Cambridge International O Level Chemistry

Question Papers

Paper #4

catadu.com

Non-traditional blended
learning institute.

CONTENTS

Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME	

CENTRE NUMBER		CANDIDATE NUMBER	

5388245127

CHEMISTRY **5070/42**

Paper 4 Alternative to Practical **May/June 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.

BLANK PAGE

1 Hydrated magnesium sulfate has the formula $MgSO_4 \cdot \mathbf{x}H_2O$.

When hydrated magnesium sulfate is heated, it loses the water of crystallisation to form anhydrous magnesium sulfate.

$$MgSO_4 \cdot \mathbf{x}H_2O(s) \rightarrow MgSO_4(s) + \mathbf{x}H_2O(g)$$

(a) A student does an experiment to find the value of **x** in $MgSO_4 \cdot \mathbf{x}H_2O$.

The student:

1 records the mass of a crucible

2 adds hydrated magnesium sulfate to the crucible and records the mass again

3 heats the crucible strongly

4 allows the crucible and contents to cool and then records the mass again

5 repeats **3** and **4** until the same mass is recorded twice

6 uses the results to calculate the initial mass of $MgSO_4 \cdot \mathbf{x}H_2O$ and the final mass of $MgSO_4$.

(i) Suggest why a crucible is used instead of a glass beaker.

....

.... [1]

(ii) Suggest why **3** and **4** are repeated until the same mass is recorded twice.

....

.... [1]

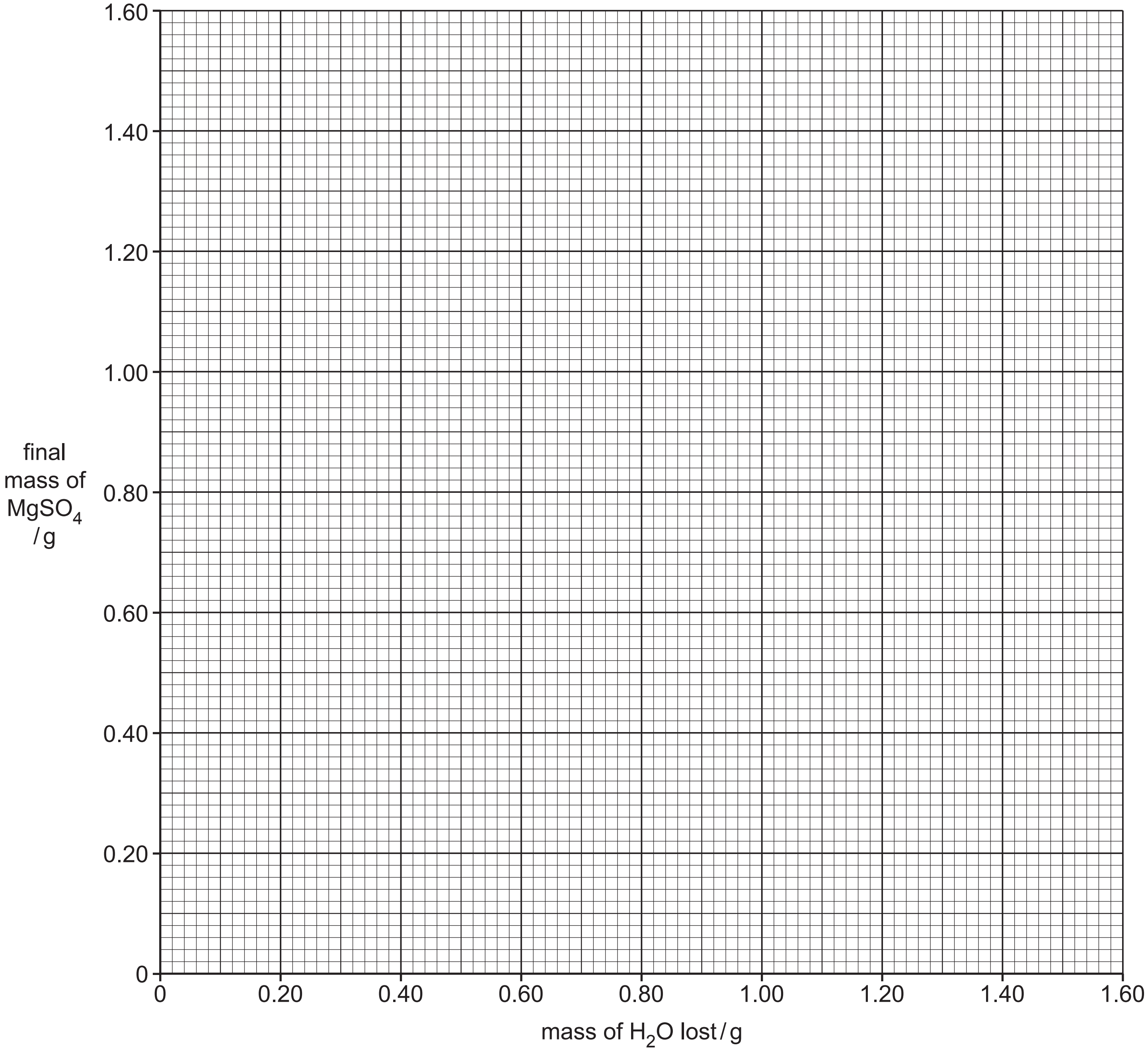
(b) Several students do the same experiment with different initial masses of $MgSO_4 \cdot \mathbf{x}H_2O$.

The results are shown in the table.

initial mass of $MgSO_4 \cdot \mathbf{x}H_2O$ / g	0.52	0.98	1.50	2.04	2.53	2.99
final mass of $MgSO_4$ / g	0.25	0.48	0.83	1.00	1.23	1.46
mass of H_2O lost / g		0.50	0.67		1.30	1.53

(i) Complete the table. [1]

(ii) On the grid, plot the final mass of $MgSO_4$ against the mass of H_2O lost. [2]



(iii) Draw a circle around the anomalous result on your graph. [1]

(iv) Suggest a reason for the anomalous result.

....

.... [1]

(v) Draw a straight line of best fit. [1]

(c) **(i)** In another experiment, the final mass of $MgSO_4$ is 1.20 g.

Use your graph to determine the mass of H_2O lost.

.... g [1]

(ii) Calculate the number of moles of water in your answer to **(i)**.

[A_r; H, 1; O, 16]

.... mol [2]

(iii) 1.20 g of $MgSO_4$ contains 0.01 mol of $MgSO_4$.

Calculate the value of **x** in $MgSO_4 \bullet \mathbf{x}H_2O$.

x .... [1]

[Total: 12]

2 **(a)** A solution contains two different cations and one anion.

Complete the table.

Name any gases formed and describe the tests used to identify these gases.

test	observations	conclusions
Add aqueous sodium hydroxide to the solution in a boiling tube.	a pale green precipitate forms	
(i) To the same boiling tube, continue adding aqueous sodium hydroxide until in excess. Keep the contents of the boiling tube for test **(ii)**.	a green precipitate dissolves to form a green solution a white precipitate remains	cation 1 is .... cation 2 is ....
(ii)	....	.... anion is NO_3^-

[2]

[4]

(b) Ammonium sulfite, $(NH_4)_2SO_3$, is a water-soluble compound.

Aqueous ammonium sulfite is slowly oxidised by oxygen in air.

This means aqueous ammonium sulfite will also contain some sulfate ions, SO_4^{2-}.

Describe a series of tests, and the observations, to show the presence of ammonium ions, sulfite ions and sulfate ions in this solution.

It must be clear in your answer which ion is identified by each test.

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

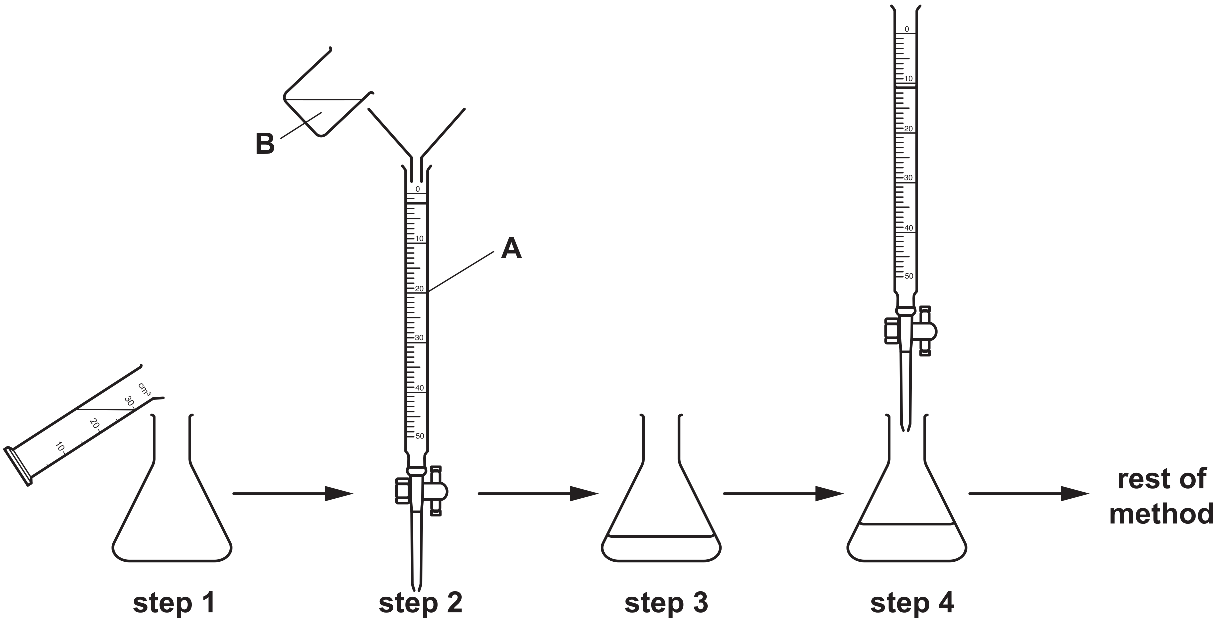
.... [6]

[Total: 12]

3 A titration method can be used to make soluble salts.

A student does an experiment to prepare a pure sample of sodium chloride.

Part of the method is shown in the diagram.



(a) In **step 1** the student uses a measuring cylinder to add 25 cm^3 of aqueous sodium hydroxide to the conical flask.

State how the accuracy of the experiment could be improved in **step 1**.

.... [1]

(b) Describe what the student does in **step 2** of the method.

Include the names of apparatus **A** and solution **B**.

....

....

....

....

.... [3]

(c) Identify what is added to the flask in **step 3** before starting the titration.

.... [1]

(d) In **step 4** the student adds solution **B** to the aqueous sodium hydroxide in the conical flask until the end-point is reached.

The student records the volume of solution **B** added.

State how the student knows when the end-point is reached.

.... [1]

(e) The rest of the method involves adding the recorded volume of solution **B** to another 25 cm^3 of aqueous sodium hydroxide.

The substance added in **step 3** of the first titration is not added.

(i) State why this substance is not added.

.... [1]

(ii) Describe how the student obtains pure crystals of sodium chloride from the solution in the conical flask.

....

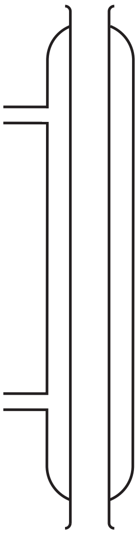
....

.... [3]

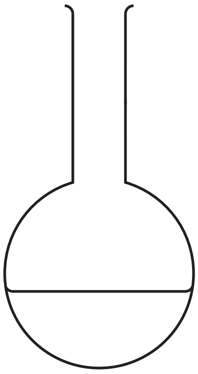
[Total: 10]

4 A student oxidises a sample of ethanol.

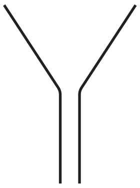
Some of the apparatus the student uses is shown.



P



Q



R

(a) Name the three pieces of apparatus.

P ....

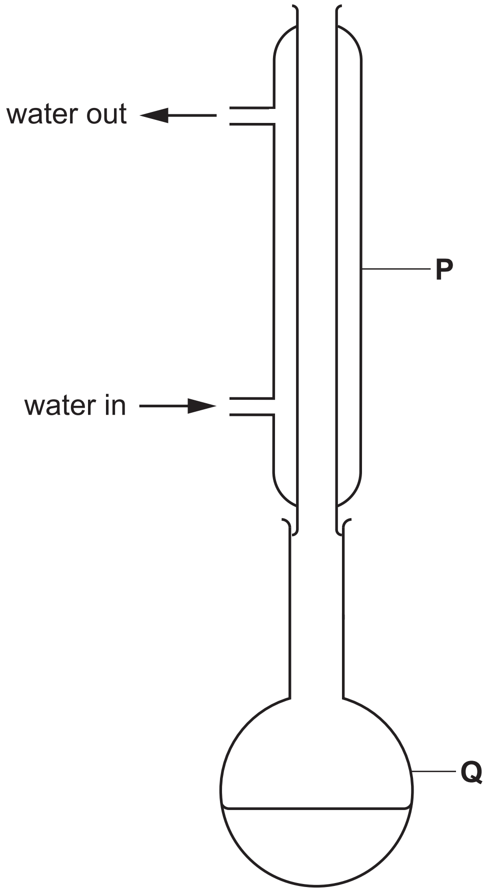
Q ....

R ....

[3]

(b) The student:

- transfers 25.0 cm^3 of ethanol into apparatus **Q**
- adds an oxidising agent
- assembles the apparatus as shown



- heats apparatus **Q** gently until all the oxidising agent has changed colour.

(i) Name a suitable piece of apparatus to measure 25.0 cm^3 of ethanol.

.... [1]

(ii) Name a suitable oxidising agent.

.... [2]

(iii) State the colour change that would be seen with this oxidising agent.

from .... to .... [1]

(iv) Suggest a reason for placing apparatus **P** vertically.

....

.... [1]

(c) After all the oxidising agent reacts, apparatus **Q** contains a mixture of ethanol, water and the product of the oxidation.

(i) Name the product of the oxidation.

.... [1]

(ii) Name the process used to separate the three liquids in apparatus **Q**.

.... [1]

(iii) State why this process is suitable.

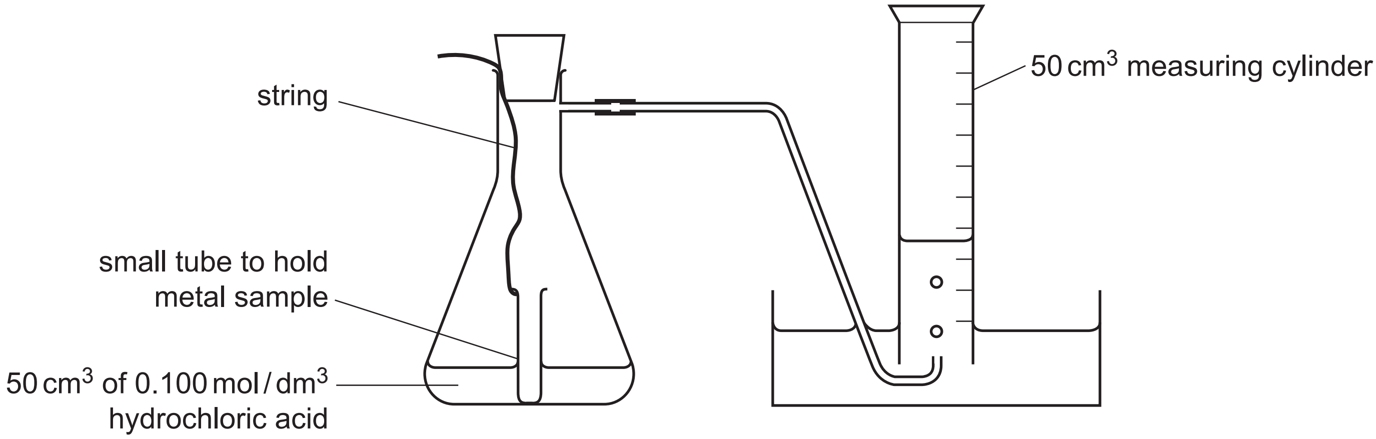
You should refer to a physical property of the liquids.

....

.... [1]

[Total: 11]

5 The apparatus shown is used to compare the rates of reaction of different metals with hydrochloric acid.



The metals used and the mass of each are shown.

metal used	calcium	iron	magnesium	zinc
mass / g	0.080	0.112	0.048	0.130

(a) The student:

- places a sample of one of the metals in the small tube
- transfers 50 cm^3 of 0.100 mol / dm^3 hydrochloric acid into the conical flask
- places the small tube into the apparatus as shown in the diagram
- tips the flask so that the small tube falls over and the metal and acid come into contact
- starts a timer
- records the total volume of gas formed at regular time intervals until the reaction finishes
- repeats the method with each metal.

(i) Name an alternative piece of apparatus that could be used, instead of the measuring cylinder, to collect the gas and measure its volume.

.... [1]

(ii) The gas collected in the measuring cylinder is hydrogen.

Give a test and its result to show that this gas is hydrogen.

test ....

result ....
[2]

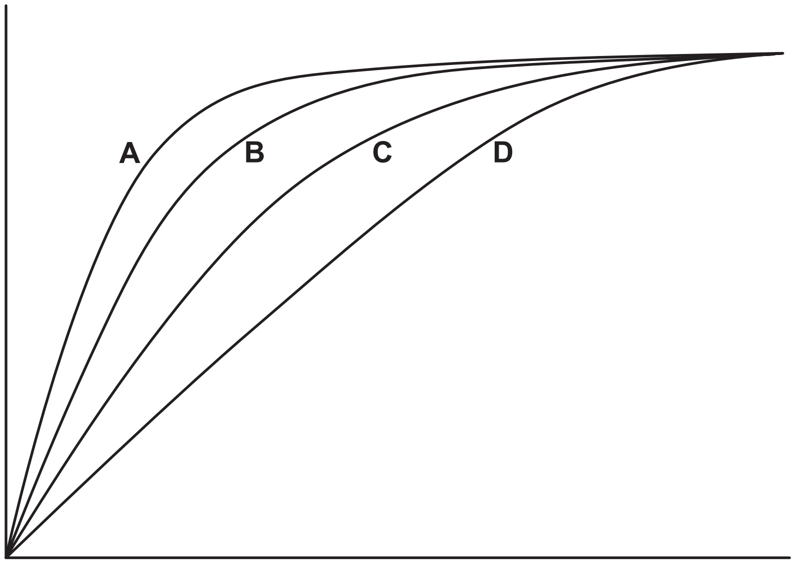
(b) Another student thinks it would be easier to remove the bung from the flask, add the metal directly to the acid and then replace the bung.

State **two** disadvantages of this method compared with the one described.

1 ....

2 ....
[2]

(c) A graph representing the results is shown.



(i) Give the correct labels for each axis of the graph.

x-axis ....

y-axis ....
[2]

(ii) State why curve **A** starts steep, gradually levels off and then becomes horizontal.

....

....

....

.... [3]

(iii) Identify which of the metals gives each of the curves **A**, **B**, **C** and **D**.

A ....

B ....

C ....

D ....

[1]

(iv) Different masses of each metal are used for the four experiments.

State **three** variables that must be kept constant for the experiments.

....

....

....

....

....

.... [3]

(v) Suggest why different masses of each metal are used for the four experiments.

....

.... [1]

[Total: 15]

BLANK PAGE

Cambridge O Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

9020441524

CHEMISTRY **5070/42**

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.

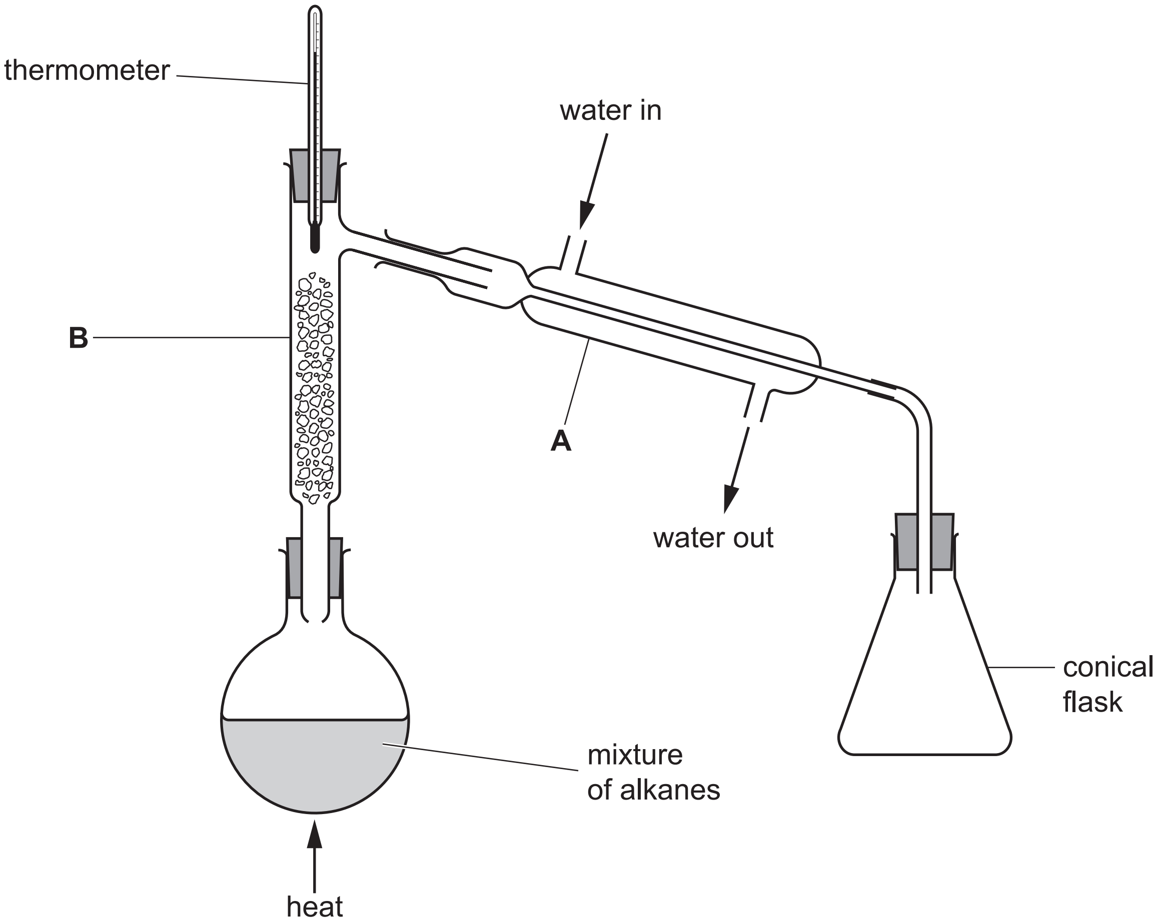
INFORMATION

- 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) 201883/4

1 A student uses the apparatus to separate a mixture of three alkanes.



(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.

The mixture of alkanes is heated in the flask to start the separation.

The boiling points of the alkanes are shown.

alkane	boiling point / °C
octane	126
nonane	151
decane	174

(c) **(i)** State why the flask is **not** heated directly with the flame of a Bunsen burner.

.... [1]

(ii) State why the flask is **not** heated with a beaker of boiling water.

.... [1]

(iii) Name a piece of apparatus that is suitable to heat the flask.

.... [1]

(d) Name the first alkane collected in the conical flask.

Explain your answer.

alkane ....

explanation ....

....
[1]

(e) State the purpose of apparatus **B**.

.... [1]

[Total: 9]

2 A student investigates the reaction between zinc and dilute sulfuric acid.

The equation for the reaction is shown.

$$Zn(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2(g)$$

(a) The student observes bubbles of a gas being produced when zinc is added to dilute sulfuric acid. The student does a test to show that the gas is hydrogen.

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

test ....

observation ....
[1]

(ii) State one **other** observation the student makes when zinc is added to dilute sulfuric acid.

.... [1]

A student does an experiment to find out how the rate of this reaction changes as the temperature of the dilute sulfuric acid changes.

Method

The student:

- measures 100 cm^3 of 1.0 mol / dm^3 dilute sulfuric acid (an excess) and pours this into a beaker
- places a thermometer in the acid
- heats the acid to the required temperature
- removes the heat
- adds a known mass of zinc to the acid
- immediately starts a clock
- stops the clock when **all** the zinc has reacted
- records this reaction time.

The student repeats the experiment several times at different temperatures.

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

The results are shown in the table.

experiment	temperature / °C	reaction time / s
1	30	150
2	40	80
3	50	45
4	60	90
5	70	2

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

.... [1]

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

.... [1]

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

.... [1]

(iv) Describe how the rate of this reaction changes as the temperature of the dilute sulfuric acid increases.

.... [1]

(c) Another student does the reaction at 90 °C.

State why it is difficult to measure an accurate reaction time at 90 °C.

.... [1]

(d) Suggest two variables, other than the temperature of the dilute sulfuric acid or the mass of zinc, 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 the bottles contain:

- dilute hydrochloric acid
- aqueous aluminium sulfate
- aqueous zinc sulfate.

The student is provided with:

- dilute nitric acid
- aqueous silver nitrate
- aqueous ammonia

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]

BLANK PAGE

4 A solid mixture contains iron(II) sulfate and sand.

A student determines the percentage by mass of iron(II) sulfate in this mixture.

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

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

mass of beaker = 36.02 g

mass of beaker + mixture = 55.96 g

Calculate the mass of the mixture used in the experiment.

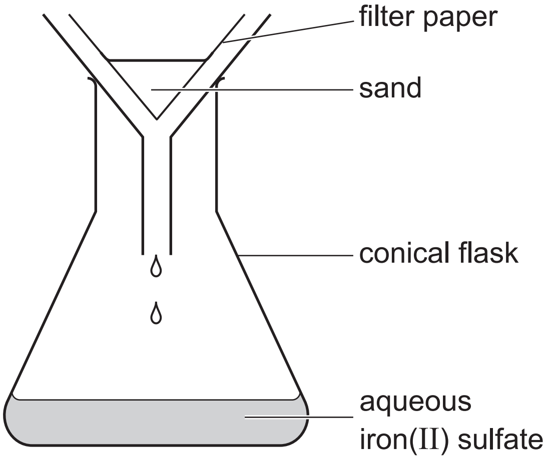
.... g [1]

The student adds water to the mixture in the beaker.

Iron(II) sulfate dissolves in the water.

The sand does not react with or dissolve in the water.

The sand is separated from the aqueous iron(II) sulfate by filtration.



(b) Suggest how the student makes sure that no iron(II) sulfate remains on the filter paper.

.... [1]

(c) The aqueous iron(II) sulfate is transferred from the conical flask into a volumetric flask.

Suggest how the student should make sure that **all** the aqueous iron(II) sulfate 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 **R**.

(d) The student uses a pipette together with another piece of apparatus to place 20.0 cm^3 of **R** into a conical flask.

Name the other piece of apparatus that is used with the pipette.

.... [1]

The student adds excess dilute sulfuric acid to the conical flask.

Solution **T** is 0.0200 mol / dm^3 potassium manganate(VII).

The student:

- fills a burette with **T**
- runs **T** into the conical flask until the end-point is reached.

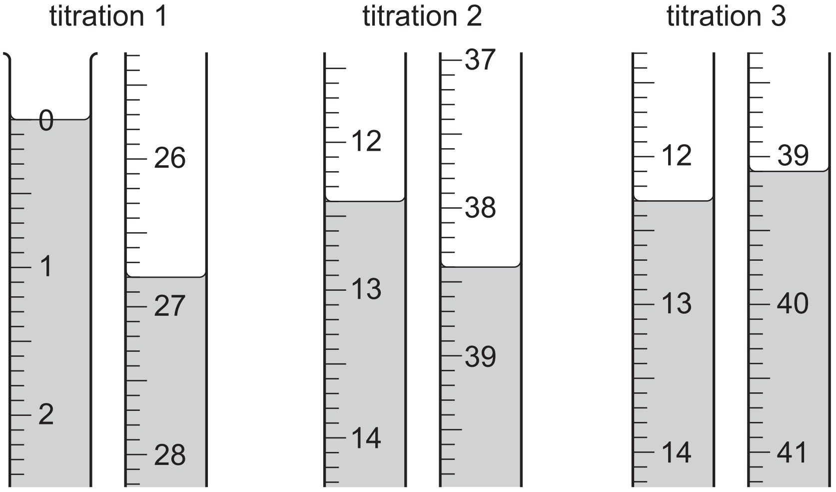
(e) Solution **T** reacts with the iron(II) sulfate in the conical flask.

Iron(II) sulfate is a reducing agent.

State the colour change in the conical flask at the end-point of the titration.

from .... to .... [1]

(f) 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.



Use the diagrams to complete the table.

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

Summary

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

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

.... cm^3 [4]

(g) Solution **T** is 0.0200 mol / dm^3 potassium manganate(VII).

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

.... mol [1]

(h) **One** mole of potassium manganate(VII) reacts with **five** moles of iron(II) sulfate, $FeSO_4$.

Calculate the number of moles of $FeSO_4$ in 20.0 cm^3 of **R**.

.... mol [1]

(i) Calculate the number of moles of $FeSO_4$ in 500 cm^3 of **R**.

.... mol [1]

(j) Calculate the mass of $FeSO_4$ in 500 cm^3 of **R**.

[M_r: $FeSO_4$, 152]

.... g [1]

(k) Use your answers to **(a)** and **(j)** to calculate the percentage by mass of $FeSO_4$ in the mixture.

.... % [1]

[Total: 15]

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

Complete the table.

Name any gases that are formed in the tests.

test	observation	conclusion	
(a) **S** 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.	....	**S** contains Cu^{2+} ions.	[1]
(ii) An excess of aqueous ammonia is added to the mixture from **(b)(i)**.	....	**S** contains Cu^{2+} ions.	[1]
(c) **(i)** To a portion of the solution from **(a)** aqueous sodium hydroxide is added until a change is seen.	....	**S** contains Cu^{2+} ions.	[1]
(ii) An excess of aqueous sodium hydroxide is added to the mixture from **(c)(i)**.	....	**S** contains Cu^{2+} ions.	[1]
(iii) The mixture from **(c)(ii)** is warmed and the gas formed is tested with damp red litmus paper.	....	**S** contains NH_4^+.	[2]
(d)	A white precipitate forms.	**S** contains SO_4^{2-}.	[2]

[Total: 9]

BLANK PAGE

6 When aqueous sodium hydroxide is added to dilute sulfuric acid a reaction occurs.

$$2NaOH(aq) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(l)$$

A student has two solutions.

W is 2.0 mol / dm^3 NaOH(aq).

X is H_2SO_4(aq) of unknown concentration.

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

The student:

- transfers 20.0 cm^3 of **W** into a glass beaker
- measures the temperature of **W**
- adds 5.0 cm^3 of **X** to **W** in the beaker
- stirs the mixture
- measures the highest temperature reached
- calculates the increase in temperature
- repeats with different volumes of **X**.

The table shows the results.

experiment	volume of **W** / cm^3	volume of **X** / cm^3	temperature increase / °C
1	20.0	5.0	2.7
2	20.0	10.0	5.4
3	20.0	15.0	8.0
4	20.0	20.0	9.1
5	20.0	25.0	7.8
6	20.0	30.0	6.5

(a) The student uses a burette to measure the volumes of **W** and **X**.

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

.... [1]

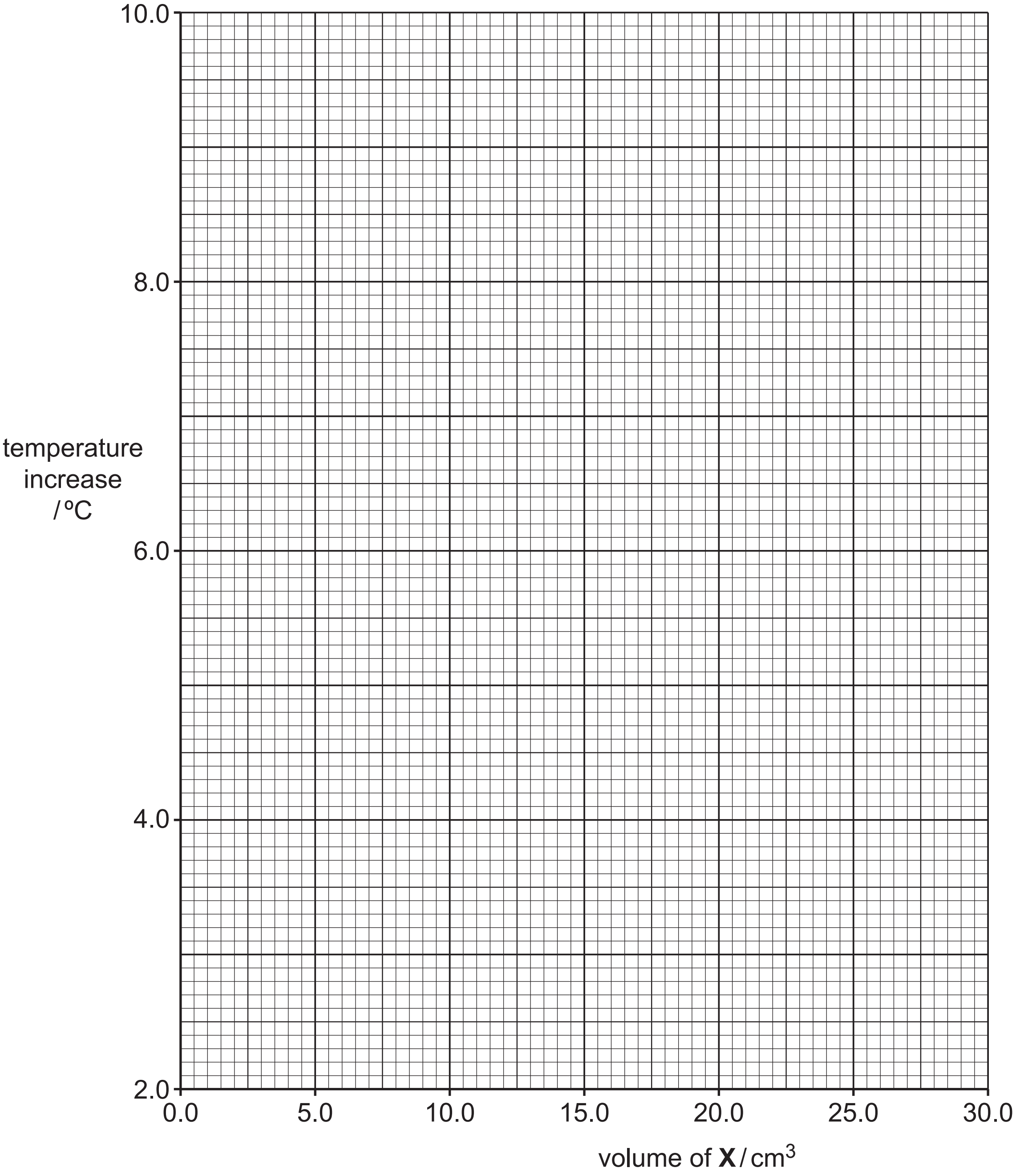
(b) State the evidence in the table that shows that the reaction is exothermic.

.... [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 volume of **X** that produces a temperature increase of 5.6 °C when added to 20.0 cm^3 of **W**.

.... cm^3 [1]

(ii) Determine the temperature increase if 12.5 cm^3 of **X** is added to 20.0 cm^3 of **W**.

.... °C [1]

(e) **(i)** Use your graph to determine the minimum volume of **X** that reacts with all of the NaOH in 20.0 cm^3 of **W**.

.... cm^3 [1]

(ii) **W** is 2.0 mol / dm^3 NaOH.

The equation for the reaction between NaOH and H_2SO_4 is shown.

$$2NaOH(aq) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(l)$$

Use your answer to **(e)(i)** and the equation to calculate the concentration of H_2SO_4 in **X**.

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

[Total: 11]

Cambridge O Level

CANDIDATE NAME	

CENTRE NUMBER		CANDIDATE NUMBER	

CHEMISTRY **5070/42**

Paper 4 Alternative to Practical **October/November 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.

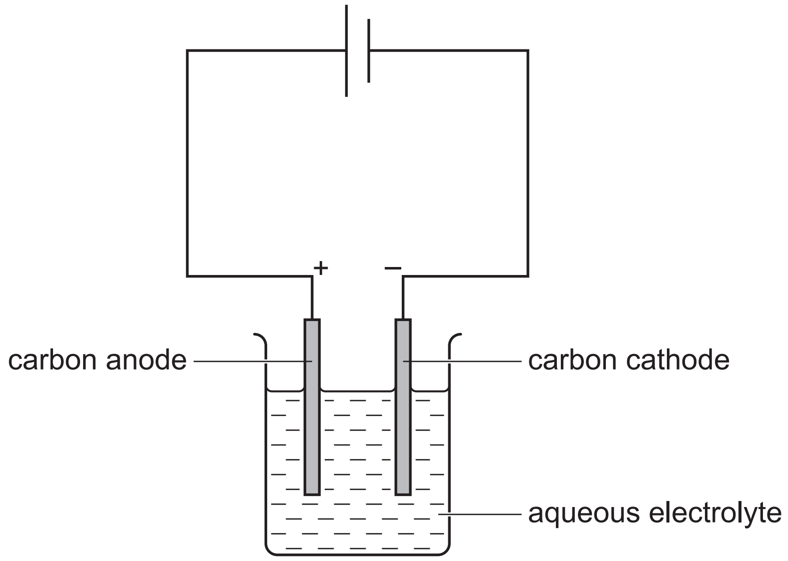
INFORMATION

- 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 **16** pages. Blank pages are indicated.

DC (RW/CB) 184037/3

1 A student investigates two different aqueous electrolytes using the apparatus shown.



(a) Complete the table.

	anode (+)		cathode (–)	
aqueous electrolyte	name of product	observation	name of product	observation
dilute sulfuric acid			hydrogen	bubbles of colourless gas
aqueous copper(II) sulfate		bubbles of colourless gas		

[5]

(b) State the test and its observation to identify hydrogen gas.

test ....

observation .... [1]

[Total: 6]

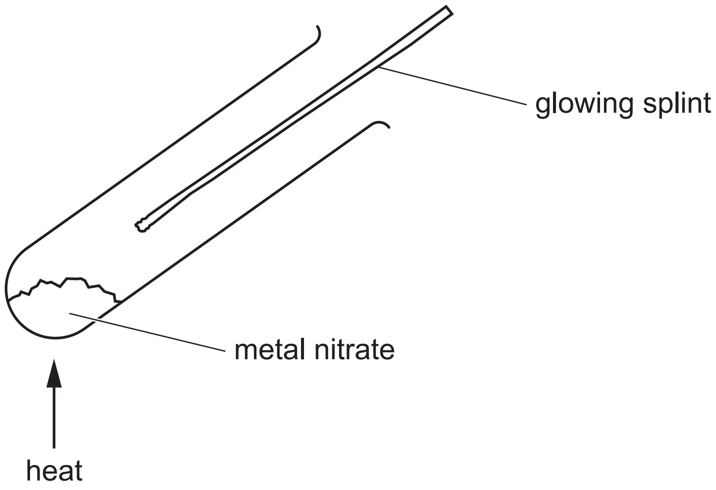
2 When solid Group I nitrates are heated they decompose and give off a gas. The gas relights a glowing splint.

(a) Name the gas that relights a glowing splint.

.... [1]

A student investigates the rate of decomposition of four Group I nitrates.

The student heats each of the nitrates separately with a Bunsen burner. The student measures the time taken for a glowing splint to relight for each nitrate.



(b) It is important to control the amount of heat supplied by the Bunsen burner.

Suggest **two** ways the amount of heat supplied is kept constant.

1 ....

2 .... [2]

(c) Suggest a variable, involving the metal nitrate, that should be controlled.

.... [1]

(d) Each experiment is repeated two more times. The results are shown in the table.

	time taken for glowing splint to relight / s			
metal nitrate	experiment 1	experiment 2	experiment 3	average time
lithium nitrate	100	150	100	
potassium nitrate	150	300	320	
rubidium nitrate	400	450	410	
sodium nitrate	200	200	240	

(i) Use the times in the table to calculate an average time for each metal nitrate. Do **not** use any anomalous times. Write your answers in the table. [2]

(ii) Which metal nitrate decomposes the fastest? Use information from the table to explain your answer.

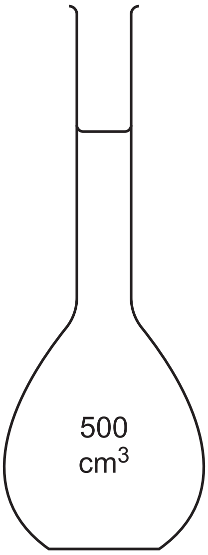
metal nitrate ....

explanation .... [2]

[Total: 8]

3 A student is provided with solution **K**, which is aqueous sodium hydroxide, NaOH. The student determines the concentration of **K** by titration.

The student measures 25.0 cm^3 of **K** and transfers it to apparatus **A**.



A

(a) Name a piece of apparatus used to measure 25.0 cm^3 accurately.

.... [1]

(b) Name apparatus **A**.

.... [1]

The student makes up the 25.0 cm^3 sample of **K** to 500 cm^3 with distilled water. This is solution **L**.

The student transfers 25.0 cm^3 of **L** into a conical flask and adds two drops of methyl orange indicator.

Solution **M** is 0.0500 mol / dm^3 sulfuric acid, H_2SO_4.

M is put into a burette and run into the conical flask until the indicator changes colour and the end-point is reached.

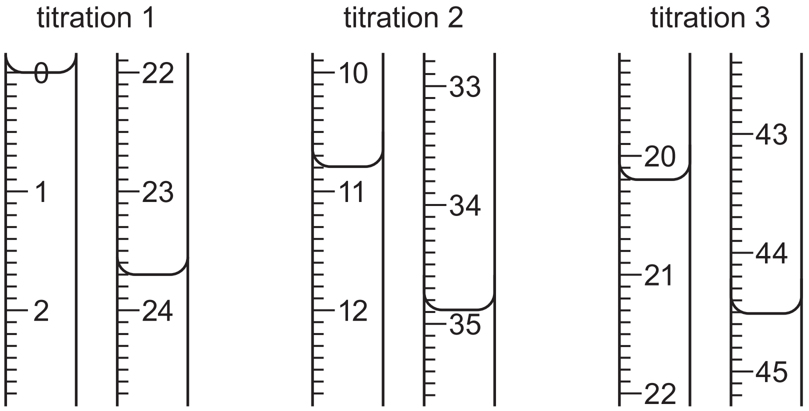
(c) Why is it wrong to wash out the burette with distilled water immediately before filling it with **M**?

