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CHEMISTRY

0620/61

Paper 6 Alternative to Practical

October/November 2025

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 40.
- The number of marks for each question or part question is shown in brackets [].
- Notes for use in qualitative analysis are provided in the question paper.

This document has **12** pages.

- 1 Hot concentrated hydrochloric acid reacts with solid manganese(IV) oxide to make chlorine gas. Chlorine gas is toxic and more dense than air. Concentrated hydrochloric acid is corrosive.

Fig. 1.1 shows the apparatus used to make and collect a sample of chlorine gas.

There is **one** error in the way the apparatus has been set up in Fig. 1.1.

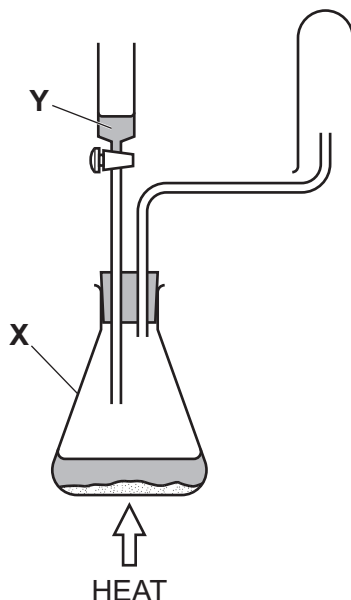


Fig. 1.1

- (a) Name the item of apparatus labelled **X** in Fig. 1.1.

..... [1]

- (b) Identify the substance labelled **Y** in Fig. 1.1.

..... [1]

- (c) Name an item of apparatus that can be used to heat **X** in Fig. 1.1.

..... [1]

- (d) There is **one** error in the way the apparatus has been set up.

Describe a change that needs to be made to the apparatus in Fig. 1.1 to correct this error.

..... [1]

- (e) Explain why this experiment should be carried out in a fume cupboard.

..... [1]

[Total: 5]



- 2 A student investigates the reaction between dilute hydrochloric acid and aqueous sodium hydroxide.

The student does five experiments.

Experiment 1

- Fill a burette with aqueous sodium hydroxide.
- Run some of the aqueous sodium hydroxide out of the burette so that the level of the aqueous sodium hydroxide is on the burette scale.
- Record the initial burette reading.
- Use a volumetric pipette to add 25.0 cm^3 of dilute hydrochloric acid to a conical flask.
- Stand the conical flask on a white tile.
- Add five drops of thymolphthalein indicator to the conical flask.
- Slowly add aqueous sodium hydroxide from the burette to the conical flask, while swirling the flask, until the solution just changes colour. This is the end-point.
- Record the final burette reading.

Experiment 2

- Empty the conical flask and rinse it with distilled water.
- Refill the burette with aqueous sodium hydroxide.
- Run some of the aqueous sodium hydroxide out of the burette so that the level of the aqueous sodium hydroxide is on the burette scale.
- Record the initial burette reading.
- Use the volumetric pipette to add 25.0 cm^3 of dilute hydrochloric acid to the conical flask.
- Add 0.25 g of sodium hydrogencarbonate to the conical flask and swirl the flask.
- Stand the conical flask on the white tile.
- Add five drops of thymolphthalein indicator to the conical flask.
- Slowly add aqueous sodium hydroxide from the burette to the conical flask, while swirling the flask, until the solution just changes colour. This is the end-point.
- Record the final burette reading.

Experiment 3

- Repeat Experiment 2 using 0.50 g of sodium hydrogencarbonate instead of 0.25 g .

Experiment 4

- Repeat Experiment 2 using 1.00 g of sodium hydrogencarbonate instead of 0.25 g .

Experiment 5

- Repeat Experiment 2 using 1.50 g of sodium hydrogencarbonate instead of 0.25 g .

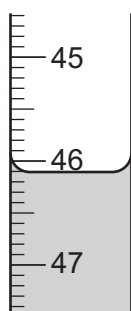


(a) Use the information in the descriptions of Experiments 1 to 5 and the burette diagrams in Fig. 2.1 and Fig. 2.2 to complete Table 2.1.

Experiment 1



initial burette
reading



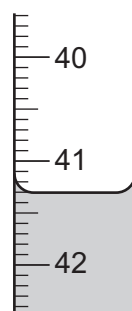
final burette
reading

Fig. 2.1

Experiment 2



initial burette
reading



final burette
reading

Fig. 2.2

Table 2.1

	Experiment 1	Experiment 2	Experiment 3	Experiment 4	Experiment 5
volume of dilute hydrochloric acid/cm ³					
mass of sodium hydrogencarbonate/g	0.00	0.25	0.50	1.00	1.50
final burette reading/cm ³			36.0	24.1	13.5
initial burette reading/cm ³			1.4	0.3	0.5
volume of aqueous sodium hydroxide added to reach the end-point/cm ³					13.0

[5]



- (b) Complete a suitable scale on the y-axis and plot the results from Experiments 1 to 5 in Table 2.1 on Fig. 2.3. Draw a straight line of best fit.

