Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

CHEMISTRY **5070/41**

Paper 4 Alternative to Practical **October/November 2021**

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.

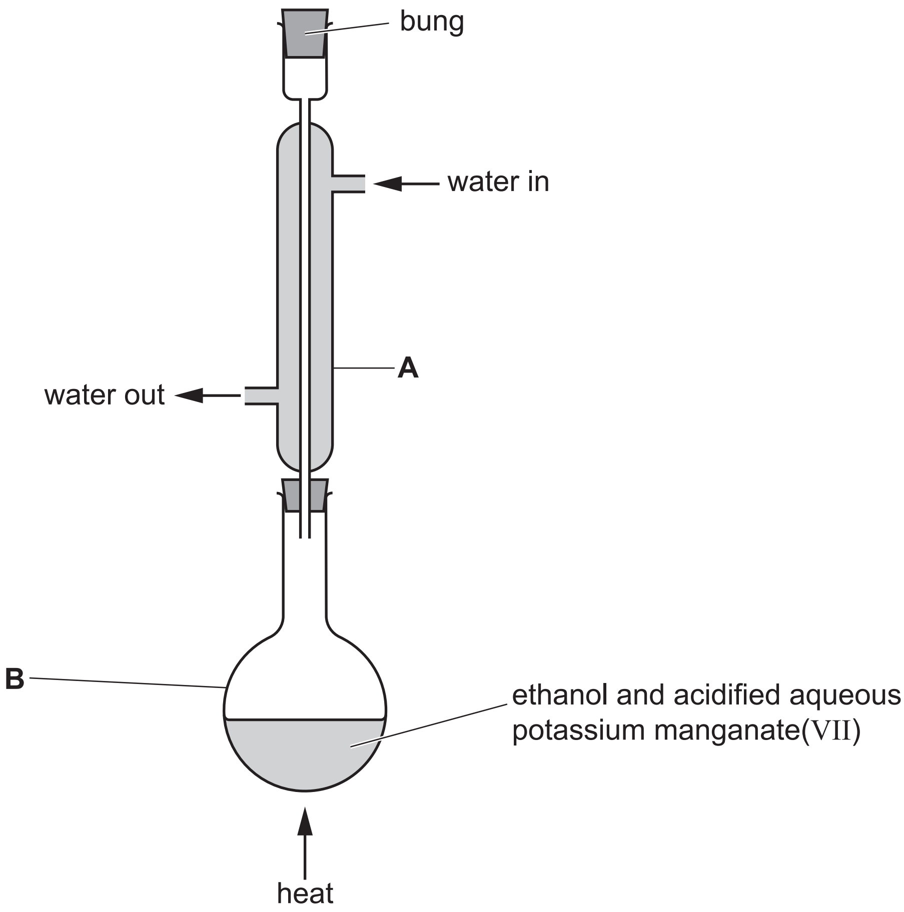
INFORMATION

- 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 **16** pages. Any blank pages are indicated.

DC (DH/AR) 201882/3

1 A student uses the apparatus to make ethanoic acid from ethanol.



(a) Name apparatus **A** and **B**.

A ....

B ....
[2]

(b) Identify **two** errors in the assembled apparatus shown in the diagram.

1 ....

2 ....
[2]

The errors are corrected and the experiment is started.

(c) **(i)** State why apparatus **B** is **not** heated directly using the flame of a Bunsen burner.

.... [1]

(ii) Name a piece of apparatus that is used for heating without a flame.

.... [1]

(d) Heating with apparatus **A** in the vertical position is called heating under reflux.

Describe what happens after the vapours from apparatus **B** enter apparatus **A**.

....

.... [2]

[Total: 8]

2 A student investigates the reaction between calcium carbonate and hydrochloric acid.

The equation for the reaction is shown.

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$$

(a) The student observes bubbles of a gas being produced when calcium carbonate is added to hydrochloric acid. The student does a test to show that the gas is carbon dioxide.

(i) Give a test and observation to identify carbon dioxide gas.

test ....

observation .... [1]

(ii) State one **other** observation the student makes when calcium carbonate is added to hydrochloric acid.

.... [1]

The student does an experiment to find out how the rate of this reaction changes as the concentration of hydrochloric acid changes.

Method

The student:

- measures 100 cm^3 of 1.0 mol / dm^3 hydrochloric acid (an excess) and pours this into a beaker
- adds a known mass of calcium carbonate to the acid
- immediately starts a clock
- stops the clock when **all** the calcium carbonate has reacted
- records this reaction time.

The student repeats the experiment several times with different concentrations of hydrochloric acid.