.... [1]

(d) What is the colour change of the methyl orange indicator at the end-point?

The colour changes from .... to .... [1]

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



Use the diagrams to complete the table.

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

Summary

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

Use the ticked results to calculate the average volume of **M**.

.... cm^3 [4]

(f) Solution **M** is 0.0500 mol / dm^3 sulfuric acid, H_2SO_4.

Calculate the number of moles of H_2SO_4 in the average volume of **M** used in the titration.

.... mol [1]

(g) Dilute sulfuric acid reacts with aqueous sodium hydroxide as shown.

$$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$$

Calculate the number of moles of NaOH in 25.0 cm^3 of **L**.

.... mol [1]

(h) Calculate the number of moles of NaOH in 500 cm^3 of **L**.

.... mol [1]

(i) Calculate the number of moles of NaOH in 25.0 cm^3 of **K**.

.... mol [1]

(j) Calculate the concentration of NaOH in **K**.

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

.... mol / dm^3 [1]

(k) Between each titration, the student washes the conical flask with water. A second student repeats the experiment but uses **L** instead of water to wash the conical flask.

State **and** explain whether the second student's titration volume of dilute sulfuric acid would be smaller, larger or unchanged compared with the first student's volume of dilute sulfuric acid.

....

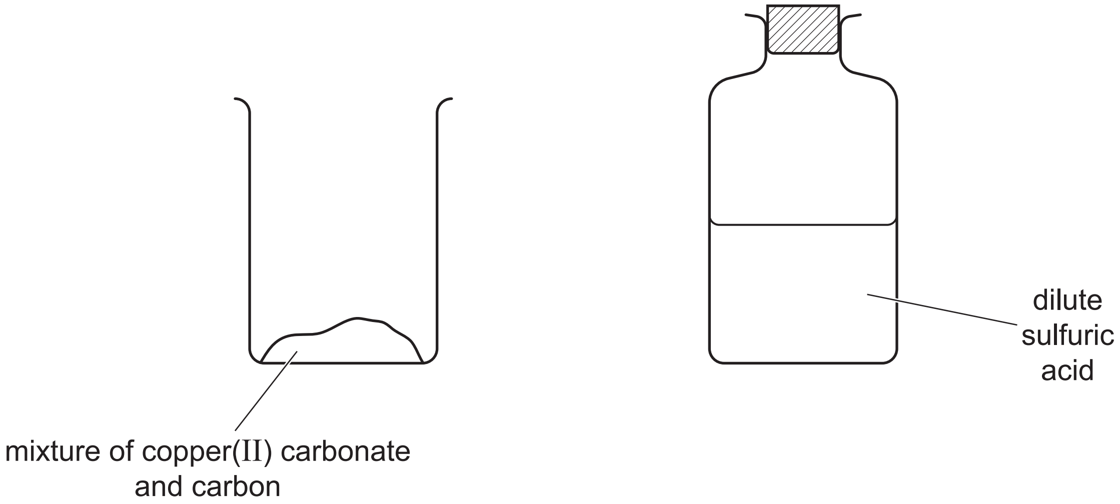
....

.... [2]

[Total: 15]

4 You are provided with a mixture of copper(II) carbonate and carbon.

Both copper(II) carbonate and carbon are solids. They are both insoluble in water. Copper(II) carbonate reacts with dilute sulfuric acid and forms an aqueous solution. Carbon does not react with or dissolve in dilute sulfuric acid.



Use this information to plan an experiment to produce a sample of **pure carbon** from the mixture.

You are provided with the mixture of copper(II) carbonate and carbon as well as dilute sulfuric acid and distilled water. You have access to the apparatus normally found in a school chemistry laboratory. No other chemicals are available.

Your plan should include details of how to:

- separate the carbon
- purify the carbon.

Chemical equations are not required.

....

....

....

....

....

....

.... [4]

5 A solid mixture **R** contains two cations and one anion. The table shows the tests that a student does on **R**.

Complete the table.

Identify any gases that are formed in the tests.

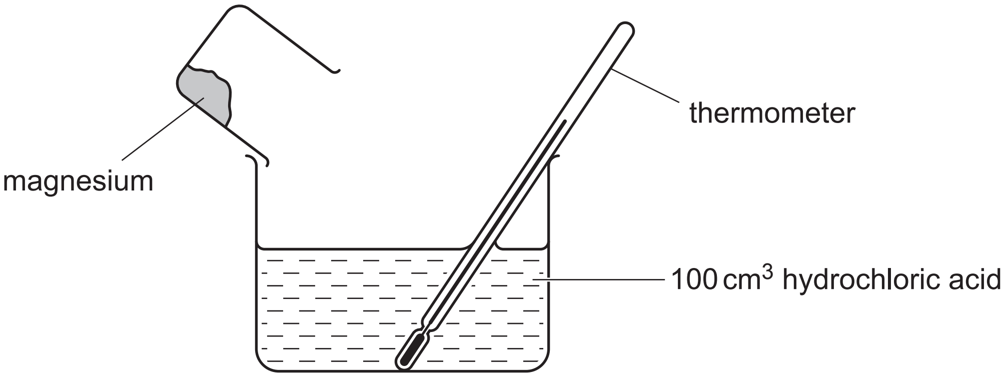
test	observation	conclusion	
(a) **R** is dissolved in water. The solution is divided into three portions for tests **(b)**, **(c)** and **(d)**.	A coloured solution is formed.	....	[1]
(b) **(i)** To a portion of the solution from **(a)**, aqueous ammonia is added until a change is seen.	....	**R** 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.	[2]
(iii) The mixture from **(c)(ii)** is warmed and the gas formed is tested with damp red litmus paper.	The gas turns damp red litmus paper blue.	....	[2]
(d)	....	**R** contains SO_4^{2-} ions.	[3]

[Total: 11]

6 A student investigates the temperature rise when different masses of magnesium are added to dilute hydrochloric acid.

In each experiment the student:

- pours 100 cm^3 of dilute hydrochloric acid into a beaker
- places a thermometer into the acid
- records the temperature of the acid
- adds a known mass of magnesium to the acid and stirs the mixture
- records the highest temperature reached.



(a) **(i)** The temperature rise with each mass of magnesium is less than expected. Give one reason for this.

....

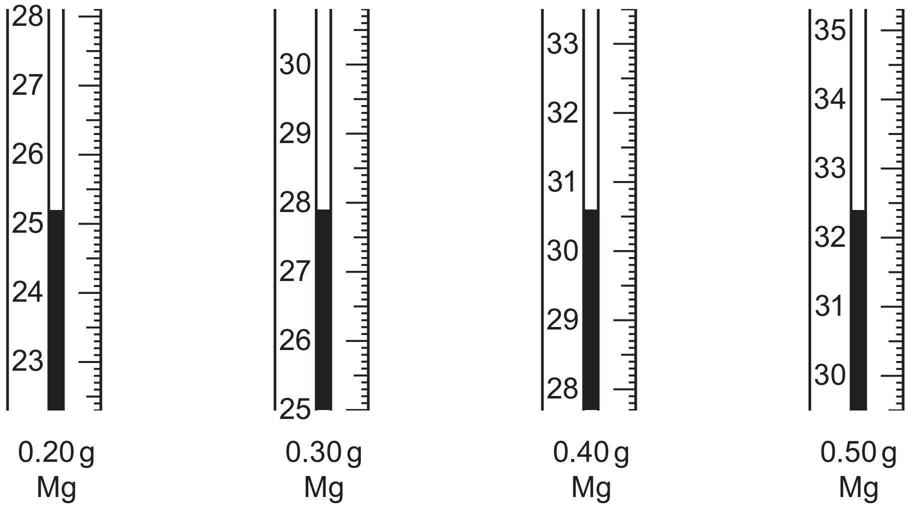
.... [1]

(ii) State **two** changes that can be made to the apparatus so that the temperature rise for each mass of magnesium is closer to the expected value for each mass.

1 ....

2 .... [2]

The diagrams show parts of the thermometer stem giving the highest temperature recorded using different masses of magnesium.



(b) Use the thermometer readings to complete the following table.

mass of magnesium / g	initial temperature of hydrochloric acid / °C	highest temperature of hydrochloric acid / °C	temperature rise / °C
0.10	20.0	22.6	2.6
0.20	20.0		
0.30	20.0		
0.40	20.0		
0.50	20.0		
0.60	20.0	32.4	12.4
0.70	20.0	32.4	12.4

[2]

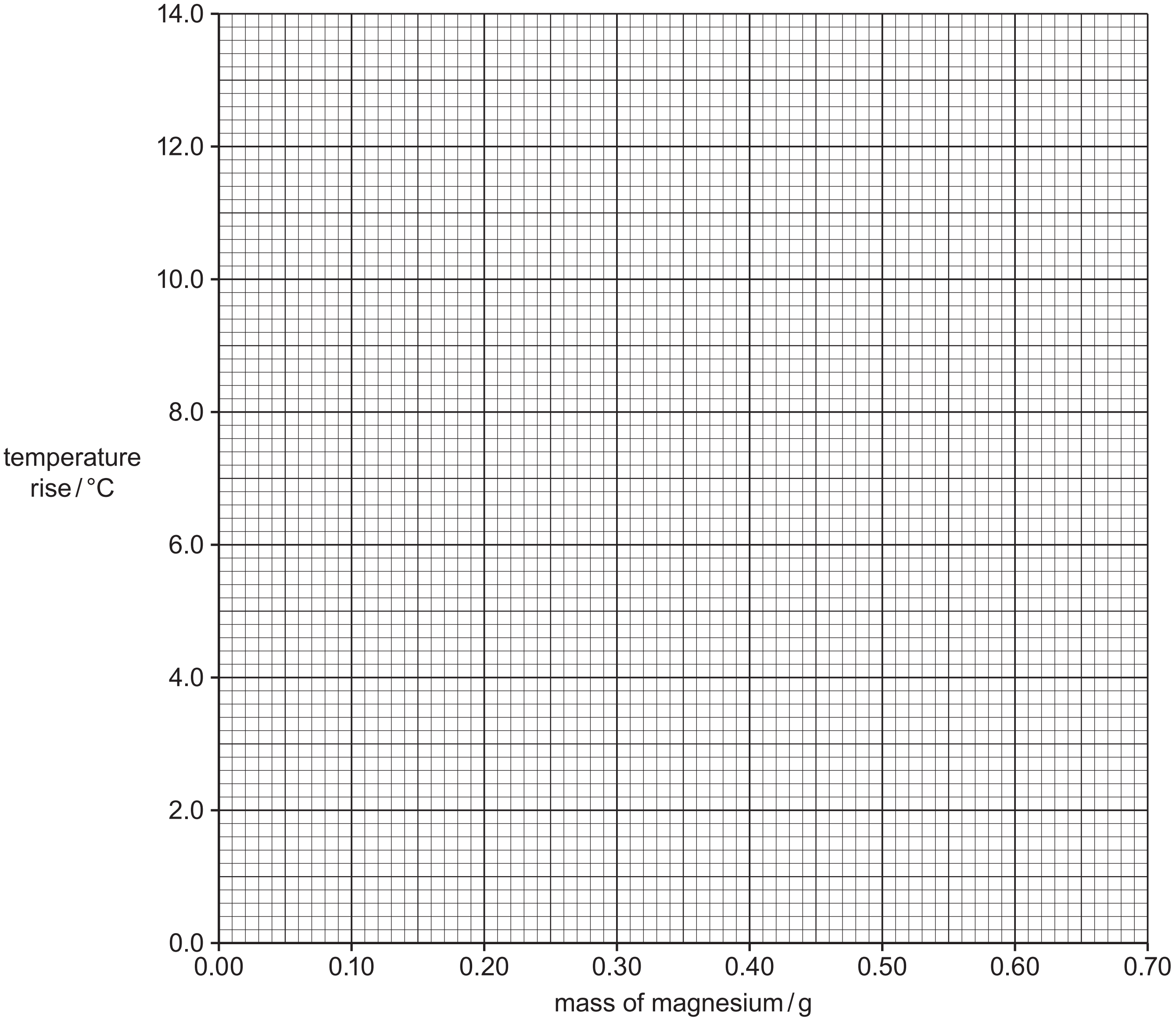
(c) What evidence in the table shows that the reaction is exothermic?

.... [1]

(d) Plot the temperature rise against the mass of magnesium on the grid.

Draw a straight line through the first four points.

Draw another straight line through the last three points. Extend both straight lines so that they cross.



[3]

(e) Use your graph to answer the questions. In each case assume that magnesium is added to 100 cm^3 of dilute hydrochloric acid at 20.0 °C.

(i) What is the temperature rise when 0.35 g of magnesium is used?

.... °C [1]

(ii) What is the highest temperature when 0.15 g of magnesium is used?

.... °C [1]

(iii) What mass of magnesium is used to give a highest temperature of 26.0 °C?

.... g [1]

(iv) What is the **minimum** mass of magnesium that reacts with all of the hydrochloric acid?

.... g [1]

(f) **(i)** Use your answer to **(e) (iv)** to calculate the number of moles of magnesium that reacts with 100 cm^3 of dilute hydrochloric acid.

[A_r: Mg, 24]

.... mol [1]

(ii) Magnesium reacts with dilute hydrochloric acid.

$$Mg + 2HCl \rightarrow MgCl_2 + H_2$$

Calculate the concentration, in mol / dm^3, of the hydrochloric acid.

.... mol / dm^3 [2]

[Total: 16]

BLANK PAGE

BLANK PAGE

BLANK PAGE

Cambridge O Level

CANDIDATE NAME	

CENTRE NUMBER		CANDIDATE NUMBER	

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.

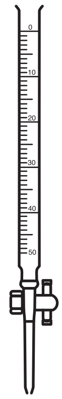
DC (JC/JG) 183903/4

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

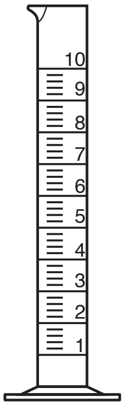
Iron tablets contain iron(II) ions, Fe^{2+}.

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



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.

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.

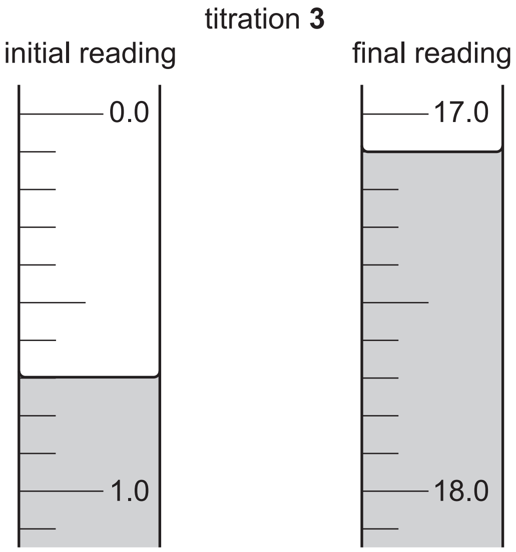
....

.... [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 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]

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

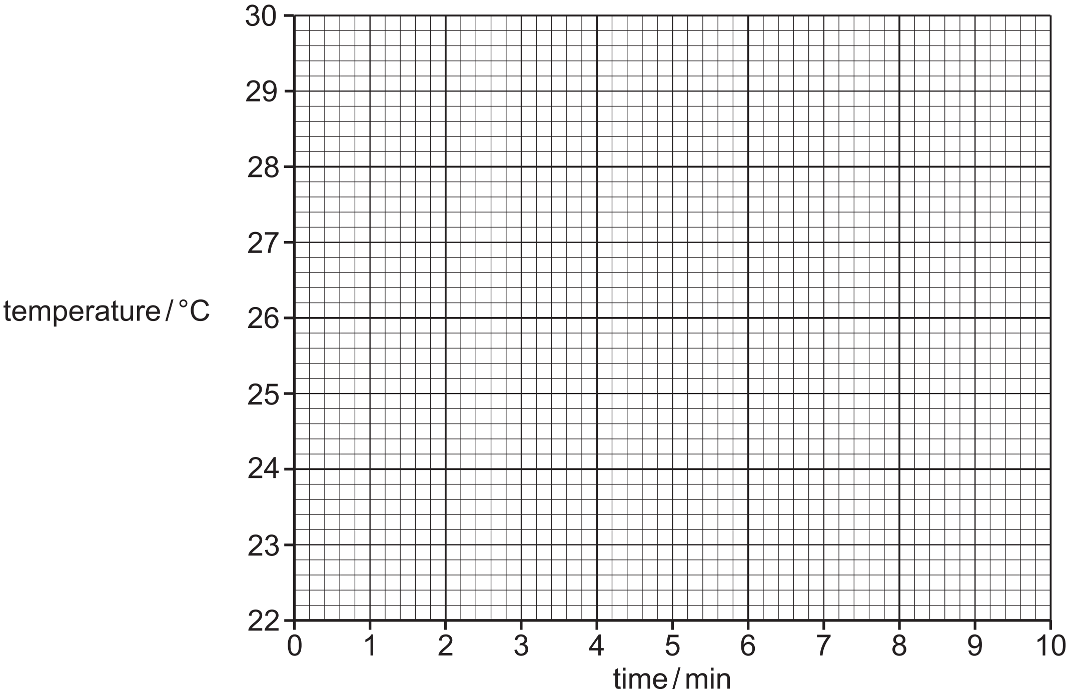
Suggest an improvement.

....

....

.... [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]

Cambridge O Level

Cambridge Assessment International Education
Cambridge Ordinary Level

CANDIDATE NAME	

CENTRE NUMBER						CANDIDATE NUMBER				

CHEMISTRY **5070/42**

Paper 4 Alternative to Practical **May/June 2019**

1 hour

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Write your answers in the spaces provided in the Question Paper.
Electronic calculators may be used.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

This document consists of **12** printed pages.

DC (ST/CT) 165353/3

Cambridge Assessment International Education

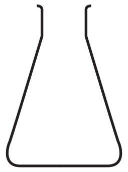
[Turn over

1 Milk of Magnesia is a liquid medicine used to treat indigestion.

Milk of Magnesia contains magnesium hydroxide, $Mg(OH)_2$.

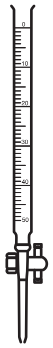
A student does a series of titrations to determine the percentage by mass of magnesium hydroxide in Milk of Magnesia.

Diagrams of some of the apparatus used by the student are shown.



A

B



C

(a) Name the three pieces of apparatus.

A ....

B ....

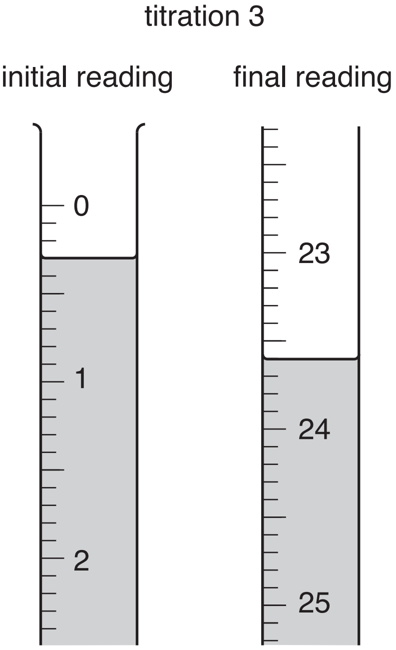
C ....
[3]

(b) The student:

- puts 5.0 cm^3 of the Milk of Magnesia into apparatus **A** and adds some distilled water
- adds a few drops of a suitable indicator to the mixture in apparatus **A**
- fills apparatus **C** with 0.600 mol / dm^3 hydrochloric acid
- titrates the contents of apparatus **A** with the 0.600 mol / dm^3 hydrochloric acid until the indicator changes colour
- records the readings.

The student repeats the procedure three further times.

(i) The diagrams show parts of apparatus **C** 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	24.1	47.5		24.4
initial reading / cm^3	0.0	23.7		
volume of 0.600 mol / dm^3 hydrochloric acid used / cm^3		23.8		23.6
best titration results (✓)				

[3]

(ii) Tick (✓) the best titration results in the table.
Use these best titration results to calculate the average volume of 0.600 mol / dm^3 hydrochloric acid used.

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

(iii) Suggest why the volume of distilled water the student adds to apparatus **A** does not affect the results of the titrations.

....

....

....

.... [1]

(c) A second student does another series of titrations using the same method. This student obtains an average volume of 23.3 cm^3.

The equation for the reaction during the titration is shown.

$$Mg(OH)_2 + 2HCl \rightarrow MgCl_2 + 2H_2O$$

(i) Calculate the number of moles of 0.600 mol / dm^3 hydrochloric acid used by this second student.

.... moles [1]

(ii) Calculate the number of moles of magnesium hydroxide present in 5.0 cm^3 of the Milk of Magnesia.

.... moles [1]

(iii) Calculate the mass of magnesium hydroxide in 5.0 cm^3 of the Milk of Magnesia.
[A_r: Mg, 24; O, 16; H, 1]

....g [2]

(iv) The density of the Milk of Magnesia is 2.34 g / cm^3.

$$\text{density in g/cm}^3 = \frac{\text{mass in g}}{\text{volume in cm}^3}$$

Calculate the mass of 5.0 cm^3 of the Milk of Magnesia.

....g [1]

(v) Calculate the percentage by mass of magnesium hydroxide in the Milk of Magnesia.

....% [1]

[Total: 14]

2 E150a and E155 are both brown food colourings.

Plan an investigation to find whether the brown food colouring in a soft drink is E150a or E155. The food colourings are both soluble in water.

You are provided with solutions of E150a, E155 and the brown food colouring from the soft drink. You also have access to the apparatus normally found in a chemistry laboratory.

You should draw a labelled diagram with your plan and include essential practical details.

....

....

....

....

....

....

....

....

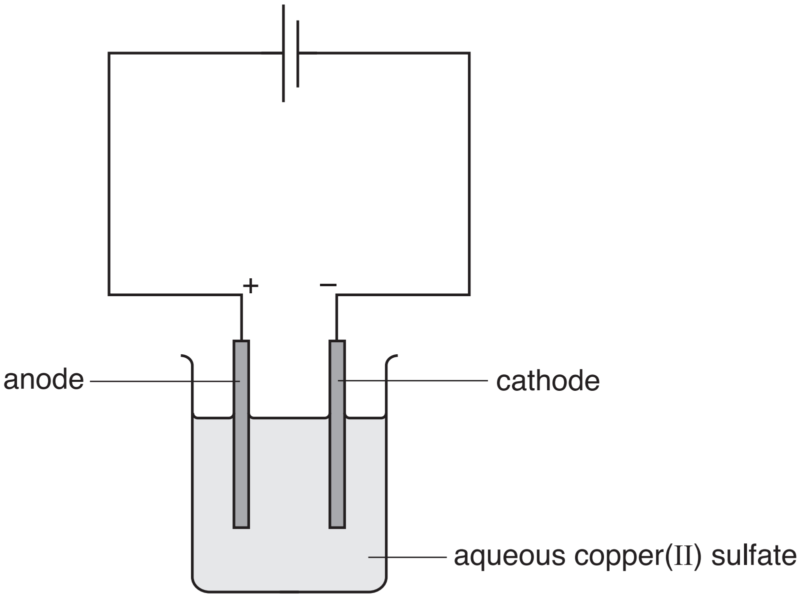
....

....

....

.... [6]

3 The apparatus shown is used for the electrolysis of aqueous copper(II) sulfate.



(a) Inert graphite electrodes are used for the electrolysis.

(i) Describe what is seen at each electrode during the electrolysis.

cathode ....

anode .... [2]

(ii) Give a test and observation to identify the product at the anode.

test ....

observation .... [2]

(iii) Describe what happens to the colour of the solution during the electrolysis. Explain your answer.

description ....

explanation ....

.... [2]

(b) The electrolysis is repeated using copper electrodes in place of the inert graphite electrodes.

(i) Describe what happens to the colour of the solution during this electrolysis.

....

.... [1]

(ii) State what happens to the mass of each electrode during this electrolysis.
Explain your answer.

mass of cathode ....

mass of anode ....

explanation ....

....

....
[3]

(iii) Suggest a practical use for the electrolysis of aqueous copper(II) sulfate.

.... [1]

[Total: 11]

4 Hydrogen peroxide, H_2O_2, reacts with iodide ions to produce water and iodine.
Acid must also be added for the reaction to occur.

$$H_2O_2(aq) \;+\; 2H^+(aq) \;+\; 2I^-(aq) \;\rightarrow\; 2H_2O(l) \;+\; I_2(aq)$$

(a) The initial reaction mixture is colourless.

State what is observed during this reaction.

....

.... [1]

(b) The rate of this reaction is investigated by removing samples of the reaction mixture, of equal volumes, at timed intervals.

Each sample is added to an excess of powdered calcium carbonate in a flask to stop the reaction in the sample.

(i) Suggest why the reaction stops when the sample is added to calcium carbonate.

....

.... [1]

(ii) Suggest why the calcium carbonate is powdered.

....

.... [1]

(iii) State what is observed when a sample of the reaction mixture is added to calcium carbonate.

....

.... [1]

(c) After each sample is added to calcium carbonate, the contents of this flask are titrated with aqueous sodium thiosulfate.

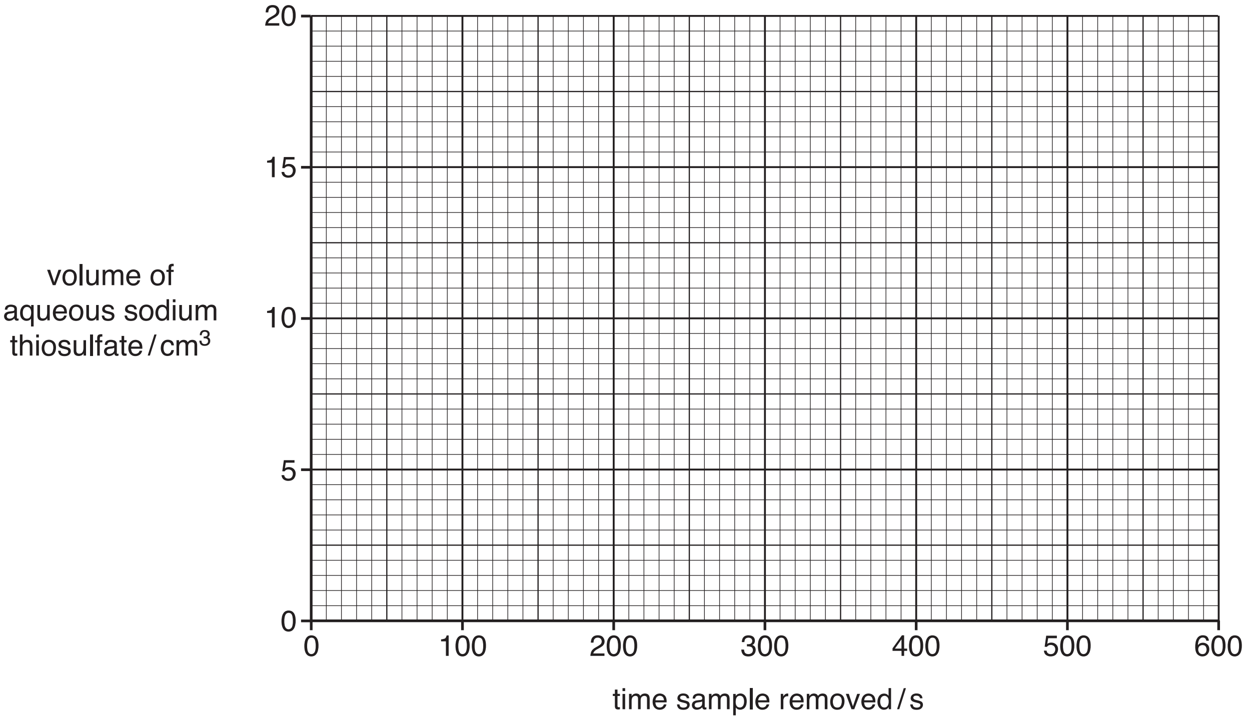
The sodium thiosulfate reacts with the iodine produced by the reaction between hydrogen peroxide and iodide ions.

The volume of aqueous sodium thiosulfate needed for each titration depends on the amount of iodine in the sample.

The results of the experiment are shown in the table.

time sample removed / s	0	100	200	300	400	500	600
volume of aqueous sodium thiosulfate needed for titration / cm^3	0	11.0	12.0	15.5	17.5	18.5	18.5

(i) Plot the results on the grid.



[2]

(ii) Draw a circle around the anomalous point on the grid. [1]

(iii) Use the points to draw a curve of best fit. [1]

(iv) Use the graph to determine the volume of aqueous sodium thiosulfate needed for a sample taken at 250 s.

volume ....cm^3 [1]

(v) Use the graph to determine the time at which a sample is taken if 6.0 cm^3 of aqueous sodium thiosulfate is needed.

time .... s [1]

(vi) Describe and explain the difference in the slope of your curve at 50 seconds and at 400 seconds.

difference in slope ....

....

explanation ....

....

....

....

....
[4]

[Total: 14]

5 Salts can be prepared in the laboratory in various ways.

Describe a suitable method to prepare a pure, dry sample of each of the named salts.

In your description you should include the names of any techniques, apparatus and chemicals used.

(a) Copper(II) sulfate
This method should use the reaction between an insoluble compound and a dilute acid.

....

....

....

....

....

....

....

....

....

....

.... [5]

(b) Silver chloride
This method should use a precipitation reaction.

....

....

....

....

....

....

....

....

....

.... [4]

[Total: 9]

[Turn over

6 The mineral alstonite contains two different cations but only one anion.

The table shows the tests a student does on a sample of alstonite.

Complete the table. Any gases formed should be named.

test	observations	conclusions	
(a) To a portion of alstonite in a boiling tube, add dilute hydrochloric acid until all the solid has dissolved. Use the resulting solution in tests **(b)**, **(c)** and **(d)**.	The solid dissolves. Effervescence is observed and the gas formed turns limewater milky.		[2]
(b) To a portion of the solution from **(a)** in a test-tube, add dilute sulfuric acid.		Alstonite contains Ba^{2+} ions.	[1]
(c) To a portion of the solution from **(a)** in a test-tube, add aqueous sodium hydroxide until in excess.		Alstonite may contain Ca^{2+} ions.	[2]
(d) To a portion of the solution from **(a)** in a test-tube, add aqueous ammonia.		Alstonite contains Ca^{2+} ions.	[1]

[Total: 6]

Cambridge Assessment International Education
Cambridge Ordinary Level

CANDIDATE NAME	

CENTRE NUMBER						CANDIDATE NUMBER					

CHEMISTRY **5070/42**

Paper 4 Alternative to Practical **October/November 2019**

1 hour

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Write your answers in the spaces provided in the Question Paper.
Electronic calculators may be used.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

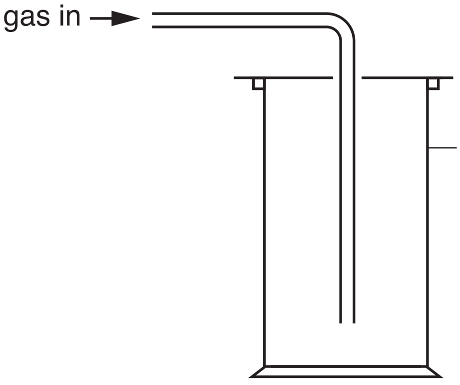
This document consists of **14** printed pages and **2** blank pages.

DC (ST/CT) 165354/2

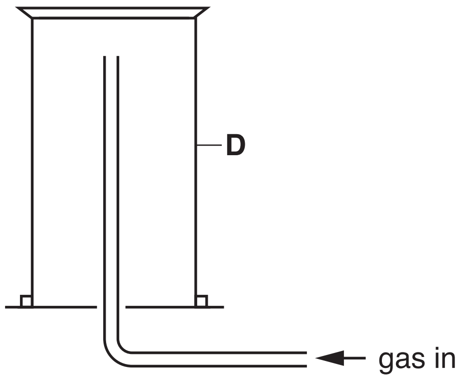
1 Three gases, **A**, **B** and **C**, have the properties shown.

gas	density	solubility in water	appearance
A	less dense than air	insoluble	colourless
B	more dense than air	insoluble	colourless
C	more dense than air	soluble	green

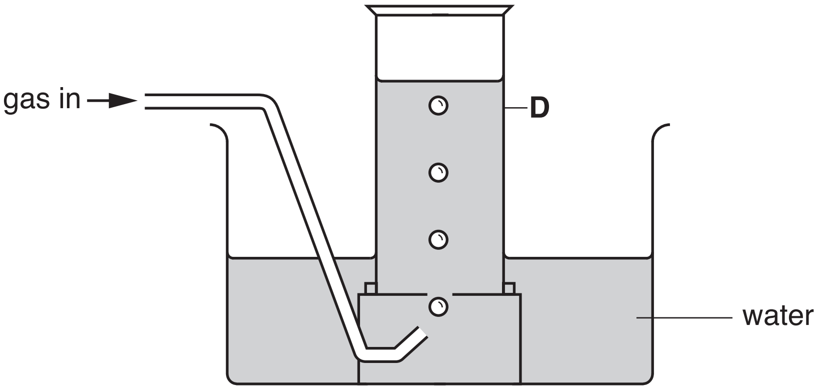
Some sets of apparatus, **X**, **Y** and **Z**, used to collect gases are shown.



X



Y



Z

(a) Apparatus **D** is used to collect the gases.

Name apparatus **D**.

.... [1]

(b) Which **two** sets of apparatus, from **X**, **Y** and **Z**, can be used to collect gas **A**?

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

(c) Which set of apparatus, **X**, **Y** or **Z**, can be used to collect gas **C**?

.... [1]

(d) **(i)** State why apparatus **Y** is less suitable than apparatus **X** to collect gas **B**.

.... [1]

(ii) State why apparatus **X** is less suitable than apparatus **Z** to collect gas **B**.

....

.... [1]

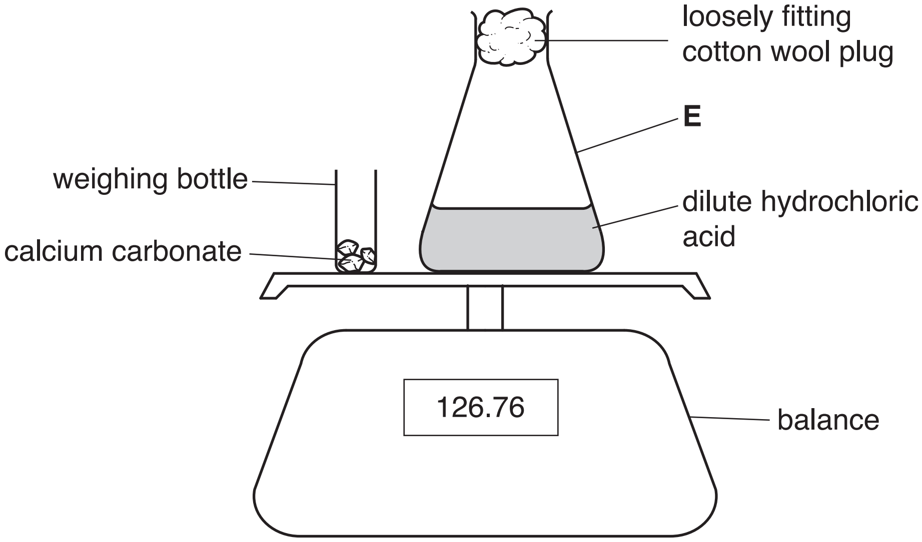
[Total: 5]

2 Calcium carbonate reacts with dilute hydrochloric acid.

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

Vigorous bubbling is seen.

A student investigates the rate of this reaction using three samples of calcium carbonate. Each sample has a different particle size.



In each experiment the student adds all of the calcium carbonate, an excess, to dilute hydrochloric acid in apparatus **E**. The weighing bottle is replaced on the balance. The student records the mass every 30 seconds.

In experiment **1** the student uses large lumps of calcium carbonate.

(a) Name apparatus **E**.

.... [1]

(b) Which variable, other than mass, is measured in the experiment? Name the piece of apparatus used to measure this variable.

variable ....

apparatus ....
[1]

(c) Why does the mass decrease?

.... [1]

(d) The student does two more experiments. In each experiment the student uses calcium carbonate of different particle sizes.

In experiment **2** the student uses small lumps of calcium carbonate instead of large lumps.

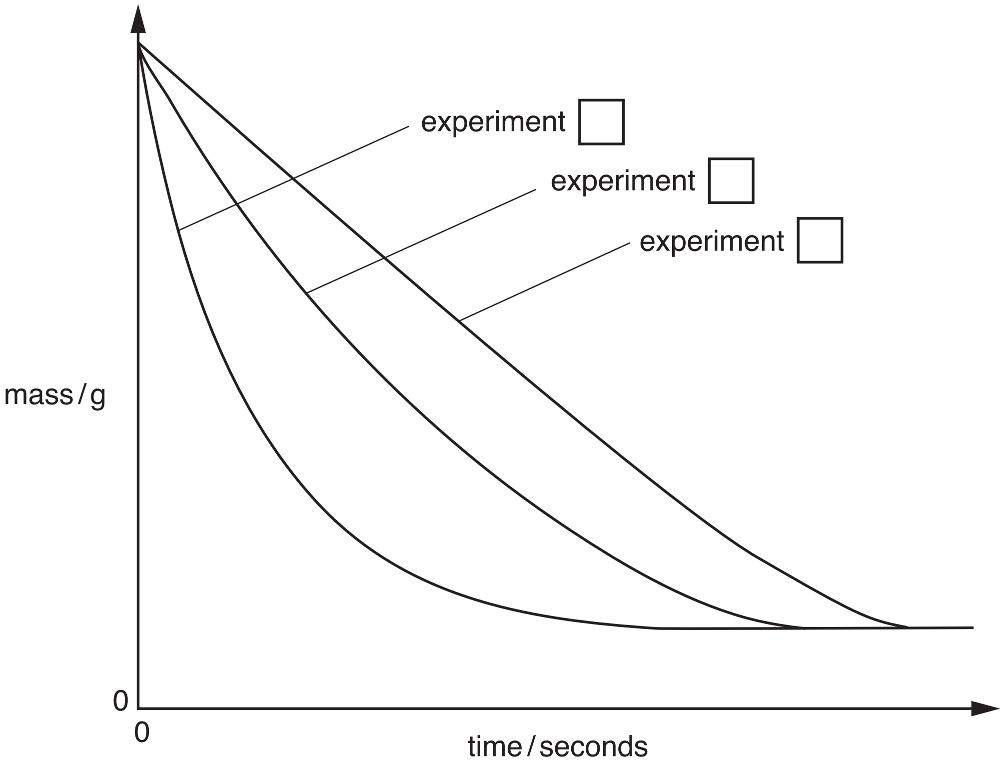
In experiment **3** the student uses powdered calcium carbonate instead of large lumps.

Suggest two variables that the student keeps constant so that the particle size of the calcium carbonate is the only variable that affects the rate of reaction.

1 ....

2 ....
[2]

(e) The student plots a graph of the results.



(i) Describe how the graphs are used to decide which experiment has the fastest rate.

....

.... [1]

(ii) Write a number in each box on the graph to identify experiments **1**, **2** and **3**. [1]

(iii) State how the graph shows that the reactions stop.

.... [1]

(iv) Why do the reactions stop?

.... [1]

[Total: 9]

3 An unlabelled bottle contains solid sodium carbonate, Na_2CO_3. Another unlabelled bottle contains solid sodium hydrogencarbonate, $NaHCO_3$.

The reaction between sodium carbonate and dilute hydrochloric acid is exothermic.

The reaction between sodium hydrogencarbonate and dilute hydrochloric acid is endothermic.

Plan experiments using the reaction of each solid with dilute hydrochloric acid:

- to identify each solid
- to determine which reaction produces the larger energy change per gram of solid.

You may use any of the apparatus normally found in a chemistry laboratory but no other chemicals.

You should state all the measurements you would make.

Chemical equations are not required.

....

....

....

....

....

....

....

....

....

....

....

....

....

....

[7]

4 A student is provided with solutions of:

- aqueous chromium(III) nitrate
- aqueous iron(II) chloride
- aqueous iron(III) chloride.

The student tests the three aqueous solutions by adding each reagent shown in the table.

Record the observations in the table.

Write 'no reaction' where appropriate.

	reagents			
solutions	aqueous sodium hydroxide	aqueous sodium hydroxide in excess	aqueous silver nitrate and dilute nitric acid	aluminium and aqueous sodium hydroxide + heat
aqueous chromium(III) nitrate				name of gas .... test for gas .... result of test ....
aqueous iron(II) chloride				
aqueous iron(III) chloride				

[10]

5 A student does an experiment to determine the percentage by mass of potassium iodate(V), KIO_3, in a sample of impure potassium iodate(V). The sample of impure potassium iodate(V) is placed in a previously weighed container which is then reweighed.

mass of container + impure potassium iodate(V) = 8.20 g

mass of empty container = 5.28 g

(a) Calculate the mass of impure potassium iodate(V) used in the experiment.

.... g [1]

(b) The student transfers the sample of impure potassium iodate(V) to a beaker, adds water and stirs with a glass rod until all the solid has dissolved. The solution is then transferred to a suitable container.

The beaker is washed out twice with water and the washings are transferred to the same container as the solution.

Why is the beaker washed out and the washings transferred to the same container as the solution?

.... [1]

(c) The solution of impure potassium iodate(V) is made up to 500.0 cm^3 with water. This is solution **G**.

Name the container in which solution **G** is made.

.... [1]

(d) The student transfers 25.0 cm^3 of **G** to a conical flask using a pipette.

Which liquid should be used to wash out the pipette, immediately before using it, to measure 25.0 cm^3 of **G**?

.... [1]

The student adds an excess of aqueous potassium iodide and an excess of dilute sulfuric acid to the conical flask. A reaction occurs to form iodine. This is solution **H**.

The amount of iodine produced can be determined by titration with aqueous sodium thiosulfate, $Na_2S_2O_3$, with a suitable indicator.

Solution **L** is 0.100 mol / dm^3 $Na_2S_2O_3$.