volume of
aqueous sodium
hydroxide
added to reach
the end-point/cm³

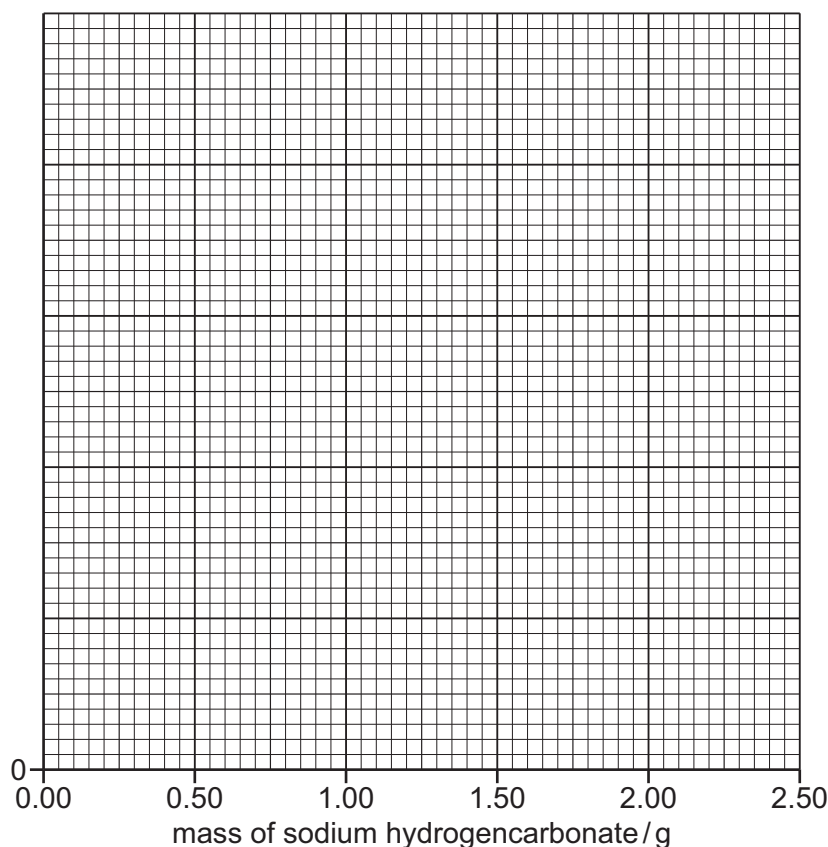


Fig. 2.3

[4]

- (c) The sodium hydrogencarbonate added in Experiments 2 to 5 neutralises some of the dilute hydrochloric acid in the conical flask. The sodium hydroxide used in the titration neutralises the remaining dilute hydrochloric acid.

Extrapolate the line on your graph in Fig. 2.3 and deduce the mass of sodium hydrogencarbonate needed to neutralise **all** of the dilute hydrochloric acid in the conical flask.

Show clearly **on Fig. 2.3** how you worked out your answer.

mass of sodium hydrogencarbonate = ...

[3]



- (d) (i) Explain why a volumetric pipette is used rather than a measuring cylinder to measure the volume of dilute hydrochloric acid used in each experiment.

.....
..... [1]

- (ii) Explain why it is **not** possible to use a volumetric pipette instead of the burette to measure the volume of aqueous sodium hydroxide added in each experiment.

.....
..... [1]

- (e) The conical flask is placed on a white tile to make the colour change of the indicator at the end-point more visible.

Explain why universal indicator is **not** a suitable indicator for this titration.

.....
.....
.....
..... [2]

- (f) Draw a line **on Fig. 2.3** to show the results you would expect if the investigation was repeated using aqueous sodium hydroxide with twice the concentration.

Label your line **F**. [2]

[Total: 18]



- 3 A student tests two solids: solid **J** and solid **K**.

Tests on solid J

Solid **J** is lithium chloride.

Record the expected observations.

- (a) The student carries out a flame test on solid **J**.

- (i) State the colour the Bunsen burner flame becomes during the flame test.

..... [1]

- (ii) The student uses a roaring Bunsen burner flame to carry out the flame test.

State why a yellow Bunsen burner flame is **not** suitable for a flame test.

.....
..... [1]

- (b) The student dissolves the remaining solid **J** in distilled water to form solution **J**.

The student divides solution **J** into two portions.

- (i) To the first portion of solution **J**, the student adds about 1 cm³ of dilute nitric acid followed by a few drops of aqueous silver nitrate.

observations
..... [1]

- (ii) To the second portion of solution **J**, the student adds aqueous sodium hydroxide until it is in excess.

observations
..... [1]



Tests on solid K

Table 3.1 shows the tests and the student's observations for solid **K**.

Table 3.1

tests	observations
test 1 Heat about half of solid K in a boiling tube until there is no further change. Hold anhydrous cobalt(II) chloride paper at the mouth of the boiling tube.	condensation forms at the top of the boiling tube the anhydrous cobalt(II) chloride paper changes colour from blue to pink
test 2 The remaining solid K is dissolved in distilled water to form solution K. Solution K is divided into three portions. To the first portion of solution K, add aqueous ammonia dropwise and then in excess.	a green precipitate forms the precipitate remains when excess aqueous ammonia is added
test 3 To the second portion of solution K, add 1 cm³ of dilute nitric acid followed by a few drops of aqueous barium nitrate.	a white precipitate forms
test 4 To the third portion of solution K, add 3 cm³ of aqueous sodium carbonate. Test any gas given off.	effervescence is seen and a green precipitate forms the gas turns limewater milky

(c) State the conclusion that can be made from the observations in **test 1**.

..... [1]

(d) Two different cations can give the observations in **test 2**.

(i) Identify the **two** possible cations that the observations in **test 2** show could be in solid **K**.

.....

..... [2]



- (ii) Describe an additional test that can be carried out on solution **K** to confirm which of the two cations you have identified in (d)(i) is in solid **K**.

Explain how the result of this test shows which of these two cations is in solid **K**.

test

.....

explanation

.....

[2]

- (e) Identify the gas given off in **test 4**.

..... [1]

- (f) Identify the anion in solid **K**.

..... [1]

[Total: 11]





- 4 When a solid metal is added to an aqueous salt of a less reactive metal, a reaction takes place. The reaction is exothermic, and the temperature of the reaction mixture increases. The larger the difference in reactivity of the two metals, the more exothermic the reaction.