The concentration of hydrochloric acid for each experiment is changed by changing the volume of 1.0 mol / dm^3 hydrochloric acid.

Water is added to make the total volume equal in each experiment.

All other variables likely to affect the rate of reaction are kept constant in each experiment.

The results are shown in the table.

experiment	volume of hydrochloric acid / cm^3	volume of water / cm^3	reaction time / s
1	100	0	30
2		20	150
3	60	40	120
4	40	60	140
5	20		170

(b) Complete the table to show the two missing volumes. [1]

(c) **(i)** State which experiment has an anomalous reaction time.

.... [1]

(ii) Suggest what the student should do to check if the reaction time in **(c)(i)** is anomalous.

.... [1]

(iii) State which experiment has the smallest rate of reaction.

.... [1]

(iv) Describe how the rate of this reaction changes as the concentration of the hydrochloric acid increases.

.... [1]

(d) There is no suitable catalyst for this reaction.

Suggest two variables, other than the concentration of the hydrochloric acid or the mass of calcium carbonate, that affect the rate of this reaction.

1 ....

2 ....
[2]

[Total: 9]

3 A student is provided with three unlabelled bottles which each contain a solution.

The student knows that the bottles contain:

- dilute sulfuric acid
- aqueous calcium chloride
- aqueous zinc chloride.

The student is provided with:

- dilute nitric acid
- aqueous barium nitrate
- aqueous sodium hydroxide

but **no other chemicals or indicators**.

For each of the three unlabelled bottles, describe a **test** and give the **observations** to identify the contents of the bottle.

You must describe tests that give positive results to identify the contents of **each** bottle.

It must be clear in your answer which solution is identified by each positive result.

Chemical equations are **not** required.

....

....

....

....

....

....

....

....

....

....

....

....

....

....

.... [7]

4 A student determines the percentage by mass of iron in a sample of impure iron.

(a) The student measures the mass of an empty beaker.

The student adds a sample of impure iron to the beaker and then measures the mass of the beaker and the impure iron.

mass of beaker	= 36.53 g
mass of beaker + impure iron	= 38.31 g

Calculate the mass of impure iron used in the experiment.

.... g [1]

(b) An excess of dilute sulfuric acid is added to the beaker containing impure iron.

The dilute sulfuric acid reacts with the iron as shown.

$$Fe(s) + 2H^{+}(aq) \rightarrow Fe^{2+}(aq) + H_2(g)$$

Hydrogen gas is produced in the reaction.

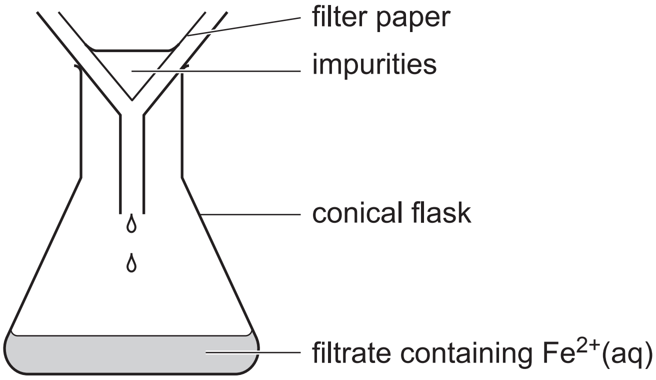
Give a test and observation to identify hydrogen gas.

test ....

observation ....
[1]

The impurities in the impure iron do not react with or dissolve in dilute sulfuric acid.

The impurities are separated from the aqueous solution by filtration.



(c) Suggest how the student makes sure that no Fe^{2+}(aq) remains on the filter paper.

.... [1]

(d) The filtrate is transferred from the conical flask into a volumetric flask.

Suggest how the student should make sure that **all** the filtrate is transferred from the conical flask to the volumetric flask.

....

.... [2]

The solution in the volumetric flask is made up to 500 cm^3 with water. This is solution **P**.

(e) The student transfers 25.0 cm^3 of **P** into a clean conical flask.

Name the piece of apparatus used to transfer 25.0 cm^3 of **P** into the conical flask.

.... [1]

Solution **Q** is 0.0100 mol / dm^3 potassium manganate(VII).