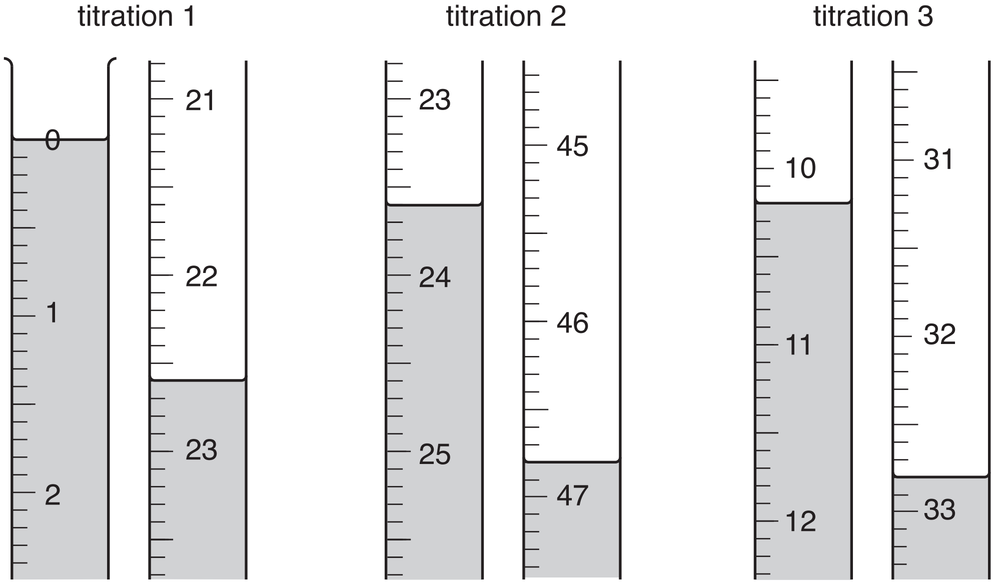
L is put into a burette and run into the conical flask until the end-point is reached.

(e) Why is it unnecessary to measure exactly the same amounts of aqueous potassium iodide and dilute sulfuric acid for each of the titrations?

....

.... [1]

(f) Three titrations are done. The diagrams show parts of the burette with the liquid levels at the beginning and end of each titration.



Use the diagrams to complete the table.

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

Summary

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

Use these best results to calculate the average volume of **L**.

.... cm^3 [4]

(g) Calculate the number of moles of $Na_2S_2O_3$ in the average volume of **L**, 0.100 mol/dm^3 $Na_2S_2O_3$, used in the titration.

.... moles [1]

(h) Use the equation to calculate the number of moles of I_2 in **H** in the conical flask.

$$2Na_2S_2O_3 + I_2 \rightarrow 2NaI + Na_2S_4O_6$$

.... moles [1]

(i) Use the equation to calculate the number of moles of KIO_3 that produces the number of moles of I_2 calculated in **(h)**. This is the number of moles of KIO_3 in 25.0 cm^3 of **G**.

$$KIO_3 + 5KI + 3H_2SO_4 \rightarrow 3I_2 + 3K_2SO_4 + 3H_2O$$

.... moles [1]

(j) Calculate the number of moles of KIO_3 in 500.0 cm^3 of **G**.

.... moles [1]

(k) Calculate the M_r of KIO_3.

[A_r: K, 39; I, 127; O, 16]

.... [1]

(l) Use your answers to **(j)** and **(k)** to calculate the mass of potassium iodate(V), KIO_3, in the sample of impure potassium iodate(V).

....g [1]

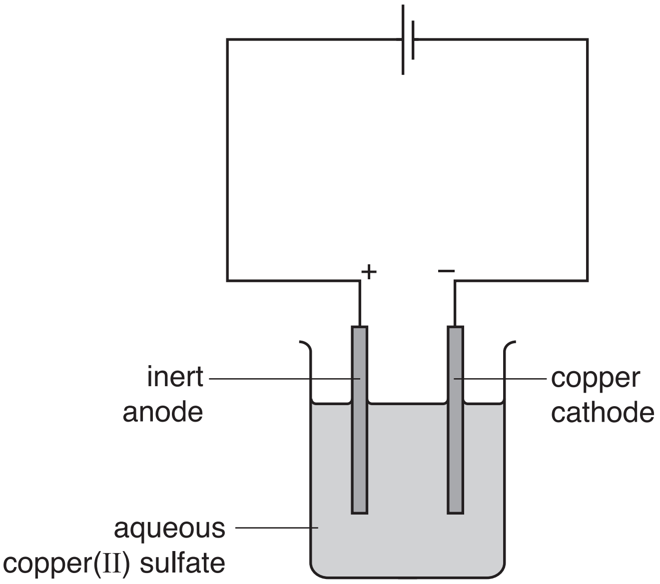
(m) Use your answers to **(a)** and **(l)** to calculate the percentage by mass of KIO_3 in the sample of impure potassium iodate(V).

.... % [1]

[Total: 16]

BLANK PAGE

6 A student passes an electric current through an electrolyte of aqueous copper(II) sulfate using an inert anode and a copper cathode.



(a) Bubbles of gas are observed at the anode.

Name the gas given off at the anode. Give a test and observation to identify the gas.

name ....

test ....

observation ....
[2]

(b) A layer of copper is deposited at the copper cathode. A student wants to find the mass of copper deposited.

The student removes the cathode after 5 minutes.

(i) What should the student do to the cathode before weighing it?

.... [1]

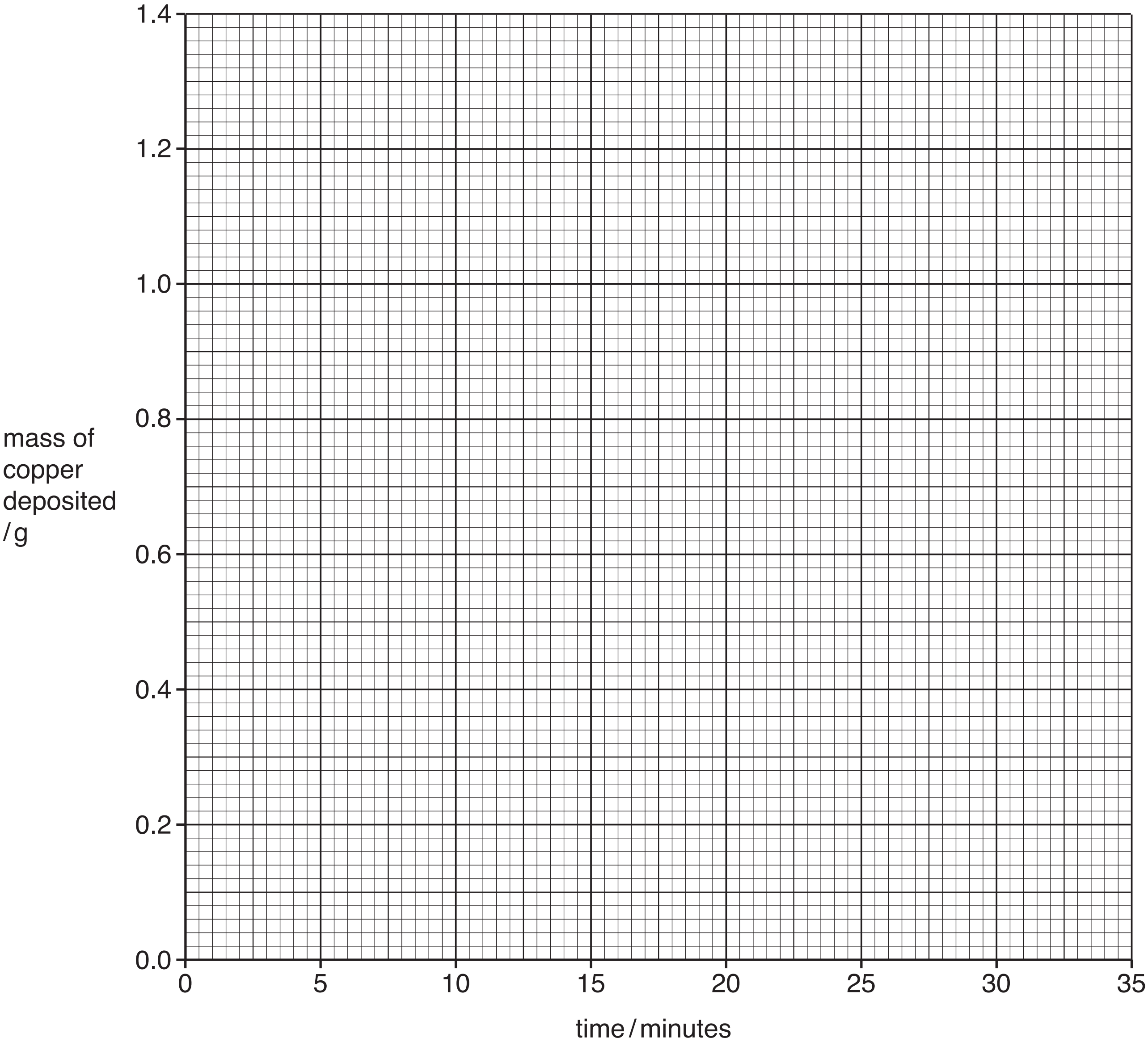
(ii) The student weighs the cathode. Which essential measurement is missing from the experimental method?

.... [1]

(c) After the student weighed the cathode she replaced it in the circuit and continued the experiment. She determined the mass of copper deposited at five-minute intervals.

time / minutes	mass of copper deposited / g
0	0.00
5	0.28
10	0.54
15	0.62
20	1.12
25	1.20
30	1.20
35	1.20

(i) Plot the results in the table on the grid. Use the points to draw two intersecting straight lines of best-fit.



[4]

(ii) Draw a circle around the anomalous point. [1]

(d) **(i)** Use your graph to determine how long it takes for 0.80 g of copper to be deposited.

.... minutes [1]

(ii) Use your graph to determine how long it takes for all the copper to be deposited.

.... minutes [1]

(e) What is the colour of the electrolyte:

- at the start of the experiment

  ....

- when **all** the copper has been deposited at the cathode?

  ....

[2]

[Total: 13]

BLANK PAGE

Cambridge International Examinations
Cambridge Ordinary Level

CANDIDATE NAME	
CENTRE NUMBER	☐☐☐☐☐
CANDIDATE NUMBER	☐☐☐☐

7522989051

CHEMISTRY **5070/42**

Paper 4 Alternative to Practical **May/June 2018**

1 hour

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Write your answers in the spaces provided in the Question Paper.
Electronic calculators may be used.

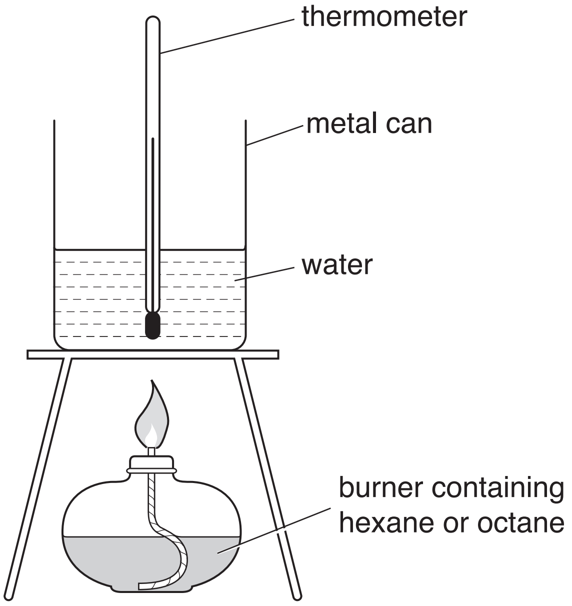
At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

This document consists of **15** printed pages and **1** blank page.

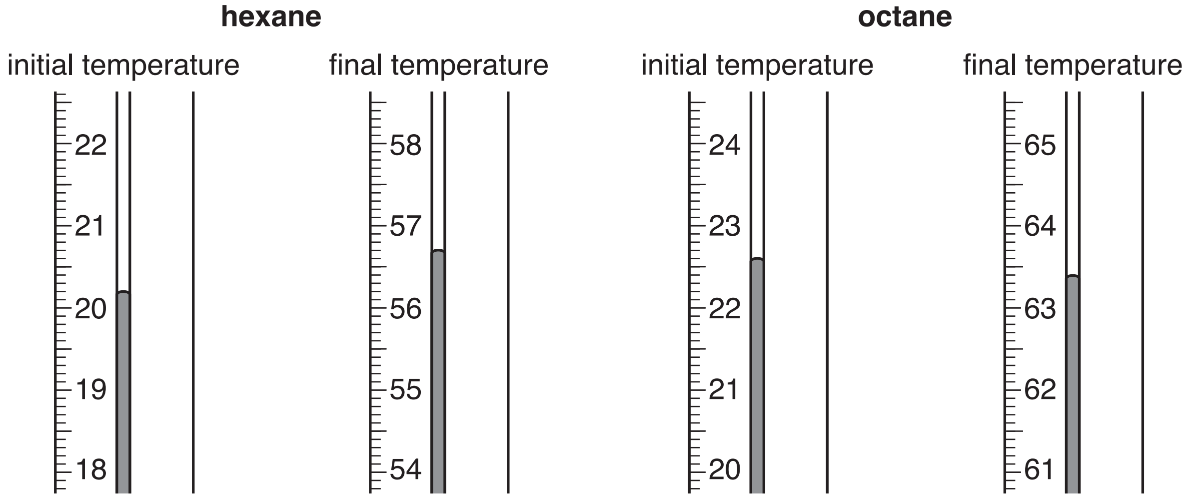
DC (SR/SW) 146475/3

1 A student investigates two fuels: hexane and octane.

The student burns the fuels using the apparatus shown. A fixed volume of water is heated for five minutes in each experiment.



The diagrams show parts of the thermometer stem with the initial and final temperatures.



(a) Read the initial and final temperatures from the thermometer stems and record them in the table.

Complete the table by calculating the temperature changes.

fuel	initial temperature / °C	final temperature / °C	temperature change / °C
hexane			
octane			

[2]

(b) The student compares the temperature changes from the experiment with correct values found in a data book.

The student's experimental values are **lower** than the correct values.

Suggest a reason, other than student error, to explain why they are lower.

....

.... [1]

(c) Look at the data in the table in **(a)**.

(i) Which fuel releases more energy in the investigation?

Explain your answer.

fuel ....

explanation..

....
[1]

(ii) What conclusion can be made from the temperature changes about the type of reaction that occurs?

....

.... [1]

[Total: 5]

2 A chemist plans an experiment to determine the concentration of acid in the juice of a lemon.

Making the solution

- Squeeze the juice out of a lemon.
- Using a measuring cylinder, transfer 10 cm^3 of the lemon juice into a 100 cm^3 volumetric flask.
- Make up to the 100 cm^3 mark with distilled water.
- Mix the solution thoroughly.

Titration

- Transfer 25.0 cm^3 of the diluted lemon juice into a conical flask.
- Add a few drops of a suitable indicator.
- Add 0.0500 mol / dm^3 sodium hydroxide, **R**, until the end-point is reached.
- Repeat the titration two more times.

(a) In the titration, state the name of the apparatus used to:

(i) transfer 25.0 cm^3 of the diluted lemon juice into the conical flask

.... [1]

(ii) add **R** to the diluted lemon juice in the conical flask.

.... [1]

(b) The results of the titrations are recorded in the table.

titration number	1	2	3
final reading / cm^3	15.6	30.8	45.8
initial reading / cm^3	0.0	15.6	30.8
volume of **R** used / cm^3			
best titration results (✓)			

(i) Complete the table by calculating the volumes of **R** used.

[1]

(ii) Tick (✓) the best titration results and explain why you have selected these values.

....

....

.... [1]

(iii) Use these best titration results to calculate the average volume of **R** used.

average volume of **R** used .... cm^3

[1]

(c) **R** is 0.0500 mol / dm^3 sodium hydroxide, NaOH.

Calculate the number of moles of NaOH present in the average volume of **R** used.

.... moles [1]

(d) The acid in lemon juice is represented by the formula H**A**.

The equation for the reaction of H**A** with NaOH is shown.

$$NaOH + H\mathbf{A} \rightarrow Na\mathbf{A} + H_2O$$

Calculate the number of moles of H**A** that react with the NaOH in the average volume of **R** used.

.... moles [1]

(e) 25.0 cm^3 of diluted lemon juice is used in each titration.

Calculate the concentration, in mol / dm^3, of H**A** in the diluted lemon juice.

.... mol / dm^3 [1]

(f) **(i)** At the start of the experiment, distilled water was added to 10 cm^3 of lemon juice to make 100 cm^3 of diluted lemon juice.

Calculate the concentration, in mol / dm^3, of H**A** in the original lemon juice.

.... mol / dm^3 [1]

(ii) The actual concentration of acid in the lemon juice is different from your answer in **(f)(i)**.

Suggest the most likely source of error in the method for making the solution described at the start of the question.

....

.... [1]

[Total: 10]

3 Calcium carbonate reacts with dilute hydrochloric acid to form carbon dioxide gas.

Describe an experiment to follow the rate of reaction between calcium carbonate and 25 cm^3 0.10 mol / dm^3 hydrochloric acid at room temperature.

Your method must include the collection of carbon dioxide gas.

You are provided with:

- 2 g of small pieces of calcium carbonate (an excess)
- 25 cm^3 0.10 mol / dm^3 hydrochloric acid
- the apparatus normally found in a school laboratory.

Your answer should include:

- a method
- the measurements you need to make during your experiment
- how you will process your results.

You may use a labelled diagram to help explain the method.

....

....

....

....

....

....

....

....

....

.... [6]

4 Two solids, **L** and **M**, are mixed together.

L is soluble in water. **M** is insoluble in water.

(a) How can **M** be separated from **L**?

....

....

.... [2]

(b) Two samples of a solution of **L** are put into separate test-tubes.

- Aqueous sodium hydroxide is added to the first test-tube and the mixture is warmed. A gas is produced which turns damp red litmus paper blue.
- Dilute nitric acid and aqueous barium nitrate are added to the second test-tube. A white precipitate is formed.

Name both ions present in **L**.

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

(c) **(i)** A sample of the insoluble solid, **M**, is put into another test tube.

Dilute hydrochloric acid is added to this test-tube. Carbon dioxide gas is produced.

Give a test and observation to identify carbon dioxide gas.

....

.... [2]

(ii) Name the negative ion in **M**.

.... [1]

(d) Solid **M** reacts with dilute hydrochloric acid to form a solution.

Describe a test and observations to show that this solution contains calcium ions.

test ....

....

observations ....

.... [3]

[Total: 10]

5 Ammonia is produced by the reaction between nitrogen and hydrogen in the presence of a catalyst.

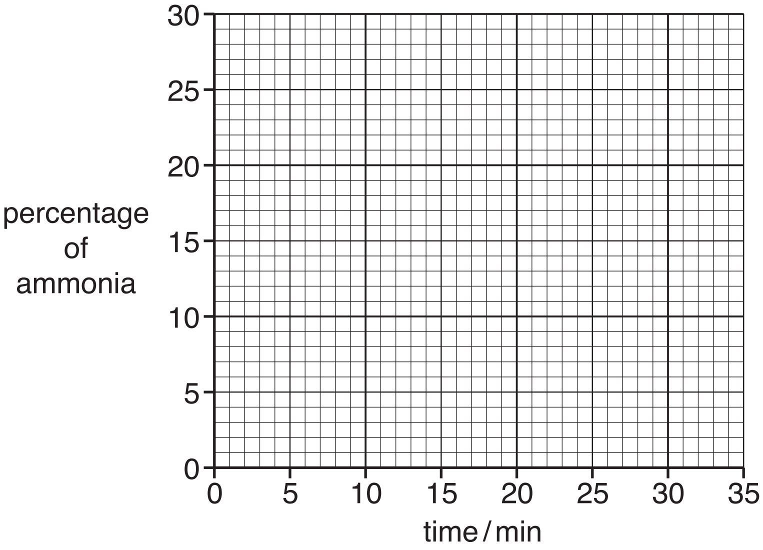
Nitrogen is mixed with hydrogen and a sample of the reaction mixture is removed every five minutes.

A student determines the percentage of ammonia in each sample.

The results are shown in the table.

time / min	percentage of ammonia
0	0
5	10
10	18
15	15
20	24
25	25
30	25

(a) **(i)** Plot the results on the grid and draw a smooth curve of best fit.



[2]

(ii) The student believes that one of the data points is anomalous. Circle the anomalous point on the graph.

[1]

(iii) Use your graph to deduce the correct percentage of ammonia corresponding to the point circled in **(a)(ii)**.

.... %

[1]

(b) The student decides to repeat the whole experiment.

Why is this a good idea?

....

.... [1]

(c) Suggest why a catalyst is used in the experiment.

....

.... [1]

(d) The reaction between nitrogen and ammonia is reversible and reaches dynamic equilibrium.

Use your **graph** to suggest the time when dynamic equilibrium is first reached.

.... [1]

[Total: 7]

6 **X** is a colourless solution of an oxidising agent.

Y is a colourless solution of a reducing agent.

Z is a metal between iron and calcium in the reactivity series.

(a) Tests are carried out on substances **X**, **Y** and **Z**. Complete the table.

substance	test	observation
X	To 1 cm depth of aqueous potassium iodide in a test-tube, **X** is added until no further change occurs.	
Y	To 1 cm depth of acidified potassium manganate(VII) in a test-tube, **Y** is added until no further change occurs.	
Z	A piece of **Z** is added to an excess of dilute hydrochloric acid in a test-tube.	

[5]

(b) **(i)** Name the gas produced by the reaction of **Z** with dilute hydrochloric acid.

.... [1]

(ii) Give a test and observation to identify this gas.

....

.... [2]

[Total: 8]

7 **(a)** A student makes an aqueous solution of potassium nitrate. She reacts dilute nitric acid with an aqueous solution of a salt.

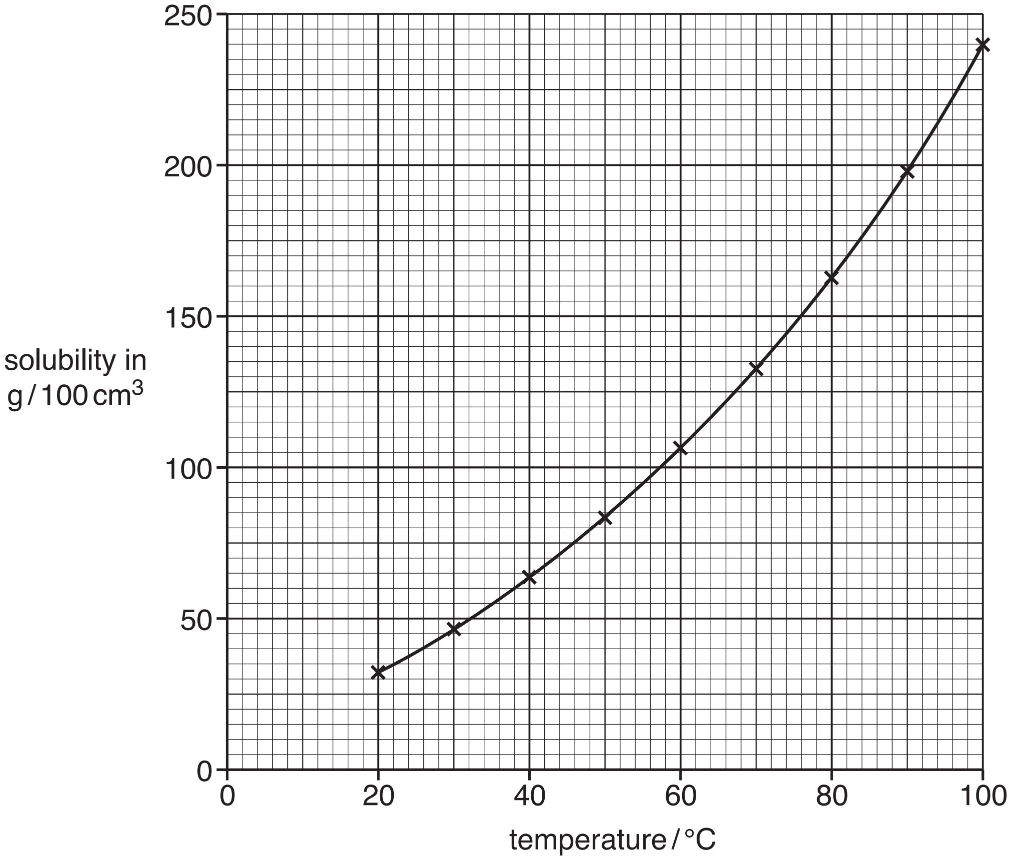
Name a salt that she could use.

.... [1]

(b) The student investigates the mass of potassium nitrate that dissolves in 100 cm^3 of water at different temperatures. This is its solubility.

The graph shows the student's results.

On the grid, extend the graph to 0°C.



[1]

(c) Using the graph, deduce the temperature at which the solubility is 180 g / 100 cm^3.

.... °C [1]

(d) Using the graph, deduce:

(i) the mass of potassium nitrate dissolved in 100 cm^3 of water at 90° C

.... g [1]

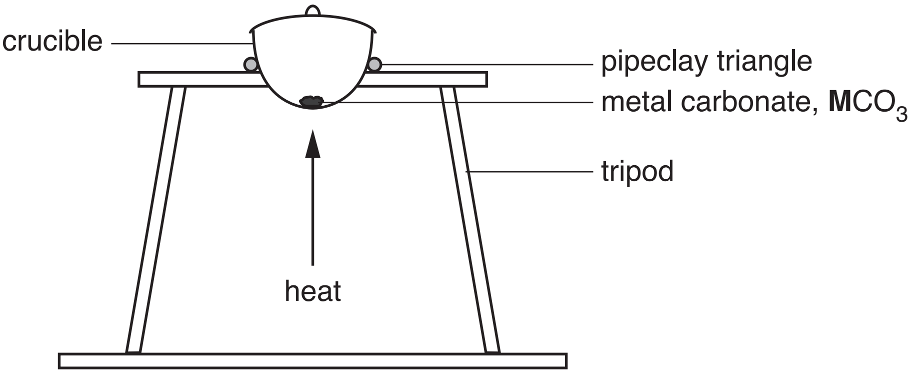
(ii) the mass of potassium nitrate that crystallises when this solution is cooled from 90° C to 20° C.

.... g [2]

[Total: 6]

8 A scientist needs to identify the metal ion in a metal carbonate, $\mathbf{M}CO_3$.

$\mathbf{M}CO_3$ is heated in a crucible for three minutes. The $\mathbf{M}CO_3$ decomposes to form the solid metal oxide, **M**O, and carbon dioxide gas.



(a) Give **two** reasons why it is important that a lid is placed loosely on the crucible.

1 ....

2 ....
[2]

(b) Complete the table of results.

mass of crucible and lid / g	mass of crucible, lid and $\mathbf{M}CO_3$ before heating / g	mass of crucible, lid and contents after heating / g	mass of $\mathbf{M}CO_3$ before heating / g	mass of carbon dioxide gas formed / g
10.1	12.6	11.7		

[2]

(c) The crucible is heated for another three minutes. The mass of the crucible, lid and contents is 11.5 g.

Explain why this is different from the value in the table.

....

....

.... [1]

(d) The total mass of carbon dioxide, CO_2, formed is 1.1 g.

Calculate the number of moles of CO_2 formed.

[M_r: CO_2, 44]

.... moles [1]

(e) The equation for the decomposition of the metal carbonate is shown.

$$\mathbf{M}CO_3 \rightarrow \mathbf{M}O + CO_2$$

Using the equation and your answers to **(b)** and **(d)**, calculate the relative formula mass of $\mathbf{M}CO_3$.

relative formula mass .... [1]

(f) Calculate the relative atomic mass, A_r, of metal **M**.

[A_r: C, 12; O, 16]

A_r of metal **M** .... [1]

[Total: 8]

BLANK PAGE

Cambridge International Examinations
Cambridge Ordinary Level

CANDIDATE NAME			
CENTRE NUMBER		CANDIDATE NUMBER	

CHEMISTRY **5070/42**

Paper 4 Alternative to Practical **October/November 2018**

1 hour

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

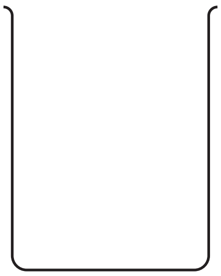
Answer **all** questions.
Write your answers in the spaces provided in the Question Paper.
Electronic calculators may be used.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

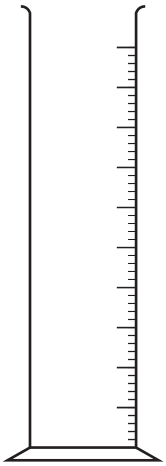
This document consists of **13** printed pages and **3** blank pages.

DC (ST/SG) 147884/3

1 State the names of the apparatus shown.



A

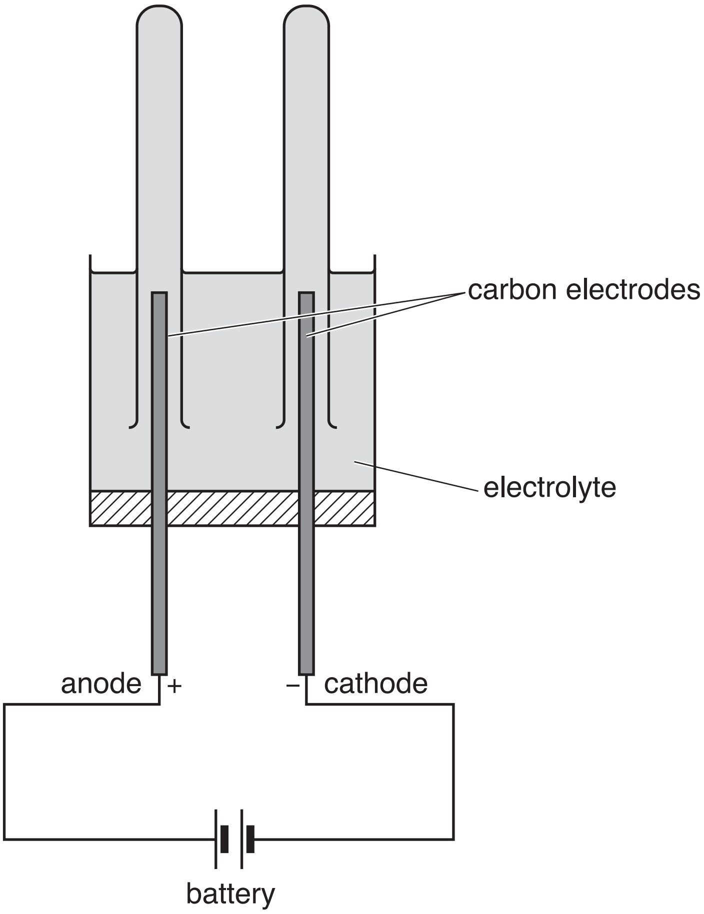


B

A ....

B ....
[2]

2 A student uses the apparatus shown for two electrolysis experiments.



(a) Complete the table.

electrolyte	name of product at the anode (+)	observations at the anode (+)	name of product at the cathode (–)	observations at the cathode (–)
concentrated aqueous potassium bromide	bromine			bubbles of colourless gas
concentrated aqueous copper(II) chloride	chlorine		copper	

[4]

(b) Give a test and observation to identify chlorine gas.

test ....

observation ....
[2]

[Total: 6]

3 Calcium carbonate reacts with dilute hydrochloric acid.

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

A student investigates how the rate of this reaction changes as the temperature increases.

The student carries out five experiments, each at a different temperature. For each experiment, he reacts a fixed mass of small pieces of calcium carbonate with an excess of dilute hydrochloric acid. He measures the time taken for all the calcium carbonate to react.

(a) State one variable, other than the concentration of the hydrochloric acid and the temperature, that is likely to affect the rate of this reaction.

....[1]

(b) The student is asked to control the temperature of each experiment so that it remains constant for the whole time that the calcium carbonate and dilute hydrochloric acid are reacting.

Method

For each experiment the student:

- measures out a suitable volume of dilute hydrochloric acid and pours it into a beaker
- places a thermometer in the acid
- heats the acid with a Bunsen burner
- stops heating when the required temperature is reached
- adds a weighed sample of calcium carbonate to the acid
- starts the clock
- stops the clock when all the calcium carbonate has reacted
- records the reaction time.

(i) This method does **not** keep the reaction mixture at constant temperature throughout the experiment. Explain why.

....

....[1]

(ii) Suggest how the method can be improved so that the reaction mixture is at constant temperature throughout the experiment.

....

....[1]

(c) The improved method was carried out at different temperatures. The results are shown.

experiment	temperature /°C	reaction time /s
1	20	120
2	30	70
3	40	130
4	50	15
5	60	2

(i) Which experiment has an anomalous reaction time?

....[1]

(ii) What can the student do to check if the result is anomalous?

....[1]

(iii) How does the rate of the reaction change as the reaction time decreases?

....[1]

(iv) Which of the five experiments has the greatest rate of reaction?

....[1]

(v) Describe how the rate of the reaction changes with the temperature of the acid.

....[1]

(d) Another student does the reaction at 80 °C.

Why would it be difficult to measure the reaction time accurately at this temperature?

....[1]

[Total: 9]

4 A student is provided with three bottles: one contains dilute hydrochloric acid, another contains aqueous sodium sulfite and the third contains aqueous sodium sulfate.

The student is provided with magnesium ribbon, aqueous barium nitrate and dilute nitric acid **but no other chemicals**. The student has access to all the apparatus normally found in a school laboratory.

For each of the three bottles, describe a test and its positive result to identify the contents of the bottle. Chemical equations are not required.

....

....

....

....

....

....

....

....

....

....

....
[3]

5 A student determines the percentage of iron in a powdered sample of impure iron by a titration method.

(a) The student adds the sample of impure iron to a previously weighed beaker which is then reweighed.

mass of beaker + impure iron = 39.36 g

mass of beaker = 37.52 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 sulfuric acid reacts with the iron.

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

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

(i) What is meant by an *excess* of dilute sulfuric acid?

....[1]

(ii) The student suggests that the beaker should be heated to make the iron react faster.

What safety precaution should be taken when heating the beaker? Explain your answer.

safety precaution ....

explanation ....

....

[2]

(iii) What else could the student do to increase the rate of the reaction in the beaker?

....[1]

(c) The insoluble impurities are separated from the aqueous solution. The aqueous solution is transferred from a beaker to a volumetric flask and made up to 250 cm^3 with water. This is solution **P**.

(i) Suggest a method of separating the insoluble impurities from the aqueous solution.

....[1]

(ii) Suggest how the student should ensure that **all** the solution is transferred to the volumetric flask.

....

....[2]

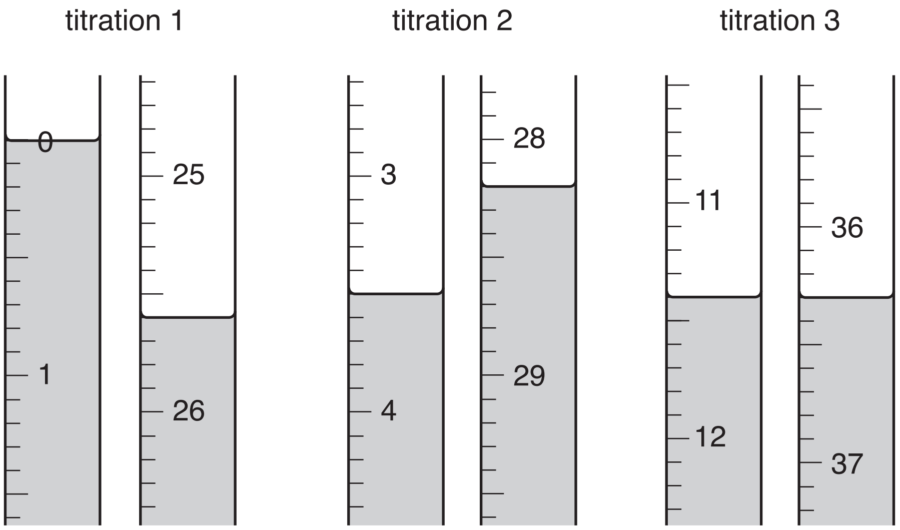
(d) The student transfers 25.0 cm^3 of **P** into a conical flask using a pipette.

Solution **Q** is 0.0200 mol/dm^3 potassium manganate(VII).

The student fills a burette with **Q** and runs it into the conical flask until the end-point is reached.

The student does three titrations.

(i) The diagrams show parts of the burette with the liquid levels both at the beginning and at the end of each titration.



Use the diagrams to complete the following 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.

Using these best results, the average volume of **Q** is

.... cm^3. [4]

(ii) Give **two** reasons why the student does three titrations using 25.0 cm^3 of **P** in each, rather than carrying out one titration using 250 cm^3 of **P**.

reason 1 ....

reason 2 ....
[2]

(e) Calculate the number of moles of potassium manganate(VII) in the average volume of 0.0200 mol / dm^3 of aqueous potassium manganate(VII) in **(d)(i)**.

.... moles [1]

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

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

.... moles [1]

(g) Calculate the number of moles of Fe^{2+} in 250 cm^3 of **P**.

.... moles [1]

(h) Calculate the mass of iron in 250 cm^3 of **P**.

[A_r: Fe, 56]

....g [1]

(i) Using your answers to **(a)** and **(h)**, calculate the percentage by mass of iron in the impure iron.

....% [1]

[Total: 19]

BLANK PAGE

6 Solid **L** is a mixture of two compounds. The compounds each contain a different cation but the same anion.

Complete the table.

Any gases given off should be named and identified by a suitable test and observation.

test	observation	conclusion	
(a) **L** is dissolved in water. The solution is divided into three parts for tests **(b)**, **(c)** and **(d)**.	A colourless solution is formed.		[1]
(b) **(i)** To the first part, aqueous sodium hydroxide is added until a change is seen.		**L** may contain Al^{3+}, Ca^{2+} or Zn^{2+} ions.	
(ii) An excess of aqueous sodium hydroxide is added to the mixture from **(i)**.		**L** contains Al^{3+} or Zn^{2+} ions.	
(iii) The mixture from **(ii)** is warmed.		**L** contains NH_4^+ ions.	[4]
(c) **(i)** To the second part, aqueous ammonia is added until a change is seen.		**L** may contain Al^{3+} or Zn^{2+} ions.	
(ii) An excess of aqueous ammonia is added to the mixture from **(i)**.		**L** contains Zn^{2+} ions.	[2]
(d)		**L** contains Cl^- ions.	[3]

[Total: 10]

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

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

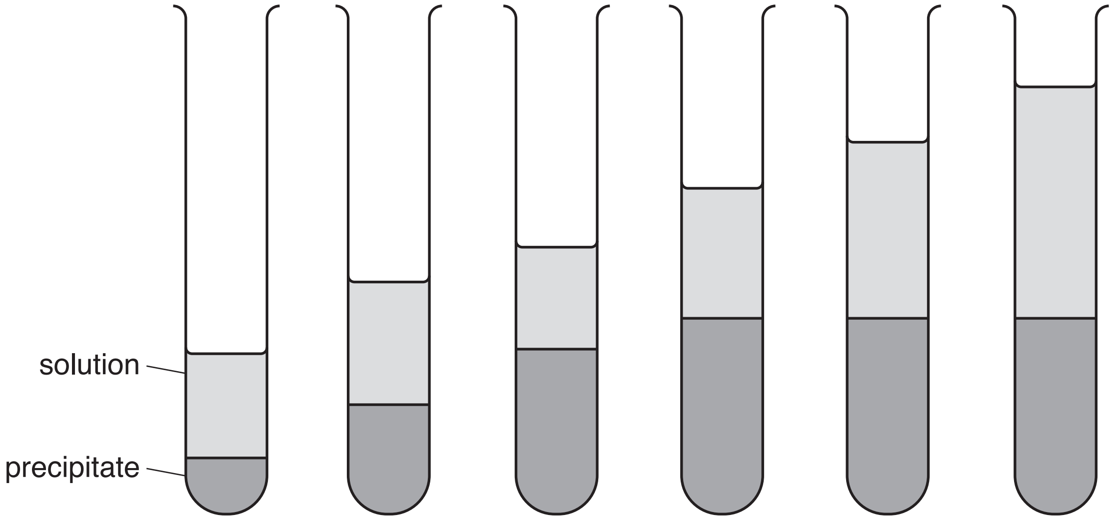
A student has two solutions.

G is an aqueous solution of potassium iodide of unknown concentration.

H is 1.0 mol / dm^3 lead(II) nitrate.

The student determines the concentration of **G** by adding different volumes of **H** to 4.0 cm^3 of **G** in a test-tube. In each case she allows the precipitate to settle, and then measures and records the height of the precipitate.

The diagrams and table show the results.



test-tube	1	2	3	4	5	6
volume of **H** / cm^3	2.0	4.0	6.0	8.0	10.0	12.0
height of precipitate / mm	7.5	14.5	22.0	26.0	26.0	26.0

(a) The student uses a burette to measure the volumes of **G** and **H**.

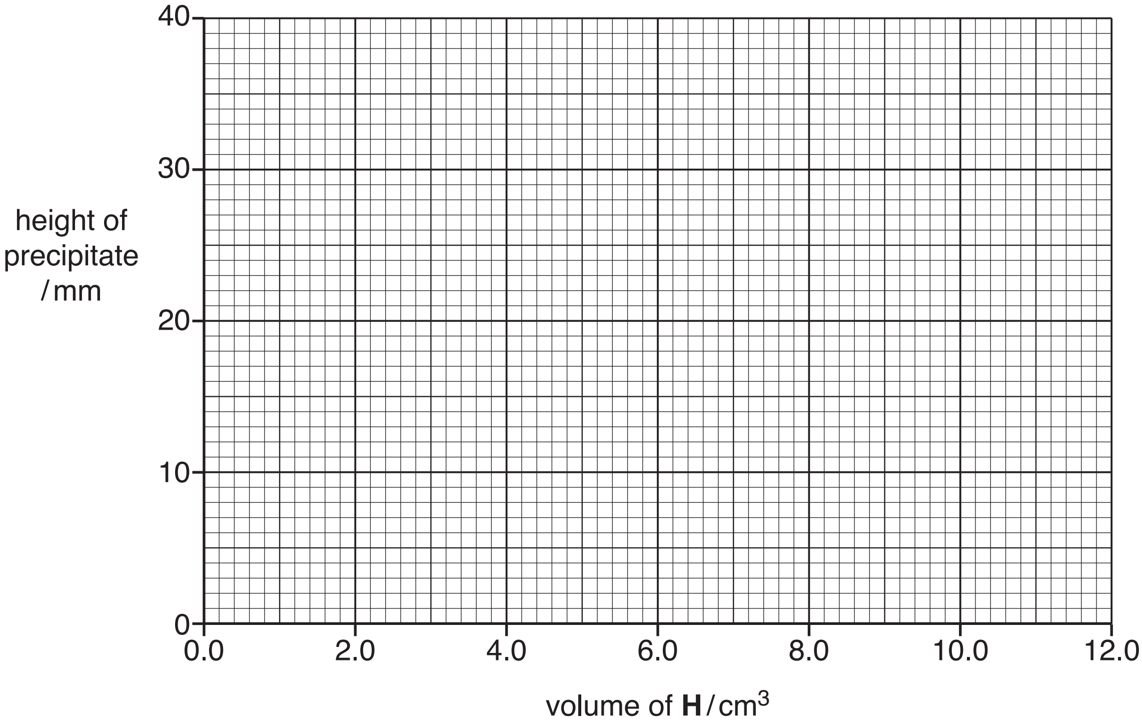
Why does the student use a burette instead of a measuring cylinder?