Cobalt, manganese and nickel are three metals which are all more reactive than copper and react with aqueous copper(II) sulfate. The temperature of the reaction mixture increases during each reaction.

Plan an investigation to find the order of reactivity of the three metals cobalt, manganese and nickel.

Your plan should include how you can use the results to find the order of reactivity of the three metals cobalt, manganese and nickel.

You are provided with powdered samples of cobalt, manganese and nickel, aqueous copper(II) sulfate and common laboratory apparatus.

[6]



Notes for use in qualitative analysis

Tests for anions

anion	test	test result
carbonate, CO_3^{2-}	add dilute acid, then test for carbon dioxide gas	effervescence, carbon dioxide produced
chloride, Cl^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	white ppt.
bromide, Br^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	cream ppt.
iodide, I^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	yellow ppt.
nitrate, NO_3^- [in solution]	add aqueous sodium hydroxide, then aluminium foil; warm carefully	ammonia produced
sulfate, SO_4^{2-} [in solution]	acidify with dilute nitric acid, then add aqueous barium nitrate	white ppt.
sulfite, SO_3^{2-}	add a small volume of acidified aqueous potassium manganate(VII)	the acidified aqueous potassium manganate(VII) changes colour from purple to colourless

Tests for aqueous cations

cation	effect of aqueous sodium hydroxide	effect of aqueous ammonia
aluminium, Al^{3+}	white ppt., soluble in excess, giving a colourless solution	white ppt., insoluble in excess
ammonium, NH_4^+	ammonia produced on warming	—
calcium, Ca^{2+}	white ppt., insoluble in excess	no ppt. or very slight white ppt.
chromium(III), Cr^{3+}	green ppt., soluble in excess	green ppt., insoluble in excess
copper(II), Cu^{2+}	light blue ppt., insoluble in excess	light blue ppt., soluble in excess, giving a dark blue solution
iron(II), Fe^{2+}	green ppt., insoluble in excess, ppt. turns brown near surface on standing	green ppt., insoluble in excess, ppt. turns brown near surface on standing
iron(III), Fe^{3+}	red-brown ppt., insoluble in excess	red-brown ppt., insoluble in excess
zinc, Zn^{2+}	white ppt., soluble in excess, giving a colourless solution	white ppt., soluble in excess, giving a colourless solution





Tests for gases

gas	test and test result
ammonia, NH_3	turns damp red litmus paper blue
carbon dioxide, CO_2	turns limewater milky
chlorine, Cl_2	bleaches damp litmus paper
hydrogen, H_2	'pops' with a lighted splint
oxygen, O_2	relights a glowing splint
sulfur dioxide, SO_2	turns acidified aqueous potassium manganate(VII) from purple to colourless

Flame tests for metal ions

metal ion	flame colour
lithium, Li^+	red
sodium, Na^+	yellow
potassium, K^+	lilac
calcium, Ca^{2+}	orange-red
barium, Ba^{2+}	light green
copper(II), Cu^{2+}	blue-green

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- 1 Eggshells are made from a mixture of calcium carbonate and other insoluble substances.

Calcium carbonate reacts with dilute hydrochloric acid. The equation for the reaction is shown.



The other substances in eggshells do **not** react with dilute hydrochloric acid.

A student finds the percentage by mass of calcium carbonate in an eggshell.

Fig. 1.1 shows the first three steps of the method the student uses.

step 1

Grind the eggshell into small pieces.

step 2

Find the mass of the small pieces of eggshell.

step 3

Add the small pieces of eggshell to excess dilute hydrochloric acid and warm the mixture while stirring it with a glass rod.

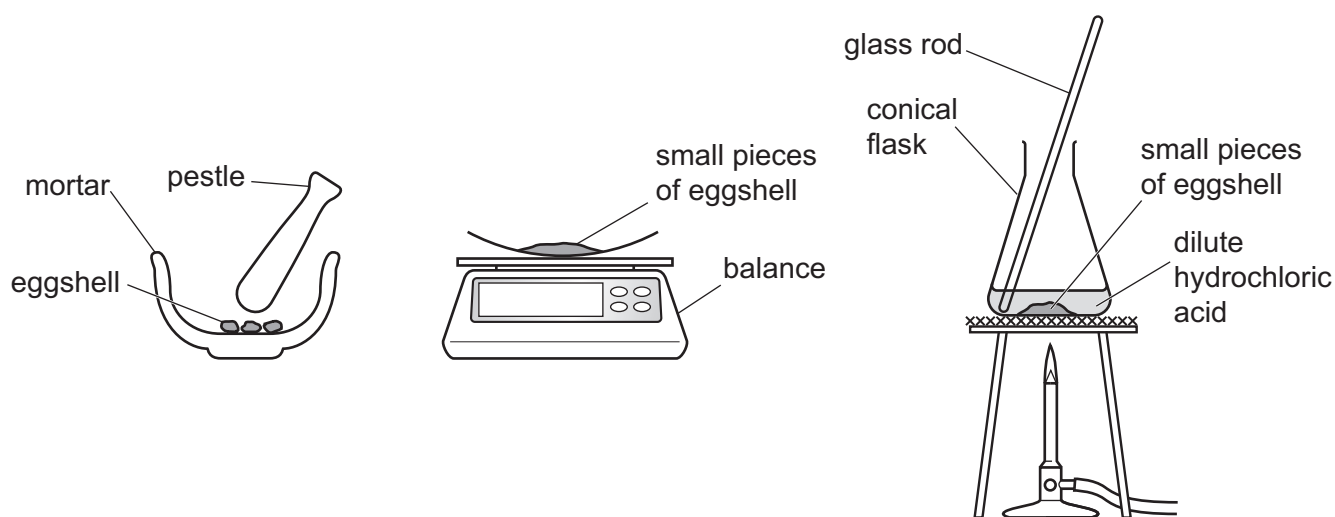


Fig. 1.1

- (a) (i) Describe what is seen when the calcium carbonate in the eggshell reacts with dilute hydrochloric acid.

