Cambridge International AS & A Level

**Cambridge Assessment International Education**
Cambridge International Advanced Subsidiary and Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

*9915509939*

**CHEMISTRY** **9701/52**

Paper 5 Planning, Analysis and Evaluation **May/June 2019**

**1 hour 15 minutes**

Candidates answer on the Question Paper.

No Additional Materials are required.

**MODIFIED LANGUAGE**

**READ THESE INSTRUCTIONS FIRST**

Write your centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.
Use of a Data Booklet is unnecessary.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

This document consists of **10** printed pages and **2** blank pages.


© UCLES 2019

Cambridge Assessment International Education

**1** **(a)** A student is provided with samples of six metal carbonate ores, known to be ores of the metals barium, calcium, copper, iron, lead and zinc. All the ores contain carbonate ions and some might also contain hydroxide ions.

Each ore sample is ground up and a measured mass of the ore is reacted with an excess of dilute hydrochloric acid. The carbon dioxide produced by the reaction is collected over water. The volume of gas collected is recorded. Each ore is tested three times.

**(i)** Name the independent variable.

.....

Name the dependent variable.

.....
[2]

**(ii)** Apart from mass of ore, state a variable that should be controlled.

..... [1]

**(iii)** The student plans to collect the carbon dioxide produced over water.

Draw a labelled diagram of the apparatus that could be used to do these experiments. The apparatus should allow the accurate recording of the carbon dioxide produced.

[3]

**(b)** State **one** weakness in the procedure of collecting carbon dioxide over water. Suggest a change in apparatus that could be made to avoid this problem.

weakness in procedure

.....

change in apparatus

.....
[2]

© UCLES 2019

**(c)** Three experiments for each of the six ores are done and the final gas volumes are recorded in the table. All 18 experiments use exactly the same mass of ore.

| metal | ore | volume of $CO_2$ collected / $cm^3$ | | | |
|---|---|---|---|---|---|
| | | Expt 1 | Expt 2 | Expt 3 | calculated average |
| barium | witherite | 67 | 70 | 69 | 69 |
| calcium | calcite | 81 | 79 | 82 | 81 |
| copper | malachite | 47 | 45 | 46 | 46 |
| iron | siderite | 68 | 55 | 70 | 64 |
| lead | cerussite | 75 | 73 | 72 | 73 |
| zinc | smithsonite | 53 | 55 | 52 | 53 |

**(i)** The student uses the results to obtain an average volume of $CO_2$ produced for each ore and records it in the table.

Suggest another reason why each ore is tested three times.

.....

..... [1]

**(ii)** The student made an error in processing the data to obtain the average volume of $CO_2$ produced for one of the ores.

State the error made by the student and calculate the correct value.

error .....

.....

correct value = ..... $cm^3$
[1]

**(d)** A second student suggested that the percentage of carbonate ions could be obtained by titrating the ground-up ore samples with hydrochloric acid.

Explain why a titration would **not** be a suitable method to determine the percentage of carbonate ions in some of these ore samples.

.....

..... [1]

© UCLES 2019

**[Turn over**

Rhodochrosite is the carbonate ore of manganese and does not contain hydroxide ions.

**(e) (i)** 2.00 g of rhodochrosite produced 148 $cm^3$ of carbon dioxide under room conditions in its reaction with excess hydrochloric acid.

$$MnCO_3 + 2HCl \rightarrow MnCl_2 + H_2O + CO_2$$

Calculate the percentage of $MnCO_3$ in rhodochrosite. Give your answer to **three significant figures**.
The molar volume of a gas is 24.0 $dm^3$ under room conditions.
[$A_r$: Mn, 54.9; C, 12.0; O, 16.0]

percentage of $MnCO_3$ in rhodochrosite = ..... %
[3]

A teacher suggested that the mass change from the thermal decomposition of a ground-up sample of rhodochrosite could be used to determine the percentage of carbonate in the sample. The teacher told the students to strongly heat a ground-up sample of the ore in a crucible.

**(ii)** State the measurements the students should make to determine the percentage of manganese carbonate in the sample of rhodochrosite.

.....

.....

..... [1]

**(iii)** Explain how the students can ensure the results in **(e)(ii)** are as accurate as possible.

.....

..... [1]

[Total: 16]

© UCLES 2019

**2** **(a)** An investigation is done to find the percentage of copper in a brass nail. The brass nail is dissolved in concentrated nitric acid and the resulting solution is diluted with distilled water.

$Cu^{2+}$ ions are formed in this reaction.