....[1]

(b) Why did the student stop at 12.0 cm^3 of **H** and not carry out further measurements using 14.0 cm^3 and 16.0 cm^3 of **H**?

....[1]

(c) Plot the results from the table on the grid and draw two intersecting straight lines through the points.



[3]

(d) Use your graph to determine:

(i) the height of the precipitate if 3.5 cm^3 of **H** is added to 4.0 cm^3 of **G**

.... mm [1]

(ii) the volume of **H** that should be added to 4.0 cm^3 of **G** to produce a precipitate which is 20.0 mm in height

.... cm^3 [1]

(iii) the minimum volume of **H** that reacts completely with 4.0 cm^3 of **G**.

.... cm^3 [1]

(e) **H** is 1.0 mol / dm^3 lead(II) nitrate.

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

Using your answer to **(d)(iii)** and the equation, calculate the concentration of the potassium iodide in solution **G**.

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

[Total: 11]

BLANK PAGE

BLANK PAGE

Cambridge International Examinations
Cambridge Ordinary Level

CANDIDATE NAME	

CENTRE NUMBER		CANDIDATE NUMBER	

CHEMISTRY **5070/42**

Paper 4 Alternative to Practical **May/June 2017**

1 hour

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

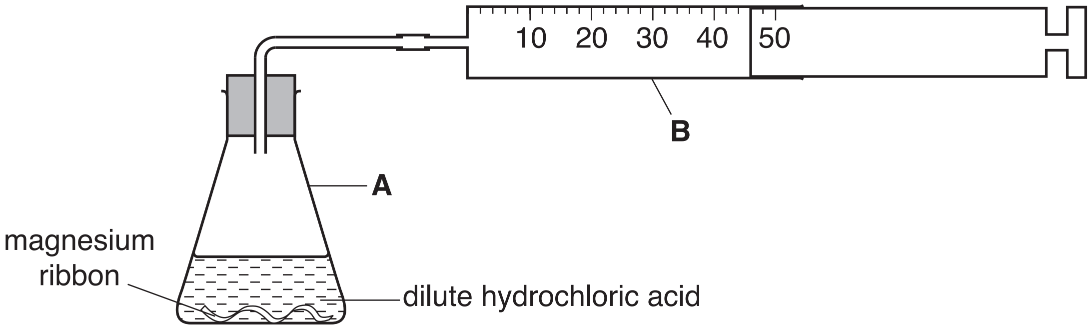
Answer **all** questions.
Write your answers in the spaces provided in the Question Paper.
Electronic calculators may be used.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

This document consists of **14** printed pages and **2** blank pages.

DC (CW/JG) 129400/3

1 A student adds a known mass of magnesium ribbon to 100 cm^3 of dilute hydrochloric acid (an excess) in the apparatus shown. Hydrogen gas is evolved.



(a) **(i)** Give a test and observation to identify hydrogen gas.

....[1]

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

A ....

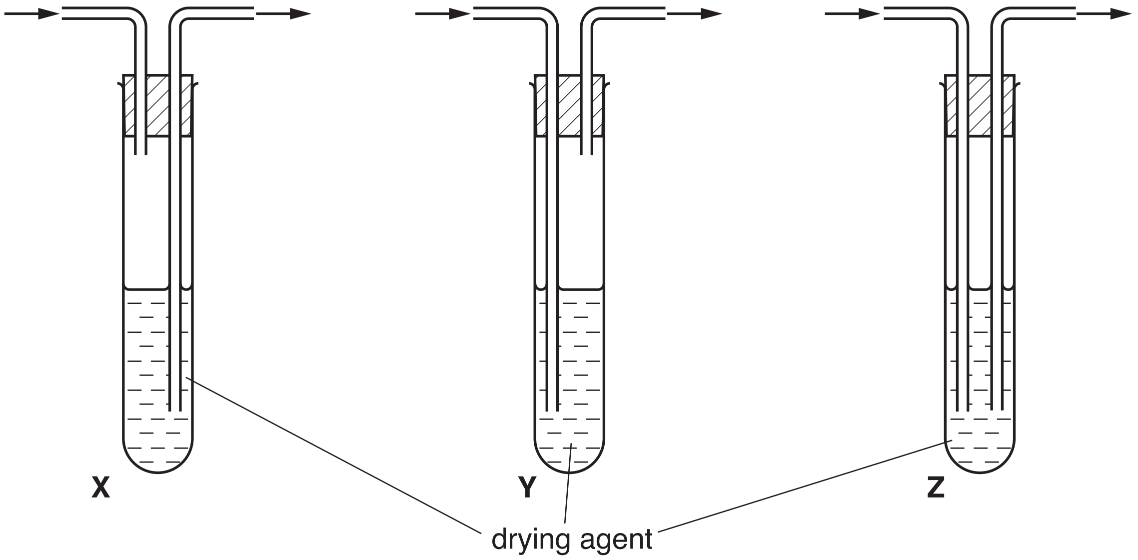
B .... [2]

(iii) What volume of hydrogen is collected in **B**?

.... cm^3 [1]

(b) **(i)** A student is asked to produce a dry sample of hydrogen by passing it through a drying agent.

The direction of flow of the gas through the apparatus is shown by the arrows.



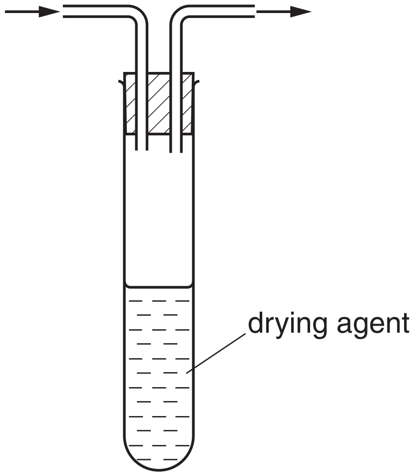
Which apparatus, **X**, **Y**, or **Z**, should be used?

....

Explain your answer.

.... [2]

(ii) Explain why the student would **not** be able to produce a dry sample of the gas using the apparatus below.

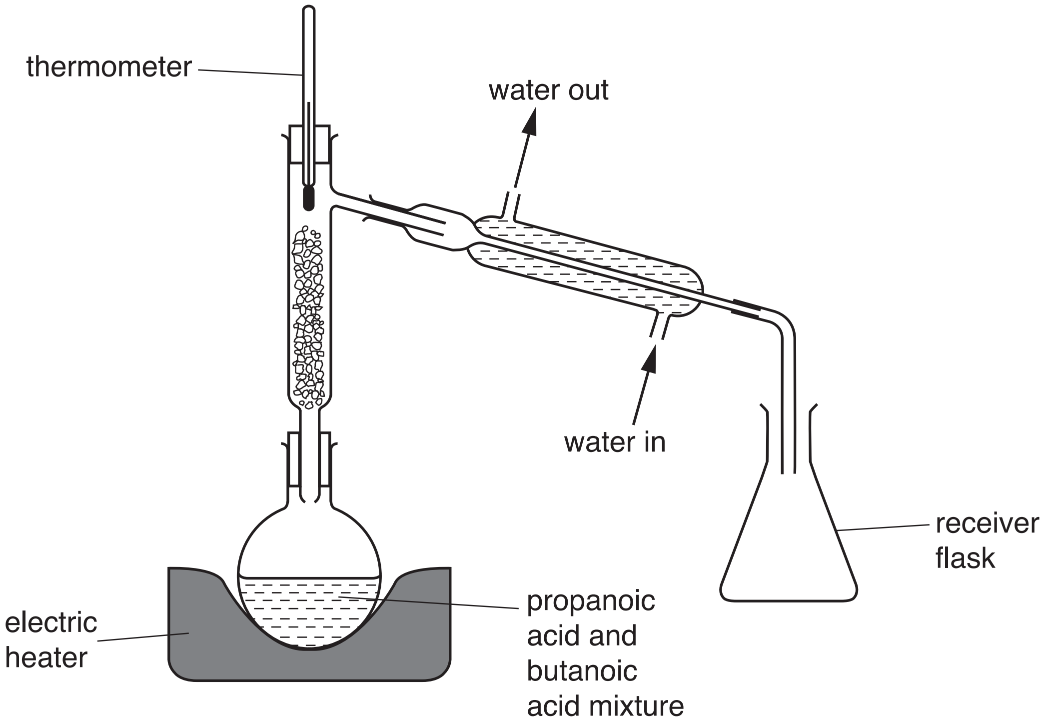


....

....[1]

[Total: 7]

2 A student separates propanoic acid (b.p. 141 °C) and butanoic acid (b.p. 164 °C) using the apparatus shown.



(a) Explain why the receiver flask must be left open.

....

....[1]

(b) **(i)** What is the reading on the thermometer when the first drops of liquid appear in the receiver flask?

.... °C [1]

(ii) Name this liquid.

....[1]

(iii) How does the student know when all of this liquid has distilled over?

....[1]

(c) Suggest a safety item that the student should use when doing this experiment.

....[1]

[Total: 5]

3 Copper(II) sulfate crystals contain water of crystallisation which may be removed by heating.

(a) You are to plan an experiment to find the percentage, by mass, of water in copper(II) sulfate crystals.

You should

- describe or draw a diagram of the apparatus that may be used to remove the water,
- suggest all the weighings that should be done,
- show how they may be used to calculate the percentage, by mass, of water.

....

....

....

....

....

....[5]

(b) The formula for copper(II) sulfate crystals is $CuSO_4.\mathbf{y}H_2O$ where **y** is the number of moles of water of crystallisation in one mole of crystals.

A student does an experiment and finds that **y** = 4. The correct value of **y** for her sample is 5.

Suggest an error in her experiment that would result in this difference. Explain how this error would lead to the lower value of **y** and suggest how the experiment could be improved to result in a correct value for **y**.

You can assume that all her weighings were read and recorded correctly and that her calculation was correct.

....

....

....

....

....

....

....[3]

[Total: 8]

4 A student is asked to determine the percentage purity of a sample of impure magnesium carbonate.

(a) The sample is added to a previously weighed container, which is then reweighed.

mass of container + impure magnesium carbonate = 8.20 g
mass of container = 6.98 g

Calculate the mass of impure magnesium carbonate used in the experiment.

.... g [1]

(b) The sample is placed in a beaker and 50.0 cm^3 of 1.00 mol / dm^3 hydrochloric acid, an excess, is added.

The mixture is allowed to react. Carbon dioxide is produced.

What is observed in the flask as the reaction takes place?

....[1]

(c) When the reaction has finished the solution is made up to 250 cm^3 with distilled water.

This is solution **V**.

(i) In which apparatus should **V** be prepared?

.... [1]

(ii) Using a pipette, 25.0 cm^3 of **V** is transferred into a conical flask.

Name a safety item that the student should attach to the pipette and suggest why it is used.

safety item ....

why it is used ....

....
[2]

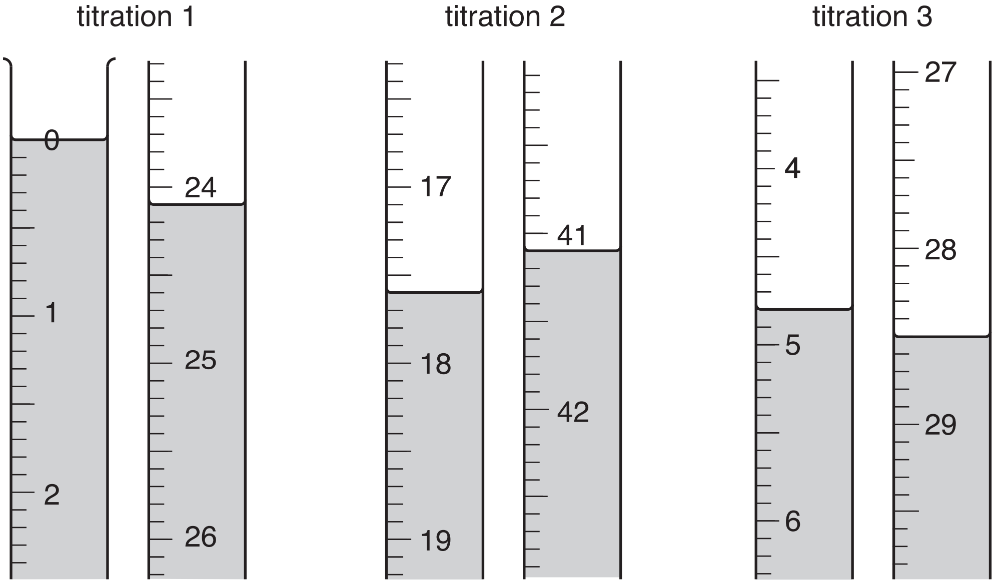
(d) A few drops of methyl orange indicator are added to the conical flask.

0.100 mol / dm^3 sodium hydroxide is added to the solution from a burette until an end-point is reached.

What is the colour change of the methyl orange at the end-point?

The colour changes from .... to .... [1]

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



Use the diagrams to complete the results table.

titration number	1	2	3
final burette reading / cm^3			
initial burette reading / cm^3			
volume of 0.100 mol / dm^3 sodium hydroxide / cm^3			
best titration results (✓)			

Summary
Tick (✓) the best titration results.

Using these results, the average volume of 0.100 mol / dm^3 sodium hydroxide required is

.... cm^3. [4]

(f) Calculate the number of moles of sodium hydroxide in the average volume of 0.100 mol / dm^3 sodium hydroxide.

.... moles [1]

(g) Using the equation and your answer to **(f)**, deduce the number of moles of hydrochloric acid in 25.0 cm^3 of **V**.

$$NaOH + HCl \rightarrow NaCl + H_2O$$

.... moles [1]

(h) Calculate the number of moles of hydrochloric acid in 250 cm^3 of **V**.

.... moles [1]

(i) 50.0 cm^3 of 1.00 mol / dm^3 hydrochloric acid contains 0.0500 moles of hydrochloric acid.

Subtract your answer to **(h)** from 0.0500 to determine the number of moles of hydrochloric acid that react with the sample of magnesium carbonate.

.... moles [1]

(j) The equation for the reaction between magnesium carbonate and hydrochloric acid is shown.

$$MgCO_3 + 2HCl \rightarrow MgCl_2 + H_2O + CO_2$$

Using the equation and your answer to **(i)**, deduce the number of moles of magnesium carbonate in the sample.

.... moles [1]

(k) **(i)** Calculate the mass of magnesium carbonate in the sample.

[The relative formula mass of magnesium carbonate is 84.]

.... g [1]

(ii) Using your answers to **(a)** and **(k)(i)**, calculate the percentage purity of the magnesium carbonate.

.... % [1]

[Total: 17]

5 You are provided with aqueous solutions of four different metal sulfates.

- chromium(III) sulfate
- copper(II) sulfate
- iron(II) sulfate
- iron(III) sulfate

(a) Using reagents that are available in a laboratory, suggest a test that can be done to confirm the presence of the sulfate ion in each of the four solutions.

test ....

....

observation ....

....
[3]

(b) **(i)** In order to identify the cation present in each solution a small volume of aqueous sodium hydroxide is added to 1 cm^3 of each solution in a test-tube, followed by an excess of the reagent.

The observations for each test are recorded in the table.

Complete the table by deducing the cation present in each solution.

addition of a small volume of aqueous sodium hydroxide	addition of excess aqueous sodium hydroxide	cation present
red-brown ppt	insoluble in excess	
light blue ppt	insoluble in excess	
green ppt	insoluble in excess	
green ppt	soluble in excess	

[4]

(ii) A small volume of aqueous ammonia is added to 1 cm^3 of each solution in a test-tube, followed by an excess of this reagent.

Record in the table the observations which correspond to the presence of each cation.

addition of a small volume of aqueous ammonia	addition of an excess of aqueous ammonia	cation present
		Cr^{3+}
		Fe^{2+}
		Cu^{2+}
		Fe^{3+}

[4]

[Total: 11]

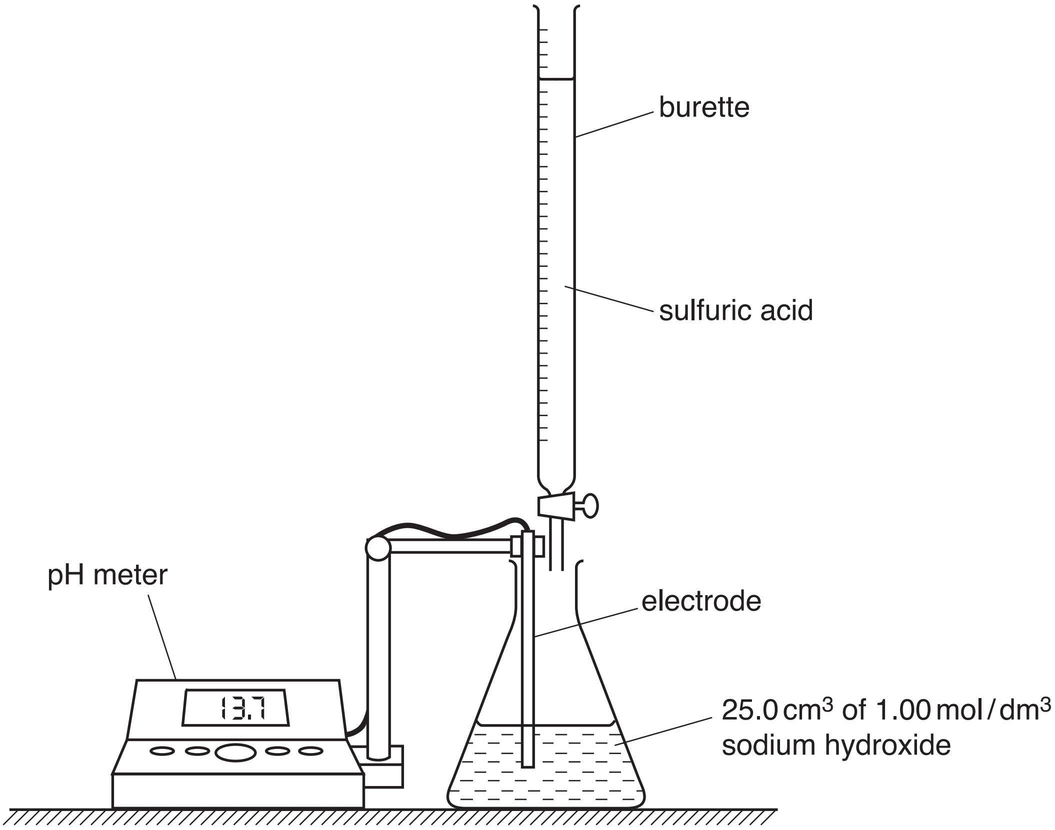
PLEASE TURN OVER.

6 A student prepares a sample of sodium sulfate crystals using a titration method.

The student transfers 25.0 cm^3 of 1.00 mol / dm^3 sodium hydroxide to a conical flask and adds dilute sulfuric acid from a burette.

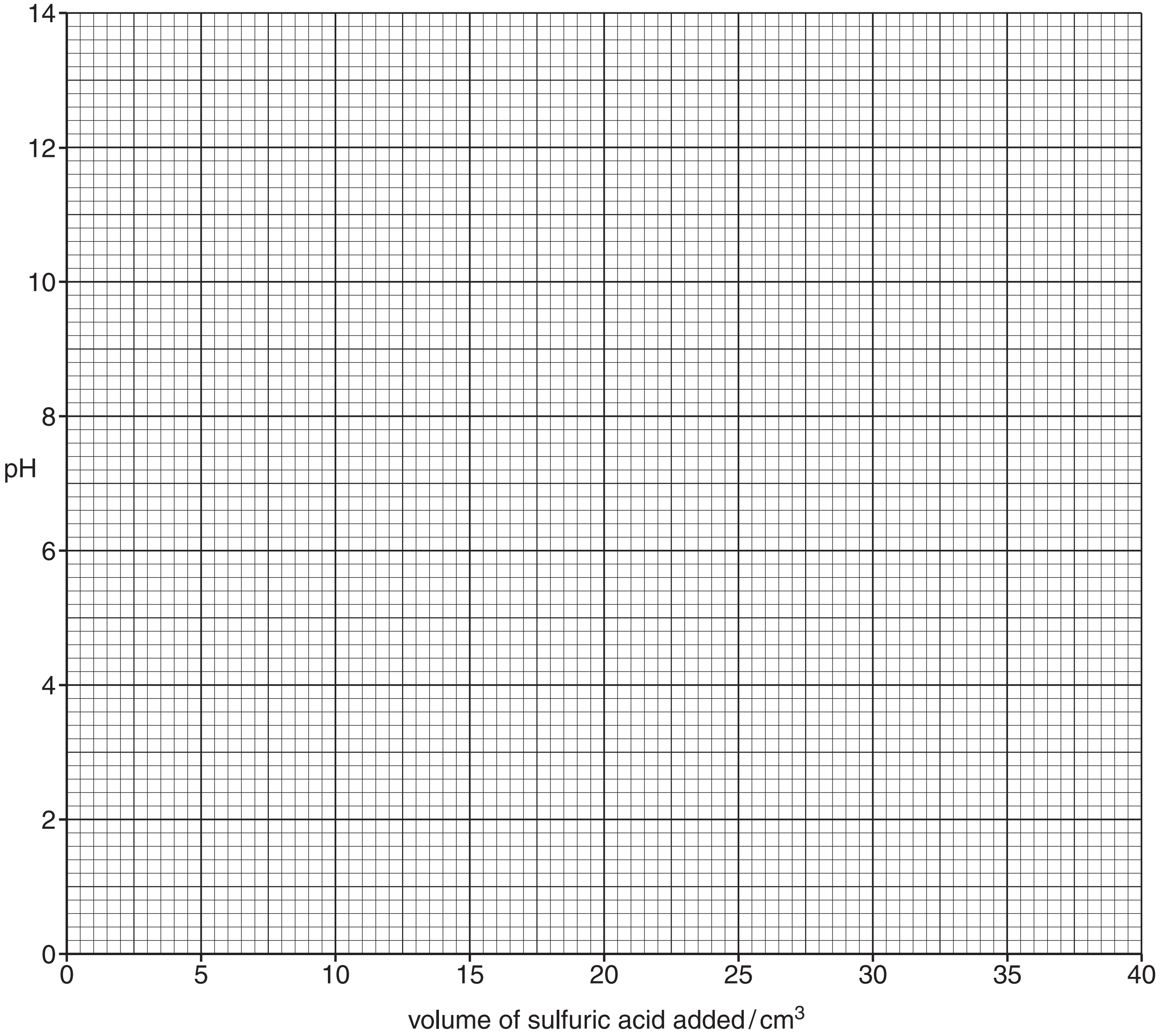
After each addition of sulfuric acid, the student records the pH of the solution, measured by a pH meter.

The apparatus and table of results are shown.



volume of sulfuric acid added / cm^3	pH value
5.0	13.7
10.0	13.5
20.0	12.2
22.0	11.8
24.0	11.2
26.0	10.0
28.0	4.2
30.0	3.0
40.0	1.2

(a) Plot the points on the grid. Draw a smooth curve through all of the points. Extend your line to cross the *y*-axis.



[3]

(b) Use the graph to answer the following questions.

(i) What is the pH of 25.0 cm^3 of 1.00 mol / dm^3 sodium hydroxide?

....[1]

(ii) What is the pH of the solution when 15.0 cm^3 of acid is added?

....[1]

(c) **(i)** At the end-point of the titration, the pH changes rapidly when only a small volume of acid is added.

Use your graph to suggest the pH of the solution at the end-point.

....[1]

(ii) Using your answer to **(i)** and your graph, what volume of acid is required to neutralise 25.0 cm^3 of 1.00 mol / dm^3 sodium hydroxide?

.... cm^3 [1]

(d) Sulfuric acid reacts with sodium hydroxide.

$$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$$

Using the equation and your answer to **(c)(ii)**, calculate the concentration of sulfuric acid used in the experiment.

....mol / dm^3 [2]

(e) Describe how a student makes pure, dry crystals from aqueous sodium sulfate.

....

....

....

....

....

....[3]

[Total: 12]

BLANK PAGE

BLANK PAGE

Cambridge International Examinations
Cambridge Ordinary Level

CANDIDATE NAME	

CENTRE NUMBER		CANDIDATE NUMBER	

CHEMISTRY **5070/42**

Paper 4 Alternative to Practical **October/November 2017**

1 hour

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Write your answers in the spaces provided in the Question Paper.
Electronic calculators may be used.

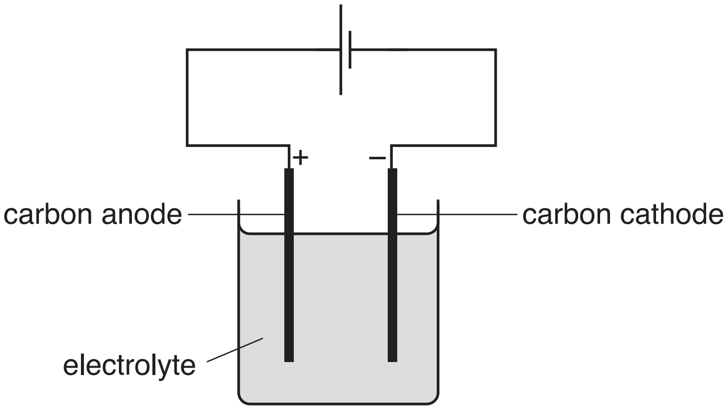
At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

This document consists of **14** printed pages and **2** blank pages.

DC (NF/SG) 129398/3

[Turn over

1 A student carries out experiments using two different electrolytes in the apparatus shown.



(a) Complete the table.

electrolyte	name of product at the anode	observations at the anode	name of product at the cathode	observations at the cathode
concentrated aqueous sodium chloride				bubbles of colourless gas
	oxygen		copper	

[6]

(b) Give a test and observation to identify oxygen gas.

.... [1]

[Total: 7]

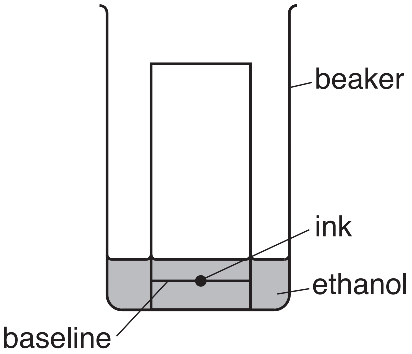
2 **(a)** Ethanol is a reducing agent. It can be oxidised by heating ethanol with acidified aqueous potassium manganate(VII).

State the colour change of the potassium manganate(VII) during the experiment.

from .... to .... [1]

(b) Ethanol evaporates easily at room temperature. It can be used as a solvent to separate the dyes in ink.

A student uses the apparatus shown to carry out the separation. There are errors in the diagram.



(i) Name the process used to separate the dyes in ink.

.... [1]

(ii) State two errors in the diagram.

1 ....

2 ....

[2]

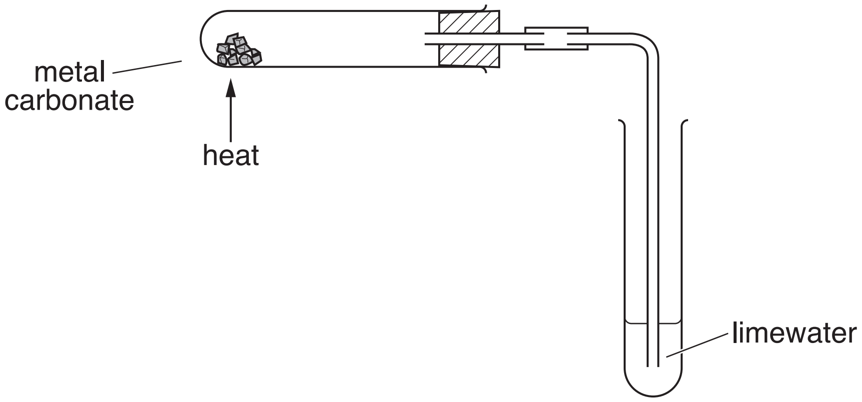
(c) Ethanol is a flammable liquid.

Suggest one safety measure that the student should take to minimise the risk of using ethanol.

.... [1]

[Total: 5]

3 A student investigates the rate of decomposition of four metal carbonates. When metal carbonates are heated, they decompose and a gas is given off. A student suggests that the ease with which different carbonates decompose can be determined by measuring the time taken for a sample of limewater to turn milky, using the following apparatus.



The results of the investigation are shown in the table.

metal carbonate	time taken for limewater to turn milky / s
calcium carbonate	600
copper(II) carbonate	220
iron(II) carbonate	340
zinc carbonate	380

(a) Name the gas that turns limewater milky.

.... [1]

(b) **(i)** To ensure that the investigation is a fair test, the amount of heat supplied must be constant in each experiment. Suggest how this could be done.

....

.... [1]

(ii) Suggest two other ways of achieving a fair test in this investigation.

....

....

.... [2]

(c) Which of the four metal carbonates decomposes the fastest?

.... [1]

(d) Another student suggests that a source of inaccuracy in this investigation is that it is a matter of opinion as to when the limewater has turned milky. Suggest how the investigation could be improved to achieve more accurate results.

....

.... [2]

[Total: 7]

4 A student is given an impure sample of calcium hydroxide, $Ca(OH)_2$. The student attempts to determine the percentage, by mass, of calcium hydroxide in the sample.

(a) The sample is placed in a previously weighed beaker, which is then reweighed.

mass of beaker + sample = 51.23 g

mass of beaker = 49.86 g

Calculate the mass of the sample used in the experiment.

.... g [1]

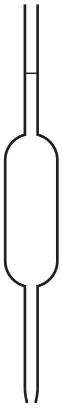
(b) 25.0 cm^3 of 2.00 mol / dm^3 hydrochloric acid, HCl, (an excess) is added to the beaker using apparatus **A**. The contents of the beaker are stirred.

Calcium hydroxide reacts with hydrochloric acid.

$$Ca(OH)_2 + 2HCl \rightarrow CaCl_2 + 2H_2O$$

The impurities dissolve but do not react with hydrochloric acid.

(i) Name apparatus **A**.



A

.... [1]

(ii) What is the safety item that should be used with apparatus **A**?

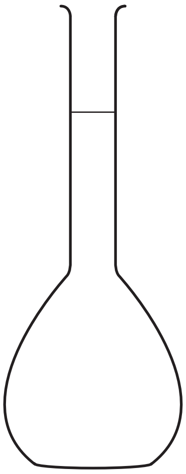
.... [1]

(iii) Why is the safety item used?

.... [1]

(c) The contents of the beaker are then transferred to apparatus **B**.

The student washes the beaker out twice with distilled water and transfers the washings to apparatus **B**. The student then makes up the solution to the 250 cm^3 mark with distilled water. This is solution **C**.



B

(i) Name apparatus **B**.

.... [1]

(ii) Why does the student wash out the beaker with distilled water and transfer the washings to apparatus **B**?

....

.... [1]

(d) The student transfers 25.0 cm^3 of **C** into a conical flask using apparatus **A** and adds three drops of methyl orange indicator.

0.100 mol / dm^3 sodium hydroxide is put into a burette and run into the conical flask until the end-point is reached.

The sodium hydroxide reacts with the hydrochloric acid that remains after reaction with calcium hydroxide. The equation for the reaction is shown.

$$NaOH + HCl \rightarrow NaCl + H_2O$$

(i) Why does the student decide to use apparatus **A** and **not** a measuring cylinder to transfer 25.0 cm^3 of **C** into the conical flask?

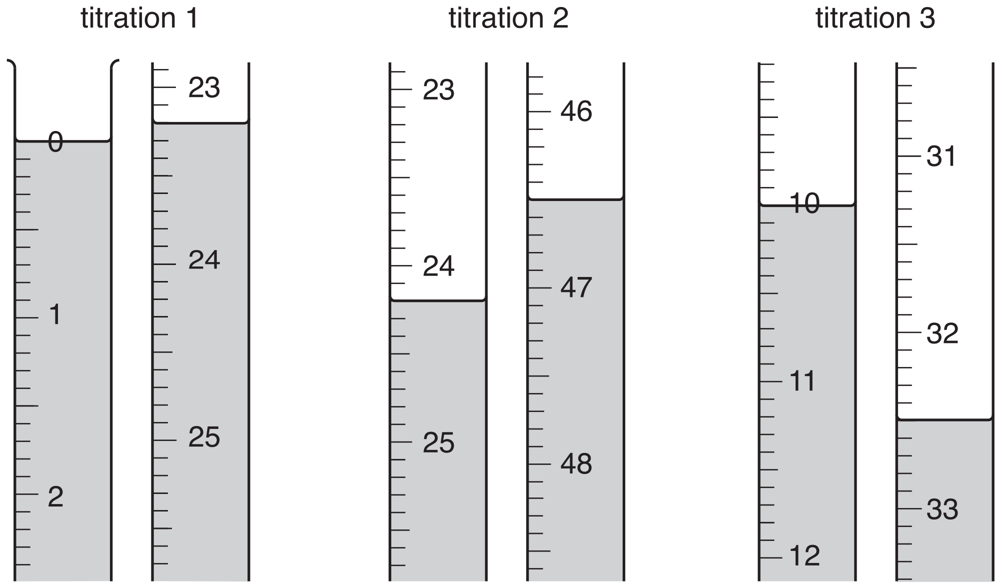
.... [1]

(ii) What is the colour change of the methyl orange indicator at the end-point?

The colour changes from .... to .... [1]

(e) The student does three titrations.

The diagrams show parts of the burette with the liquid levels both at the beginning and at the end of each titration.



Use the diagrams to complete the table.

titration number	1	2	3
final burette reading / cm^3			
initial burette reading / cm^3			
volume of 0.100 mol / dm^3 sodium hydroxide used / cm^3			
best titration results (✓)			

Summary

Tick (✓) the best titration results.

Using these best titration results, the average volume of 0.100 mol / dm^3 sodium hydroxide used is

.... cm^3. [4]

(f) Calculate the number of moles of sodium hydroxide in the average volume of 0.100 mol/dm^3 sodium hydroxide in **(e)**.

.... moles [1]

(g) Using your answer to **(f)** and the equation

$$NaOH + HCl \rightarrow NaCl + H_2O$$

calculate the number of moles of hydrochloric acid in 25.0 cm^3 of **C**.

.... moles [1]

(h) Calculate the number of moles of hydrochloric acid in 250 cm^3 of **C**.

.... moles [1]

(i) Calculate the number of moles of hydrochloric acid in 25.0 cm^3 of 2.00 mol/dm^3 hydrochloric acid.

.... moles [1]

(j) Using your answers to both **(h)** and **(i)**, calculate the number of moles of hydrochloric acid that react with the calcium hydroxide in the sample.

.... moles [1]

(k) Using your answer to **(j)** and the equation

$$Ca(OH)_2 + 2HCl \rightarrow CaCl_2 + 2H_2O$$

calculate the number of moles of calcium hydroxide in the sample.

.... moles [1]

(l) Calculate the mass of calcium hydroxide in the sample.

[A_r: Ca, 40; O, 16; H, 1]

.... g [1]

(m) Using your answers to both **(a)** and **(l)**, calculate the percentage by mass of calcium hydroxide in the sample.

....% [1]

(n) Another student carries out an experiment to determine the percentage, by mass, of calcium hydroxide in a sample. She uses the same technique but instead of using three drops of methyl orange indicator in the titration, she uses 3 cm^3. Methyl orange is a weak acid.

State and explain whether the average titration volume of sodium hydroxide would be smaller, larger or unchanged if 3 cm^3 of methyl orange indicator was used instead of three drops.

....

....

.... [2]

[Total: 22]

BLANK PAGE

5 The following table shows the tests a student does on compound **L**. Complete the table by adding the conclusion for **(a)**, the observations for tests **(b)** and **(c)** and both the test and observation which lead to the conclusion for test **(d)**.

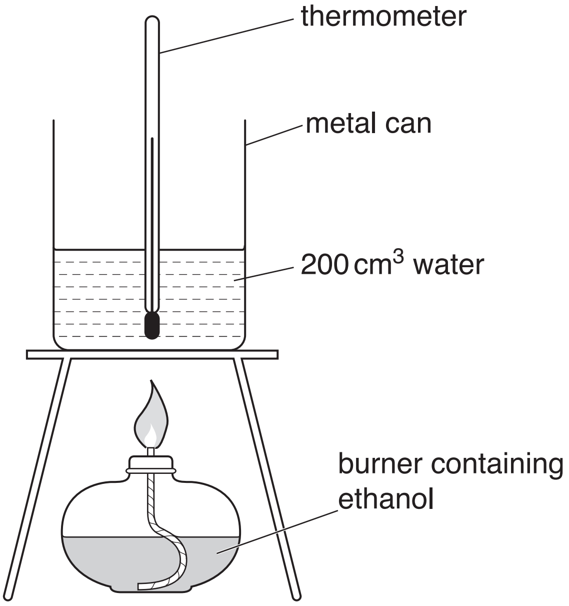
test	observation	conclusion	
(a) **L** is dissolved in water and the solution divided into three parts for tests **(b)**, **(c)** and **(d)**.	A coloured solution is formed.		[1]
(b) **(i)** To the first part, aqueous ammonia is added until a change is seen.		**L** may contain Cr^{3+} or Fe^{2+} ions.	
(ii) An excess of aqueous ammonia is added to the mixture from **(i)**.		**L** contains Cr^{3+} or Fe^{2+} ions.	[2]
(c) **(i)** To the second part, aqueous sodium hydroxide is added until a change is seen.		**L** may contain Cr^{3+} or Fe^{2+} ions.	
(ii) An excess of aqueous sodium hydroxide is added to the mixture from **(i)**.		**L** contains Cr^{3+} ions.	[3]
(d)		**L** contains SO_4^{2-} ions.	[3]

[Total: 9]

6 When alcohols burn in air they give out heat energy to the surroundings. A student investigates the amount of heat energy produced when alcohols burn.

The student is provided with a burner containing ethanol, a metal can containing 200 cm^3 of water, a thermometer and the other apparatus shown in the diagram.

The student determines the temperature rise of the water in the metal can when a known mass of ethanol undergoes combustion. The student assumes that all the heat energy produced by the burning ethanol is transferred to the water in the metal can.



(a) The student finds that when she uses 0.5 g of ethanol, the temperature of the water increases by 9.9 °C.

(i) What are the measurements the student takes to obtain these two figures?

....

.... [2]

(ii) A data book states that the temperature increase should have been greater than 9.9 °C.

Suggest two reasons why the temperature of the water did not increase by as much as the data book suggested.

1 ....

2 ....

[2]

(iii) Suggest two ways in which the apparatus can be improved to produce a temperature rise closer to the data book value.

1 ....

2 ....

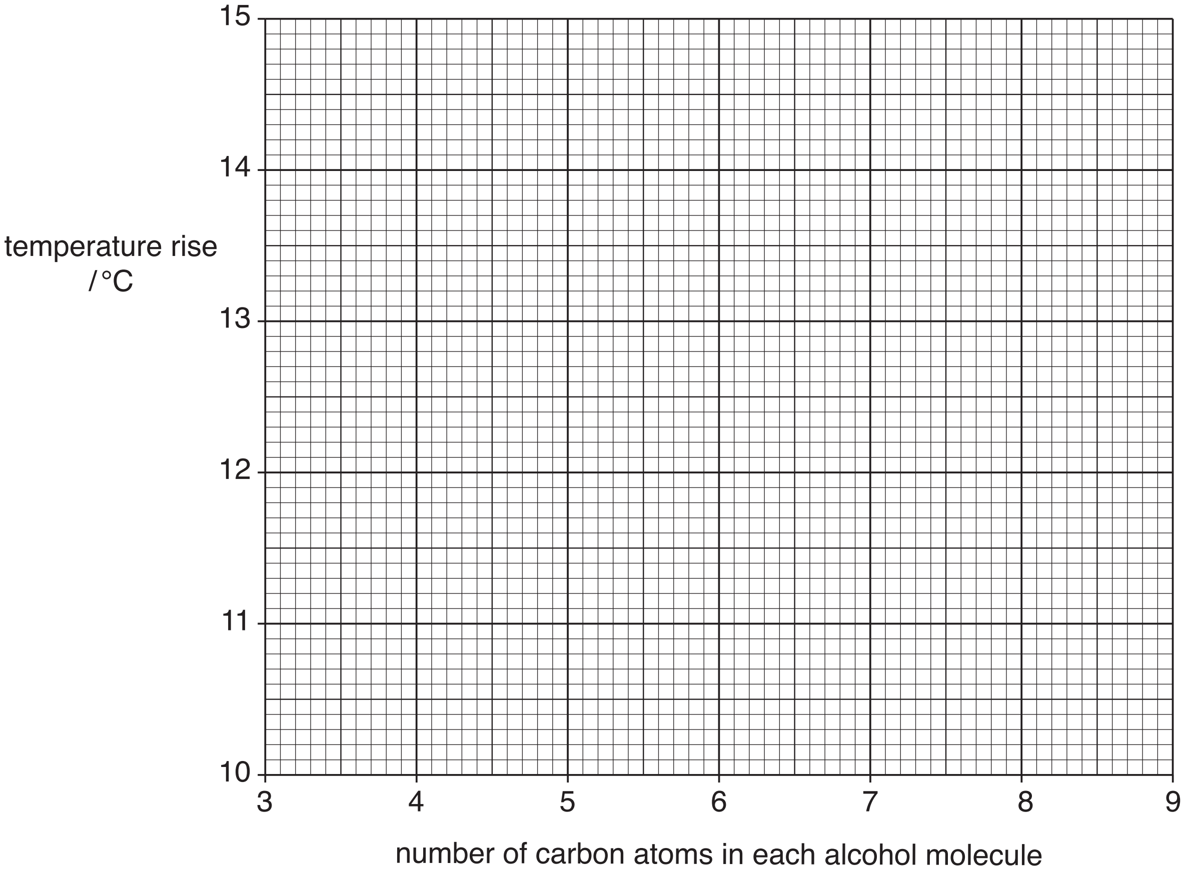
[2]

(b) The student repeats the experiment using several different alcohols. The same amount of alcohol is burnt in each case.