..... [1]

- (ii) Describe what the student should do to make sure the acid is in excess and all of the calcium carbonate has reacted.

.....

.....

..... [2]



(b) After **step 3**, the student filters the mixture to obtain the unreacted solid left from the eggshell.

(i) Draw a labelled diagram of the apparatus the student should use to filter the mixture.

[2]

(ii) After the filtration, the student washes the residue.

Identify the **two** substances removed from the residue by washing.

substance 1

substance 2 [2]

(iii) After washing the residue, the student dries the residue in an oven.
The student then measures the mass of the dry residue.

The masses the student records are shown in Table 1.1.

Table 1.1

mass of small pieces of eggshell/g	2.00
mass of dry residue after filtration/g	0.11

Use the data in Table 1.1 to calculate the percentage by mass of calcium carbonate in the eggshell.

percentage of calcium carbonate = ... [2]

[Total: 9]





- 2 A student investigates the reaction between acidic solution **B** and two different solutions of aqueous sodium hydroxide, solution **C** and solution **D**, using two different indicators.

The student does two experiments.

Experiment 1

- Rinse a burette with distilled water and then with solution **C**.
- Fill the burette with solution **C**. Run some of solution **C** out of the burette so that the level of the solution is on the burette scale.
- Record the initial burette reading.
- Use a measuring cylinder to pour 25 cm³ of solution **B** into a conical flask.
- Add five drops of methyl orange indicator **and** five drops of thymolphthalein indicator to the conical flask.
- Stand the conical flask on a white tile.
- Slowly add solution **C** from the burette to the conical flask, while swirling the flask, until the solution changes colour from red to orange. This is the first end-point.
- Record the burette reading at the first end-point.
- Continue to add solution **C** from the burette to the conical flask while swirling the flask. The solution changes colour from orange to yellow.
- Continue to add solution **C**, while swirling the flask, until the solution changes colour from yellow to green. This is the second end-point.
- Record the burette reading at the second end-point.

Experiment 2

- Empty the conical flask and rinse it with distilled water.
- Repeat Experiment 1 using solution **D** instead of solution **C**.



- (a) Use the burette diagrams in Fig. 2.1 and Fig. 2.2 to record the readings for Experiment 1 and Experiment 2 in Table 2.1. Complete Table 2.1.

Experiment 1

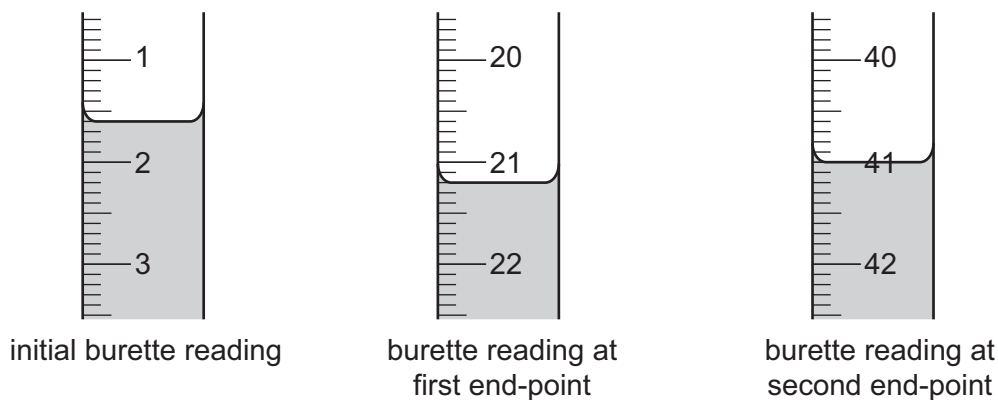


Fig. 2.1

Experiment 2

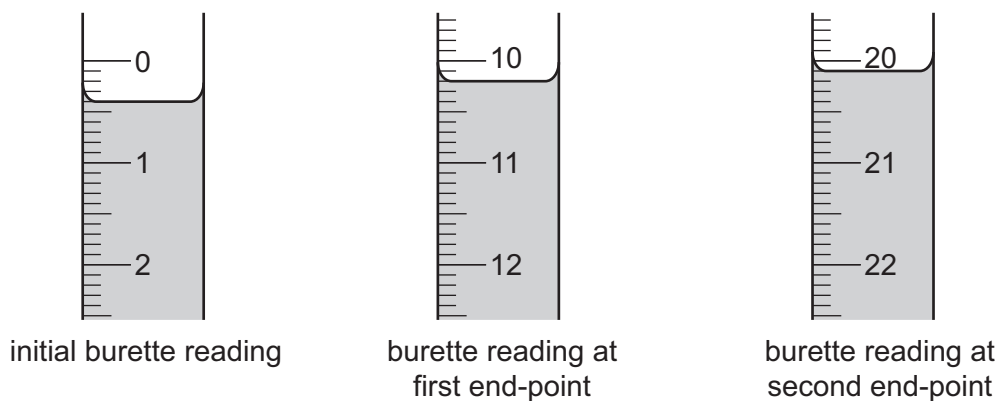


Fig. 2.2

Table 2.1

	Experiment 1 using solution C	Experiment 2 using solution D
burette reading at first end-point/cm ³		
burette reading at second end-point/cm ³		
initial burette reading/cm ³		
volume added from burette to reach first end-point/cm ³		
total volume added from burette to reach second end-point/cm ³		



- (b) (i) Explain why the conical flask is rinsed with distilled water at the start of Experiment 2.