Use the electrode potentials shown to write a balanced ionic equation for the reaction between the copper in the brass nail and the concentrated nitric acid.

| equation | electrode potential, $E^{\ominus}$/V |
|---|---|
| $2H^+(aq) + 2e^- \rightleftharpoons H_2(g)$ | 0.00 |
| $Cu^{2+}(aq) + e^- \rightleftharpoons Cu^+(aq)$ | +0.15 |
| $Cu^{2+}(aq) + 2e^- \rightleftharpoons Cu(s)$ | +0.34 |
| $NO_3^-(aq) + 2H^+(aq) + e^- \rightleftharpoons NO_2(g) + H_2O(l)$ | +0.81 |

..... [2]

**(b)** A balance accurate to two decimal places was used to weigh a small beaker and the mass of the beaker recorded.
The brass nail was placed in the beaker and the mass increased by 3.76 g.

Calculate the percentage error in measuring the mass of this nail.

percentage error = ..... %
[1]

**(c)** 50 $cm^3$ of concentrated nitric acid was added to the nail in the beaker. When the reaction finished and the nail had dissolved, the solution was completely transferred to a 250.0 $cm^3$ volumetric flask along with the washings. The solution was made up to the mark with distilled water.

Concentrated nitric acid is corrosive.

State **one** precaution related to this hazard that must be taken when using concentrated nitric acid.

.....

..... [1]

© UCLES 2019

**[Turn over**

**(d) (i)** A colorimeter can be used to determine concentrations of metal ions in solution. When light passes through solutions of metal ions some of the light may be absorbed.

The quantity of light absorbed is called the absorbance and is measured by a colorimeter. The absorbance of solutions of known concentration of copper(II) ions can be used to determine an unknown concentration of copper(II) ions.

A solution of copper(II) nitrate of concentration 0.800 mol $dm^{-3}$ is required for this investigation.

Calculate the mass of copper(II) nitrate, $Cu(NO_3)_2$, needed to prepare 100.0 $cm^3$ of 0.800 mol $dm^{-3}$ solution. Give your answer to **three significant figures**.
[$A_r$: Cu, 63.5; N, 14.0; O, 16.0]

mass of copper(II) nitrate, $Cu(NO_3)_2$ = ..... g
[2]

© UCLES 2019

**Question 2 continues on the next page.**

Volumes of 0.800 mol $dm^{-3}$ copper(II) nitrate are diluted with distilled water to prepare a series of ten solutions of different concentrations of copper(II) ions.

**(ii)** The total volume needed of each solution is 20.00 $cm^3$.

The absorbance of each solution is recorded in a colorimeter at a wavelength of light of 630 nm and recorded in the table.

Complete the table to show the volumes of 0.800 mol $dm^{-3}$ copper(II) nitrate and distilled water needed to prepare each solution. Give all volumes to **two decimal places**.

| solution | volume of 0.800 mol $dm^{-3}$ copper(II) nitrate / $cm^3$ | volume of distilled water / $cm^3$ | concentration of $Cu^{2+}(aq)$ / mol $dm^{-3}$ | absorbance |
|---|---|---|---|---|
| 1 | 0.00 | 20.00 | 0.00 | 0.00 |
| 2 | | | 0.04 | 0.12 |
| 3 | | | 0.12 | 0.36 |
| 4 | | | 0.16 | 0.48 |
| 5 | | | 0.22 | 0.66 |
| 6 | | | 0.30 | 0.89 |
| 7 | | | 0.36 | 1.06 |
| 8 | | | 0.42 | 1.25 |
| 9 | | | 0.48 | 1.41 |
| 10 | | | 0.60 | 1.76 |

[1]