The results obtained are shown in the table.

number of carbon atoms in each alcohol molecule	temperature rise / °C
3	10.5
4	11.1
5	11.6
6	12.5
7	12.8
8	13.4

Plot the results on the grid. Draw a straight line of best fit. Extend your graph to the right hand edge of the grid.



[2]

(c) One of the results is incorrect. Circle this result on your grid and suggest what the correct result should be.

.... °C [1]

(d) Use your graph to deduce the temperature rise if a compound from the homologous series of alcohols with **nine** carbon atoms in each molecule is used in the experiment.

.... °C [1]

[Total: 10]

BLANK PAGE

Cambridge International Examinations
Cambridge Ordinary Level

CANDIDATE NAME	

CENTRE NUMBER		CANDIDATE NUMBER	

CHEMISTRY **5070/42**

Paper 4 Alternative to Practical **May/June 2016**

1 hour

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

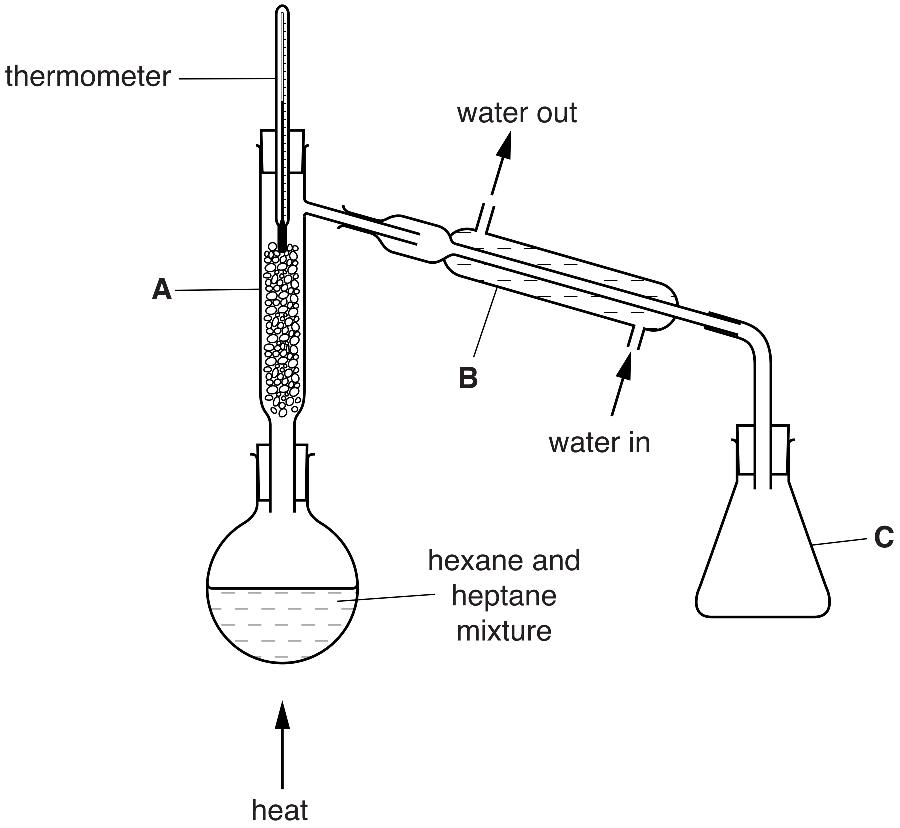
Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Write your answers in the spaces provided in the Question Paper.
Electronic calculators may be used.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

This document consists of **14** printed pages and **2** blank pages.

1 A student separates hexane, C_6H_{14}, (b.p. 69°C) and heptane, C_7H_{16}, (b.p. 98°C) using the apparatus shown.



(a) Identify two errors in the student's apparatus.

1. ....

2. .... [2]

The errors were then corrected and the separation started.

(b) **(i)** Name apparatus **A**.

.... [1]

(ii) What is the purpose of apparatus **A**?

....[1]

(iii) Name apparatus **B**.

.... [1]

(iv) What is the purpose of apparatus **B**?

....[1]

(c) **(i)** What is the reading on the thermometer when the first few drops of liquid appear in **C**?

.... [1]

(ii) Name this liquid.

.... [1]

(d) Suggest which method should be used to heat the mixture and explain your choice.

method ....

explanation ....

....
[2]

[Total: 10]

2 **(a)** Give a test and observation to identify the presence of the nitrate ion, $NO_3^-(aq)$.

test ....

....

observation ....

....[4]

(b) Describe briefly how pure crystals of potassium nitrate may be made from aqueous potassium nitrate.

....

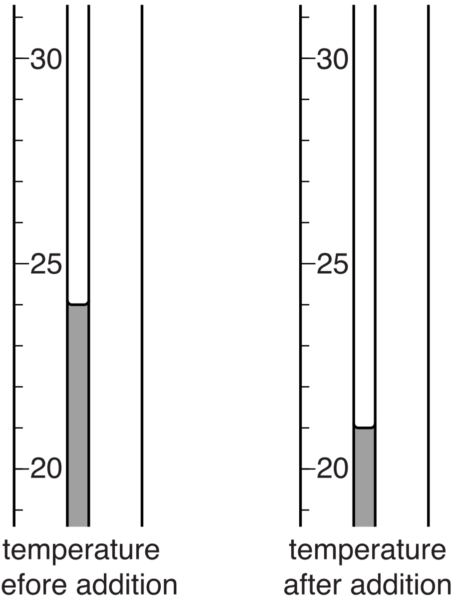
....

....

....

....[3]

(c) A few grams of potassium nitrate are added to water.
A thermometer is used to measure the temperature of the liquid before and after the addition of potassium nitrate.
The diagrams below show parts of the thermometer stem giving the two temperatures.



(i) Complete the table and calculate the temperature change.

temperature after potassium nitrate is added / °C	
temperature before potassium nitrate is added / °C	
change in temperature / °C	

[2]

(ii) What type of process does this temperature change indicate?

....[1]

[Total: 10]

3 **(a)** When zinc is heated in air it reacts with oxygen to form an oxide.
A student does an experiment to find the formula of zinc oxide.

Some zinc is placed in a previously weighed crucible and reweighed.

mass of crucible + zinc = 7.04 g
mass of crucible = 5.74 g

(i) Calculate the mass of zinc used in the experiment.

.... g [1]

The crucible containing the zinc is heated and zinc oxide is produced. The crucible with zinc oxide is weighed.

mass of crucible + zinc oxide = 7.36 g

(ii) Calculate the mass of zinc oxide produced.

.... g [1]

(iii) Using your answers to **(i)** and **(ii)**, calculate the mass of oxygen that combines with the zinc.

.... g [1]

(iv) Using your answers to **(i)** and **(iii)**, calculate the formula of zinc oxide. Show all your working.
[A_r : Zn, 65; O, 16]

formula ....[2]

(b) When zinc reacts with dilute hydrochloric acid, a gas is produced.
Name the gas. Give a test and observation to identify the gas.

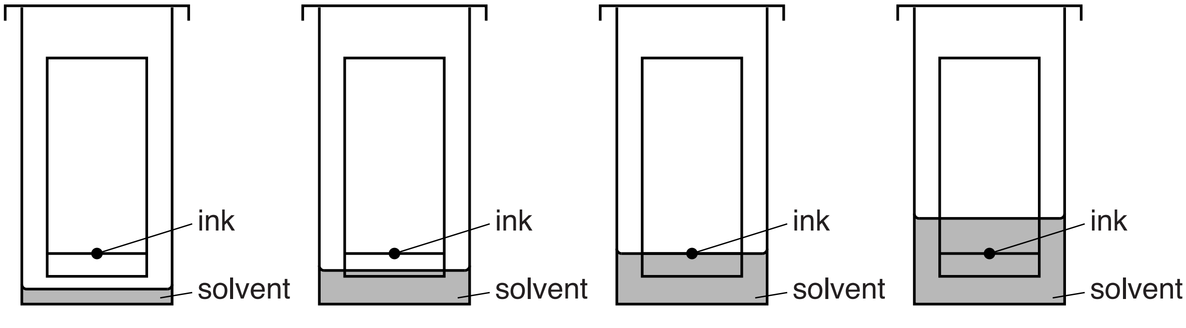
gas ....

test and observation ....
[2]

[Total: 7]

In questions **4** to **6** inclusive, place a tick (✓) in the box against the correct answer.

4 Chromatography can be used to separate the dyes present in black ink.
Which diagram shows the correct arrangement at the beginning of the experiment?



(a) ☐ **(b)** ☐ **(c)** ☐ **(d)** ☐

[Total: 1]

5 A student is given a sample of damp soil which is known to be acidic.
Which of the following substances may be used to neutralise the soil?

(a) calcium hydroxide ☐

(b) sodium chloride ☐

(c) potassium sulfate ☐

(d) zinc nitrate ☐

[Total: 1]

6 A small piece of calcium is added to a test-tube containing water coloured green by Universal Indicator.
A gas is given off and the indicator changes colour.
Which pair of observations is correct?

	final colour of indicator	test on gas	
(a)	purple	relights a glowing splint	☐
(b)	red	pops in a flame	☐
(c)	purple	pops in a flame	☐
(d)	red	relights a glowing splint	☐

[Total: 1]

7 A student is given a sample of an organic acid and asked to

- determine its relative molecular mass,
- deduce its molecular formula.

The student titrates **R**, an aqueous solution containing 8.00 g/dm^3 of the organic acid, with **S**, an aqueous solution containing 0.100 mol/dm^3 of sodium hydroxide.

25.0 cm^3 of **S** is transferred into a conical flask. A few drops of thymolphthalein indicator are added to the conical flask.

Thymolphthalein is colourless in acid solution and blue in alkaline solution.

R is put into a burette and added to the solution in the conical flask until an end-point is reached.

(a) What is the colour in the conical flask

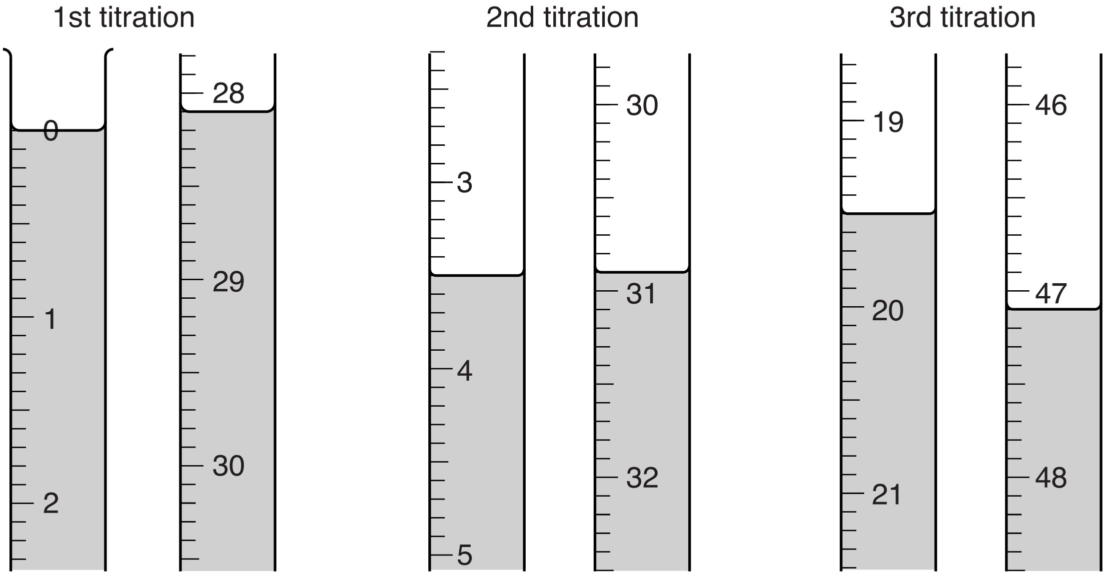
- before **R** is added,

  ....

- at the end-point?

  .... [1]

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



Use these diagrams to complete the following table.

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

Summary
Tick (✓) the best titration results.
Using these results, the average volume of **R** used is .... cm^3. [4]

(c) Calculate the number of moles of sodium hydroxide in 25.0 cm^3 of **S**.

.... moles [1]

(d) Given that 1 mol of acid neutralises 1 mol of sodium hydroxide, use your answer in **(c)** to deduce the number of moles of the organic acid in the average volume of **R**.

.... moles [1]

(e) Calculate the number of moles of the acid in 1.00 dm^3 of **R**.

.... moles [1]

(f) Using your answer to **(e)** and the information that **R** contains 8.00 g / dm^3 of the acid, calculate the relative molecular mass of the acid.

....[1]

(g) The organic acid has the formula

$$C_{\mathbf{n}}H_{2\mathbf{n}+1}CO_2H$$

where **n** is a whole number.

Using your answer to **(f)**, deduce the value of **n** and hence the molecular formula and the name for the organic acid.
[A_r: H, 1; C, 12; O, 16]

n = ...

molecular formula ....

name ....
[4]

[Total: 13]

8 **M** is a compound which contains two ions.
Complete the table by adding the observation in test **(a)**, the conclusions in tests **(b)** and **(c)** and both the test and observation for test **(d)**.

test	observations	conclusions	
(a) **M** is dissolved in water and the resulting solution is divided into three parts for tests **(b)**, **(c)** and **(d)**.		**M** is not a compound of a transition metal.	[1]
(b) **(i)** To the first part, aqueous sodium hydroxide is added until a change is seen. **(ii)** An excess of aqueous sodium hydroxide is added to the mixture from **(i)**.	A white precipitate forms. The precipitate dissolves.		[1]
(c) **(i)** To the second part, aqueous ammonia is added until a change is seen. **(ii)** An excess of aqueous ammonia is added to the mixture from **(i)**.	A white precipitate forms. The precipitate is insoluble.		[1]
(d)		**M** contains Cl^- ions.	[3]

(e) Conclusion: the formula of **M** is .... [1]

[Total: 7]

Question 9 begins on page 12.

[Turn over

9 The reaction between aqueous barium chloride and dilute sulfuric acid produces a precipitate of barium sulfate.

$$BaCl_2(aq) + H_2SO_4(aq) \rightarrow 2HCl(aq) + BaSO_4(s)$$

(a) State the colour of this precipitate.

.... [1]

A series of experiments are done to find the mass of precipitate formed when different volumes of dilute sulfuric acid are added to a fixed volume of aqueous barium chloride. The precipitate formed is filtered, dried and transferred to a container.

Solution **V** is 1.20 mol / dm^3 barium chloride.
Solution **W** is sulfuric acid of unknown concentration.

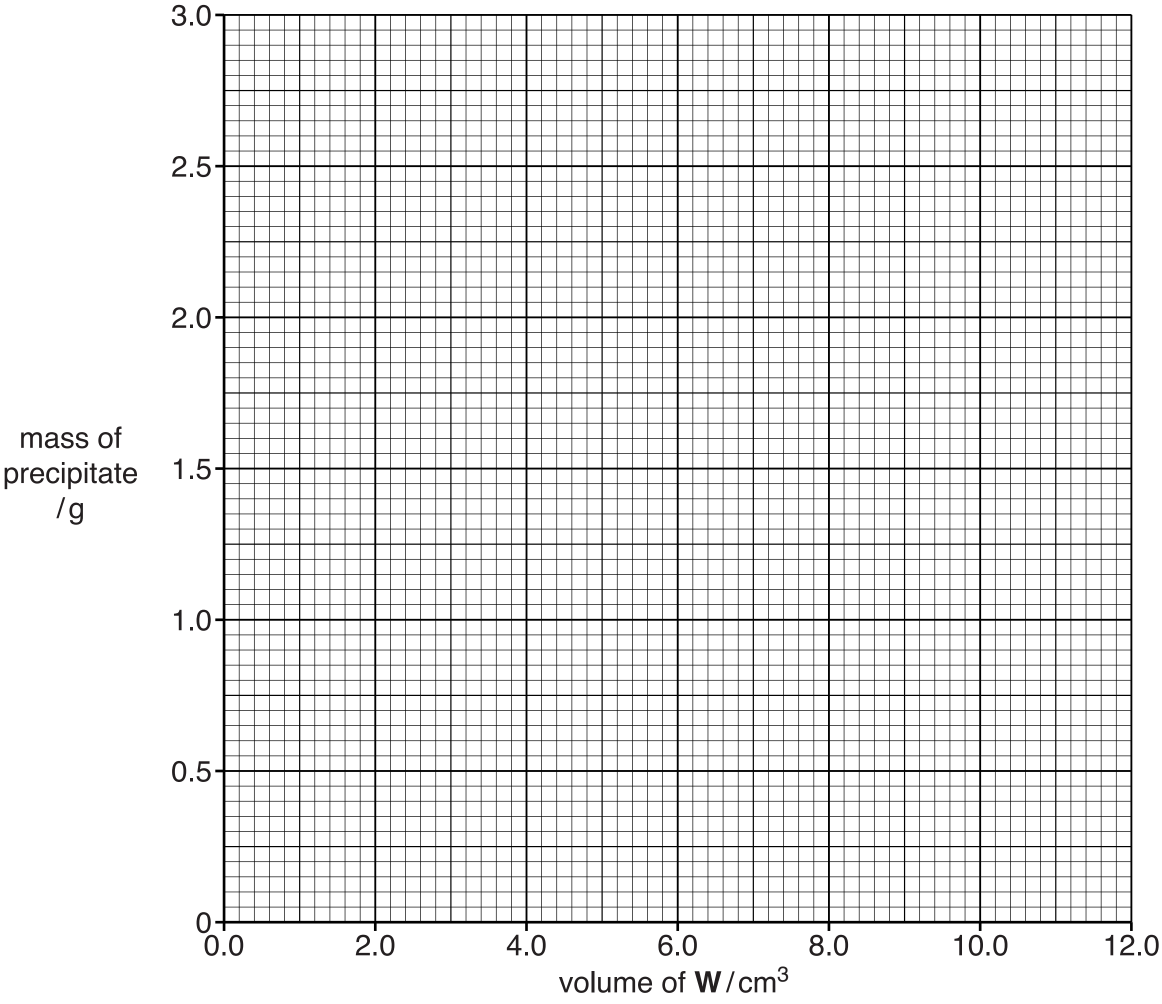
The table below shows the results of these experiments.

(b) Complete the final column by calculating the mass of precipitate formed in each experiment.

volume of **V** /cm^3	volume of **W** /cm^3	mass of empty container / g	mass of container + precipitate / g	mass of precipitate /g
10.0	2.0	2.70	3.35	0.65
10.0	4.0	2.70	4.00	
10.0	6.0	2.70	4.65	
10.0	8.0	2.70	5.30	
10.0	10.0	2.70	5.50	
10.0	12.0	2.70	5.50	

[1]

(c) Plot the mass of precipitate against the volume of **W** on the grid. Draw **two** intersecting straight lines through the points.



[3]

(d) Use the data on your grid to deduce

(i) the volume of **W** that would produce 1.20 g of precipitate,

.... cm^3 [1]

(ii) the maximum mass of precipitate that is produced,

.... g [1]

(iii) the minimum volume of **W** that reacts completely to produce the maximum mass in **(ii)**.

.... cm^3 [1]

(e) Using your answer to **(d)(iii)** and the equation for the reaction, calculate the concentration of the sulfuric acid, **W**, used in the experiment.

$$BaCl_2(aq) + H_2SO_4(aq) \rightarrow 2HCl(aq) + BaSO_4(s)$$

.... mol/dm^3 [2]

[Total: 10]

BLANK PAGE

BLANK PAGE

Cambridge International Examinations
Cambridge Ordinary Level

CANDIDATE NAME	

CENTRE NUMBER		CANDIDATE NUMBER	

CHEMISTRY **5070/42**

Paper 4 Alternative to Practical **October/November 2016**

1 hour

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

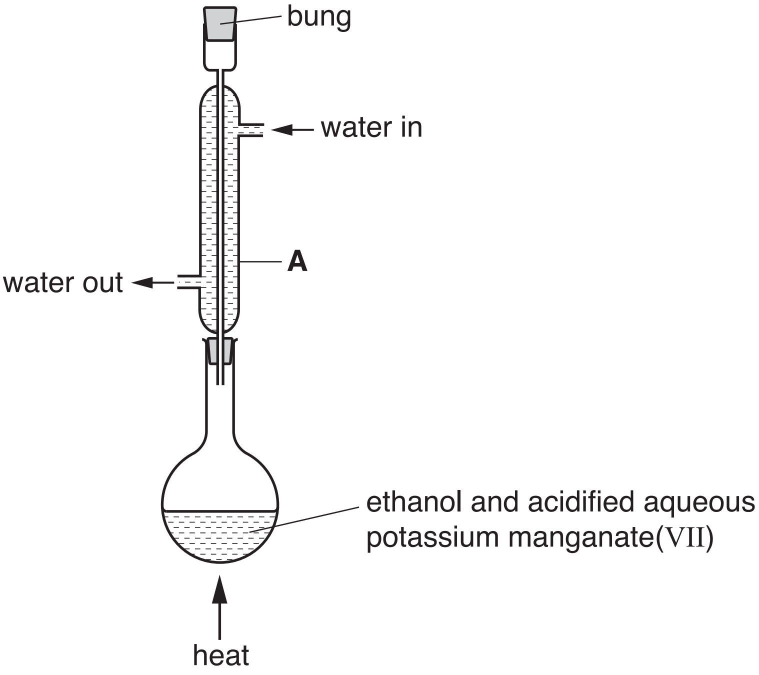
Answer **all** questions.
Write your answers in the spaces provided in the Question Paper.
Electronic calculators may be used.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

This document consists of **16** printed pages.

DC (NF/FD) 107618/4

1 A student uses acidified aqueous potassium manganate(VII) to oxidise ethanol to ethanoic acid.



(a) **(i)** Name apparatus **A**.

.... [1]

(ii) What is the purpose of apparatus **A**?

.... [1]

(b) Identify **two** errors in the student's apparatus.

1. ....

2. ....
[2]

The errors are corrected before the student begins heating.

(c) **(i)** State why a Bunsen burner should not be used to heat the mixture of ethanol and potassium manganate(VII).

.... [1]

(ii) What should be used instead of a Bunsen burner?

.... [1]

(d) Name the process that the student uses to separate ethanoic acid from the mixture after heating.

.... [1]

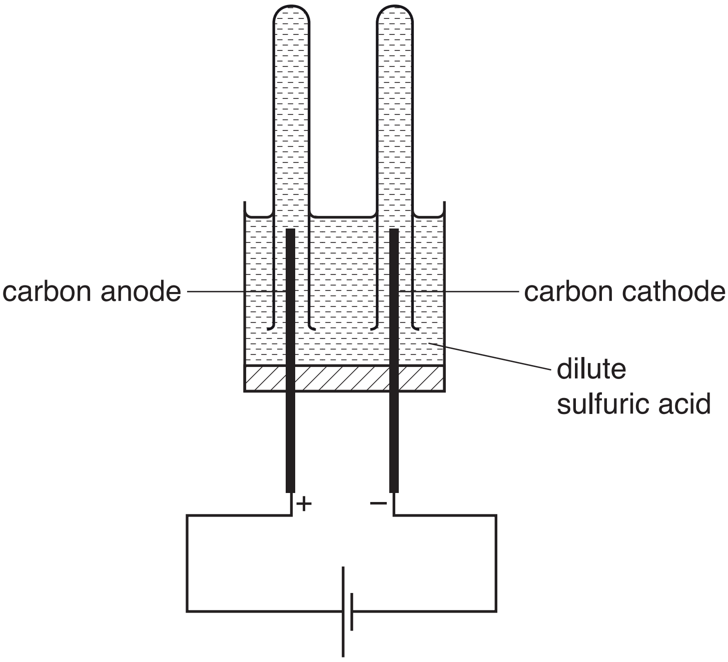
(e) The ethanoic acid is heated with another sample of ethanol and a catalyst of sulfuric acid.

Name the organic product.

.... [1]

[Total: 8]

2 The apparatus shown is used to electrolyse dilute sulfuric acid.



(a) Name the gas that collects at the anode. Give a test and observation to identify this gas.

name of gas ....

test and observation ....

[2]

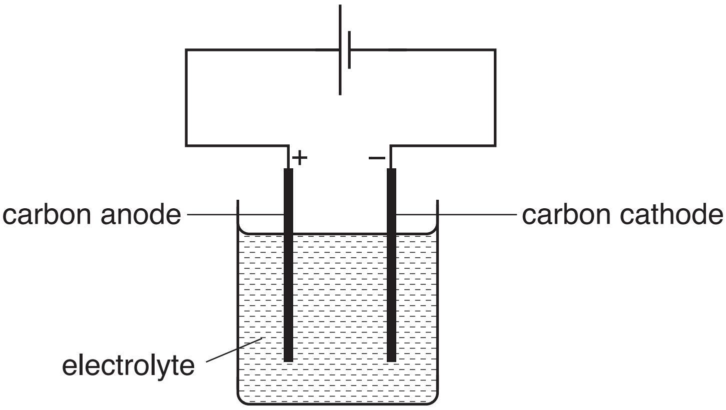
(b) Name the gas that collects at the cathode. Give a test and observation to identify this gas.

name of gas ....

test and observation ....

[2]

(c) The student does three more experiments with different electrolytes, using the apparatus shown.



Complete the table.

electrolyte	name of product at the anode	observations at the anode	name of product at the cathode	observations at the cathode
concentrated aqueous sodium iodide		black solid /brown solution		bubbles of colourless gas
concentrated aqueous copper(II) sulfate		bubbles of colourless gas		pink solid
concentrated aqueous sodium chloride	chlorine		hydrogen	

[6]

[Total: 10]

In questions **3** to **6** inclusive, place a tick (✓) in the box against the correct answer.

3 A student burns 4.8 g of an element **X** in excess oxygen. The mass of the oxide produced is 8.0 g.

What is the empirical formula of the oxide of **X**?

[A_r: **X**, 24; O, 16]

(a) **X**O ☐

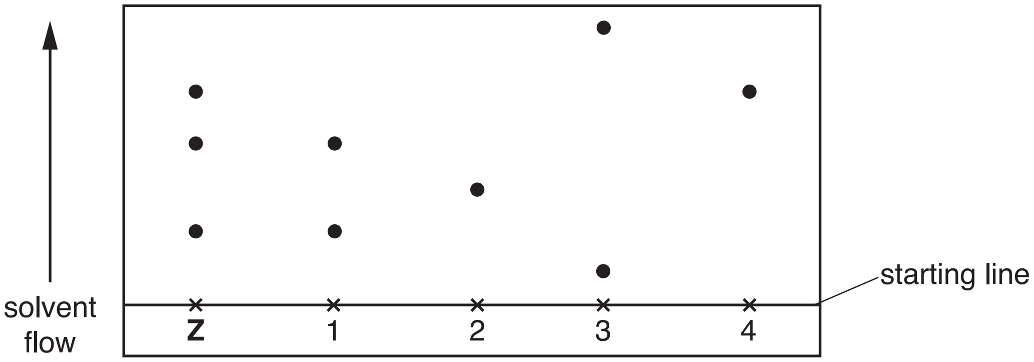
(b) $\mathbf{X}_2O$ ☐

(c) $\mathbf{X}_2O_2$ ☐

(d) $\mathbf{X}_3O_5$ ☐

[Total: 1]

4 The chromatogram shows the results of chromatography using mixture **Z** as well as individual dyes labelled 1, 2, 3 and 4.



Which of the dyes does **Z** contain?

(a) 1 only ☐

(b) 2 and 3 ☐

(c) 1 and 4 ☐

(d) 4 only ☐

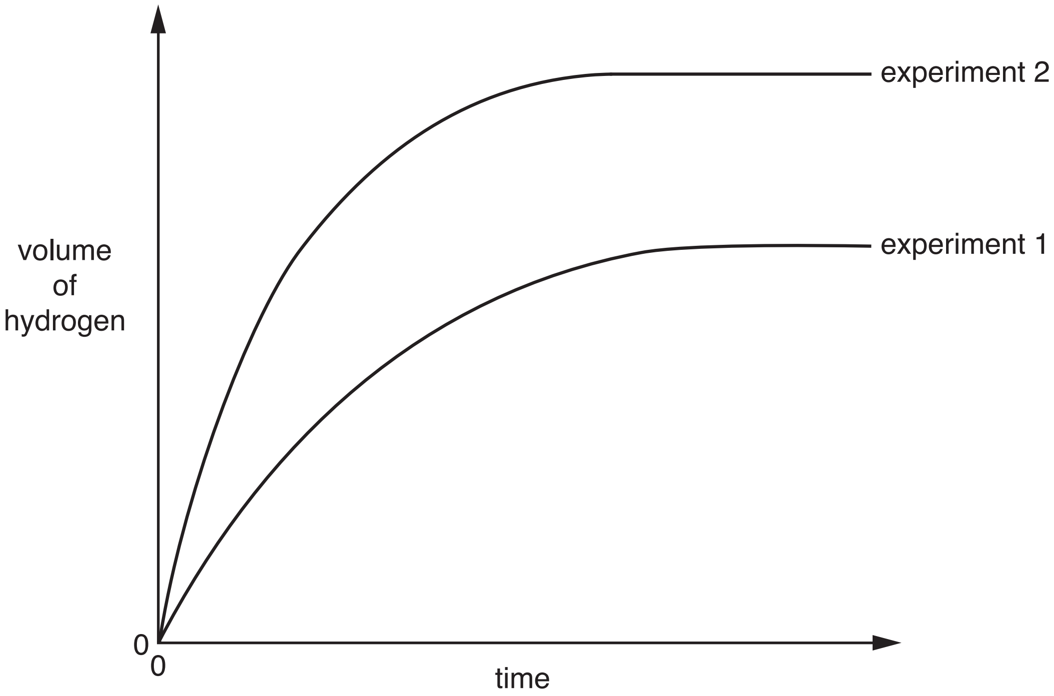
[Total: 1]

5 A student adds excess zinc to hydrochloric acid and measures the volume of hydrogen gas given off at regular time intervals. This is experiment 1.

The student makes a change to **one** of the conditions and then repeats the experiment. This is experiment 2.

The volume of hydrochloric acid is the same in both experiments.

Graphs for both experiments 1 and 2 are shown.



What is the different condition used in experiment 2?

(a) A catalyst is added. ☐

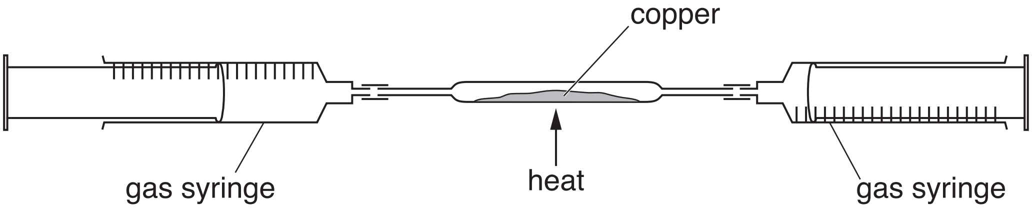
(b) A higher temperature is used. ☐

(c) A greater mass of zinc is used. ☐

(d) A higher concentration of hydrochloric acid is used. ☐

[Total: 1]

6 A student passes air backwards and forwards over heated copper using the apparatus shown. The original volume of air in the apparatus is 50.0 cm^3.



The experiment continues until the volume of gas stops changing. Some unreacted copper remains.

What is the final volume of gas in the apparatus?

[All volumes are measured at room temperature and pressure.]

(a) 10 cm^3 ☐

(b) 30 cm^3 ☐

(c) 40 cm^3 ☐

(d) 60 cm^3 ☐

[Total: 1]

7 Vinegar contains dilute ethanoic acid. Different brands of vinegar contain different concentrations of ethanoic acid.

You are provided with two different brands of colourless vinegar as well as the apparatus and chemicals normally found in a laboratory.

Describe how you would carry out experiments to find out which of the two brands contains the higher concentration of ethanoic acid.

You should give experimental details and the observations occurring at each stage of the procedure.

....

....

....

....

....

....

....

....

....

....

[Total: 5]

8 A student does an experiment to determine the percentage by mass of copper in a sample of impure copper. The sample of impure copper is placed in a previously weighed container and reweighed.

mass of container + impure copper = 7.45 g

mass of empty container = 5.72 g

(a) Calculate the mass of impure copper used in the experiment.

.... g [1]

The student transfers the sample of impure copper to a beaker, adds excess concentrated nitric acid and stirs until all the solid has dissolved. The copper reacts with the nitric acid producing aqueous copper nitrate as shown in **equation 1**.

equation 1 $Cu + 4HNO_3 \rightarrow Cu(NO_3)_2 + 2NO_2 + 2H_2O$

An excess of aqueous potassium iodide and an excess of dilute hydrochloric acid are then added to the beaker. A further reaction occurs as shown in **equation 2**.

equation 2 $2Cu(NO_3)_2 + 4KI + 4HCl \rightarrow 4KCl + 2CuI + 4HNO_3 + I_2$

The contents of the beaker are transferred to a suitable container and made up to 250 cm^3 with distilled water. This is solution **J**.

(b) Name the container in which solution **J** should be made.

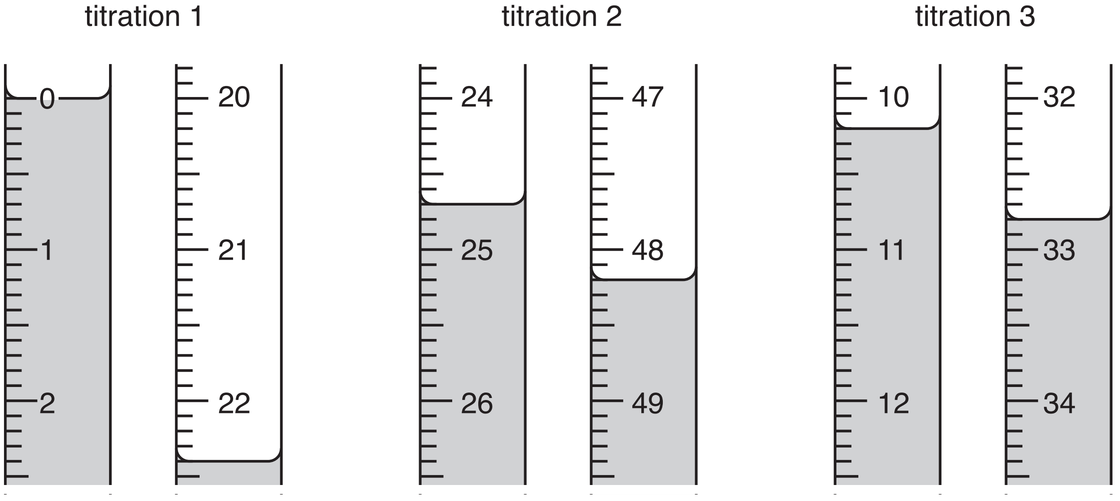
.... [1]

The student transfers 25.0 cm^3 of **J** to a conical flask and adds a few drops of a suitable indicator.

An aqueous solution of 0.100 mol/dm^3 sodium thiosulfate, $Na_2S_2O_3$, is put into a burette and run into the conical flask until the end-point is reached. The reaction between sodium thiosulfate, $Na_2S_2O_3$, and iodine, I_2, is shown in **equation 3**.

equation 3 $2Na_2S_2O_3 + I_2 \rightarrow 2NaI + Na_2S_4O_6$

(c) Three titrations are done. The diagrams show parts of the burette with the liquid levels at the beginning and end of each titration.



Use the diagrams to complete the results table.

titration number	1	2	3
final burette reading / cm^3			
initial burette reading / cm^3			
volume of 0.100 mol / dm^3 $Na_2S_2O_3$ / cm^3			
best titration results (✓)			

Summary

Tick (✓) the best titration results.

Using these results, the average volume of 0.100 mol / dm^3 $Na_2S_2O_3$ is

.... cm^3.
[4]

(d) Calculate the number of moles of $Na_2S_2O_3$ in the average volume of 0.100 mol / dm^3 $Na_2S_2O_3$.

.... moles [1]

(e) Use your answer to **(d)** and **equation 3** to calculate the number of moles of I_2 in 25.0 cm^3 of **J**.

equation 3 $2Na_2S_2O_3 + I_2 \rightarrow 2NaI + Na_2S_4O_6$

.... moles [1]

(f) Use your answer to **(e)** to calculate the number of moles of I_2 in 250 cm^3 of **J**.

.... moles [1]

(g) Use your answer to **(f)** and **equation 2** to calculate the number of moles of $Cu(NO_3)_2$ that produce the number of moles of I_2 calculated in **(f)**.

equation 2 $2Cu(NO_3)_2 + 4KI + 4HCl \rightarrow 4KCl + 2CuI + 4HNO_3 + I_2$

.... moles [1]

(h) Use your answer to **(g)** and **equation 1** to deduce the number of moles of Cu that produce the number of moles of $Cu(NO_3)_2$ calculated in **(g)**.

equation 1 $Cu + 4HNO_3 \rightarrow Cu(NO_3)_2 + 2NO_2 + 2H_2O$

.... moles [1]

(i) Use your answer to **(h)** to calculate the mass of copper in the sample of impure copper.

[A_r: Cu, 63.5]

.... g [1]

(j) Use your answers to **(i)** and **(a)** to calculate the percentage by mass of copper in the sample of impure copper.

....% [1]

[Total: 13]

9 The following table shows the tests a student does on a mixture **L**, which contains two compounds.

L contains three different ions.

Complete the table by adding the conclusion for **(a)**, the observations for **(b) (i)**, **(ii)** and **(iii)**, the conclusions for tests **(c) (i)** and **(ii)**, and both the test and observation which lead to the conclusion for test **(d)**. Any gases produced should be identified by test, result and name.

test	observation	conclusion	
(a) **L** is dissolved in water and the solution divided into three parts for tests **(b)**, **(c)** and **(d)**.	A colourless solution is formed.		[1]
(b) **(i)** To the first part, aqueous sodium hydroxide is added until a change is seen.		**L** contains Al^{3+}, Zn^{2+} or Ca^{2+} ions.	
(ii) An excess of aqueous sodium hydroxide is added to the mixture from **(i)**.		**L** contains Al^{3+} or Zn^{2+} ions.	
(iii) This mixture is then heated.		**L** contains NH_4^+ ions.	[4]
(c) **(i)** To the second part, aqueous ammonia is added until a change is seen.	A white precipitate forms.		
(ii) An excess of aqueous ammonia is added to the mixture from **(i)**.	The precipitate is insoluble in excess.		[1]
(d)		**L** contains SO_4^{2-} ions.	[3]

(e) Give the formulae of the two compounds which are present in mixture **L**.

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

[Total: 11]

10 When metal **M** is added to aqueous copper(II) sulfate the temperature rises.

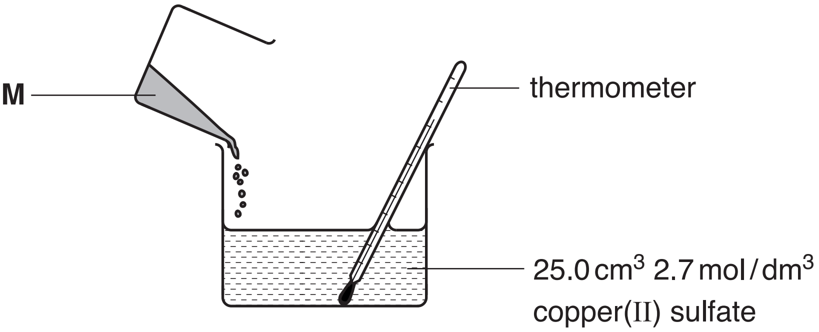
(a) What type of reaction does the temperature rise indicate?

.... [1]

The equation for the reaction is shown.

$$\mathbf{M} + CuSO_4 \rightarrow \mathbf{M}SO_4 + Cu$$

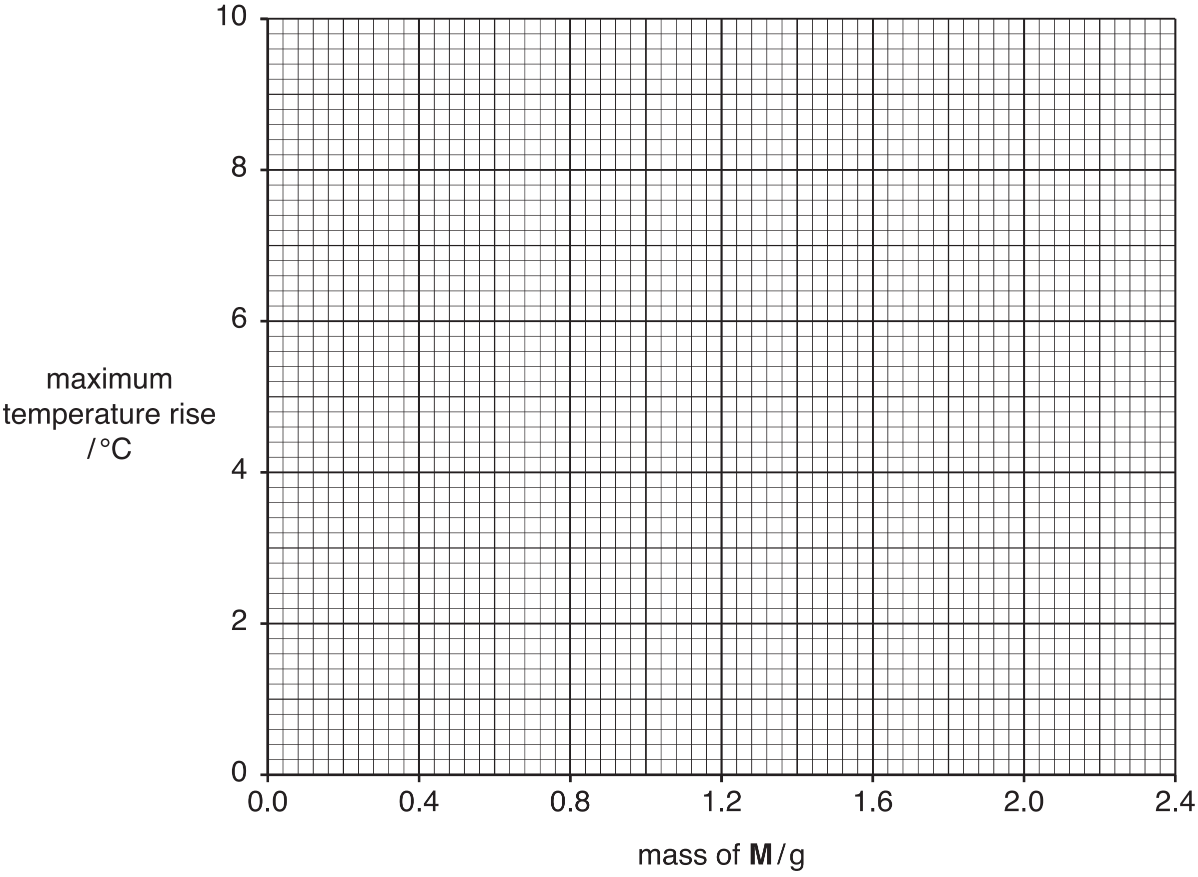
A student transfers 25.0 cm^3 of 2.7 mol / dm^3 of aqueous copper(II) sulfate to a glass beaker. A 0.4 g sample of metal **M** is added to the beaker and the mixture is stirred. The student records the maximum temperature rise with a thermometer.