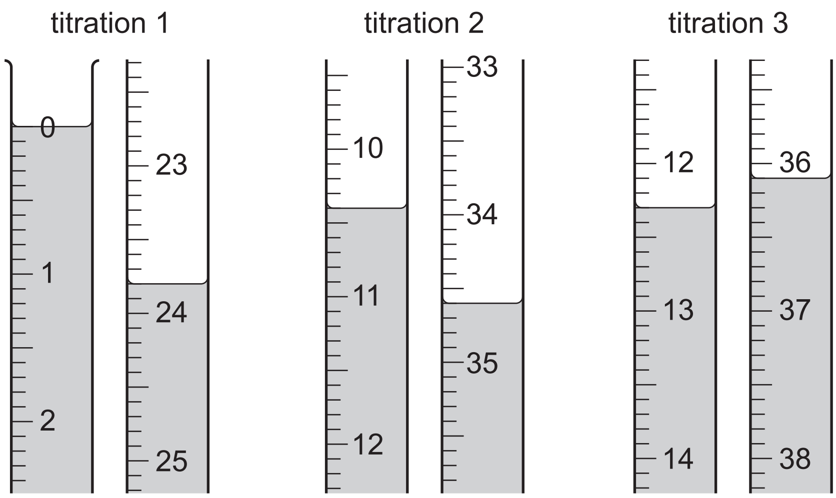
The student:

- washes out a burette with distilled water
- washes out the burette with a solution
- fills the burette with **Q**
- adds **Q** from the burette into the conical flask until the end-point is reached.

(f) Identify the solution used to wash out the burette before it is filled with **Q**.

.... [1]

The student does three titrations. The diagrams show parts of the burette with the liquid levels at the beginning and at the end of each titration.



(g) Use the diagrams to complete the table.

titration number	1	2	3
final burette reading / cm^3			
initial burette reading / cm^3			
volume of **Q** / cm^3			
best titration results (✓)			

Summary

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

Use the ticked values to calculate the average volume of **Q**.

.... cm^3 [4]

(h) Solution **Q** is 0.0100 mol / dm^3 potassium manganate(VII).

Calculate the number of moles of potassium manganate(VII) in the average volume of **Q** used in the titration.

.... mol [1]

(i) **One** mole of potassium manganate(VII) reacts with **five** moles of Fe^{2+}(aq).

Calculate the number of moles of Fe^{2+} (aq) in 25.0 cm^3 of **P**.

.... mol [1]

(j) Calculate the number of moles of Fe^{2+} (aq) in 500 cm^3 of **P**.

.... mol [1]

(k) Calculate the mass of iron in 500 cm^3 of **P**.

[A_r: Fe, 56]

.... g [1]

(l) Use your answers to **(a)** and **(k)** to calculate the percentage by mass of iron in the impure iron.

.... % [1]

[Total: 16]

5 A solid **R** contains two cations and one anion.

Complete the table.

Name any gases that are formed in the tests.

test	observation	conclusion	
(a) **R** is dissolved in water. The solution is divided into three portions for tests **(b)**, **(c)** and **(d)**.	A coloured solution forms.	....	[1]
(b) **(i)** To a portion of the solution from **(a)**, aqueous ammonia is added until a change is seen.	....	**R** contains Cr^{3+} or Fe^{2+} ions.	[1]
(ii) An excess of aqueous ammonia is added to the mixture from **(b)(i)**.	....	**R** contains Cr^{3+} or Fe^{2+} ions.	[1]
(c) **(i)** To a portion of the solution from **(a)**, aqueous sodium hydroxide is added until a change is seen.	....	**R** contains Cr^{3+} or Fe^{2+} ions.	[1]
(ii) An excess of aqueous sodium hydroxide is added to the mixture from **(c)(i)**.	....	**R** contains Cr^{3+} ions.	[1]
(iii) The mixture from **(c)(ii)** is warmed and the gas formed is tested with damp red litmus paper.	....	**R** contains NH_4^+.	[2]
(d)	A white precipitate forms	**R** contains Cl^-.	[2]

[Total: 9]

6 The reaction between aqueous lead(II) nitrate and aqueous potassium iodide produces a precipitate of lead(II) iodide.

$$Pb(NO_3)_2(aq) + 2KI(aq) \rightarrow PbI_2(s) + 2KNO_3(aq)$$

A student has two solutions.

G is 1.0 mol / dm^3 KI(aq).

H is $Pb(NO_3)_2$(aq) of unknown concentration.

The student determines the concentration of **H**.

The student:

- adds 5.0 cm^3 of **H** to 10.0 cm^3 of **G** in a test-tube
- removes the precipitate by filtration
- measures the mass of the pure dry precipitate
- repeats with different volumes of **H**.

The table shows the results.

experiment	volume of **G** / cm^3	volume of **H** / cm^3	mass of precipitate / g
1	10.0	5.0	0.64
2	10.0	10.0	1.28
3	10.0	15.0	1.92
4	10.0	20.0	2.31
5	10.0	25.0	2.31
6	10.0	30.0	2.31

(a) The student uses a burette to measure the volume of **H**.