.....
 [1]

- (ii) At the start of Experiment 1, the burette is rinsed with distilled water and then with solution **C**.

Explain how the volume added from the burette to reach the first end-point would be different if the burette was **not** rinsed with solution **C**.

.....

 [2]

- (iii) Explain why the conical flask is placed on a white tile during the titration.

.....
 [1]

- (c) Compare the concentration of solution **C** used in Experiment 1 with the concentration of solution **D** used in Experiment 2.

Explain your answer.

.....

 [3]

- (d) (i) Deduce the volume of solution **C** required to reach the **first** end-point if Experiment 1 is repeated using 50 cm³ of solution **B** instead of 25 cm³.

volume of solution **C** = ... [2]

- (ii) State why using 50 cm³ of solution **B** would cause a problem when finding the volume of solution **C** needed to reach the **second** end-point in Experiment 1.

.....
 [1]





(e) A student repeats Experiment 2.

The student warms solution **B** in the conical flask before carrying out the titration.

State the effect, if any, on the volume of solution **D** required to reach the **second** end-point in Experiment 2.

Explain your answer.

effect on volume of solution **D**

explanation

[2]

(f) State **one** change to the **apparatus** that will improve the accuracy of the results.

[1]

[Total: 18]



- 3 A student tests two solids: solid **E** and solid **F**.

Tests on solid E

Solid **E** is ammonium sulfate.

Record the expected observations.

The student dissolves solid **E** in distilled water to form solution **E**. The student divides solution **E** into three approximately equal portions.

- (a) (i) To the first portion of solution **E**, the student adds about 2 cm³ of aqueous sodium hydroxide. The student warms the mixture gently and tests any gas produced.

observations

..... [1]

- (ii) Identify the gas given off in (a)(i).

..... [1]

- (b) To the second portion of solution **E**, the student adds about 1 cm³ of dilute nitric acid followed by a few drops of aqueous barium nitrate.

observations

..... [1]

- (c) To the third portion of solution **E**, the student adds a few drops of acidified aqueous potassium manganate(VII).

observations

..... [1]





Tests on solid F

Table 3.1 shows the tests and the student's observations for solid F.

Table 3.1

tests	observations
test 1 Carry out a flame test on solid F.	yellow flame
test 2 Dissolve the remaining solid F in distilled water to form solution F. Divide solution F into three portions. To the first portion of solution F, add about 1 cm ³ of dilute nitric acid followed by a few drops of aqueous silver nitrate.	yellow precipitate forms
test 3 To the second portion of solution F, add aqueous sodium hydroxide dropwise until in excess.	white precipitate forms the precipitate dissolves in excess aqueous sodium hydroxide to form a colourless solution
test 4 To the third portion of solution F, add aqueous ammonia dropwise until in excess.	white precipitate forms the precipitate dissolves in excess aqueous ammonia to form a colourless solution

(d) Identify the **three** ions in solid F.

.....

 [3]

[Total: 7]



- 4** Liquid alcohols can be burned as fuels in spirit burners. The energy given out can be used to heat water in a boiling tube as shown in Fig. 4.1.

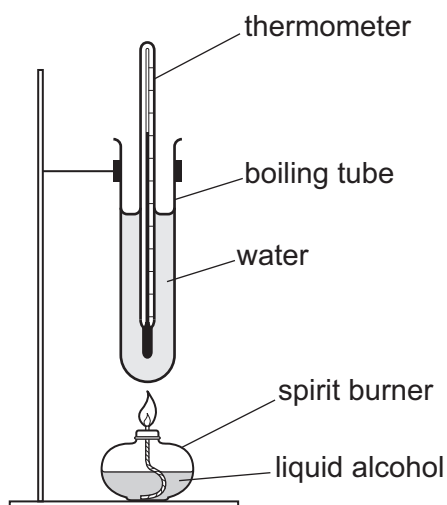


Fig. 4.1

Describe how to investigate which of three liquid alcohols, ethanol, propanol and butanol, heats the water in the boiling tube the fastest.

You are provided with three spirit burners, samples of the three alcohols, water and common laboratory apparatus.

[illegible]







Notes for use in qualitative analysis

Tests for anions

anion	test	test result
carbonate, CO_3^{2-}	add dilute acid, then test for carbon dioxide gas	effervescence, carbon dioxide produced
chloride, Cl^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	white ppt.
bromide, Br^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	cream ppt.
iodide, I^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	yellow ppt.
nitrate, NO_3^- [in solution]	add aqueous sodium hydroxide, then aluminium foil; warm carefully	ammonia produced
sulfate, SO_4^{2-} [in solution]	acidify with dilute nitric acid, then add aqueous barium nitrate	white ppt.
sulfite, SO_3^{2-}	add a small volume of acidified aqueous potassium manganate(VII)	the acidified aqueous potassium manganate(VII) changes colour from purple to colourless

Tests for aqueous cations

cation	effect of aqueous sodium hydroxide	effect of aqueous ammonia
aluminium, Al^{3+}	white ppt., soluble in excess, giving a colourless solution	white ppt., insoluble in excess
ammonium, NH_4^+	ammonia produced on warming	—
calcium, Ca^{2+}	white ppt., insoluble in excess	no ppt. or very slight white ppt.
chromium(III), Cr^{3+}	green ppt., soluble in excess	green ppt., insoluble in excess
copper(II), Cu^{2+}	light blue ppt., insoluble in excess	light blue ppt., soluble in excess, giving a dark blue solution
iron(II), Fe^{2+}	green ppt., insoluble in excess, ppt. turns brown near surface on standing	green ppt., insoluble in excess, ppt. turns brown near surface on standing
iron(III), Fe^{3+}	red-brown ppt., insoluble in excess	red-brown ppt., insoluble in excess
zinc, Zn^{2+}	white ppt., soluble in excess, giving a colourless solution	white ppt., soluble in excess, giving a colourless solution