The student repeats the experiment using different masses of metal **M** and in each case calculates and records the maximum temperature rise.

mass of **M** / g	maximum temperature rise / °C
0.4	2.2
0.8	4.4
1.2	6.6
1.6	8.8
2.0	8.8
2.4	8.8

(b) Plot the maximum temperature rise against the mass of **M** on the grid and draw two intersecting straight lines through the points.



[3]

(c) **(i)** Use your graph to determine the mass of **M** required to produce a maximum temperature rise of 5.0 °C.

.... g [1]

(ii) Use your graph to determine the maximum temperature rise which would occur if 1.5 g of **M** is used in the experiment.

.... °C [1]

(d) **(i)** Calculate the number of moles of copper(II) sulfate in 25.0 cm^3 of 2.7 mol / dm^3 aqueous copper(II) sulfate.

.... moles [1]

(ii) Use your graph to deduce the mass of **M** that reacts completely with 25.0 cm^3 of 2.7 mol / dm^3 aqueous copper(II) sulfate.

.... g [1]

(iii) Use the equation

$$\mathbf{M} + CuSO_4 \rightarrow \mathbf{M}SO_4 + Cu$$

and your answers to **(d)(i)** and **(d)(ii)** to calculate the relative atomic mass of metal **M**.

.... [1]

[Total: 9]

Cambridge International Examinations
Cambridge Ordinary Level

CANDIDATE NAME	

CENTRE NUMBER						CANDIDATE NUMBER					

CHEMISTRY **5070/42**

Paper 4 Alternative to Practical **May/June 2015**

1 hour

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
Write your answers in the spaces provided in the Question Paper.
At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

This document consists of **14** printed pages and **2** blank pages.

DC (LK/AR) 89254/3

1 **(a)** A student heats a small piece of magnesium ribbon in a crucible for several minutes. Some magnesium oxide is produced.

(i) Describe the appearance of the magnesium before heating.

....[1]

(ii) Construct the equation for this reaction.

....[1]

(b) When magnesium is added to dilute sulfuric acid a gas is produced.

Name the gas and give a test and observation to identify this gas.

name ....

test and observation

....[2]

(c) **(i)** Describe what is seen when magnesium oxide is added to excess dilute sulfuric acid.

....[1]

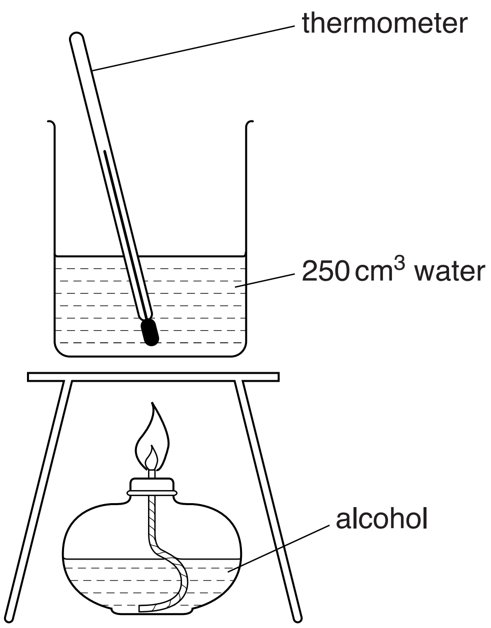
(ii) Construct the equation for this reaction.

....[1]

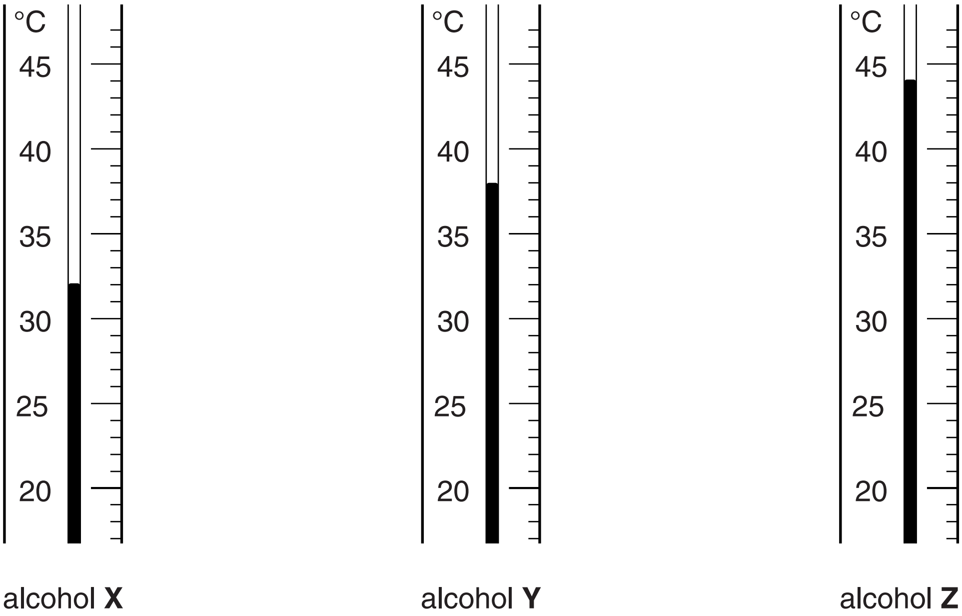
[Total: 6]

2 A student uses the apparatus shown to find the energy released by the combustion of each of three alcohols, **X**, **Y** and **Z**.

In each experiment 0.1 mol of alcohol is burnt and the initial temperature of the water is 20 °C.



(a) **(i)** The diagrams show parts of the thermometer stem giving the temperature of the water after 0.1 mol of each alcohol is burnt.



Use the thermometer readings to complete the following table and calculate the rise in temperature in each experiment.

	alcohol **X**	alcohol **Y**	alcohol **Z**
final temperature / °C			
initial temperature / °C	20	20	20
rise in temperature / °C			

[2]

(ii) Deduce from these results what type of reaction is taking place.

....[1]

(b) When analysed, alcohol **Y** is found to contain 60.0% carbon, 13.3% hydrogen and 26.7% oxygen by mass. Its relative formula mass is 60.
[A_r: C, 12; H, 1; O, 16]

(i) Calculate the empirical formula and hence the molecular formula of **Y**.

empirical formula ....

molecular formula .... [2]

(ii) Using your answers to **(a)(i)** and **(b)(i)** suggest the formula for **X** and the formula for **Z**, giving reasons for your choices.

X ....

Z ....

reasons ....

....[3]

(c) The student oxidises alcohol **Y** to make a carboxylic acid.

(i) Name and give the structure of this acid.

name ....

structure .... [1]

(ii) Suggest both the name of an oxidising agent that can be used and the colour change of the mixture that is seen during the reaction.

oxidising agent ....

The colour changes from .... to .... [2]

(d) Give the name and structure of the ester which may be prepared by reacting alcohol **Y** with the acid produced in **(c)(i)**.

name ....

structure .... [2]

[Total: 13]

In questions **3** to **7** inclusive, place a tick (✓) in the box against the correct answer.

3 Which apparatus should a student use to measure 25.0 cm^3 of a liquid?

(a) beaker ☐

(b) conical flask ☐

(c) measuring cylinder ☐

(d) pipette ☐

[Total: 1]

4 Water containing a little dilute sulfuric acid is electrolysed using carbon electrodes.

If 20 cm^3 of oxygen is produced at the positive electrode, what volume of hydrogen is produced at the negative electrode?

(a) 10 cm^3 ☐

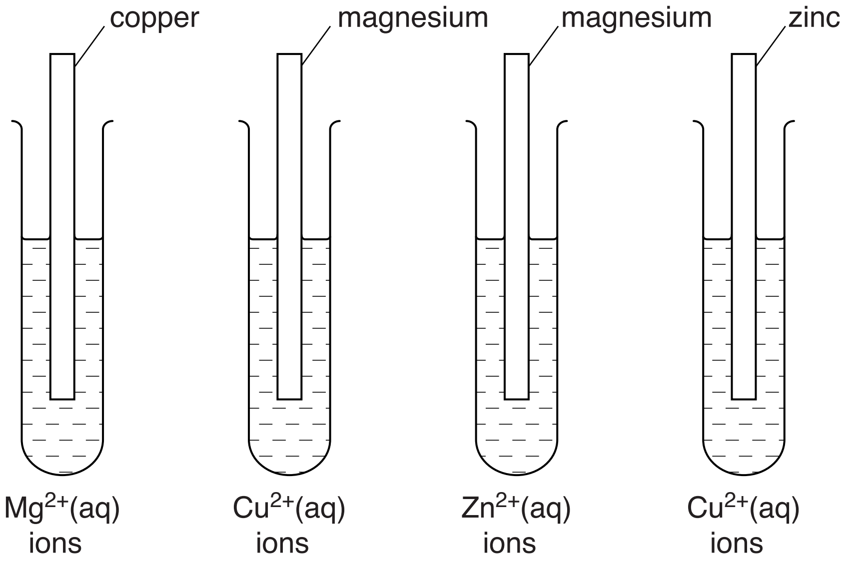
(b) 20 cm^3 ☐

(c) 30 cm^3 ☐

(d) 40 cm^3 ☐

[Total: 1]

5 Four tubes are arranged as in the diagrams. Each tube contains a piece of metal immersed in an aqueous solution of ions of one of the other two metals.



In a total of how many tubes is a coating formed on the piece of metal?

- **(a)** 1 ☐
- **(b)** 2 ☐
- **(c)** 3 ☐
- **(d)** 4 ☐

[Total: 1]

6 A small piece of sodium is placed on the surface of water. The sodium reacts and a solution is produced.

Which of the following is **not** correct?

- **(a)** The piece of sodium moves around the surface. ☐
- **(b)** A gas is evolved which relights a glowing splint. ☐
- **(c)** The resulting solution turns litmus blue. ☐
- **(d)** The temperature of the water increases. ☐

[Total: 1]

7 Calcium hydroxide reacts with hydrochloric acid according to the equation shown.

$$Ca(OH)_2 + 2HCl \rightarrow CaCl_2 + 2H_2O$$

Which of the following solutions of hydrochloric acid will produce 1.11g of calcium chloride when reacted with excess calcium hydroxide?
[M_r: $CaCl_2$, 111]

(a) 25 cm^3 of 0.200 mol / dm^3 of hydrochloric acid ☐

(b) 50 cm^3 of 0.400 mol / dm^3 of hydrochloric acid ☐

(c) 75 cm^3 of 0.050 mol / dm^3 of hydrochloric acid ☐

(d) 100 cm^3 of 0.100 mol / dm^3 of hydrochloric acid ☐

[Total: 1]

8 ‘Lawn sand’ is sand mixed with iron(II) sulfate and ammonium sulfate. It is used to promote the growth of grass.

A student determines the percentage by mass of iron in a sample of lawn sand, **L**, using 0.0200 mol / dm^3 aqueous potassium manganate(VII), solution **P**.

(a) A sample of **L** is added to a previously weighed beaker which is then reweighed.

mass of beaker + **L** = 38.04 g
mass of beaker = 21.93 g

Calculate the mass of **L** used in the experiment.

.... g [1]

(b) 100 cm^3 of dilute sulfuric acid is added to the beaker containing **L** and stirred well.
Sand is insoluble.

The sand is removed from the mixture. How could this be done?

....[1]

The remaining solution is transferred to a volumetric flask and made up to 250 cm^3 with distilled water. This is solution **M**.

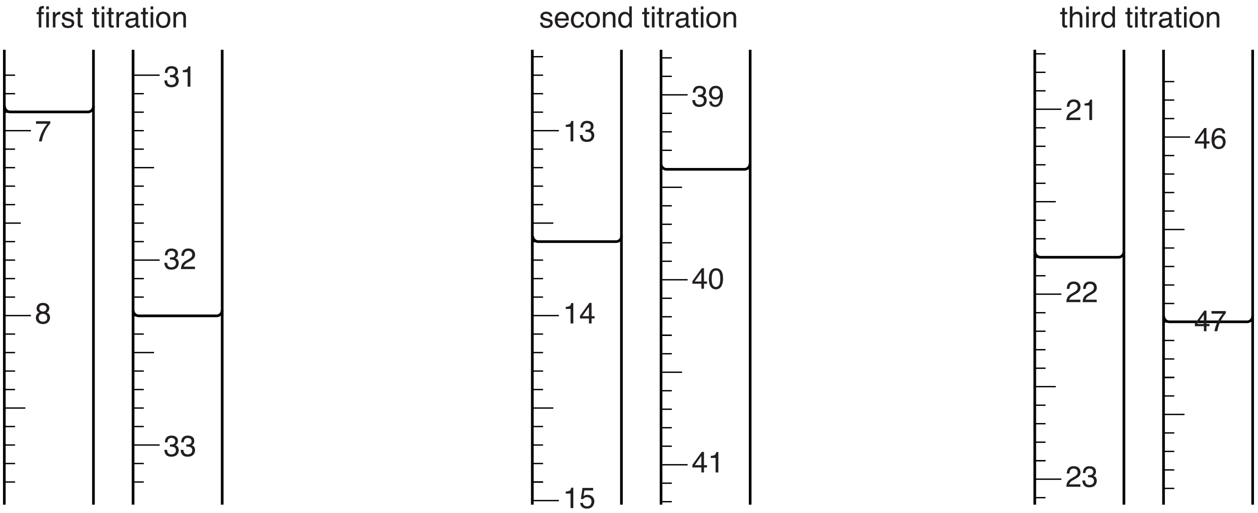
25.0 cm^3 of **M** is transferred into a conical flask.

Solution **P** is put into a burette and run into the conical flask containing **M** until **P** is just in excess.

(c) What is the colour of the solution in the conical flask

- before **P** is added, ...
- when **P** is just in excess? .... [1]

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



Use the diagrams to complete the table.

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

Summary

Tick (✓) the best titration results.

Using these results, the average volume of **P** used is

.... cm^3. [4]

(e) **P** is 0.0200 mol/dm^3 aqueous potassium manganate(VII).

Calculate the number of moles of potassium manganate(VII) in the average volume of **P** in **(d)**.

.... moles [1]

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

Calculate the number of moles of Fe^{2+} in 25.0 cm^3 of **M**.

.... moles [1]

(g) Calculate

(i) the number of moles of Fe^{2+} in 250 cm^3 of **M**,

.... moles [1]

(ii) the mass of iron in 250 cm^3 of **M**.
[A_r: Fe, 56]

....g [1]

(h) Using your answers to **(a)** and **(g)(ii)**, calculate the percentage by mass of iron in **L**.

....% [1]

(i) Lawn sand also contains ammonium sulfate, $(NH_4)_2SO_4$, which is a nitrogenous fertiliser.

(i) Calculate the percentage by mass of nitrogen in ammonium sulfate.
[A_r: N, 14; H, 1; S, 32; O, 16]

....% [2]

(ii) Name another compound which can be used as a nitrogenous fertiliser.

....[1]

[Total: 15]

9 The table shows the tests a student does on compound **V**.

Complete the table by stating the conclusion in test **(a)**, the observations in tests **(b)** and **(c)** and suggest both the test and observation that lead to the conclusion in test **(d)**.

test	observation	conclusion
(a) **V** is dissolved in water and the solution divided into three parts for tests **(b)**, **(c)** and **(d)**.	A colourless solution is obtained.	
(b) **(i)** To the first part, aqueous sodium hydroxide is added until a change is seen. **(ii)** An excess of aqueous sodium hydroxide is added to the mixture from **(i)**.		**V** may contain Al^{3+}, Ca^{2+} or Zn^{2+} ions. **V** may contain Al^{3+} or Zn^{2+} ions.
(c) **(i)** To the second part, aqueous ammonia is added until a change is seen. **(ii)** An excess of aqueous ammonia is added to the mixture from **(i)**.		The presence of Zn^{2+} ions in **V** is confirmed.
(d)		**V** contains NO_3^- ions.

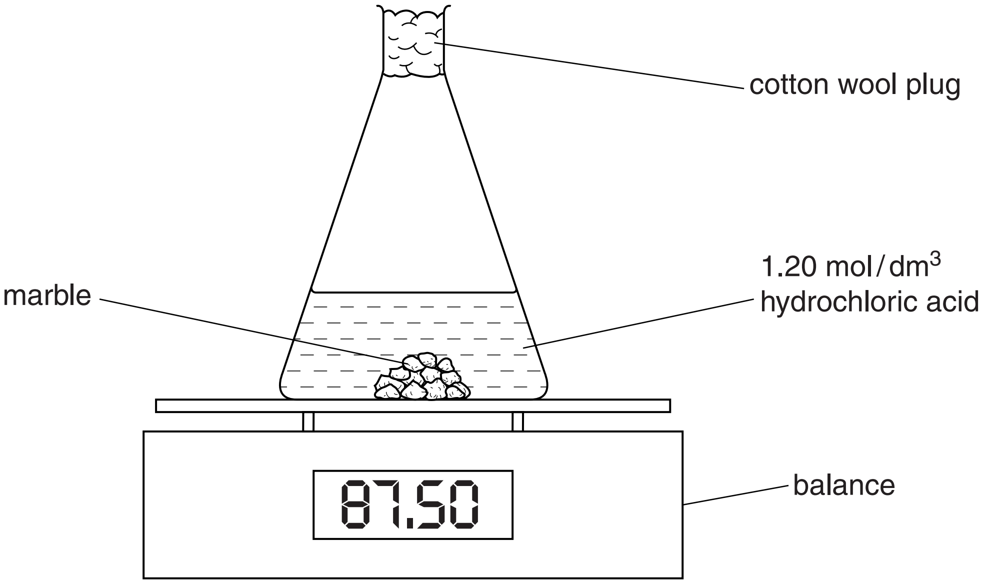
[Total: 8]

10 A student uses the apparatus shown to investigate the reaction between marble ($CaCO_3$) and hydrochloric acid.

10.0 g of marble lumps (an excess) are added to 30.0 cm^3 of 1.20 mol / dm^3 hydrochloric acid contained in a flask.

The mass of the flask and contents is recorded every 30 seconds. This is experiment **1**.

The experiment is repeated using the same mass of marble but finely powdered instead of lumps. The volume and concentration of the hydrochloric acid used is unchanged. This is experiment **2**.



(a) The results of the two experiments are recorded in the table.

Complete the table by calculating the total change in mass at each time for both experiments.

time / s	experiment **1** (lumps)		experiment **2** (powder)	
	mass of flask and contents / g	total change in mass / g	mass of flask and contents / g	total change in mass / g
0	87.50	0.00	87.50	0.00
30	87.22	0.28	87.02	0.48
60	87.02	0.48	86.83	0.67
90	86.87		86.74	
120	86.77		86.69	
150	86.69		86.69	
180	86.69		86.69	

[2]

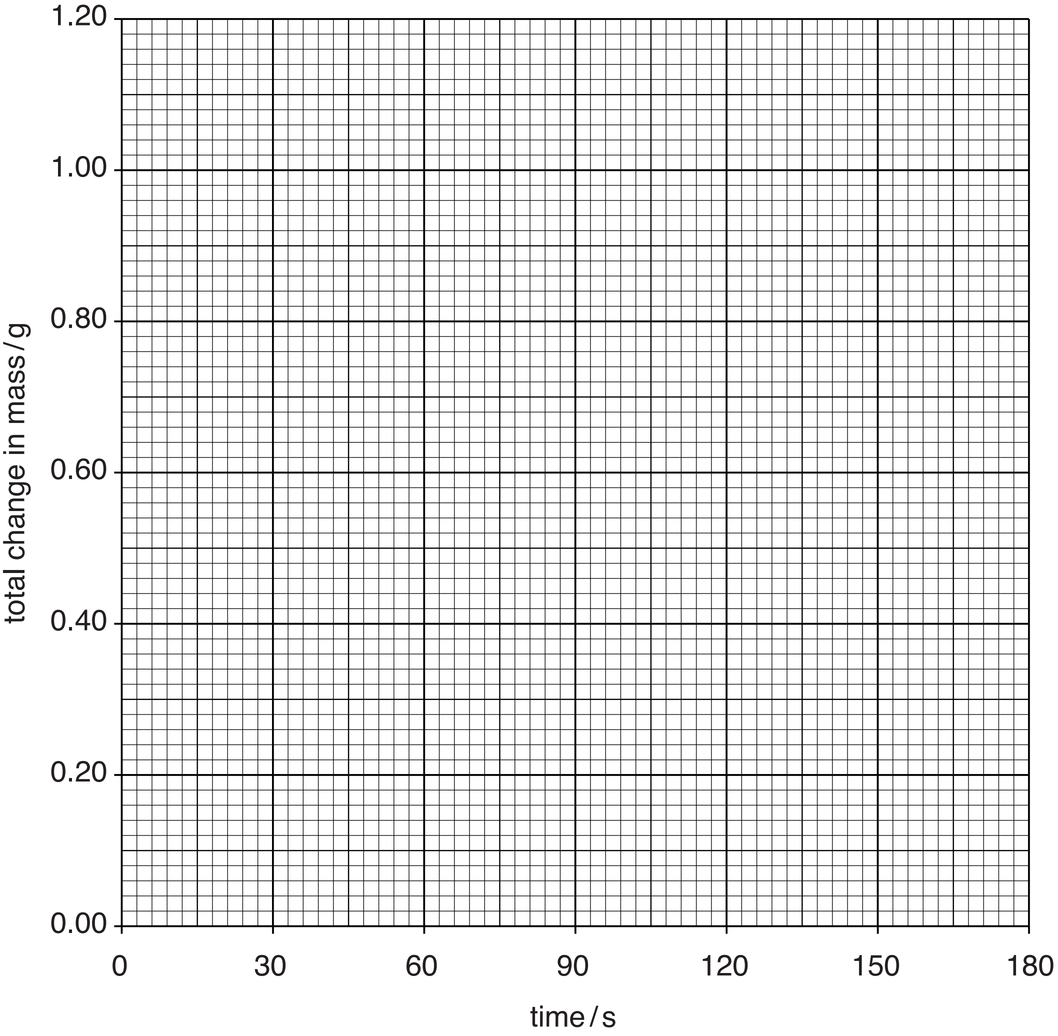
(b) Construct the equation for the reaction between calcium carbonate and hydrochloric acid.

....[1]

(c) Suggest why the mass of the flask and contents decreases as the reaction progresses.

....[1]

(d) Plot the points for each experiment on the grid.
Draw a smooth curve through each set of points.
Label the curves 'experiment **1**' and 'experiment **2**'.



[3]

(e) Using your graph,

(i) what is the total change in mass in experiment **1** after 75 seconds,

.... g [1]

(ii) what is the mass of the flask and contents in experiment **2** after 45 seconds?

.... g [1]

(f) State and explain how the use of powdered marble rather than marble lumps in experiment **2** affects the rate of the reaction.

....

....

....[2]

(g) Using your equation in **(b)**, calculate the mass of marble that remains after reaction with 30 cm^3 of 1.20 mol / dm^3 hydrochloric acid.
[A_r: Ca, 40; C, 12; O, 16]

.... g [2]

[Total:13]

BLANK PAGE

BLANK PAGE

Cambridge International Examinations
Cambridge Ordinary Level

CANDIDATE NAME	

CENTRE NUMBER		CANDIDATE NUMBER	

6377602299

CHEMISTRY **5070/42**

Paper 4 Alternative to Practical **October/November 2015**

1 hour

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Write your answers in the spaces provided in the Question Paper.
Electronic calculators may be used.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

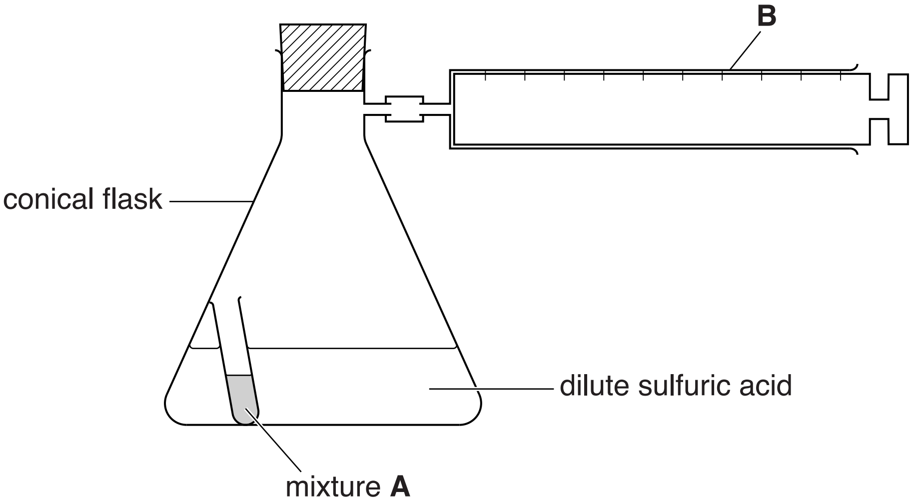
This document consists of **14** printed pages and **2** blank pages.

DC (LK/CGW) 89576/6

1 A student determines the mass of copper in mixture **A** which is composed of only copper and zinc.

Zinc reacts with dilute sulfuric acid. Copper does not.

Dilute sulfuric acid is mixed with **A** in the apparatus below. A gas is given off which is collected in **B**.



(a) Name apparatus **B**.

.... [1]

(b) **(i)** Name the gas collected in **B**. Give a test and observation to identify the gas.

name of gas ....

test and observation..
[2]

(ii) Construct an equation for the reaction between zinc and dilute sulfuric acid.

.... [1]

(c) When all the zinc has reacted, the volume of gas collected in **B** is 96.0 cm^3 when measured at room temperature and pressure.
[1 mole of any gas occupies 24 000 cm^3 at room temperature and pressure.]

(i) Calculate the number of moles of gas in 96.0 cm^3.

.... moles [1]

(ii) Using your answers to **(b)(ii)** and **(c)(i)** calculate the mass of zinc in **A**.
[A_r: Zn, 65]

.... g [1]

(iii) The mass of mixture **A** is 1.20 g. Calculate the mass of copper in mixture **A**.

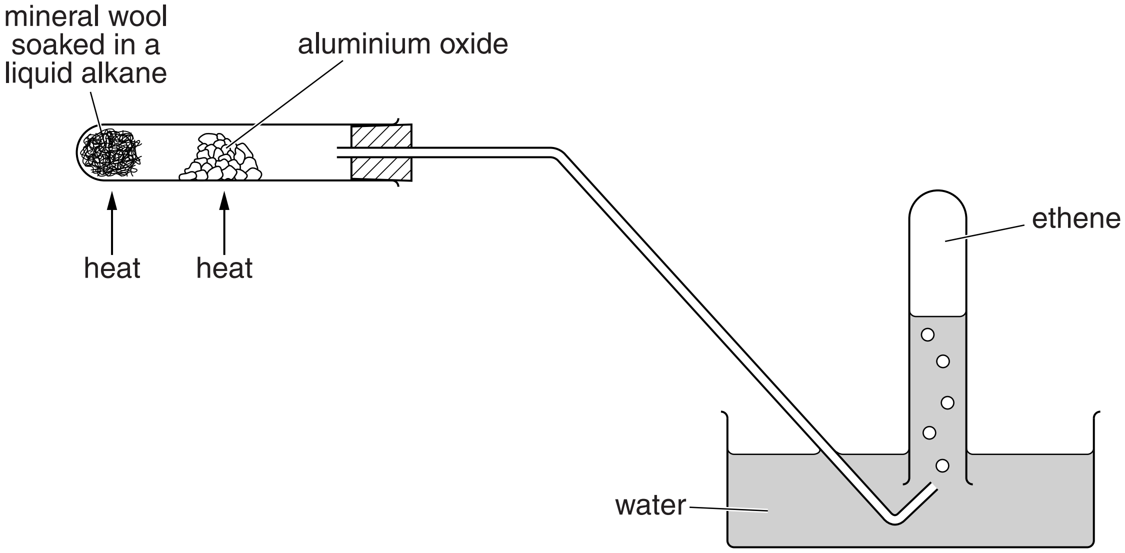
.... g [1]

(d) When the reaction has finished, the student separates the copper from the solution remaining in the conical flask by filtration, using a previously weighed filter paper. As soon as the filtration finishes the student weighs the filter paper containing the copper residue and finds that its mass is greater than he expected. Explain why.

....[1]

[Total: 8]

2 A student prepares ethene, C_2H_4, using the apparatus below.



(a) **(i)** What is this type of reaction called?

....[1]

(ii) Suggest why aluminium oxide is used in this reaction.

....[1]

(iii) The liquid alkane has eight carbon atoms in each molecule. Give the molecular formula of the alkane.

.... [1]

(iv) The reaction produces ethene and one other product. Construct a possible equation for the reaction.

.... [1]

(b) Two drops of aqueous bromine are added to ethene.

(i) What observation is made?

.... [1]

(ii) What type of reaction occurs?

.... [1]

(iii) Construct an equation for the reaction between bromine and ethene.

.... [1]

(c) When ethene undergoes complete combustion in air, the products are water and a colourless gas.

Name the colourless gas. Give a test and observation to identify this gas.

name of gas ....

test and observation ....
[2]

[Total: 9]

In questions **3** to **6** inclusive, place a tick (✓) in the box against the correct answer.

3 A compound, **T**, contains 41.0 % potassium, 33.7 % sulfur and 25.3 % oxygen by mass.

What is the empirical formula of **T**?
[A_r: K, 39; S, 32; O, 16]

(a) $K_4S_3O_3$ ☐

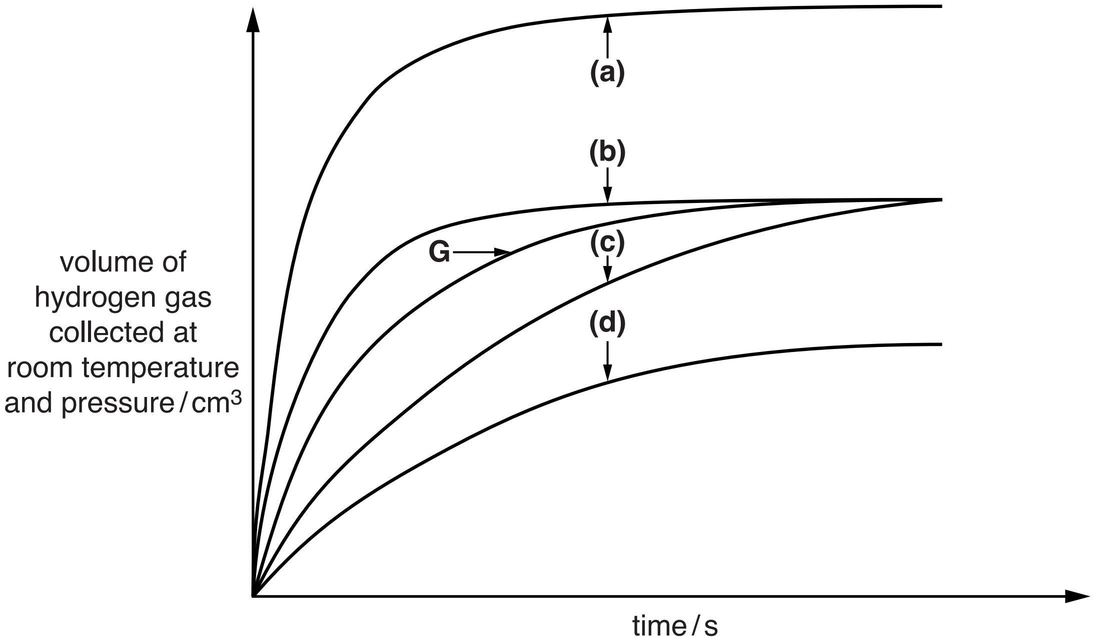
(b) K_2SO_3 ☐

(c) K_2SO_4 ☐

(d) $K_2S_2O_3$ ☐

[Total: 1]

4 A student adds excess zinc to 50 cm^3 of 1.00 mol / dm^3 hydrochloric acid at 20 °C.
A graph, labelled **G**, is drawn, showing how the volume of hydrogen gas evolved varies with time.



The experiment is repeated using identical conditions but with the hydrochloric acid at a temperature of 40 °C.

Which of the graphs correctly shows how the volume of hydrogen gas evolved varies with time when using hydrochloric acid at 40 °C?

(a) ☐

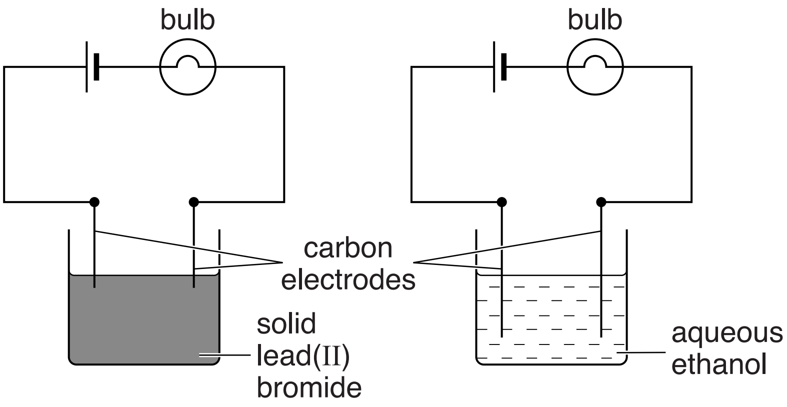
(b) ☐

(c) ☐

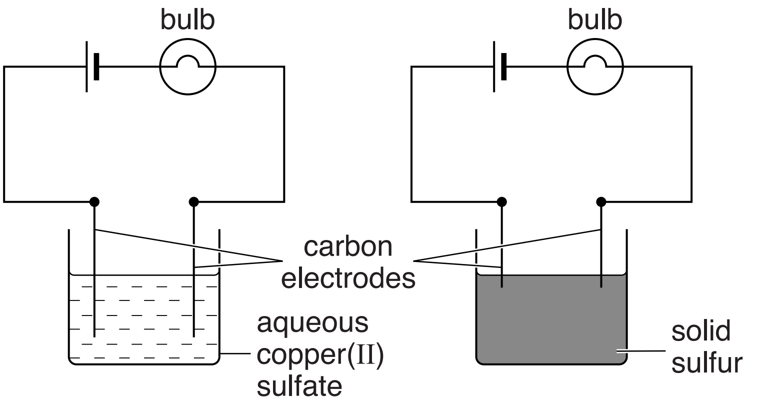
(d) ☐

[Total: 1]

5 In which of the following circuits would the bulb light?



(a) **(b)**



(c) **(d)**

(a) ☐

(b) ☐

(c) ☐

(d) ☐

[Total: 1]

6 Which of the following would **not** react together to form a precipitate?

(a) aqueous sodium hydroxide and aqueous ammonium chloride ☐

(b) aqueous silver nitrate and aqueous sodium chloride ☐

(c) aqueous sodium hydroxide and aqueous iron(II) sulfate ☐

(d) aqueous barium nitrate and aqueous magnesium sulfate ☐

[Total:1]

7 A student determines the percentage composition by mass of a mixture of two solids, sodium chloride, NaC*l*, and sodium carbonate, Na_2CO_3. This is mixture **M**.

(a) A sample of **M** is placed in a previously weighed container, which is then reweighed.

mass of container + **M** = 9.05 g

mass of container = 7.23 g

Calculate the mass of **M** used in the experiment.

.... g [1]

(b) The sample of **M** is dissolved in distilled water and the solution made up to 250 cm^3. This is solution **Q**.

Name the apparatus in which solution **Q** should be made up to 250 cm^3.

....[1]

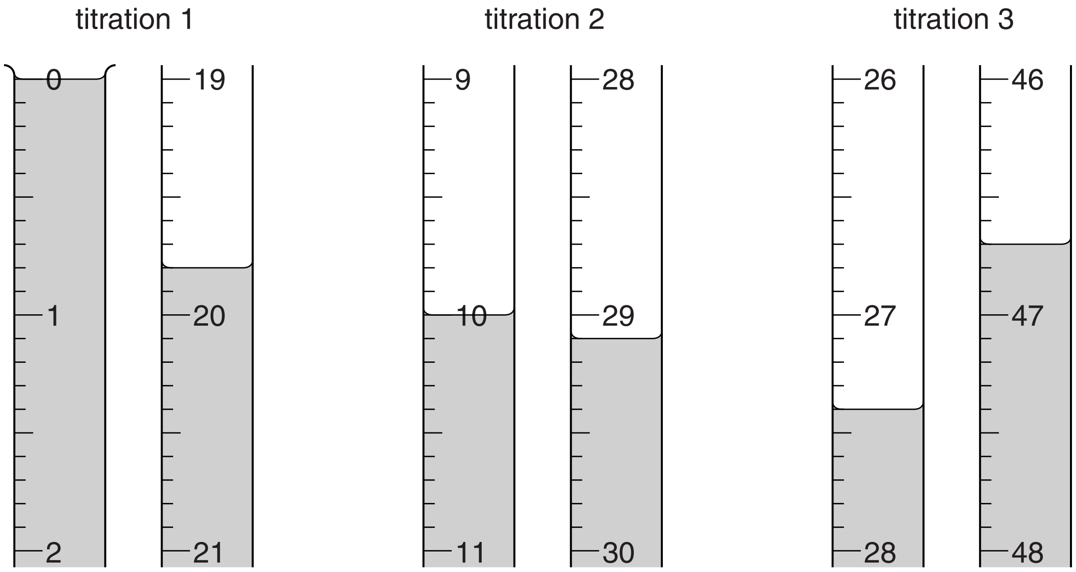
(c) A 25.0 cm^3 sample of **Q** is transferred into a conical flask and a few drops of methyl orange indicator are added. A burette is filled with 0.100 mol / dm^3 hydrochloric acid.

The hydrochloric acid is added to **Q** until the end-point is reached.

What is the colour of the solution in the conical flask

- before the hydrochloric acid is added, ...
- at the end-point? .... [1]

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



Use the diagrams to complete the following table.

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

Summary

Tick (✓) the best titration results.

Using these results, the average volume of hydrochloric acid required is

.... cm^3. [4]

(e) Calculate the number of moles of hydrochloric acid in the average volume of 0.100 mol/dm^3 hydrochloric acid in **(d)**.

.... moles [1]

(f) Sodium carbonate reacts with hydrochloric acid but sodium chloride does not.

Construct the equation for the reaction between sodium carbonate, Na_2CO_3, and hydrochloric acid.

One mole of sodium carbonate reacts with two moles of hydrochloric acid.

....[1]

(g) Using the information in **(f)** and your answer to **(e)**, deduce the number of moles of sodium carbonate in 25.0 cm^3 of **Q**.

.... moles [1]

(h) Calculate the number of moles of sodium carbonate in 250 cm^3 of **Q**.

.... moles [1]

(i) Use your answer to **(h)** to calculate the mass of sodium carbonate, Na_2CO_3, in the sample of **M**.
[A_r: Na, 23; C, 12; O, 16]

.... g [1]

(j) Using your answers to **(i)** and **(a)**, calculate the mass of sodium chloride in the sample of **M**.

.... g [1]

(k) Calculate the percentage by mass of sodium chloride in **M**.

.... % [1]

[Total: 14]

8 Compound **L** is a solid. The following table shows the tests a student does on compound **L**.

Complete the table by adding the conclusion for test **(a)**, the observations for tests **(b)** and **(c)** and both the test and observation which lead to the conclusion for test **(d)**.

test	observation	conclusion
(a) **L** is dissolved in water and the solution divided into three parts for tests **(b)**, **(c)** and **(d)**.	A colourless solution is formed.	
(b) **(i)** To the first part, aqueous sodium hydroxide is added until a change is seen.		**L** may contain Al^{3+}, Ca^{2+} or Zn^{2+} ions.
(ii) An excess of aqueous sodium hydroxide is added to the mixture from **(i)**.		**L** may contain Al^{3+} or Zn^{2+} ions.
(c) **(i)** To the second part, aqueous ammonia is added until a change is seen.		**L** may contain Al^{3+} or Zn^{2+} ions.
(ii) An excess of aqueous ammonia is added to the mixture from **(i)**.		**L** contains Al^{3+} ions.
(d)		**L** contains SO_4^{2-} ions.

[8]

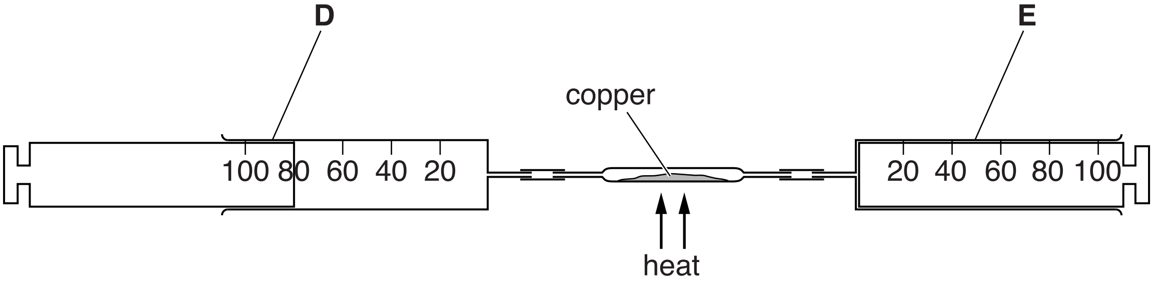
(e) Conclusion: the formula of compound **L** is .... [1]

[Total: 9]

Question 9 begins on page 12.

[Turn over

9 A student uses the apparatus below to oxidise copper.



At the start of the experiment, **D** contains 80 cm^3 of air. The air is forced over heated copper into **E**. The air is then forced back into **D**. The process is repeated several times until the volume of gas forced back into **D** is constant. The gas is allowed to cool to room temperature before recording the final volume.

(a) The copper reacts with oxygen in the air to produce copper(II) oxide. Construct an equation for this reaction.