State why the student uses a burette instead of a measuring cylinder.

.... [1]

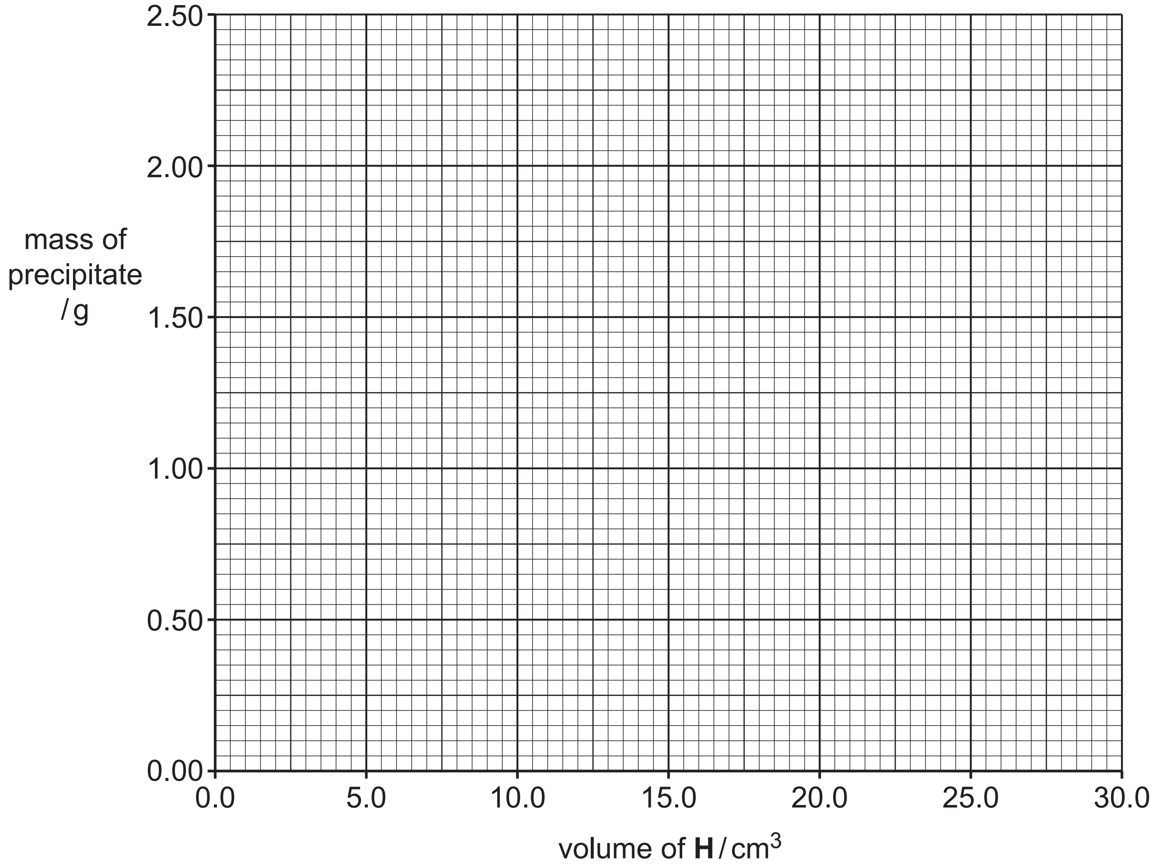
(b) Suggest why the student does not repeat the experiment with more than 30.0 cm^3 of **H**.

.... [1]

(c) Plot the results from the table on the grid.

Draw one straight line through the first three points and a second straight line through the other three points.

Extend both straight lines until they intersect.



[3]

(d) Use your graph to answer these questions.

(i) Determine the mass of precipitate formed when 12.0 cm^3 of **H** is added to 10.0 cm^3 of **G**.

.... g [1]

(ii) Determine the minimum volume of **H** added to 10.0 cm^3 of **G** to make exactly 0.80 g of precipitate.

.... cm^3 [1]

(e) **(i)** Use your graph to determine the minimum volume of **H** that reacts with all of the KI in $10.0\,cm^3$ of **G**.

.... cm^3 [1]

(ii) **G** is $1.0\,mol/dm^3$ KI(aq).

The equation for the reaction between $Pb(NO_3)_2$ and KI is shown.

$$Pb(NO_3)_2(aq) + 2KI(aq) \rightarrow PbI_2(s) + 2KNO_3(aq)$$

Use your answer to **(e)(i)** and the equation to calculate the concentration of $Pb(NO_3)_2$ in **H**.

.... mol/dm^3 [3]

[Total: 11]

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