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.

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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]

(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]

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]

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]

(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]

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

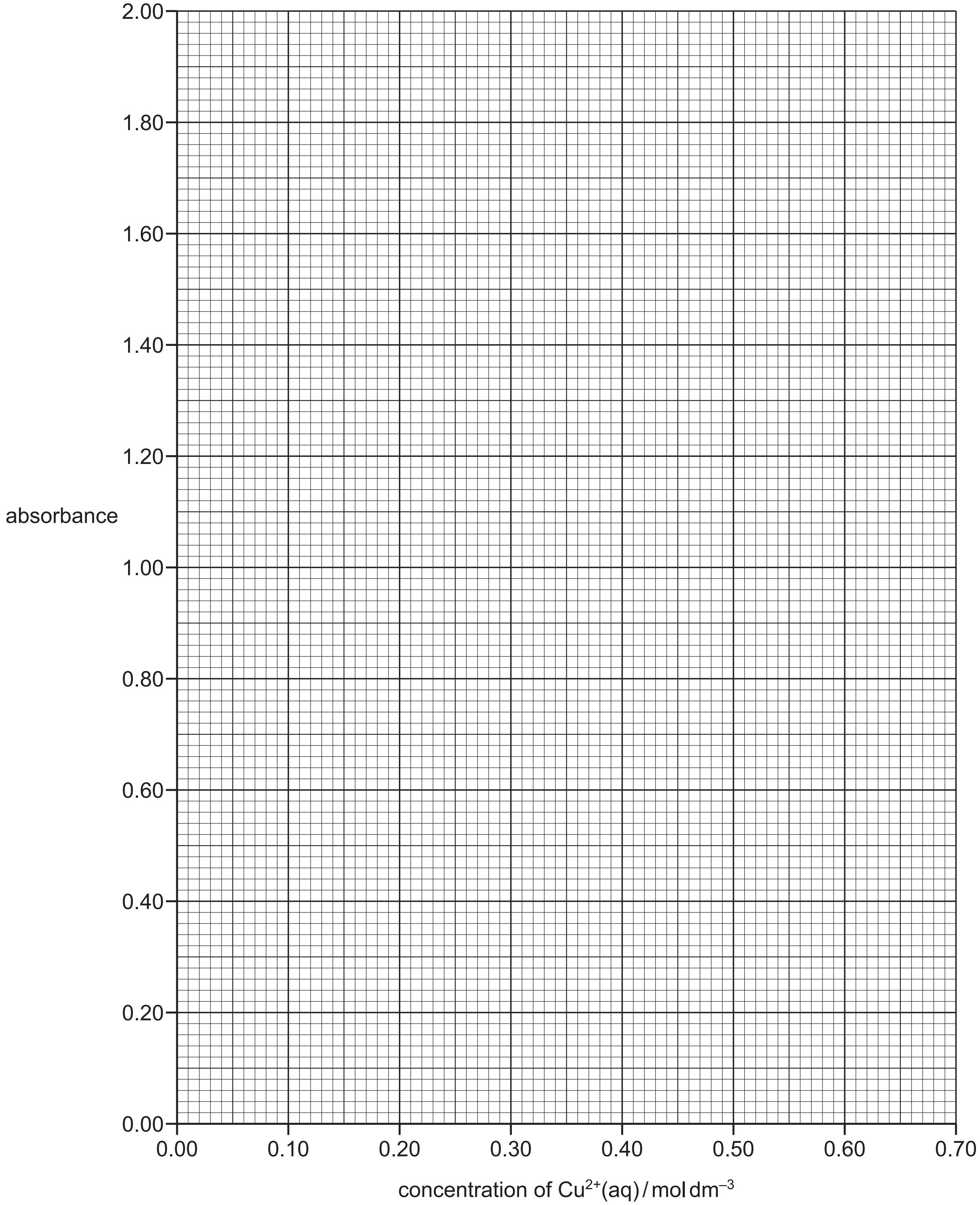
[1]

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

.... [1]

(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]

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