The test was carried out using 50 $cm^3$ of each solution. The students were given a **stock solution** of concentration 0.5 M and asked to dilute this as required to make the other solutions.

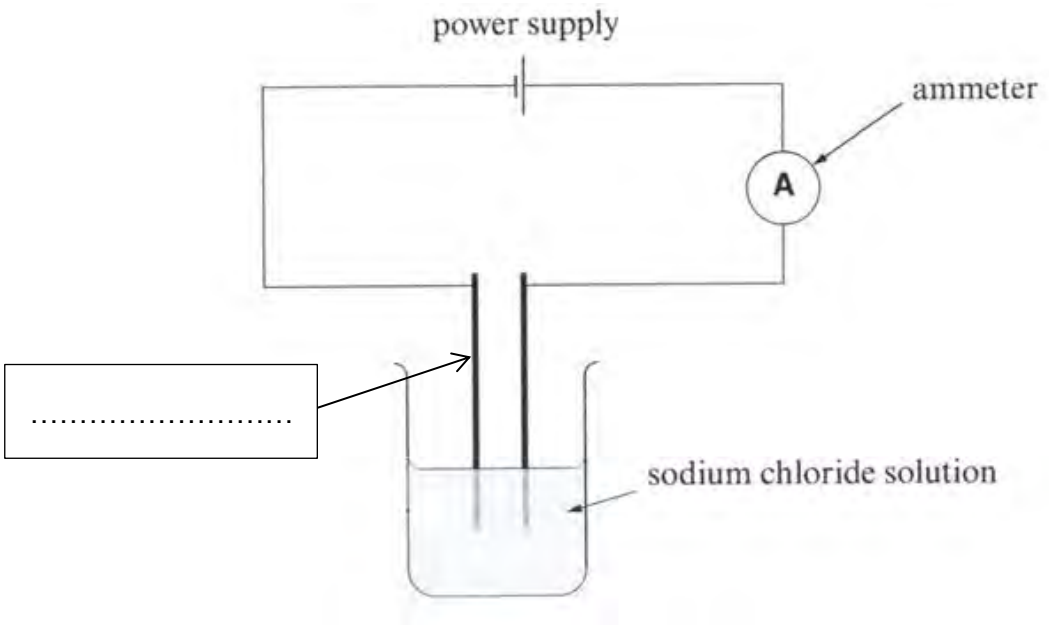



Table of results

| | **Current (A)** | | |
|---|---|---|---|
| **Concentration (M)** | **Group A** | **Group B** | **Group C** |
| 0.1 | 0.07 | 0.06 | 0.06 |
| 0.2 | 0.14 | 0.12 | 0.13 |
| 0.3 | 0.20 | 0.19 | 0.20 |
| 0.4 | 0.28 | 0.26 | 0.27 |
| 0.5 | 0.35 | 0.33 | 0.34 |

(a) **Add the missing label** on the diagram. [1]

(b) Using the information in the table, describe the relationship between the concentration of sodium chloride solution and the current. [1]

……

……

(c) Using the information in the table, state whether the evidence to support your answer in *(b)* is strong or weak. Explain your answer. [1]

……

……

(d) (i) Calculate the mean value for the current using sodium chloride concentration with a value of 0.5 M. [1]

mean current = …… A

(ii) Use the formula below to calculate the percentage variation in the current measured using this solution. [1]

$$\frac{\text{(furthest value from the mean value – mean value)}}{\text{mean value}} \times 100$$

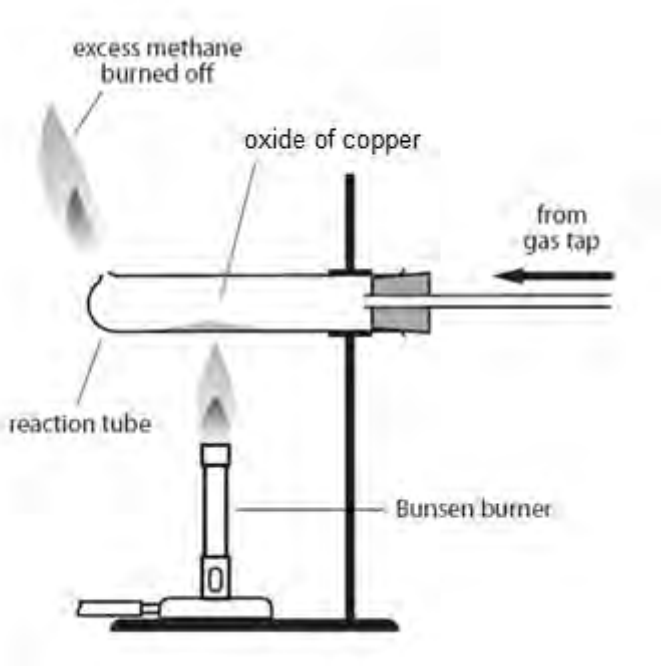
percentage variation = …… %

(e) Calculate the total volume of the stock solution required by the students in **Group A** to prepare all five of their solutions. [2]