....[1]

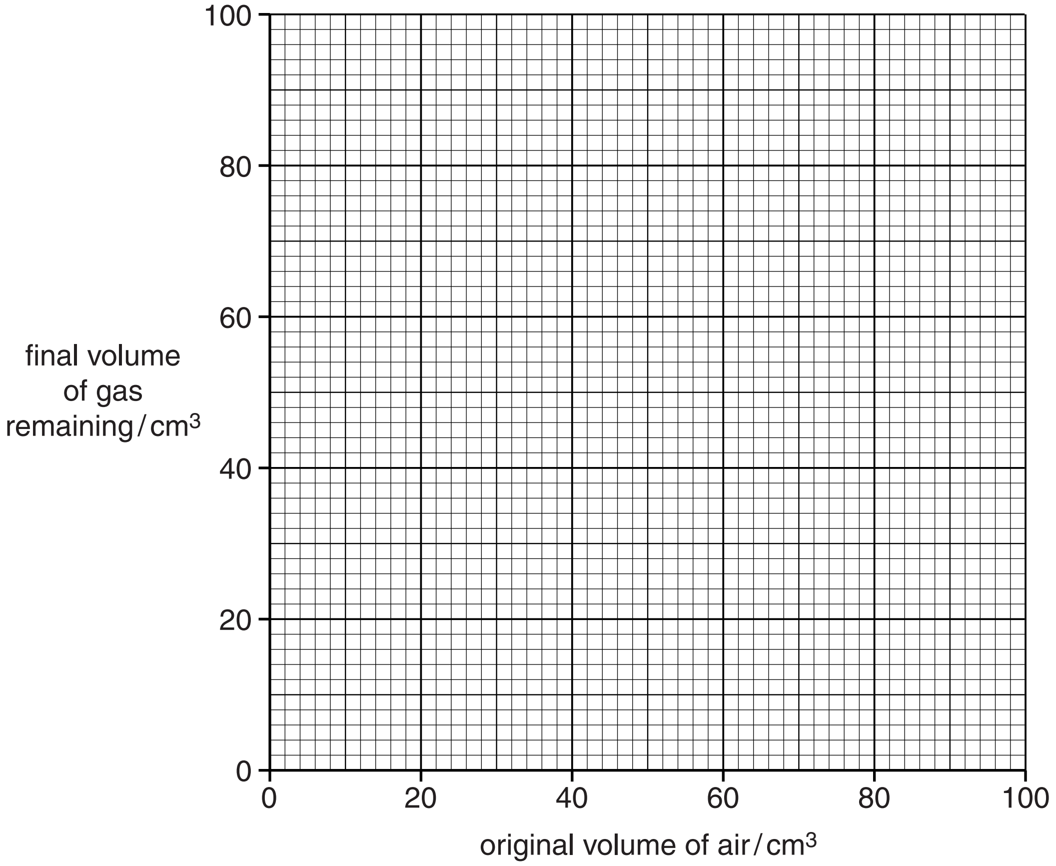
(b) Name the major component of the gas remaining in **D** at the end of the experiment.

....[1]

(c) The student repeats the experiment several times using different volumes of air in **D**. The results are recorded in the table.

original volume of air / cm^3	final volume of gas remaining / cm^3
80	64
70	56
65	52
50	45
35	28
20	16

(i) Plot the results on the grid opposite and draw a straight line of best fit through your points.



[3]

(ii) There is one anomalous reading of the final volume of gas. Circle the anomalous point. [1]

(iii) Use your graph to deduce the correct final volume of gas corresponding to the point circled in **(c)(ii)**.

.... cm^3 [1]

(iv) The anomalous result is not due to an error in reading the final volume of gas. Suggest a reason why the anomalous result occurred.

....

....[1]

(d) Use your graph to answer the following questions.

(i) What is the final volume of gas if the student uses 25.0 cm^3 as the original volume of air?

.... cm^3 [1]

(ii) If the final volume of gas is 35.0 cm^3, what is the original volume of air that the student uses?

.... cm^3 [1]

[Total: 10]

10 A student converts copper(II) oxide into copper(II) sulfate.

(a) Name the substance that reacts with copper(II) oxide to produce aqueous copper(II) sulfate.

....[1]

(b) Construct an equation for the reaction between copper(II) oxide and the substance in **(a)**.

....[1]

(c) What colour is the solution when the reaction is complete?

....[1]

(d) Describe how the student can make pure dry crystals of copper(II) sulfate from the solution formed by the reaction in **(b)**.

....

....

....

....

....[3]

[Total: 6]

BLANK PAGE

BLANK PAGE

Cambridge International Examinations
Cambridge Ordinary Level

CANDIDATE NAME

CENTRE NUMBER ☐☐☐☐☐ CANDIDATE NUMBER ☐☐☐☐

0673865816

CHEMISTRY **5070/42**

Paper 4 Alternative to Practical **May/June 2014**

1 hour

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
Write your answers in the spaces provided in the Question Paper.
At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

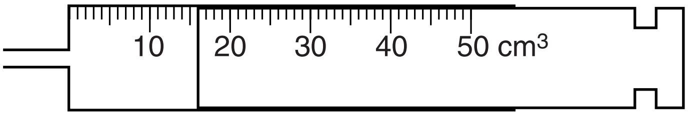
This document consists of **14** printed pages and **2** blank pages.

DC (NH/SW) 71966/4

CAMBRIDGE
International Examinations

[Turn over

1



(a) **(i)** Name the apparatus shown above.

.... [1]

(ii) What is the volume of gas in the apparatus?

.... cm^3
[1]

(b) Each of the following pairs of substances react together to produce a gas as one of the products.

In each case
- name the gas produced,
- describe a test for the gas,
- construct an equation for the reaction.

(i) calcium carbonate and dilute hydrochloric acid

gas ....

test ....

equation for the reaction ....
[3]

(ii) zinc and dilute sulfuric acid

gas ....

test ....

equation for the reaction ....
[3]

[Total: 8]

2 A student adds 50.0 cm^3 of 1.0 mol / dm^3 aqueous silver nitrate to a beaker containing 40.0 cm^3 of 1.5 mol / dm^3 aqueous sodium bromide.

(a) **(i)** A precipitate of silver bromide is produced.

Suggest the colour of the precipitate.

.... [1]

(ii) How is the precipitate separated from the reaction mixture?

.... [1]

(b) **(i)** Calculate the number of moles of silver nitrate in 50.0 cm^3 of 1.0 mol / dm^3 silver nitrate.

.... moles [1]

(ii) Calculate the number of moles of sodium bromide in 40.0 cm^3 of 1.5 mol / dm^3 sodium bromide.

.... moles [1]

(c) The equation for the reaction is

$$AgNO_3 + NaBr \rightarrow NaNO_3 + AgBr$$

Using your answers to **(b)(i)**, **(b)(ii)** and the equation, calculate the mass of silver bromide produced in the experiment.
[A_r: Ag, 108; Br, 80]

....g [2]

(d) The student repeats the experiment using 50.0 cm^3 of 1.0 mol / dm^3 silver nitrate with 60.0 cm^3 of 0.5 mol / dm^3 sodium bromide.

Calculate the mass of silver bromide produced in this experiment.

....g [2]

[Total: 8]

3 **(a)** Using the general formula for the homologous series of alkanes, suggest the formula for both hexane and heptane, the sixth and seventh members of the alkane series respectively.

hexane

....

heptane

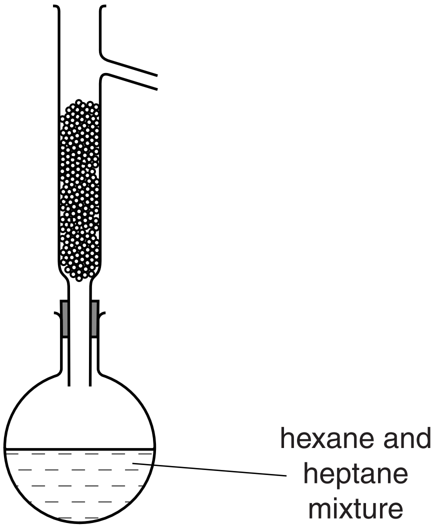
....

[1]

(b) A mixture of hexane (b.p. 69 °C) and heptane (b.p. 89 °C) may be separated by fractional distillation.

The diagram below shows a fractionating column attached to a flask which contains a mixture of hexane and heptane.

Complete the diagram by adding further apparatus to enable each alkane to be collected.



[4]

[Total: 5]

In questions **4** to **8** inclusive place a tick (✓) in the box against the correct answer.

4 What mass of magnesium oxide is produced when 3.0 g of magnesium is burned in excess oxygen?
[A_r: Mg, 24; O, 16]

(a) 3.0 g ☐

(b) 4.0 g ☐

(c) 5.0 g ☐

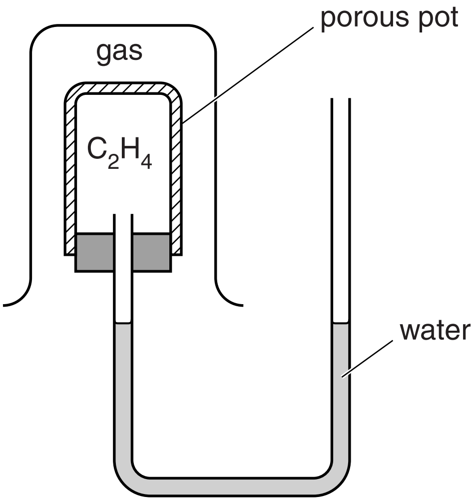
(d) 6.0 g ☐

[Total: 1]

5 The apparatus below is used in experiments with four gases: ammonia, NH_3; methane, CH_4; hydrogen, H_2; and nitrogen, N_2.

In each experiment another gas, ethene, C_2H_4, is in the inner container.

Each of the other gases is put into the outer container in turn.



Which gas does **not** cause a change in the water levels?
[A_r: H, 1; C, 12; N, 14]

(a) CH_4 ☐

(b) NH_3 ☐

(c) H_2 ☐

(d) N_2 ☐

[Total: 1]

6 When zinc is added to aqueous copper(II) sulfate, copper is produced.
The ionic equation for the reaction is

(a) $Cu + Zn^{2+} \rightarrow Cu^{2+} + Zn$ ☐

(b) $Cu^{+} + Zn \rightarrow Cu + Zn^{+}$ ☐

(c) $2Cu^{2+} + Zn \rightarrow 2Cu^{+} + Zn^{2+}$ ☐

(d) $Cu^{2+} + Zn \rightarrow Cu + Zn^{2+}$ ☐

[Total: 1]

7 Concentrated aqueous sodium chloride is electrolysed using carbon electrodes. What is produced at each electrode?

	cathode (negative electrode)	anode (positive electrode)	
(a)	sodium	chlorine	☐
(b)	hydrogen	chlorine	☐
(c)	hydrogen	oxygen	☐
(d)	sodium	oxygen	☐

[Total: 1]

8 The table below shows two indicators and their colours in acid and alkali respectively.

indicator	colour in acid	colour in alkali
bromothymol blue	red	yellow
thymol blue	yellow	blue

The two indicators are used in titrations involving hydrochloric acid and aqueous sodium hydroxide.

Which of the following shows the correct colour changes?

	solution in flask	solution in burette	colour change of bromothymol blue	colour change of thymol blue	
(a)	hydrochloric acid	sodium hydroxide	red → yellow	blue → yellow	☐
(b)	hydrochloric acid	sodium hydroxide	yellow → red	yellow → blue	☐
(c)	sodium hydroxide	hydrochloric acid	yellow → red	blue → yellow	☐
(d)	sodium hydroxide	hydrochloric acid	red → yellow	yellow → blue	☐

[Total: 1]

9 A student determines the percentage of zinc oxide in mixture **C**, containing both copper and zinc oxide.

(a) A sample of **C** is added to a previously weighed beaker which is then reweighed.

mass of beaker + **C** = 29.15 g
mass of beaker = 25.30 g

Calculate the mass of **C** used in the experiment.

....g [1]

(b) 50.0 cm^3 of 1.00 mol/dm^3 sulfuric acid (an excess) is added to the beaker containing the sample of **C**. This mixture is warmed gently while being stirred and then left to stand for a few minutes.

Zinc oxide reacts with sulfuric acid but copper does not.

The unreacted copper settles at the bottom of the beaker and is removed by filtration.

Construct the equation for the reaction between zinc oxide and sulfuric acid.

....[1]

(c) When the reaction has finished the mixture is transferred to a volumetric flask and made up to 250 cm^3 with distilled water. This is solution **D**.

Using a pipette, 25.0 cm^3 of **D** is transferred into a conical flask and a few drops of methyl orange indicator are added.

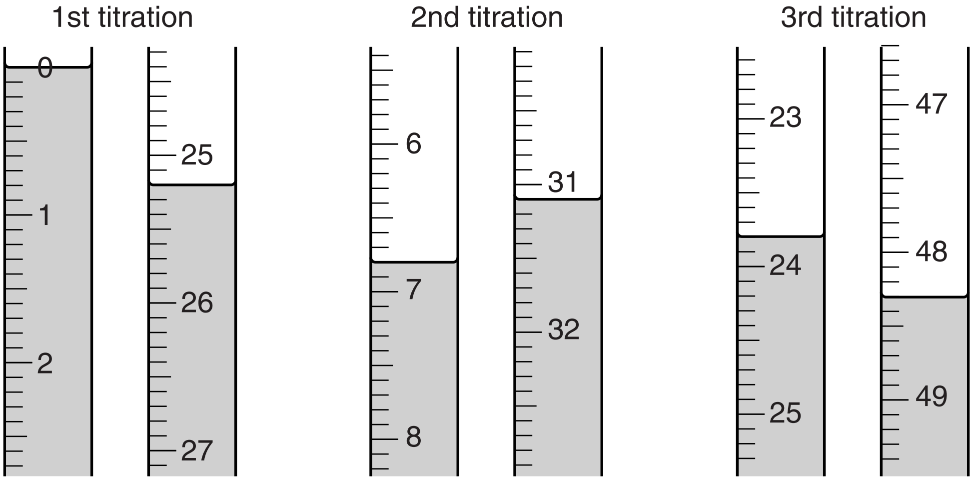
A burette is filled with 0.100 mol / dm^3 sodium hydroxide.

Aqueous sodium hydroxide is run into the conical flask containing **D** until the end-point is reached.

What is the colour change of the methyl orange during the reaction?

The colour changes from .... to .... [1]

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



(d) Use the diagrams to complete the following results table.

titration number	1	2	3
final reading / cm^3			
initial reading / cm^3			
volume of 0.100 mol / dm^3 sodium hydroxide / cm^3			
best titration results (✓)			

Summary

Tick (✓) the best titration results.
Using these results, the average volume of 0.100 mol / dm^3 sodium hydroxide is

.... cm^3. [4]

(e) Calculate the number of moles of sodium hydroxide in the average volume of 0.100 mol/dm^3 sodium hydroxide in **(d)**.

.... moles [1]

(f) Sodium hydroxide reacts with sulfuric acid according to the following equation.

$$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$$

Calculate the number of moles of sulfuric acid which reacts with the sodium hydroxide in **(e)**.

.... moles [1]

(g) Using your answer in **(f)**, calculate the number of moles of sulfuric acid in 250 cm^3 of **D**.

.... moles [1]

(h) Calculate the number of moles of sulfuric acid in 50.0 cm^3 of 1.00 mol/dm^3 sulfuric acid.

.... moles [1]

(i) Using your answers in **(g)** and **(h)**, calculate the number of moles of sulfuric acid which reacts with the zinc oxide in the sample of **C**.

.... moles [1]

(j) Using your equation in **(b)** and your answer in **(i)**, deduce the number of moles of zinc oxide in the sample of **C**.

.... moles [1]

(k) Calculate the mass of zinc oxide in the sample of **C**.
[A_r: Zn, 65; O,16]

....g [1]

(l) Using your answers in **(a)** and **(k)** calculate the percentage by mass of zinc oxide in the sample of **C**.

....% [1]

[Total: 15]

10 A student does some reactions using gas **X** and gas **Y**.

A colour change is seen in each case.

Complete the observations by stating the initial and final colours in each test.

test	observations	conclusions
(a) **X** is passed through aqueous potassium iodide.		**X** is an oxidising agent.
(b) **Y** is passed through acidified potassium dichromate(VI).		**Y** is a reducing agent.
(c) **Y** is passed through acidified potassium manganate(VII).		**Y** is a reducing agent.

[Total: 6]

Question 11 begins on page 12.

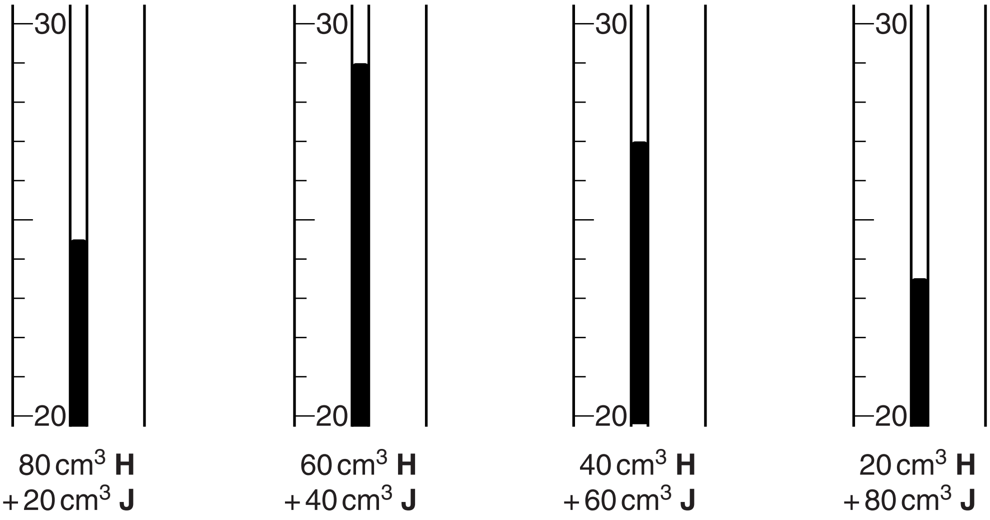
11 The addition of an acid solution to aqueous sodium hydroxide produces a rise in temperature.

A student is provided with **H**, aqueous sulfuric acid, and **J**, 1.00 mol / dm^3 sodium hydroxide.

He investigates the changes in temperature produced on mixing together different volumes of **H** and **J** while, in each experiment, keeping the total volume of solution constant at 100 cm^3.

The initial temperature of both **H** and **J** is 20 °C.

The diagrams below show parts of the thermometer stems indicating the maximum temperature recorded in each experiment.

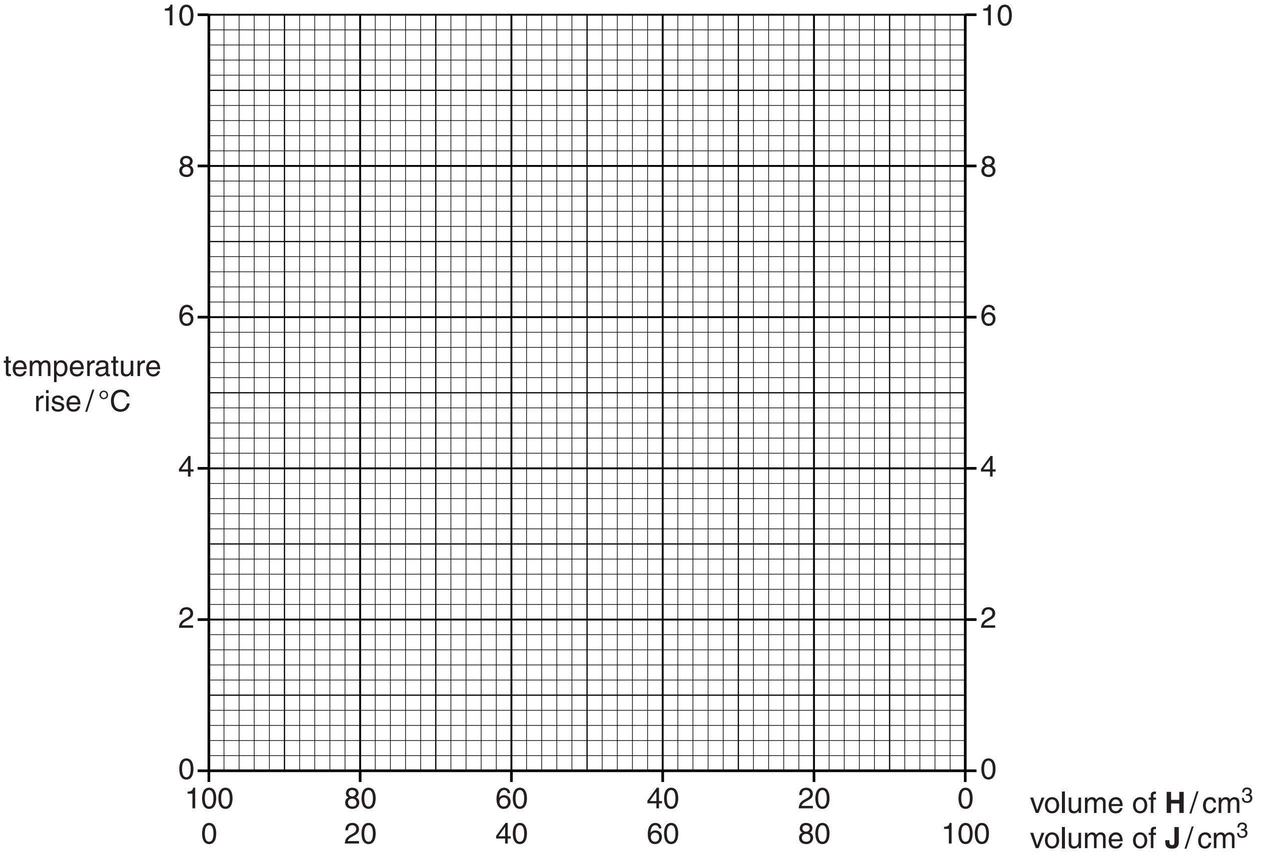


(a) Record these temperatures in the table below and then calculate the rise in temperature in each case.

volume of **H** / cm^3	volume of **J** / cm^3	maximum temperature / °C	temperature rise / °C
80	20		
60	40		
40	60		
20	80		

[2]

(b) Plot these results on the grid below.
Using the points, draw two intersecting straight lines.



[3]

(c) Use your graph to deduce

(i) the volumes of **H** and **J** in two mixtures, each of which produces a final temperature of 26 °C,

	volume of **H** / cm^3	volume of **J** / cm^3
mixture 1		
mixture 2		

[2]

(ii) the greatest temperature rise that can occur,

....°C [1]

(iii) the volumes of **H** and **J** which produce this temperature rise.

H .... cm^3

J .... cm^3
[1]

(d) Solution **J** is 1.00 mol/dm^3 sodium hydroxide.
H is aqueous sulfuric acid.

Sodium hydroxide reacts with sulfuric acid according to the following equation.

$$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$$

Using this equation and your answers to **(c)(iii)**, calculate the concentration of **H**.

....mol/dm^3 [2]

(e) The student repeats the experiment having first diluted the concentrations of both **H** and **J** to half those used in the original experiment.

Suggest

(i) the greatest temperature rise that would occur,

....°C [1]

(ii) the volumes of both **H** and **J** that would produce this temperature rise.

H .... cm^3

J .... cm^3
[1]

[Total: 13]

BLANK PAGE

BLANK PAGE

Cambridge International Examinations
Cambridge Ordinary Level

CANDIDATE NAME ☐

CENTRE NUMBER ☐☐☐☐☐

CANDIDATE NUMBER ☐☐☐☐

CHEMISTRY **5070/42**

Paper 4 Alternative to Practical **October/November 2014**

1 hour

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

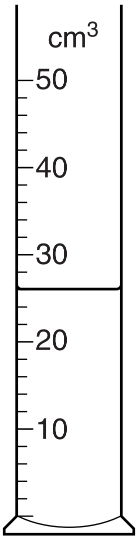
Answer **all** questions.
Write your answers in the spaces provided in the Question Paper.
Electronic calculators may be used.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

This document consists of **14** printed pages and **2** blank pages.

DC (KN/SW) 103570/6 **R**

1 The apparatus shown below contains aqueous propanoic acid.



(a) Name the apparatus.

.... [1]

(b) What is the volume of aqueous propanoic acid in the apparatus?

.... cm^3 [1]

(c) What is observed when

(i) a few drops of litmus solution are added to aqueous propanoic acid,

....[1]

(ii) aqueous propanoic acid is added to a test-tube containing solid magnesium carbonate until no further reaction occurs?

....[1]

(d) Name the alcohol which, on oxidation, gives propanoic acid.

....[1]

(e) Name, and give the structure of, the ester formed when propanoic acid reacts with ethanol.

name ....

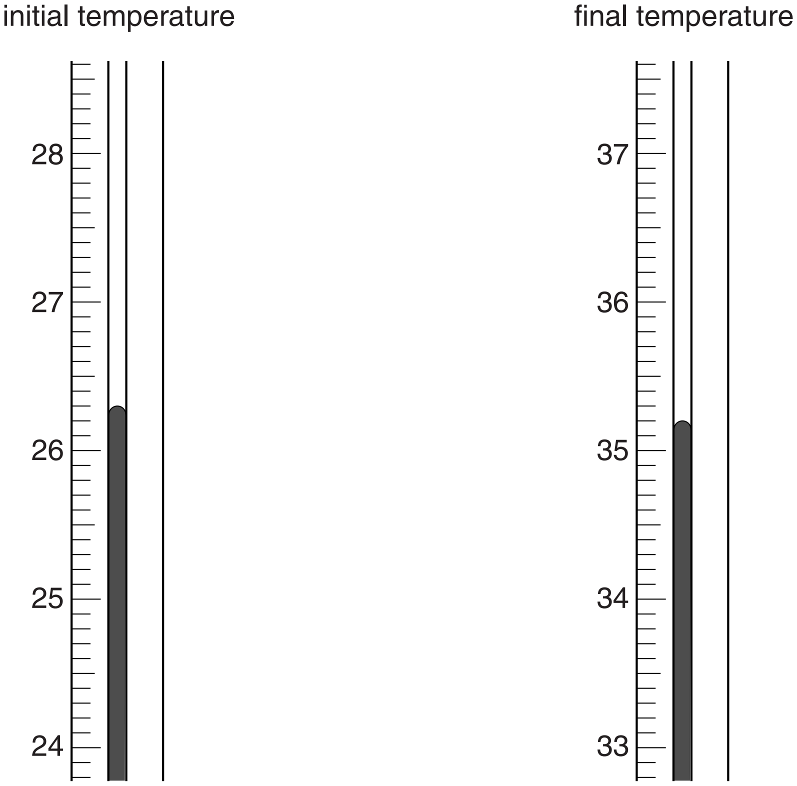
structure ....

[2]

[Total: 7]

2 A student adds magnesium ribbon to dilute hydrochloric acid. The temperature of the dilute hydrochloric acid changes.

The diagrams below show parts of the thermometer stem giving the temperatures of the dilute hydrochloric acid both before and after the addition of magnesium ribbon.



(a) A gas is produced during the reaction.
Name this gas. Give a test and observation to identify the gas.

name of gas ....

test and observation ....[2]

(b) Construct the equation for the reaction between magnesium and dilute hydrochloric acid.

....[1]

(c) Complete the following table and calculate the change in temperature.

final temperature of the acid / °C	
initial temperature of the acid / °C	
change in temperature / °C	

[2]

(d) What type of reaction does this temperature change indicate?

....[1]

[Total: 6]

3 A student heats 0.336 g of a metal carbonate, MCO_3. The sample decomposes according to the equation shown.

$$MCO_3 \rightarrow MO + CO_2$$

0.176 g of carbon dioxide is produced.

(a) Describe a test for carbon dioxide gas.

.... [1]

(b) How can the student be sure that **all** the MCO_3 decomposes?

....

.... [1]

(c) **(i)** Calculate the mass of MO produced.

.... g [1]

(ii) Calculate the number of moles in 0.176 g of carbon dioxide.
[A_r: C, 12; O, 16]

.... moles [1]

(iii) Use the equation

$$MCO_3 \rightarrow MO + CO_2$$

and your answer to **(c)(ii)** to deduce the number of moles of MO produced.

.... moles [1]

(iv) Using your answers to **(c)(i)** and **(c)(iii)**, calculate the relative formula mass of MO.

relative formula mass .... [1]

(v) Calculate the relative atomic mass of M.
[A_r: O, 16]

.... [1]

[Total: 7]

In questions **4** to **8** inclusive, place a tick (✓) in the box against the correct answer.

4 A compound **Q** contains 0.69 g of sodium, 1.92 g of sulfur and 1.44 g of oxygen.
[A_r: Na, 23; S, 32; O, 16]

Its empirical formula is

(a) Na_2SO_3 ☐

(b) Na_2SO_4 ☐

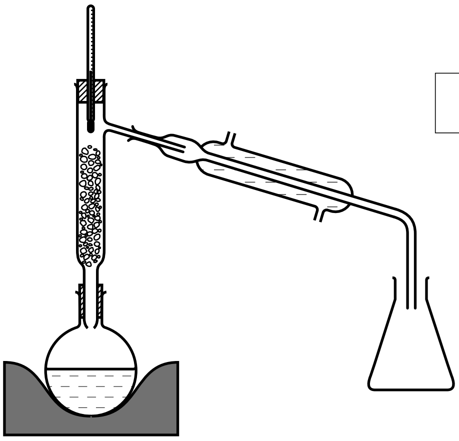
(c) $Na_2S_2O_3$ ☐

(d) NaS_2O_3 ☐

[Total: 1]

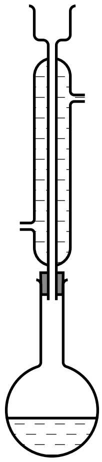
5 Which apparatus is used to separate a mixture of ethanol and water?

(a)



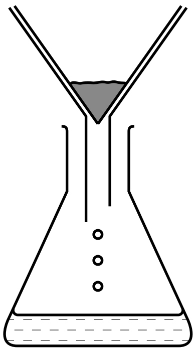
☐

(b)



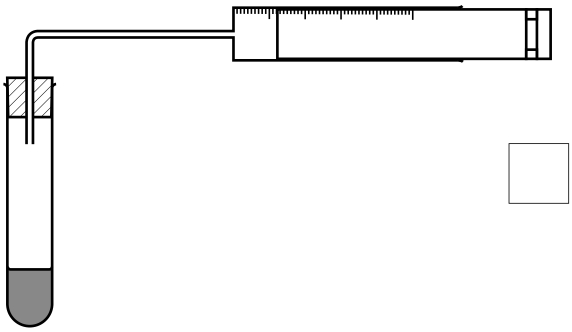
☐

(c)



☐

(d)



☐

[Total: 1]

6 A student adds a solid to dilute hydrochloric acid. The solid dissolves and bubbles of a gas are evolved.

The solid could be

(a) copper. ☐

(b) copper(II) oxide. ☐

(c) copper(II) hydroxide. ☐

(d) copper(II) carbonate. ☐

[Total: 1]

7 Which **two** of the following compounds will decolourise bromine water?

A C_2H_4

B C_2H_6

C C_3H_6

D C_3H_8

(a) **A** and **B** ☐

(b) **A** and **C** ☐

(c) **B** and **C** ☐

(d) **B** and **D** ☐

[Total: 1]

8 Which of the pairs, on mixing, does **not** produce a precipitate?

(a) aqueous barium chloride and aqueous sulfuric acid ☐

(b) aqueous silver nitrate and aqueous hydrochloric acid ☐

(c) aqueous sodium hydroxide and aqueous sulfuric acid ☐

(d) aqueous lead nitrate and aqueous hydrochloric acid ☐

[Total: 1]

9 A student is asked to determine the value of **x** in the formula $Na_2CO_3.\mathbf{x}H_2O$.

(a) A sample of $Na_2CO_3.\mathbf{x}H_2O$ is added to a previously weighed container, which is then reweighed.

mass of container + $Na_2CO_3.\mathbf{x}H_2O$ = 10.84 g

mass of container = 7.49 g

Calculate the mass of $Na_2CO_3.\mathbf{x}H_2O$ used in the experiment.

.... g [1]

(b) The sample is dissolved in distilled water and the solution made up to 250.0 cm^3. This is **H**.

In which apparatus should the solution be made up to 250.0 cm^3?

....[1]

(c) A 25.0 cm^3 sample of **H** is transferred into a conical flask and a few drops of methyl orange indicator are added.

(i) Name the apparatus used to transfer 25.0 cm^3 of **H** into the conical flask.

....[1]

(ii) A burette is filled with 0.100 mol/dm^3 hydrochloric acid.

The hydrochloric acid is added to **H** until the end-point is reached.

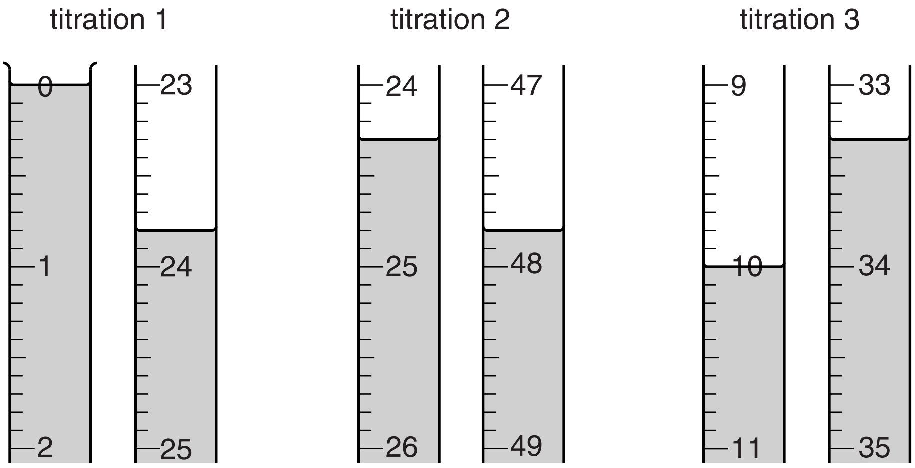
What is the colour of the solution in the conical flask

before the hydrochloric acid is added, ...

at the end-point?..

[1]

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


titration 1 titration 2 titration 3

Use the diagrams to complete the following table.

titration number	1	2	3
final burette reading / cm^3			
initial burette reading / cm^3			
volume of 0.100 mol / dm^3 hydrochloric acid / cm^3			
best titration results (✓)			

Summary

Tick (✓) the best titration results.

Using these results, the average volume of 0.100 mol / dm^3 hydrochloric acid required is

.... cm^3 [4]

(e) Calculate the number of moles of hydrochloric acid in the average volume of 0.100 mol / dm^3 hydrochloric acid in **(d)**.

.... moles [1]

(f) Using the equation and your answer to **(e)**, deduce the number of moles of sodium carbonate, Na_2CO_3, in 25.0 cm^3 of **H**.

$$Na_2CO_3 + 2HCl \rightarrow 2NaCl + CO_2 + H_2O$$

.... moles [1]

(g) Calculate the number of moles of sodium carbonate, Na_2CO_3, in 250 cm^3 of **H**.

.... moles [1]

(h) 1 mole of Na_2CO_3 is produced from 1 mole of $Na_2CO_3.\mathbf{x}H_2O$.

Use this information and your answers to **(a)** and **(g)** to calculate the relative formula mass of $Na_2CO_3.\mathbf{x}H_2O$.

....[1]

(i) Use your answer to **(h)** to calculate the value of **x** in $Na_2CO_3.\mathbf{x}H_2O$.
[A_r: H, 1; C, 12; O, 16; Na, 23]

x = ...[2]

[Total: 14]

10 The following table shows the tests a student does on compound **Z**. Complete the table by adding the conclusion for **(a)**, the observations for tests **(b)** and **(c)** and both the test and observation which lead to the conclusion for test **(d)**.

test	observations	conclusions
(a) **Z** is dissolved in water and the solution divided into three parts for tests **(b)**, **(c)** and **(d)**.	A coloured solution is formed.	
(b) **(i)** To the first part, aqueous sodium hydroxide is added until a change is seen. **(ii)** An excess of aqueous sodium hydroxide is added to the mixture from **(i)**.		**Z** contains Fe^{2+} ions.
(c) **(i)** To the second part, aqueous ammonia is added until a change is seen. **(ii)** An excess of aqueous ammonia is added to the mixture from **(i)**.		The presence of Fe^{2+} ions is confirmed.
(d)		**Z** contains SO_4^{2-} ions.

Conclusion

The formula for **Z** is ....

[Total: 9]

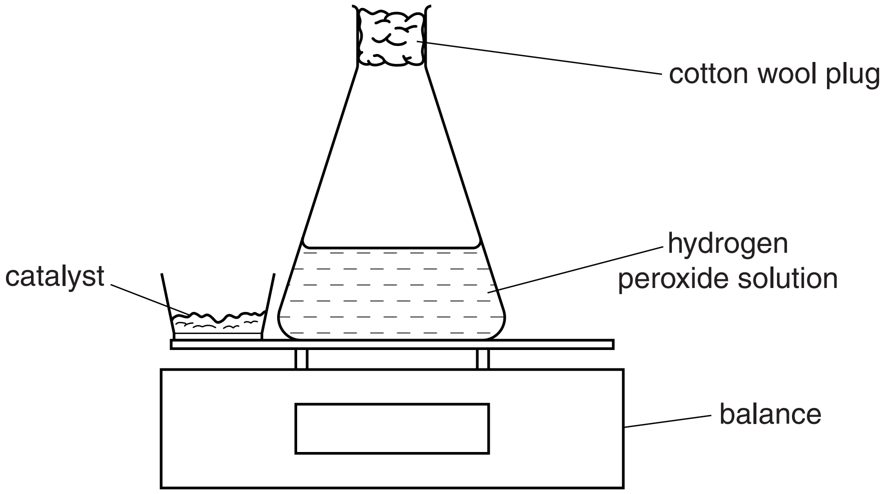
Question 11 begins on page 12.

11 Hydrogen peroxide decomposes slowly at room temperature to form water and oxygen.

$$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$$

A student uses the apparatus shown below to investigate how the rate of decomposition changes when using two different catalysts, manganese(IV) oxide and copper(II) oxide.

The student does two experiments using the same volume and concentration of hydrogen peroxide solution but with the same mass of a different catalyst in each experiment.



The manganese(IV) oxide is added to the hydrogen peroxide solution and the mass of the flask and contents recorded every 30 seconds. This is **experiment 1**.

(a) Why does the mass of the flask and contents decrease during the reaction?

....[1]

(b) Give two reasons for using the loosely fitting cotton wool plug.

reason 1 ....

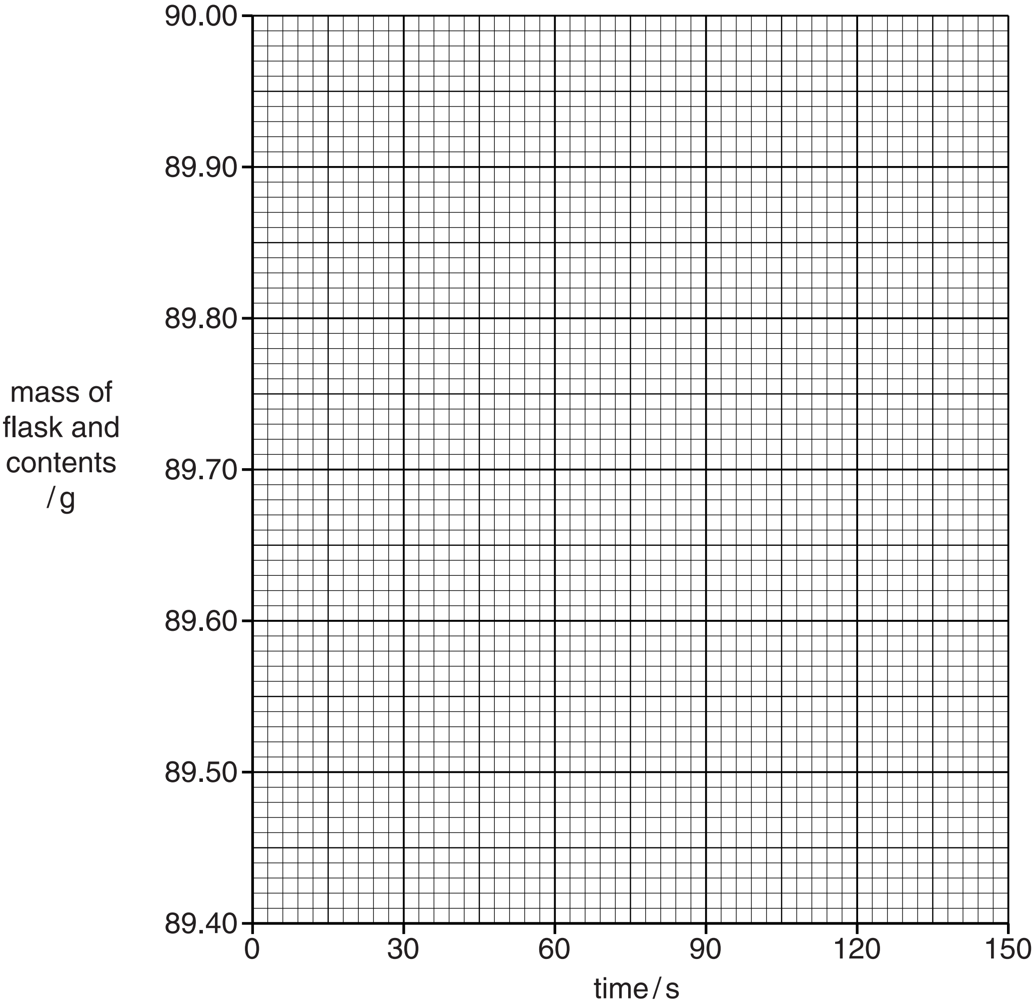
reason 2 ....[2]

The experiment is repeated using the catalyst copper(II) oxide instead of manganese(IV) oxide. All other experimental conditions are the same. This is **experiment 2**.

The results of the two experiments are recorded in the table below.

time/s	**experiment 1** mass of flask and contents / g	**experiment 2** mass of flask and contents / g
0	90.00	90.00
30	89.63	89.71
60	89.48	89.58
90	89.46	89.52
120	89.45	89.47
150	89.45	89.45

(c) Plot the results for both **experiment 1** and **experiment 2** on the grid below and draw a smooth curve through each set of points. Label the curves '**experiment 1**' and '**experiment 2**'.



[3]

(d) **Use your graphs** to answer the following questions.

(i) What is the total loss in mass in **experiment 1** after 45 seconds?

.... g [1]

(ii) How much greater is the loss in mass after 75 seconds in **experiment 1** than in **experiment 2**? Show your working.

