Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

8664013420

CHEMISTRY **5070/42**

Paper 4 Alternative to Practical **May/June 2020**

1 hour

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 60.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **12** pages. Blank pages are indicated.

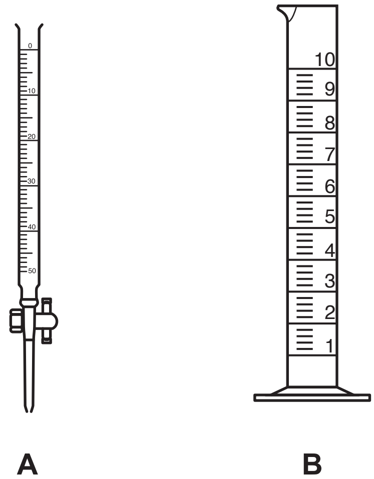
DC (JC/JG) 183903/4

1 Iron tablets are used to treat iron deficiency in the body.

Iron tablets contain iron(II) ions, Fe^{2+}.

A student does a series of titrations with aqueous potassium manganate(VII), $KMnO_4$, to determine the percentage of iron in some iron tablets.

Diagrams of some of the apparatus the student uses are shown.



(a) Name the three pieces of apparatus.

A ....

B ....

C ....

[3]

(b) The student:

- records the total mass of **five** iron tablets
- crushes the tablets, dissolves them in distilled water and makes the solution up to $250\,cm^3$
- uses apparatus **C** to transfer $25.0\,cm^3$ of the solution of Fe^{2+} ions into a conical flask
- uses apparatus **B** to add $10.0\,cm^3$ of dilute sulfuric acid to the conical flask
- fills apparatus **A** with $0.00500\,mol/dm^3$ $KMnO_4(aq)$
- titrates the solution of Fe^{2+} with the $0.00500\,mol/dm^3$ $KMnO_4(aq)$ until the first permanent pink colour is seen in the conical flask
- repeats the titration three times.

The equation for the reaction is shown.

$$MnO_4^- + 5Fe^{2+} + 8H^+ \rightarrow Mn^{2+} + 5Fe^{3+} + 4H_2O$$

(i) Suggest why dilute sulfuric acid is added to the conical flask.

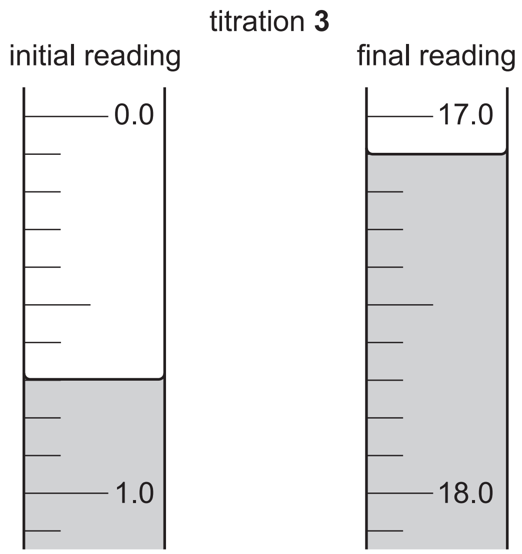
....

.... [1]

(ii) Give the formula of the ion responsible for the pink colour seen at the end-point.

.... [1]

(iii) The diagrams show parts of apparatus **A** with the liquid levels at the beginning and the end of titration **3**.



Record the values in the results table.

Complete the results table for each of titrations **1**, **3** and **4**.

titration number	1	2	3	4
final reading / cm^3	17.2	34.1		16.9
initial reading / cm^3	0.0	17.2		
volume used / cm^3		16.9		16.7
best titration results (✓)				

[3]

(iv) Tick (✓) the best titration results in the table.

Use the ticked values to calculate the average volume of 0.00500 mol / dm^3 $KMnO_4$(aq) used.

average volume .... cm^3 [1]

(c) A second student does another series of titrations using the same method and 0.00500 mol / dm^3 $KMnO_4$(aq).

This student obtains an average volume of 16.9 cm^3.

The equation for the reaction is shown.

$$MnO_4^- + 5Fe^{2+} + 8H^+ \rightarrow Mn^{2+} + 5Fe^{3+} + 4H_2O$$

(i) Calculate the number of moles of MnO_4^- used by the second student.