Tests for gases

gas	test and test result
ammonia, NH_3	turns damp red litmus paper blue
carbon dioxide, CO_2	turns limewater milky
chlorine, Cl_2	bleaches damp litmus paper
hydrogen, H_2	'pops' with a lighted splint
oxygen, O_2	relights a glowing splint
sulfur dioxide, SO_2	turns acidified aqueous potassium manganate(VII) from purple to colourless

Flame tests for metal ions

metal ion	flame colour
lithium, Li^+	red
sodium, Na^+	yellow
potassium, K^+	lilac
calcium, Ca^{2+}	orange-red
barium, Ba^{2+}	light green
copper(II), Cu^{2+}	blue-green

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- 1 A student uses the apparatus in Fig. 1.1 to show that water is formed as one of the products when a fuel is burned. The gases produced when the fuel is burned are passed through the apparatus using a suction pump.

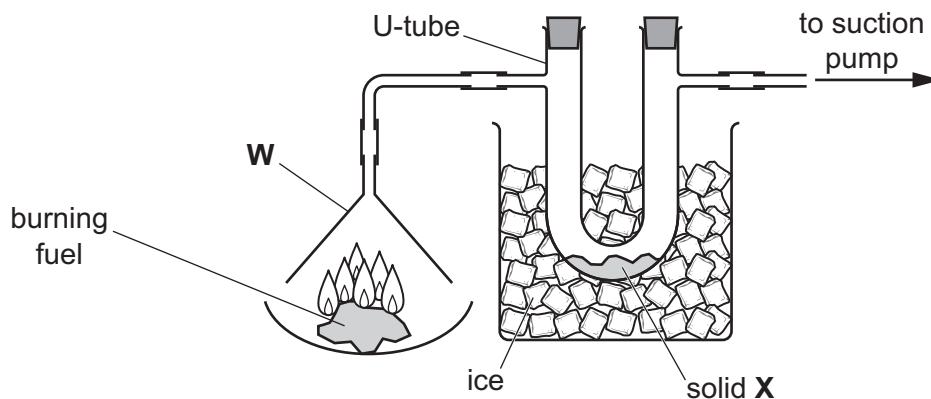


Fig. 1.1

- (a) Identify the item of apparatus labelled **W** in Fig. 1.1.

..... [1]

- (b) When the fuel is burned, the steam produced passes into the U-tube.

Suggest why the U-tube is surrounded by ice.

..... [1]

- (c) Water causes solid **X** in the U-tube to change colour.

Name solid **X** and state the colour change seen.

solid **X**

colour change from to

[2]



The student tries to use the apparatus in Fig. 1.2 to pass the gases produced through acidified aqueous potassium manganate(VII).

There is an error in the apparatus in Fig. 1.2 so that the gases produced will **not** pass through the acidified aqueous potassium manganate(VII).

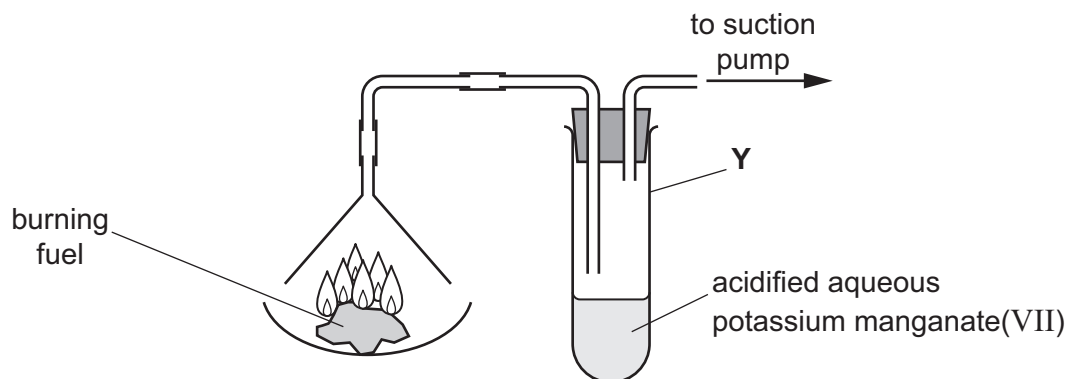


Fig. 1.2

- (d) Identify the item of apparatus labelled **Y** in Fig. 1.2.

..... [1]

- (e) **On Fig. 1.2**, draw a circle around the error in the apparatus.

[1]

- (f) The error in the apparatus in Fig. 1.2 is corrected.
The student observes that the acidified aqueous potassium manganate(VII) changes colour from purple to colourless.

Suggest why this colour change occurs.

.....

..... [1]

[Total: 7]





- 2 A student investigates the temperature change when a 5 cm length of coiled magnesium ribbon reacts with excess dilute sulfuric acid.

The student does five experiments.

Experiment 1

- Rinse a burette with distilled water and then with dilute sulfuric acid.
- Fill the burette with dilute sulfuric acid. Run some of the dilute sulfuric acid out of the burette so that the level of the dilute sulfuric acid is on the 0.0 cm^3 mark.
- Use the burette to add 30.0 cm^3 of dilute sulfuric acid to a boiling tube.
- Use a thermometer to measure the initial temperature of the acid.
- Record the initial temperature.
- Add a coil of magnesium ribbon to the boiling tube. At the same time start a stop-watch.
- Continually stir the contents of the boiling tube using the thermometer.
- After 1 minute, measure the temperature of the mixture in the boiling tube.
- Record this temperature.