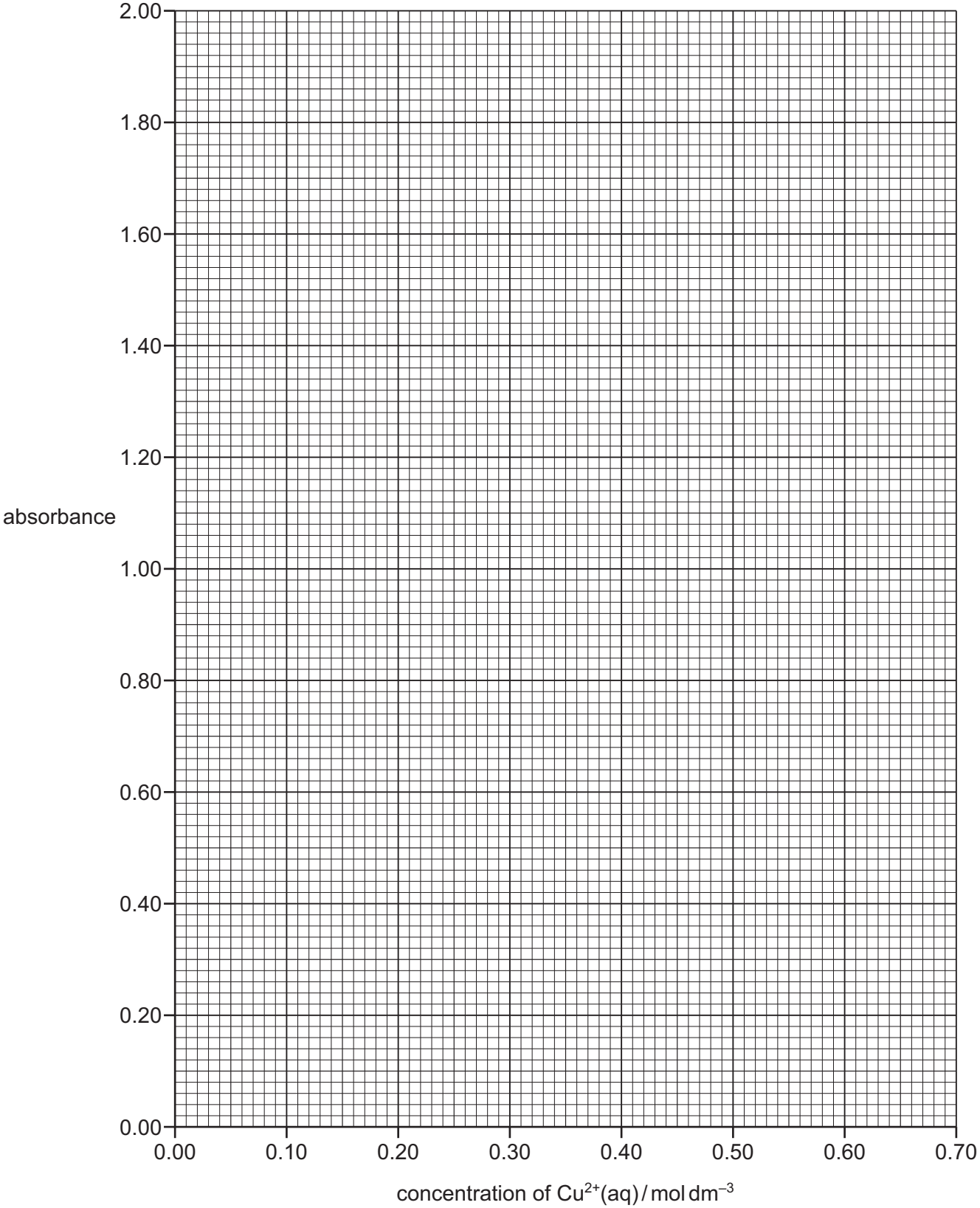
**(iii)** Name a suitable piece of apparatus for accurately measuring the volumes you have calculated in **(d)(ii)**.

..... [1]

© UCLES 2019

**(e) (i)** The plot produced by comparing the absorbance of each solution with its concentration is referred to as a calibration graph.

Plot a calibration graph of absorbance (*y*-axis) against concentration of $Cu^{2+}(aq)$ (*x*-axis). Use a cross (×) to plot each data point. Draw a line of best fit.




[2]

**(ii)** State the relationship between concentration of $Cu^{2+}(aq)$ and absorbance.

.....

..... [1]

**(f) (i)** The absorbance of the solution prepared in **(c)** from the brass nail was found to be 0.56.

Use your calibration graph to find the concentration of $Cu^{2+}(aq)$ in this solution.

concentration of $Cu^{2+}(aq)$ = ..... $mol\,dm^{-3}$ [1]

**(ii)** Use your answer to **(f)(i)** and the information in **(b)** and **(c)** to calculate the percentage of copper, by mass, in the brass nail. Give your answer to **three significant figures**.

(If you were unable to obtain an answer to **(f)(i)** you may use the value $0.22\,mol\,dm^{-3}$. This is **not** the correct value.)
[$A_r$: Cu, 63.5]

percentage of copper in the brass nail = .....%
[2]

[Total: 14]

© UCLES 2019

**BLANK PAGE**

**BLANK PAGE**

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced online in the Cambridge Assessment International Education Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download at www.cambridgeinternational.org after the live examination series.

Cambridge Assessment International Education is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of the University of Cambridge Local Examinations Syndicate (UCLES), which itself is a department of the University of Cambridge.