.... mol [1]

(ii) Calculate the number of moles of Fe^{2+} ions present in the 25.0 cm^3 sample of solution.

.... mol [1]

(iii) Calculate the total mass of Fe^{2+} ions in the five tablets.

[A_r: Fe, 56]

.... g [2]

(iv) The total mass of the five tablets is 1.83 g.

Calculate the percentage, by mass, of iron in the tablets.

Give your answer to **three** significant figures.

.... % [1]

[Total: 14]

2 **(a)** A solution contains one cation and two different anions.

The table shows the tests a student does on this solution.

Complete the table.

Name any gases formed.

test	observations	conclusions	
(i) To a portion of the solution in a boiling tube, add aqueous sodium hydroxide.	....	The solution contains Fe^{2+} ions.	[1]
(ii) To a portion of the solution in a test-tube add dilute nitric acid until no further change is seen. Keep the solution for test **(iii)**.	A gas is evolved that turns limewater milky.	....	[2]
(iii) Add aqueous barium nitrate.	A white precipitate forms.	....	[1]

(b) Calcium ammonium nitrate, $CaNH_4(NO_3)_3$, is a water-soluble compound.

Describe a series of tests, and the observations, to identify the calcium, ammonium and nitrate ions in a sample of $CaNH_4(NO_3)_3$.

Your description will need to explain how to prevent ammonium ions interfering with the test for nitrate ions.

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

.... [6]

[Total: 10]

3 **(a)** Name the process used to separate ethanol from a mixture of ethanol and water.

State why this process is suitable.

....

....

.... [2]

(b) Describe a suitable method in each case to separate the named substance from the mixture.

Explain your choice in each case.

(i) pure, dry sodium chloride from a mixture of sodium chloride and sand

....

....

....

.... [3]

(ii) a food colouring from a mixture of three food colourings

....

....

....

.... [3]

[Total: 8]

4 A student suggests a method to prepare pure, dry crystals of hydrated copper(II) sulfate but some processes are missing.

step **1** Measure a known volume of 0.5 mol / dm^3 sulfuric acid into a beaker.

step **2** Add a spatula measure of solid copper(II) oxide and stir.

step **3** Heat to evaporate all the water and obtain the crystals.

(a) There is a process missing between steps **1** and **2** to increase the rate of reaction.

Identify the missing process.

.... [1]

(b) In step **2** all the solid copper(II) oxide disappears.

State **and** explain what the student should do next in step **2**.

....

....

....

.... [2]

(c) There is a process missing between steps **2** and **3**.

Identify the missing process **and** explain why it is important.

....

....

....

.... [2]

(d) Step **3** will not make crystals of hydrated copper(II) sulfate.

State and explain how the student should change step **3** to make pure, dry crystals of hydrated copper(II) sulfate.

....

....

....

.... [3]

(e) Describe **two** observations the student makes during the preparation of pure, dry crystals of hydrated copper(II) sulfate.

For each observation make clear at which step it is seen.

observation 1 ....

....

observation 2 ....

....
[2]

(f) State a hazard involved in this preparation and a safety precaution the student should take to reduce the risk from this hazard.

....

....

.... [1]

[Total: 11]

5 A student does an experiment to determine the enthalpy change for the displacement reaction between zinc and aqueous copper(II) sulfate, $CuSO_4(aq)$.

$$Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$$

(a) State what is observed during this reaction.

....

.... [1]

(b) The student:

- weighs a sample bottle with a small amount of zinc powder
- pours $25.0\,cm^3$ of $0.500\,mol/dm^3$ $CuSO_4(aq)$ into a glass beaker and records the temperature
- records the temperature of the $CuSO_4(aq)$ at one minute intervals for three minutes
- adds the zinc powder to the $CuSO_4(aq)$ at the 4^{th} minute and reweighs the sample bottle
- stirs the mixture in the glass beaker and records the temperature at one minute intervals for six minutes.

The masses recorded are shown.

mass of container with zinc powder	15.18 g
mass of container after zinc powder added to $CuSO_4(aq)$	14.23 g

(i) Calculate the mass of zinc powder added to $CuSO_4(aq)$.

mass of zinc powder .... g [1]

The student's results are shown.

time / min	0	1	2	3	4	5	6	7	8	9	10
temperature / °C	22.1	22.1	22.1	22.1		29.1	28.9	28.7	28.5	28.3	28.1

(ii) Suggest why no temperature was recorded at the 4^{th} minute.