Experiment 2

- Refill the burette with dilute sulfuric acid. Run some of the dilute sulfuric acid out of the burette so that the level of the dilute sulfuric acid is on the 0.0 cm^3 mark.
- Use the burette to add 25.0 cm^3 of dilute sulfuric acid to a new boiling tube.
- Use the thermometer to measure the initial temperature of the acid.
- Record the initial temperature.
- Add a coil of magnesium ribbon to the boiling tube. At the same time start the stop-watch.
- Continually stir the contents of the boiling tube using the thermometer.
- After 1 minute, measure the temperature of the mixture in the boiling tube.
- Record this temperature.

Experiment 3

- Repeat Experiment 2, using 20.0 cm^3 of dilute sulfuric acid instead of 25.0 cm^3 .

Experiment 4

- Repeat Experiment 2, using 15.0 cm^3 of dilute sulfuric acid instead of 25.0 cm^3 .

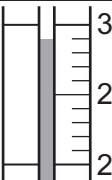
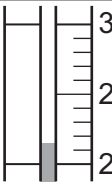
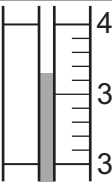
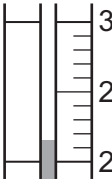
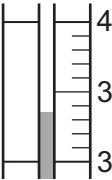
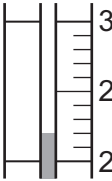
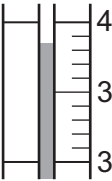
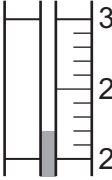
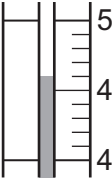
Experiment 5

- Repeat Experiment 2, using 10.0 cm^3 of dilute sulfuric acid instead of 25.0 cm^3 .



(a) Use the thermometer diagrams to complete Table 2.1.

Table 2.1

experiment	volume of dilute sulfuric acid /cm ³	thermometer diagram for initial temperature /°C	initial temperature /°C	thermometer diagram for temperature after 1 minute /°C	temperature after 1 minute /°C	temperature increase /°C
1	30.0					
2	25.0					
3	20.0					
4	15.0					
5	10.0					

[4]



- (b) On Fig. 2.1, complete a suitable scale on the y-axis and plot the results from Experiments 1 to 5. Draw a line of best fit.

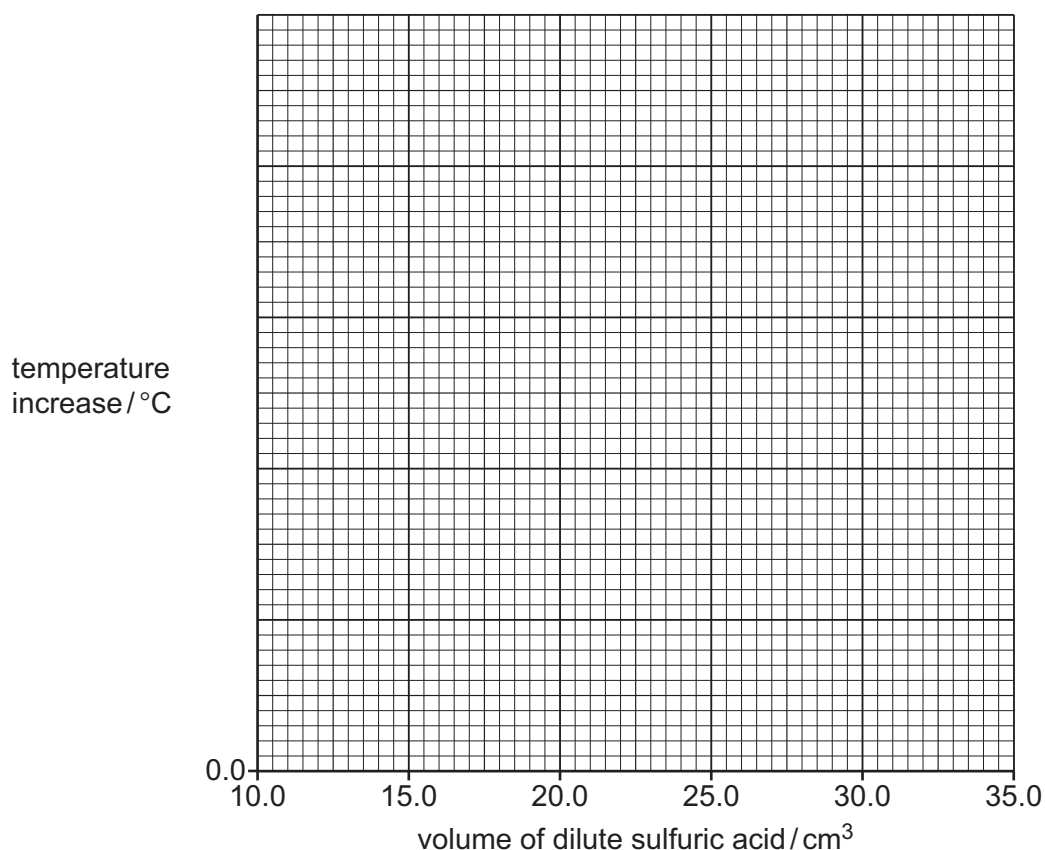


Fig. 2.1

[4]

- (c) Explain why the temperature increase changes as the volume of dilute sulfuric acid changes.

