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.

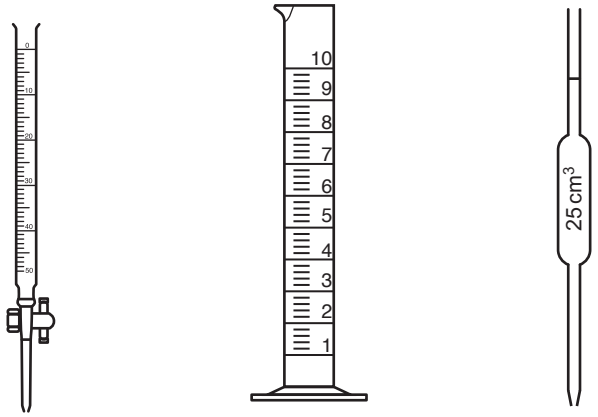
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1 Iron tablets are used to treat iron deficiency in the body.

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 **B** **C**

(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.

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The equation for the reaction is shown.

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

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

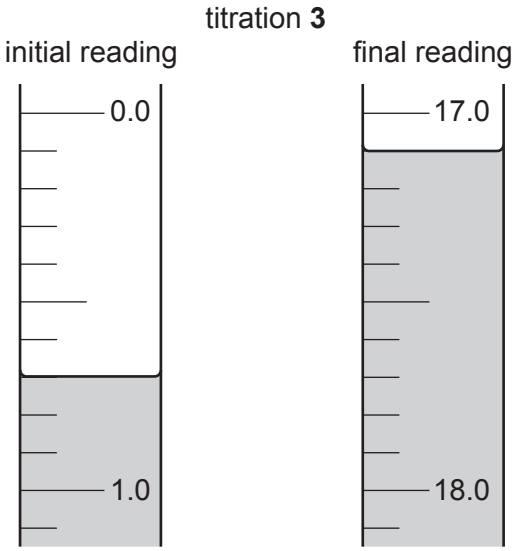
.....

..... [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]

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(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]

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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.

.....

.....

.....

.....

.....

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.....

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.....

.....

.....

.....

.....

..... [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]

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(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, $CuSO_4(aq)$.

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

(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 4th 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 4th minute.

.....

..... [1]

(iii) Suggest why the zinc is powdered.

.....

..... [1]

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

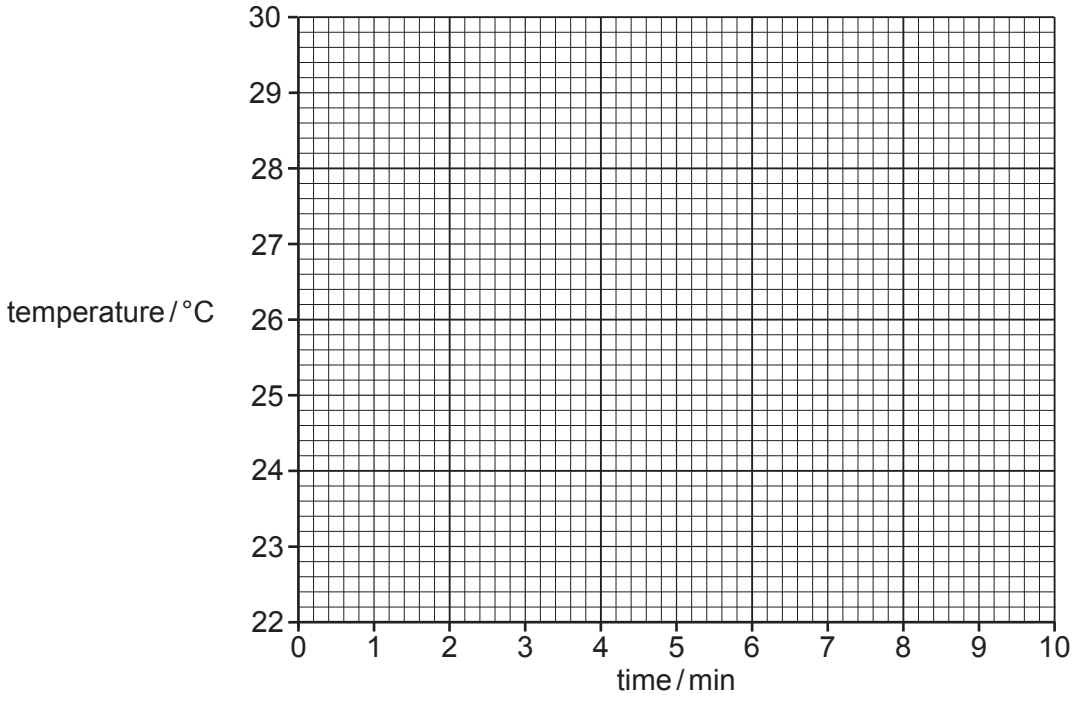
Suggest an improvement.

.....

.....

..... [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 4th minute. [1]

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

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

(viii) Use your extrapolated lines to determine the temperature change, ΔT, at the 4th 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]

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