....

.... [1]

(iii) Suggest why the zinc is powdered.

....

.... [1]

(iv) State why the glass beaker is not the most suitable piece of apparatus for this experiment.

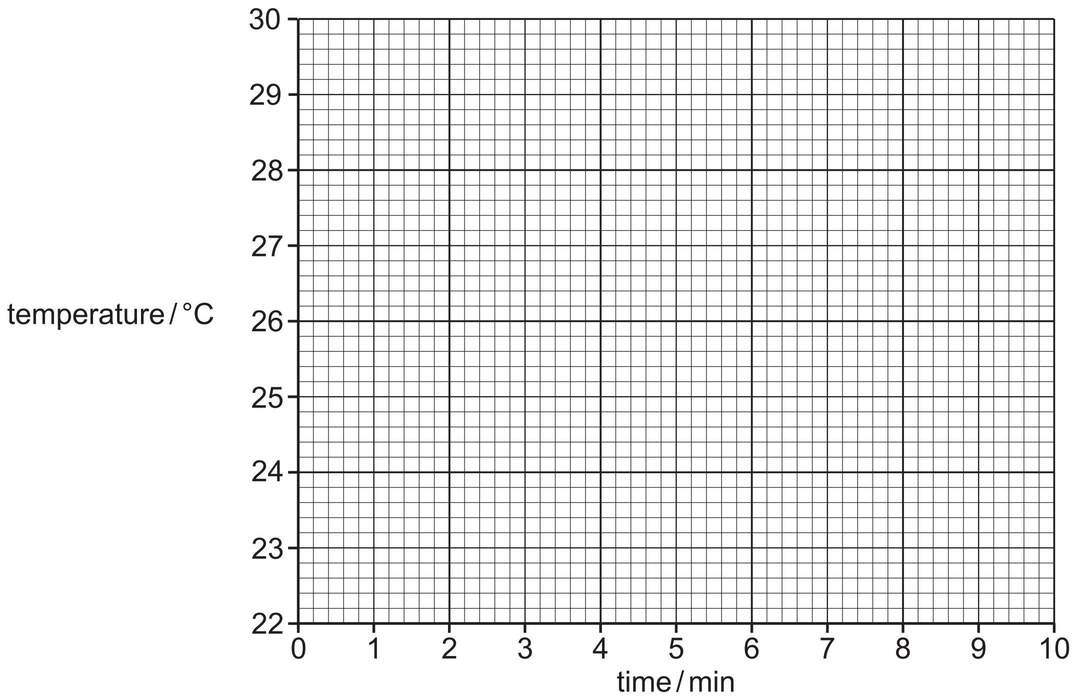
Suggest an improvement.

....

....

.... [2]

(v) Plot the values of temperature / °C against time / min on the grid.



[2]

(vi) Draw a straight line of best fit through the points from 0 to 3 minutes.

Extrapolate this line to the 4^{th} minute. [1]

(vii) Draw a straight line of best fit through the points from 5 to 10 minutes.

Extrapolate this line back to the 4^{th} minute. [1]

(viii) Use your extrapolated lines to determine the temperature change, ΔT, at the 4^{th} minute.

ΔT .... °C [1]

(ix) Calculate the energy change, q, in J, during the reaction.

Use the expression shown.

$$q = m \times c \times \Delta T$$

[m = mass of solution, 25.0 g; c = specific heat capacity of solution, 4.2 J / g °C]

q .... J [1]

(x) The limiting reagent is $CuSO_4$.

Calculate the number of moles of $CuSO_4$ in 25.0 cm^3 of 0.500 mol / dm^3 $CuSO_4$(aq).

.... mol [1]

(xi) Use your answers from **(b)(ix)** and **(b)(x)** to calculate the enthalpy change, ΔH, of the reaction in kJ / mol.

Include the appropriate sign with your answer.

ΔH .... kJ / mol [3]

(c) The actual enthalpy change of this reaction is likely to be greater than the value calculated in **(b)(xi)**.

Suggest the reason for this difference.

....

.... [1]

[Total: 17]