volume = …… $cm^3$

7

5. Thomas was asked to carry out an experiment to find the formula of an oxide of copper using the apparatus below.




Thomas weighed the bung and tube. He added the oxide of copper and re-weighed the bung and tube.

He began heating and passing the methane gas over the oxide. After 5 minutes, he stopped heating and turned off the gas. He allowed the tube to cool and weighed the bung, the tube and its contents again. He repeated these steps twice more.

His results are shown in the table.

| | |
|---|---|
| **Mass of bung and tube** | 20.0 g |
| **Mass of bung, tube and oxide of copper** | 25.9 g |
| **Mass of bung, tube and contents after 5 minutes** | 25.1 g |
| **Mass of bung, tube and contents after 10 minutes** | 24.7 g |
| **Mass of bung, tube and contents after 15 minutes** | 24.7 g |

(a) State why methane gas was passed through the tube. [1]

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(b) Explain why Thomas heated and weighed the tube and its contents several times. [1]

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(c) (i) Calculate the mass of oxygen in the oxide of copper. [1]

mass of oxygen = …… g

(ii) Calculate the empirical formula for this oxide of copper.
*Show your working.* [4]

empirical formula ……

| |
|---|
| 7 |

6. (a) The labels have fallen off three bottles. The bottles contain solutions of sodium bromide, sodium chloride and potassium chloride. It is not known which bottle is which. Suggest how you could identify the three solutions using two tests.

You will be rewarded for a logical testing sequence in which you carry out the minimum amount of testing necessary to identify each solution.
Give the observations you would expect for each solution in each test.
*Detailed practical details are not required.* [5]

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(b) It is thought that magnesium ions have contaminated a solution containing barium ions.

Use the information below to develop a method to test for the presence of magnesium ions in a solution which also contains barium ions.

No other metal ions are present in the solution.

Explain the purpose of each step in the method.

Include the observations you expect to make if magnesium ions are present. [5]

| Compound | Soluble or insoluble? |
|---|---|
| barium sulfate | insoluble |
| barium carbonate | insoluble |
| magnesium sulfate | soluble |
| magnesium carbonate | insoluble |
| sodium sulfate | soluble |
| sodium carbonate | soluble |

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10

7. Group 1 compounds are all soluble in water.

Explain how you could prepare **crystals** of potassium nitrate from an acid and alkali of your choice.

Include a balanced **symbol** equation in your answer. [6 QER]

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| 6 |

## FORMULAE FOR SOME COMMON IONS

| POSITIVE IONS | | NEGATIVE IONS | |
|---|---|---|---|
| Name | Formula | Name | Formula |
| Aluminium | $Al^{3+}$ | Bromide | $Br^{-}$ |
| Ammonium | $NH_4^{+}$ | Carbonate | $CO_3^{2-}$ |
| Barium | $Ba^{2+}$ | Chloride | $Cl^{-}$ |
| Calcium | $Ca^{2+}$ | Fluoride | $F^{-}$ |
| Copper(II) | $Cu^{2+}$ | Hydroxide | $OH^{-}$ |
| Hydrogen | $H^{+}$ | Iodide | $I^{-}$ |
| Iron(II) | $Fe^{2+}$ | Nitrate | $NO_3^{-}$ |
| Iron(III) | $Fe^{3+}$ | Oxide | $O^{2-}$ |
| Lithium | $Li^{+}$ | Sulfate | $SO_4^{2-}$ |
| Magnesium | $Mg^{2+}$ | | |
| Nickel | $Ni^{2+}$ | | |
| Potassium | $K^{+}$ | | |
| Silver | $Ag^{+}$ | | |
| Sodium | $Na^{+}$ | | |
| Zinc | $Zn^{2+}$ | | |

# THE PERIODIC TABLE