



CANDIDATE
NAME

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CENTRE
NUMBER

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CANDIDATE
NUMBER

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5070/42

May/June 2020

1 hour

You must answer on the question paper.

No additional materials are needed.

- 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.

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

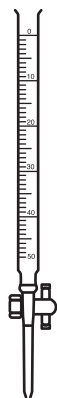
This document has **12** pages. Blank pages are indicated.

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

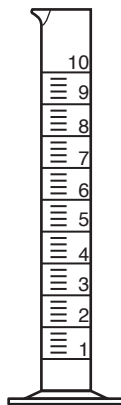
Iron tablets contain iron(II) ions, Fe^{2+} .

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

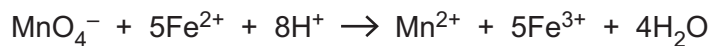
C

[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 $0.00500\text{ mol/dm}^3\text{ KMnO}_4(\text{aq})$
- titrates the solution of Fe^{2+} with the $0.00500\text{ mol/dm}^3\text{ KMnO}_4(\text{aq})$ until the first permanent pink colour is seen in the conical flask
- repeats the titration three times.

The equation for the reaction is shown.



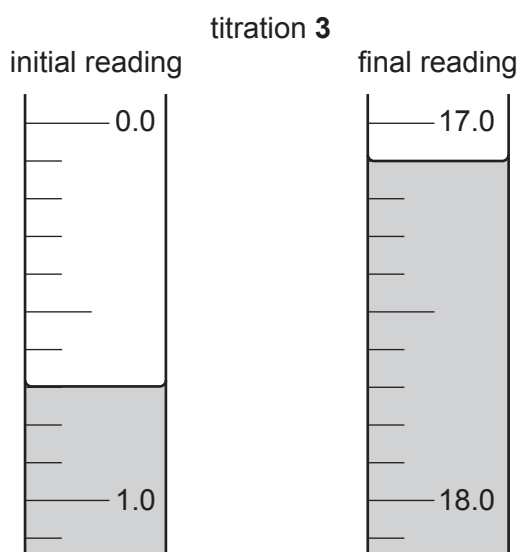
- (i) Suggest why dilute sulfuric acid is added to the conical flask.

.....
 [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.

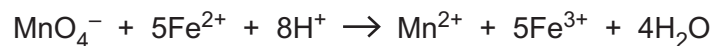
Use the ticked values to calculate the average volume of 0.00500 mol/dm³ KMnO₄(aq) used.

average volume cm³ [1]

- (c) A second student does another series of titrations using the same method and $0.00500 \text{ mol/dm}^3 \text{ KMnO}_4(\text{aq})$.

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

The equation for the reaction is shown.



- (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, $\text{CaNH}_4(\text{NO}_3)_3$, 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 $\text{CaNH}_4(\text{NO}_3)_3$.

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.

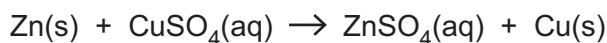
.....

.....

..... [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, $\text{CuSO}_4(\text{aq})$.



- (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 $\text{CuSO}_4(\text{aq})$ into a glass beaker and records the temperature
- records the temperature of the $\text{CuSO}_4(\text{aq})$ at one minute intervals for three minutes
- adds the zinc powder to the $\text{CuSO}_4(\text{aq})$ 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 $\text{CuSO}_4(\text{aq})$ 14.23 g

- (i) Calculate the mass of zinc powder added to $\text{CuSO}_4(\text{aq})$.

mass of zinc powderg [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.

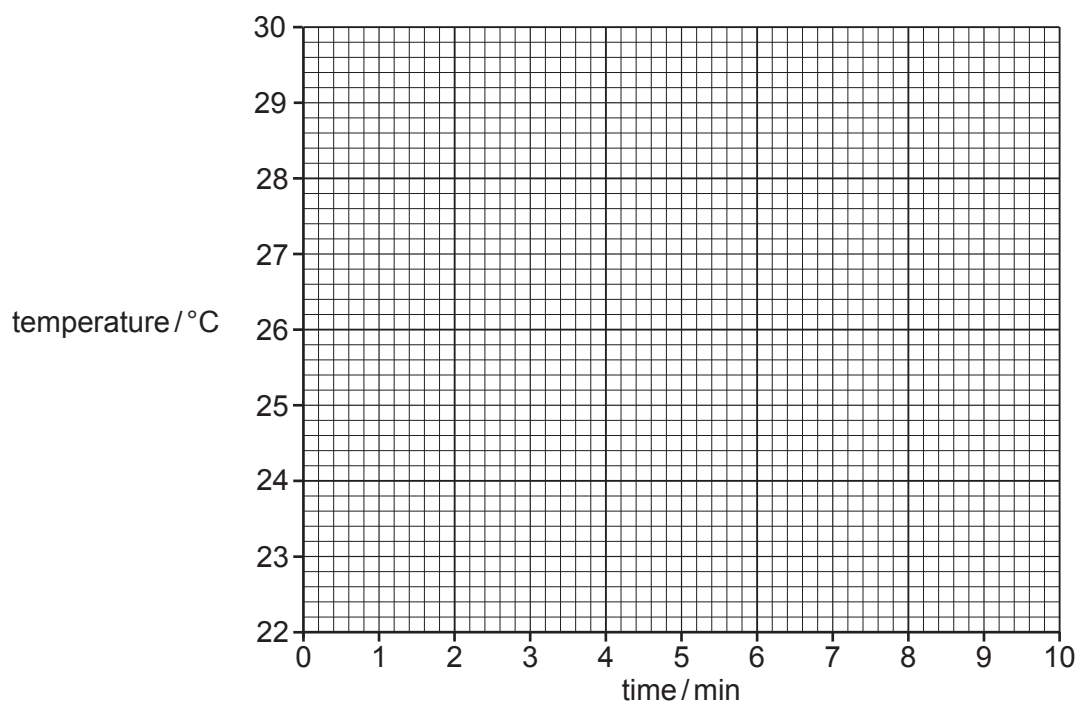
.....
 [1]

- (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 cm³ of 0.500 mol/dm³ $\text{CuSO}_4(\text{aq})$.

..... 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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