.....

 [2]

- (d) Extrapolate the line of best fit on your graph in Fig. 2.1 to deduce the temperature increase if 33.0 cm^3 of dilute sulfuric acid is used.

Show clearly **on Fig. 2.1** how you worked out your answer.

temperature increase = ... [3]

- (e) The investigation is repeated using 2.5 cm lengths of coiled magnesium ribbon instead of 5 cm lengths.

On Fig. 2.1, sketch a line to show the results you would expect. Label this line **E**. [1]





- (f) (i) Give **one** reason why a burette, rather than a measuring cylinder, is used to measure the volume of the dilute sulfuric acid.

.....
 [1]

- (ii) Explain why the contents of the boiling tube are stirred during each experiment.

.....
 [1]

- (g) Describe **one** change to the apparatus that will give more accurate results.

Explain your answer.

change to apparatus

.....

explanation

.....

[2]

[Total: 18]



- 3 A student tests two substances: solution **A** and solid **B**.

Tests on solution A

Solution **A** is aqueous iron(III) nitrate.

Record the expected observations.

The student divides solution **A** into three approximately equal portions.

- (a) To the first portion of solution **A**, the student adds aqueous ammonia dropwise and then in excess.

observations when added dropwise

observations in excess

[2]

- (b) (i) To the second portion of solution **A**, the student adds excess aqueous sodium hydroxide.

observations

..... [1]

- (ii) To the product from (b)(i), the student adds a small piece of aluminium foil. The student gently warms the mixture formed and tests any gas produced.

observations

..... [1]

- (iii) Identify the gas produced in (b)(ii).

..... [1]

- (c) To the third portion of solution **A**, the student adds about 1 cm³ of dilute nitric acid followed by a few drops of aqueous barium nitrate.

observations

..... [1]



Tests on solid B

Table 3.1 shows the tests and the student's observations for solid **B**.

Table 3.1

tests	observations
test 1 Do a flame test on solid B .	light green flame colour
test 2 Add the remaining solid B to dilute hydrochloric acid. Test any gas produced.	effervescence and a colourless solution forms limewater turns milky

(d) Identify the gas produced in **test 2**.

..... [1]

(e) Identify solid **B**.

.....
..... [2]

[Total: 9]





- 4 *Duralumin* is an alloy containing a mixture of the metals aluminium, copper, magnesium and manganese only.

Table 4.1 gives some information about the four metals in *duralumin*.

Table 4.1

metal	reaction with dilute hydrochloric acid	reaction with dilute nitric acid
aluminium	reacts to form a soluble salt	does not react
copper	does not react	reacts very slowly at room temperature and quickly when heated to form a soluble salt
magnesium	reacts quickly to form a soluble salt	reacts quickly to form a soluble salt
manganese	reacts quickly to form a soluble salt	reacts quickly to form a soluble salt

Plan an investigation to find the percentage by mass of aluminium in a sample of *duralumin*. Your plan must include how you will calculate the percentage by mass of aluminium in *duralumin*.

You are provided with a powdered sample of the alloy *duralumin*, dilute hydrochloric acid, dilute nitric acid, distilled water and common laboratory apparatus.

..... [6









Notes for use in qualitative analysis

Tests for anions

anion	test	test result
carbonate, CO_3^{2-}	add dilute acid, then test for carbon dioxide gas	effervescence, carbon dioxide produced
chloride, Cl^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	white ppt.
bromide, Br^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	cream ppt.
iodide, I^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	yellow ppt.
nitrate, NO_3^- [in solution]	add aqueous sodium hydroxide, then aluminium foil; warm carefully	ammonia produced
sulfate, SO_4^{2-} [in solution]	acidify with dilute nitric acid, then add aqueous barium nitrate	white ppt.
sulfite, SO_3^{2-}	add a small volume of acidified aqueous potassium manganate(VII)	the acidified aqueous potassium manganate(VII) changes colour from purple to colourless

Tests for aqueous cations

cation	effect of aqueous sodium hydroxide	effect of aqueous ammonia
aluminium, Al^{3+}	white ppt., soluble in excess, giving a colourless solution	white ppt., insoluble in excess
ammonium, NH_4^+	ammonia produced on warming	—
calcium, Ca^{2+}	white ppt., insoluble in excess	no ppt. or very slight white ppt.
chromium(III), Cr^{3+}	green ppt., soluble in excess	green ppt., insoluble in excess
copper(II), Cu^{2+}	light blue ppt., insoluble in excess	light blue ppt., soluble in excess, giving a dark blue solution
iron(II), Fe^{2+}	green ppt., insoluble in excess, ppt. turns brown near surface on standing	green ppt., insoluble in excess, ppt. turns brown near surface on standing
iron(III), Fe^{3+}	red-brown ppt., insoluble in excess	red-brown ppt., insoluble in excess
zinc, Zn^{2+}	white ppt., soluble in excess, giving a colourless solution	white ppt., soluble in excess, giving a colourless solution





Tests for gases

gas	test and test result
ammonia, NH_3	turns damp red litmus paper blue
carbon dioxide, CO_2	turns limewater milky
chlorine, Cl_2	bleaches damp litmus paper
hydrogen, H_2	'pops' with a lighted splint
oxygen, O_2	relights a glowing splint
sulfur dioxide, SO_2	turns acidified aqueous potassium manganate(VII) from purple to colourless

Flame tests for metal ions

metal ion	flame colour
lithium, Li^+	red
sodium, Na^+	yellow
potassium, K^+	lilac
calcium, Ca^{2+}	orange-red
barium, Ba^{2+}	light green
copper(II), Cu^{2+}	blue-green

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