.... g [2]

(iii) Which of the two catalysts is the more effective? **Use your graphs** to explain your answer.

....[1]

(e) Why are the last two masses in the table the same in **experiment 1**?

....[1]

(f) Predict what the mass of the flask and contents would have been if **experiment 2** had been carried out for another 30 seconds.

....g [1]

[Total: 12]

BLANK PAGE

BLANK PAGE

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Ordinary Level

CANDIDATE NAME			
CENTRE NUMBER		CANDIDATE NUMBER	

4644435523

CHEMISTRY **5070/42**

Paper 4 Alternative to Practical **May/June 2013**

1 hour

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
Write your answers in the spaces provided in the Question Paper.
At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

This document consists of **16** printed pages.

DC (SJF/SW) 58058/4

1 Iron(II) sulfate crystals have the formula $FeSO_4.\mathbf{x}H_2O$, where **x** is a whole number. A student is asked to find the value of **x**.

The crystals are placed in a previously weighed crucible which is then reweighed.

(a) What colour are iron(II) sulfate crystals?

.... [1]

(b) Mass of crucible + iron(II) sulfate crystals = 9.01 g
Mass of crucible = 5.97 g

Calculate the mass of iron(II) sulfate crystals used in the experiment.

.... g [1]

(c) The crystals are gently heated until no more water is given off.
The crucible and contents are cooled and reweighed.

Mass of crucible and iron(II) sulfate after heating = 7.66 g

(i) Calculate the mass of iron(II) sulfate which remains after heating.

.... g [1]

(ii) Calculate the mass of water lost from the crystals.

.... g [1]

(iii) Calculate the number of moles of iron(II) sulfate that remain after heating.
[M_r: $FeSO_4$, 152]

.... moles [1]

(iv) Calculate the number of moles of water which are lost on heating.
[M_r: H_2O, 18]

.... moles [1]

(d) **(i)** Using your answers to **(c)(iii)** and **(c)(iv)** calculate the number of moles of water combined with one mole of iron(II) sulfate.

.... moles [1]

(ii) What is the value of **x** in the formula $FeSO_4.\mathbf{x}H_2O$?

x = ... [1]

[Total: 8]

2 **(a)** **(i)** Draw the structure of ethanol showing all the atoms and bonds.

[1]

(ii) Give the name and formula of the carboxylic acid that can be made by the oxidation of ethanol.

name ....

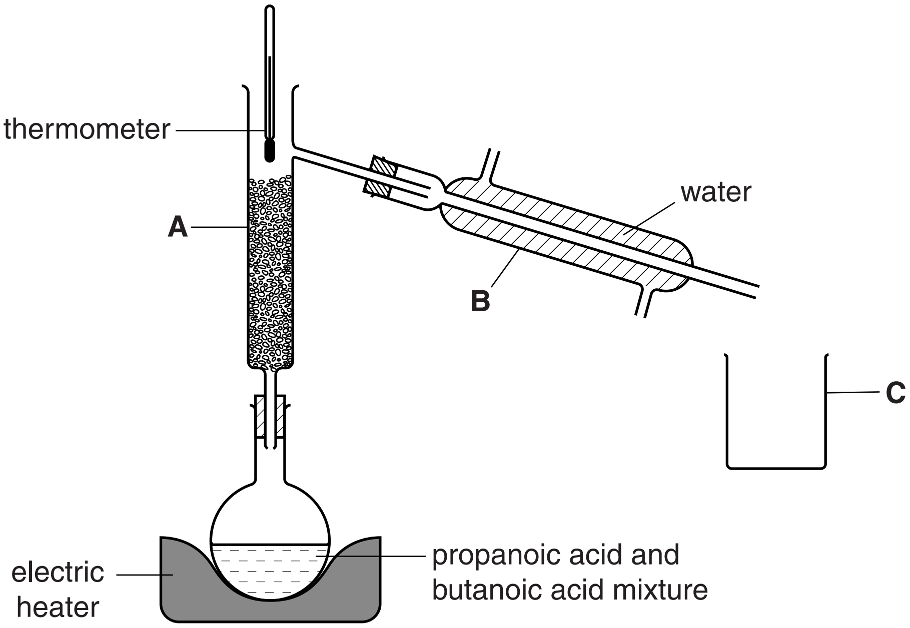
formula ....
[1]

(iii) Suggest an oxidising agent that can be used and the colour change seen during the course of the reaction in **(ii)**.

oxidising agent ....

colour change ....
[3]

A student separates propanoic acid (b.p. 141 °C) and butanoic acid (b.p. 164 °C) using the apparatus shown below.



(b) **(i)** The student has left out one item in setting up the apparatus. Draw this item on the diagram in the correct position. [1]

Now that this addition has been made the apparatus is ready for the separation of the two acids.

(ii) Name apparatus **A**.

....[1]

(iii) What is the purpose of apparatus **A**?

....[1]

(iv) Apparatus **B** is a condenser. On the diagram, indicate both where water enters and where water leaves the apparatus. [1]

(c) **(i)** What is the reading on the thermometer when the first few drops of distillate appear in **C**?

.... °C [1]

(ii) Name this distillate.

....[1]

(iii) How does the student know when all of this compound has distilled over?

....[1]

[Total: 12]

In questions **3** to **7** inclusive place a tick (✓) in the box against the correct answer.

3 A student makes an ester by warming a mixture of propanol and propanoic acid together with a small amount of sulfuric acid.

The formula of the ester is

(a) $C_2H_5CO_2C_3H_7$ ☐

(b) $C_3H_7CO_2C_2H_5$ ☐

(c) $CH_3CO_2C_3H_7$ ☐

(d) $C_2H_5CO_2C_2H_5$ ☐

[Total: 1]

4 Which of the following statements regarding chlorine is **not** correct?

(a) It bleaches litmus. ☐

(b) It is a pale green gas. ☐

(c) It displaces bromine from aqueous potassium bromide. ☐

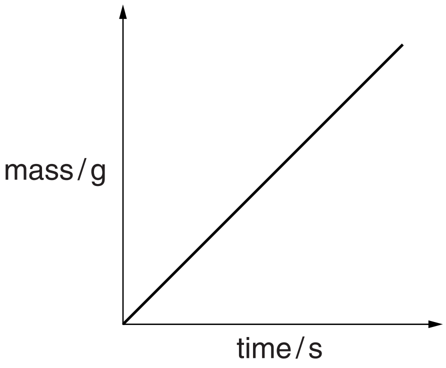
(d) It is produced at the cathode during the electrolysis of aqueous sodium chloride. ☐

[Total:1]

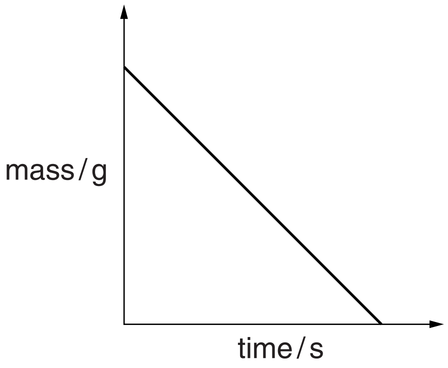
5 Manganese(IV) oxide, MnO_2, is used as a catalyst in the decomposition of hydrogen peroxide.

$$2H_2O_2(aq) \longrightarrow 2H_2O(l) + O_2(g)$$

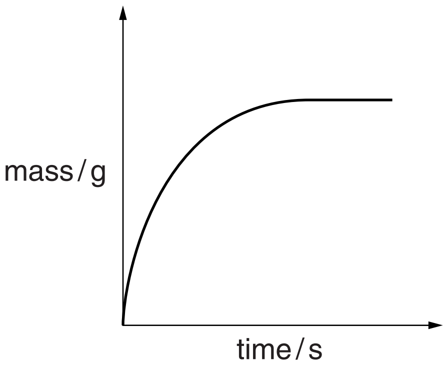
Which graph is obtained when the mass of manganese(IV) oxide is plotted against time as the decomposition progresses?



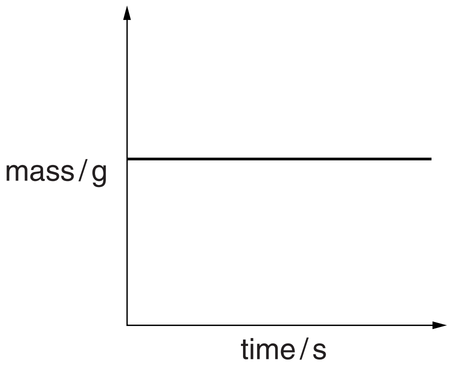
(a) ☐



(b) ☐



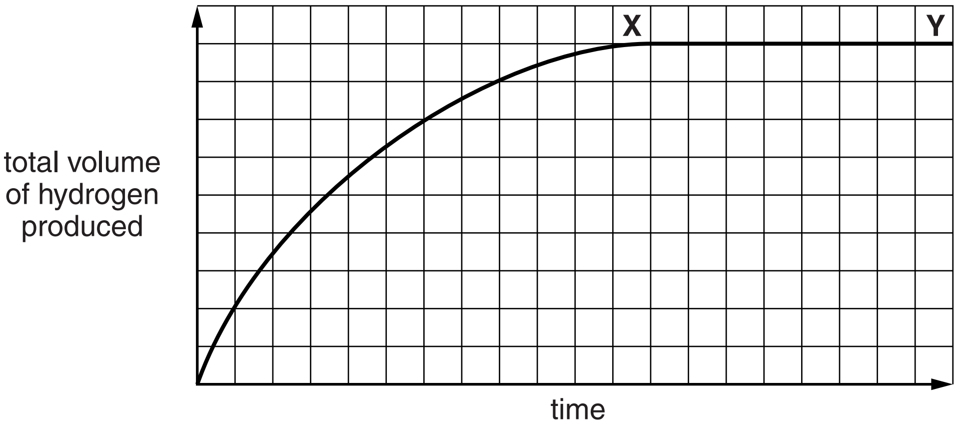
(c) ☐



(d) ☐

[Total: 1]

6



The graph shows how the volume of hydrogen, produced by the reaction between hydrochloric acid and an excess of magnesium, varies with time.

Which statement regarding section **XY** of the curve is correct?

(a) All the magnesium has reacted. ☐

(b) No more hydrogen is being produced. ☐

(c) The rate of reaction is at a maximum. ☐

(d) The concentration of the acid is decreasing. ☐

[Total: 1]

7 A student adds 10.0 cm^3 of 0.200 mol/dm^3 sulfuric acid to an excess of magnesium. Hydrogen gas is produced.

The experiment is repeated with a different acid solution, again using an excess of magnesium.

Which acid solution will give twice the volume of hydrogen?

(a) 20 cm^3 of 0.200 mol/dm^3 hydrochloric acid ☐

(b) 20 cm^3 of 0.100 mol/dm^3 sulfuric acid ☐

(c) 40 cm^3 of 0.200 mol/dm^3 hydrochloric acid ☐

(d) 40 cm^3 of 0.050 mol/dm^3 sulfuric acid ☐

[Total: 1]

8 A student is given a sample of a metal carbonate, $\mathbf{R}CO_3$.
She is asked to determine the relative atomic mass of **R** and suggest its identity.

(a) A sample of the metal carbonate is added to a previously weighed container which is then reweighed.

mass of container + $\mathbf{R}CO_3$ = 12.01 g
mass of container = 10.97 g

Calculate the mass of $\mathbf{R}CO_3$ used in the experiment.

.... g [1]

(b) The student transfers the sample of $\mathbf{R}CO_3$ to a beaker and adds 50.0 cm^3 of 1.00 mol / dm^3 hydrochloric acid (an excess).
All the solid reacts to form an aqueous solution.
When the reaction has finished, the contents of the beaker are transferred to a volumetric flask.
The solution is made up to 250 cm^3 with distilled water and mixed well.
This is solution **S**.

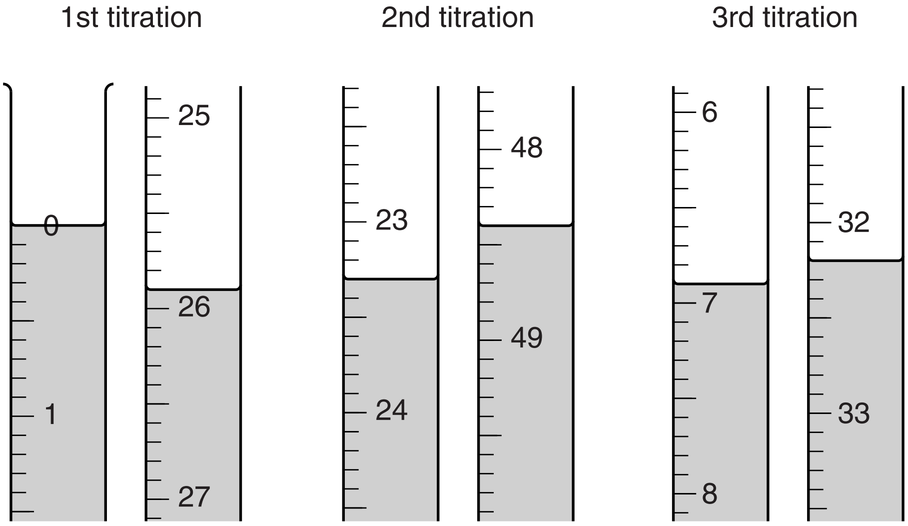
Using a pipette, 25.0 cm^3 of **S** is transferred to a conical flask and a few drops of methyl orange indicator are added.
A burette is filled with 0.100 mol / dm^3 aqueous sodium hydroxide which is added to the conical flask until an end-point is reached.

What is the colour of the solution in the conical flask

(i) before the alkali is added, ...

(ii) at the end-point? ....
[1]

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



Use the diagrams to complete the following table.

titration number	1	2	3
final burette reading / cm^3			
initial burette reading / cm^3			
volume of 0.100 mol / dm^3 sodium hydroxide / cm^3			
best titration results (✓)			

Summary:

Tick (✓) the best titration results.

Using these results, the average volume of 0.100 mol / dm^3 sodium hydroxide is

.... cm^3. [4]

(d) Calculate the number of moles of sodium hydroxide in the average volume of 0.100 mol / dm^3 sodium hydroxide.

.... moles [1]

(e) Using the equation

$$NaOH + HCl \rightarrow NaCl + H_2O$$

calculate the number of moles of hydrochloric acid in 25.0 cm^3 of **S**.

.... moles [1]

(f) Calculate the number of moles of hydrochloric acid in 250 cm^3 of **S**.

.... moles [1]

(g) Calculate the number of moles of hydrochloric acid in the original 50.0 cm^3 of 1.00 mol / dm^3 hydrochloric acid.

.... moles [1]

(h) By subtracting your answer in **(f)** from your answer in **(g)**, calculate the number of moles of hydrochloric acid that reacts with the sample of **R**CO$_3$.

.... moles [1]

(i) Using the equation

$$\mathbf{R}CO_3 + 2HCl \rightarrow \mathbf{R}Cl_2 + H_2O + CO_2$$

calculate the number of moles of **R**CO$_3$ that reacts with the number of moles of hydrochloric acid in your answer **(h)**.

.... moles [1]

(j) Using your answers to **(a)** and **(i)**, calculate the relative formula mass of **R**CO$_3$ and hence the relative atomic mass of **R**.
[A_r: C, 12; O, 16]

relative formula mass of **R**CO$_3$ = ...

relative atomic mass of **R** = ...
[2]

(k) **R** is less reactive than calcium but more reactive than zinc.
Suggest the identity of **R**.

R is .... [1]

[Total: 15]

9 **M** is a compound which contains two ions.
Complete the table by adding the observation in test **(a)**, the conclusions in tests **(b)** and **(c)** and both the test and observation for test **(d)**.

test	observations	conclusions
(a) **M** is dissolved in water and the resulting solution is divided into three parts for tests **(b)**, **(c)** and **(d)**.		**M** is probably not a compound of a transition metal.
(b) **(i)** To the first part, aqueous sodium hydroxide is added until a change is seen. **(ii)** An excess of aqueous sodium hydroxide is added to the mixture from **(i)**.	white precipitate the precipitate dissolves	
(c) **(i)** To the second part, aqueous ammonia is added until a change is seen. **(ii)** An excess of aqueous ammonia is added to the mixture from **(i)**.	white precipitate the precipitate dissolves	
(d)		**M** contains I^- ions.

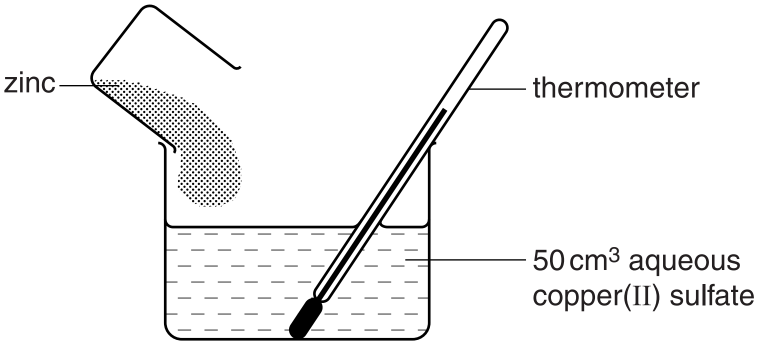
Conclusion: the formula of **M** is ....

[Total: 8]

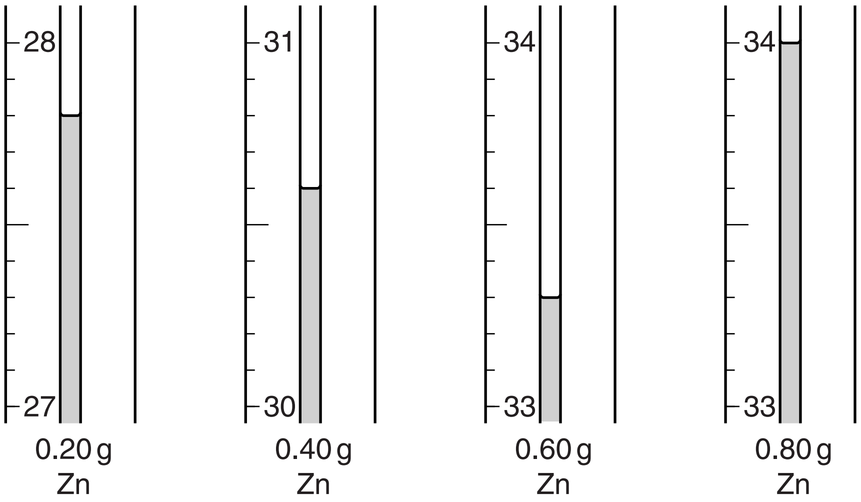
Question 10 begins on page 14.

10 A student investigates the rise in temperature when different masses of powdered zinc are added to 50 cm^3 of aqueous copper(II) sulfate in a beaker as shown in the diagram below.

In each case the initial temperature of the aqueous copper(II) sulfate is 25.0 °C.



The diagrams below show parts of the thermometer stem giving the highest temperature reached after each addition of zinc.

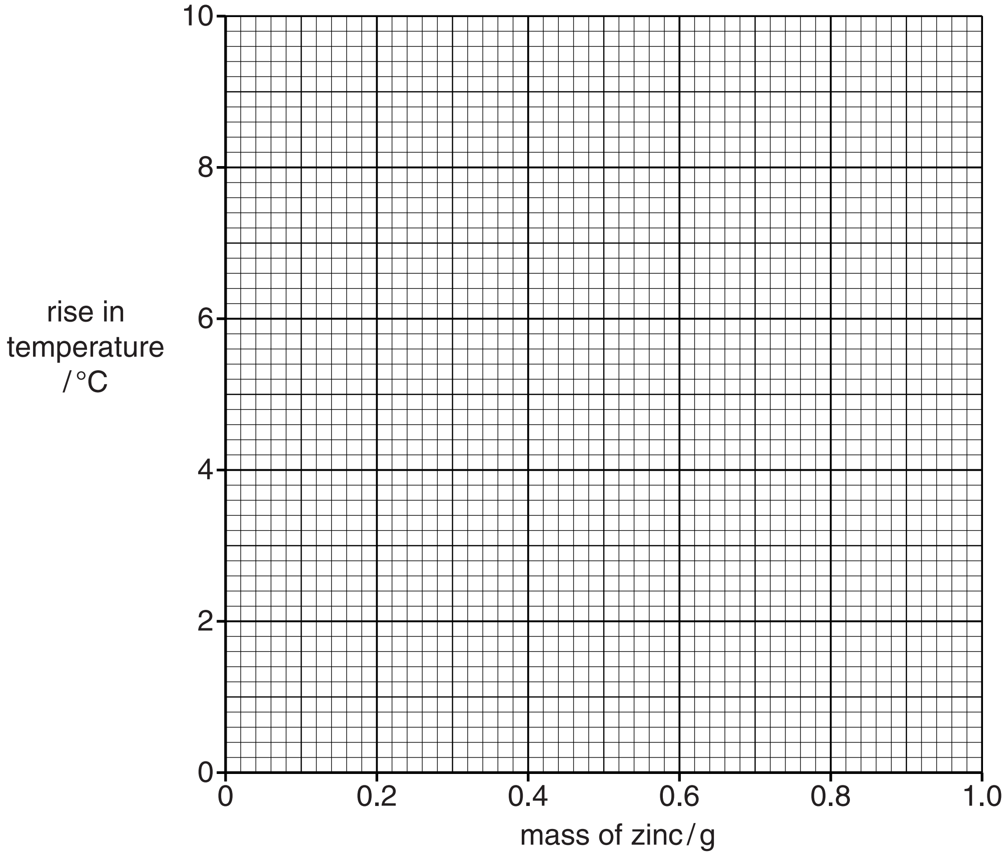


(a) Use the thermometer readings to complete the table below.

mass of zinc / g	initial temperature of aqueous copper(II) sulfate / °C	highest temperature of mixture / °C	rise in temperature / °C
0.20	25.0		
0.40	25.0		
0.60	25.0		
0.80	25.0		
1.00	25.0	34.0	

[2]

(b) Plot the results on the grid. Draw two intersecting straight lines through the points.



[3]

(c) **(i)** Use your graph to find the maximum temperature produced when 0.3 g of zinc is added to the aqueous copper(II) sulfate.

.... °C [1]

(ii) Deduce from your graph the mass of zinc required to react completely with 50 cm^3 of aqueous copper(II) sulfate.

.... g [1]

(iii) Construct the equation for the reaction between zinc and aqueous copper(II) sulfate.

.... [1]

(iv) Using your answers to **(c)(ii)** and **(c)(iii)**, calculate the concentration of the aqueous copper(II) sulfate used in the experiment.
[A_r : Zn, 65]

.... mol / dm^3 [2]

(d) State two observations, other than rise in temperature, which can be made when zinc reacts with copper(II) sulfate.

....

....[2]

[Total: 12]

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Ordinary Level

CANDIDATE NAME			
CENTRE NUMBER		CANDIDATE NUMBER	

CHEMISTRY **5070/42**

Paper 4 Alternative to Practical **October/November 2013**

1 hour

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
Write your answers in the spaces provided in the Question Paper.
At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

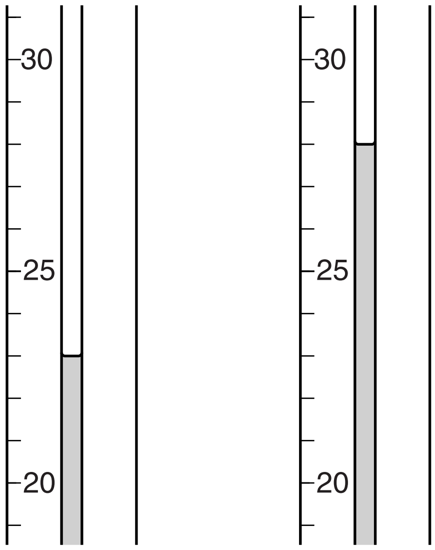
This document consists of **14** printed pages and **2** blank pages.

DC (CW/SW) 58061/4

UNIVERSITY *of* CAMBRIDGE
International Examinations

[Turn over

1 Approximately 4 g of sodium hydroxide is added to 100 cm^3 of water. A thermometer is used to measure the temperature of the liquid both before and after the addition of sodium hydroxide.
The diagrams below show parts of the thermometer stem giving the two temperatures.



T_1(before) T_2(after)

(a) Complete the table and calculate the change in temperature.

temperature T_2 after sodium hydroxide is added / °C	
temperature T_1 before sodium hydroxide is added / °C	
change in temperature / °C	

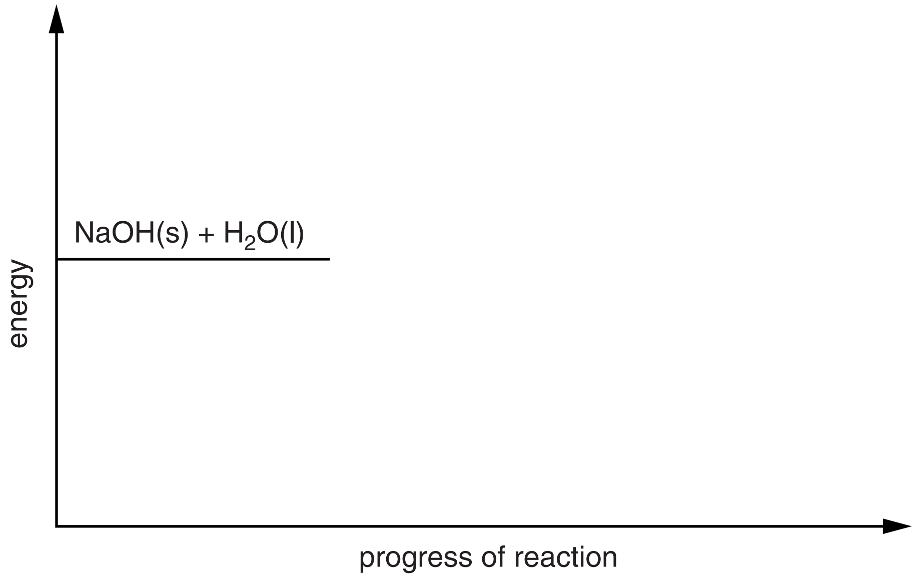
[2]

(b) **(i)** What type of process does this temperature change suggest has taken place?

.... [1]

(ii) Complete the energy profile diagram for sodium hydroxide dissolving in water.
On your diagram label

- the products,
- the enthalpy change, ΔH.



[2]

(c) (i) If aqueous litmus is added to aqueous sodium hydroxide, what colour is the resulting solution?

.... [1]

(ii) How can the pH of aqueous sodium hydroxide be determined?

....[1]

(iii) Suggest a value for the pH of aqueous sodium hydroxide.

.... [1]

[Total: 8]

2 The fertiliser ammonium nitrate is a source of nitrogen.
It has the formula NH_4NO_3.
It can be made by adding an acid to aqueous ammonia.

(a) Name and give the formula of this acid.

name ....

formula .... [1]

(b) Describe briefly how crystals of ammonium nitrate can be made from aqueous ammonium nitrate.

....

....

.... [3]

(c) **(i)** Calculate the mass of nitrogen contained in 1000 g of ammonium nitrate.
[A_r: H,1; N,14; O,16]

.... g [2]

(ii) What volume would the mass of nitrogen calculated in **(i)** occupy in the gaseous state at room temperature and pressure?
[One mole of a gas occupies 24 dm^3 at room temperature and pressure.]

.... dm^3 [1]

(d) Name and give the formula of another ammonium salt which may be used as a fertiliser.

name ....

formula .... [1]

(e) Give both the formula and a test for the ammonium ion.

formula ....

test ....

observation .... [3]

[Total: 11]

In questions **3** to **6** inclusive, place a tick (✓) in the box against the correct answer.

3 Which method can be used to obtain pure water from aqueous sodium chloride?

(a) chromatography ☐

(b) distillation ☐

(c) evaporation ☐

(d) titration ☐

[Total: 1]

4 Which is the best apparatus for transferring 25.0 cm^3 of a liquid from one flask to another during a titration experiment?

(a) beaker ☐

(b) burette ☐

(c) measuring cylinder ☐

(d) pipette ☐

[Total: 1]

5 A student does an experiment to decompose hydrogen peroxide.

$$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$$

He repeats this experiment using solid manganese(IV) oxide as a catalyst.

Which observation regarding the use of manganese(IV) oxide is correct?

(a) The rate of decomposition of hydrogen peroxide increases. ☐

(b) The manganese(IV) oxide reacts with hydrogen peroxide. ☐

(c) The total volume of oxygen produced in the reaction increases. ☐

(d) The mass of manganese(IV) oxide decreases. ☐

[Total: 1]

6 The presence of an alkene is confirmed by its reaction with aqueous bromine.
1 mole of alkene reacts with 1 mole of bromine, Br_2.

In an experiment 8.4 g of an alkene reacts completely with 32 g of bromine.
[A_r: H,1; C,12; Br, 80]

The alkene is

(a) C_2H_4. ☐

(b) C_3H_6. ☐

(c) C_4H_8. ☐

(d) C_5H_{10}. ☐

[Total: 1]

7 A student determines the percentage of iron in iron wire by titration with 0.0200 mol/dm^3 potassium manganate(VII), $KMnO_4$.

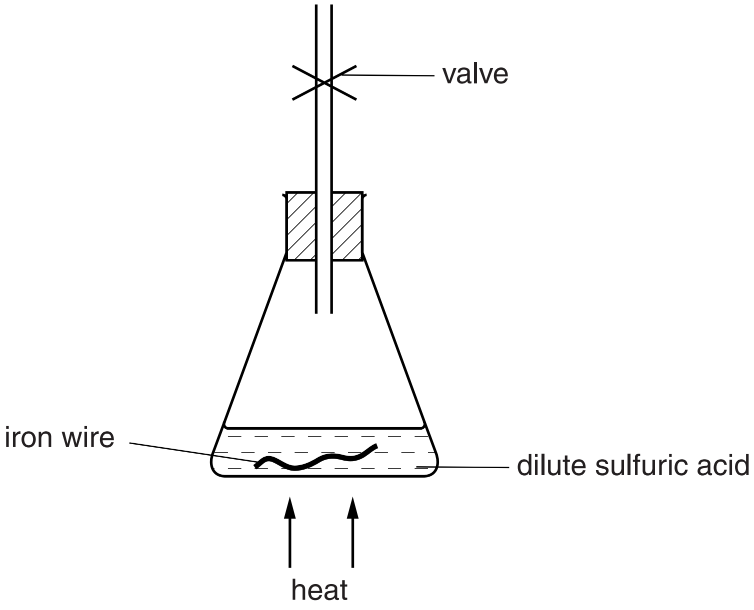
(a) A piece of iron wire is added to a previously weighed container which is then reweighed.

mass of container + iron wire = 8.59 g
mass of container = 6.94 g

Calculate the mass of iron wire used in the experiment.

.... g [1]

(b) The iron wire is placed in a conical flask as shown in the diagram below.
Dilute sulfuric acid is added to react completely with all the iron in the wire.
The iron in the wire is oxidised to Fe^{2+} ions.
The valve allows the gas to escape but does not allow air into the flask.



(i) Suggest why it is necessary to prevent air entering the apparatus.

.... [1]

(ii) Name and give a test for the gas produced during the reaction.

name ....

test .... [2]

(c) When all the iron has reacted, the contents of the conical flask are transferred to a volumetric flask.
The solution is made up to 250 cm^3 with distilled water.
This is solution **P**.

25.0 cm^3 of **P** is transferred to a conical flask.

A burette is filled with 0.0200 mol / dm^3 potassium manganate(VII) which is added to the conical flask.

What is the colour of **P**

(i) before the addition of aqueous potassium manganate(VII),

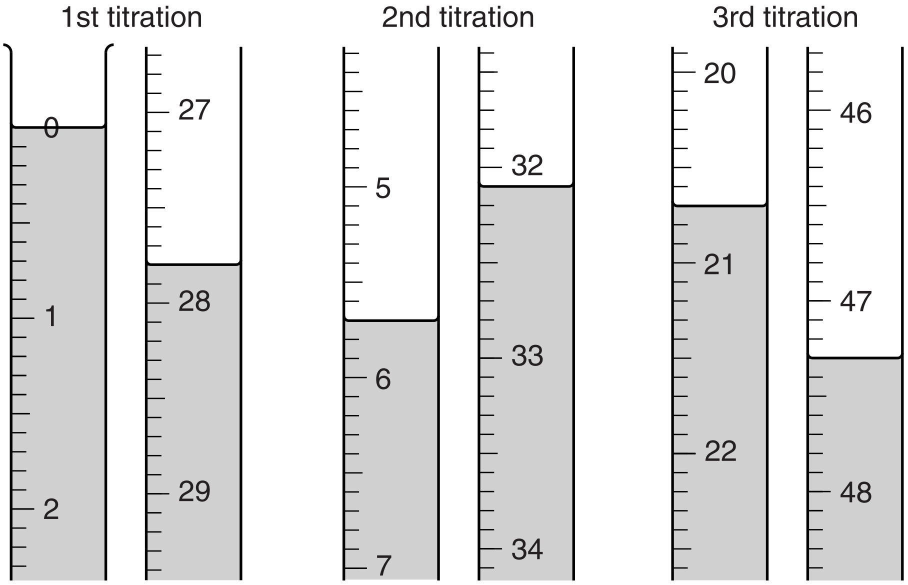
....

(ii) at the end-point?

....

[2]

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



Use the diagrams to complete the results table.

titration number	1	2	3
final burette reading / cm^3			
initial burette reading / cm^3			
volume of 0.0200 mol / dm^3 potassium manganate(VII) added / cm^3			
best titration results (✓)			

Summary:

Tick (✓) the best titration results.

Using these results, the average volume of 0.0200 mol / dm^3 potassium manganate(VII) is

.... cm^3. [4]

(e) Calculate the number of moles of potassium manganate(VII) in the average volume of 0.0200 mol / dm^3 $KMnO_4$.

.... moles [1]

(f) Five moles of Fe^{2+} ions react with one mole of $KMnO_4$.

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

.... moles [1]

(g) Calculate the number of moles of Fe^{2+} ions in 250 cm^3 of **P**.

.... moles [1]

(h) Calculate the mass of iron in 250 cm^3 of **P**.
[A_r: Fe, 56]

.... g [1]

(i) Using your answers to **(a)** and **(h)**, calculate the percentage by mass of iron in the sample of iron wire.

....% [1]

[Total: 15]

8 **V** is a compound which contains two ions.
Complete the table by adding the observations for tests **(a)**, **(b)** and **(c)** and the test and observation for test **(d)**.

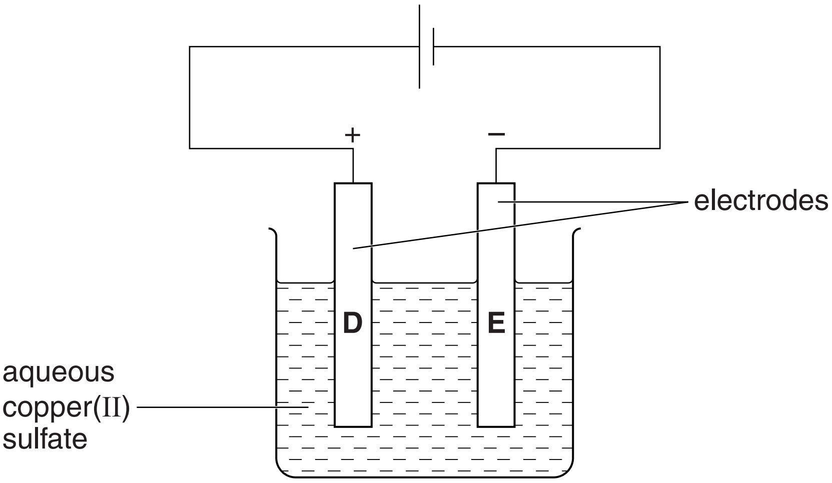
test	observations	conclusions
(a) **V** is dissolved in water and the resulting solution divided into three parts for tests **(a)**, **(b)** and **(c)**.		**V** is probably not a compound of a transition metal.
(b) **(i)** To the first part, aqueous sodium hydroxide is added until a change is seen.		
(ii) An excess of aqueous sodium hydroxide is added to the mixture from **(i)**.		**V** may contain Al^{3+} or Zn^{2+} ions.
(c) **(i)** To the second part, aqueous ammonia is added until a change is seen.		
(ii) An excess of aqueous ammonia is added to the mixture from **(i)**.		The presence of Al^{3+} ions is confirmed.
(d)		**V** contains SO_4^{2-} ions.

Conclusion: the formula of **V** is ....

[Total: 8]

9 A constant current is passed through aqueous copper(II) sulfate using inert electrodes as shown in the diagram below.

Copper is deposited at one of the electrodes.



(a) Name a suitable material for the inert electrodes.

.... [1]

(b) At which electrode is copper deposited?

.... [1]

(c) What is seen at the other electrode?

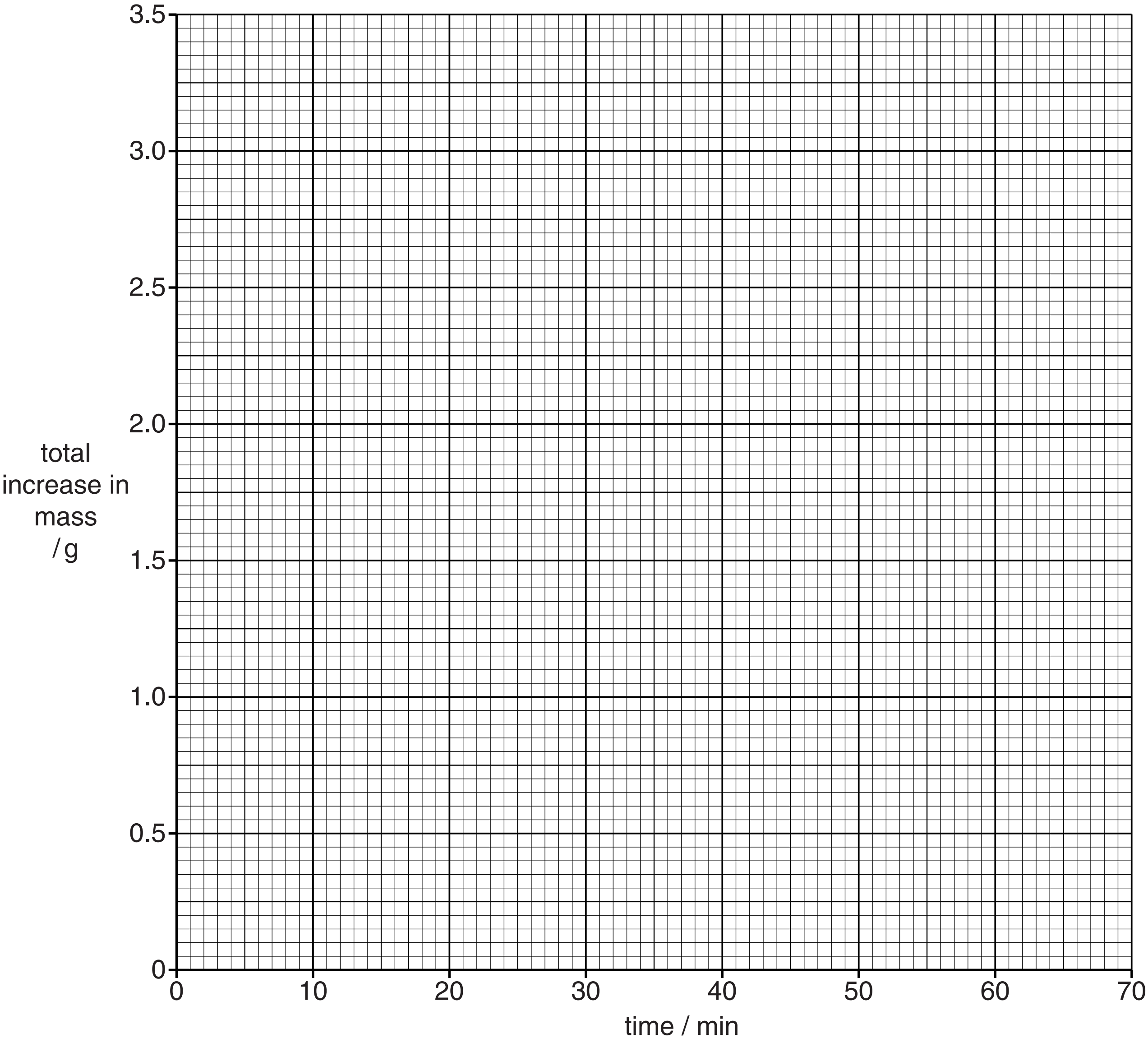
....[1]

(d) **(i)** The electrode at which copper is deposited is removed at 10 minute intervals, washed, dried and weighed.
The results are shown in the table below.
Complete the table by calculating the total increase in mass after each 10 minute interval.

time / min	mass of cathode / g	total increase in mass / g
0	7.55	0.00
10	8.05	0.50
20	8.55	1.00
30	9.05	
40	9.55	
50	9.80	
60	9.80	
70	9.80	

[1]

(ii) Plot these results on the grid below.
Draw two intersecting straight lines through the points.



[3]

(iii) How long does it take for 1.60 g of copper to be deposited?

.... min [1]

(iv) How long does it take for all the copper to be deposited?

.... min [1]

(e) What is the colour of the electrolyte

(i) at the start of the experiment,

.... [1]

(ii) at the end of the experiment?

.... [1]

(f) The experiment is repeated using aqueous copper(II) sulfate of the same concentration as before but this time using copper electrodes.
The same current is passed for the same length of time.

Draw a line on your graph, labelled **S**, to show the result you would expect for this second experiment. [1]

(g) State and explain the colour of the electrolyte at the end of the experiment.

....

....[2]

[Total: 14]

BLANK PAGE

BLANK PAGE

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Ordinary Level

CANDIDATE NAME	

CENTRE NUMBER		CANDIDATE NUMBER	

CHEMISTRY **5070/42**

Paper 4 Alternative to Practical **May/June 2012**

1 hour

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

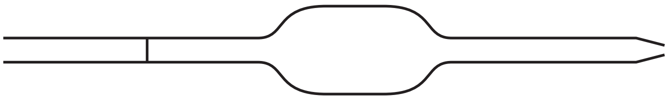
Answer **all** questions.
Write your answers in the spaces provided in the Question Paper.
At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use

This document consists of **16** printed pages.

DC (SJF/SW)) 42237/3

1 **(a)** Name the apparatus shown below.



.... [1]

(b) **(i)** What safety item should be used with this apparatus?

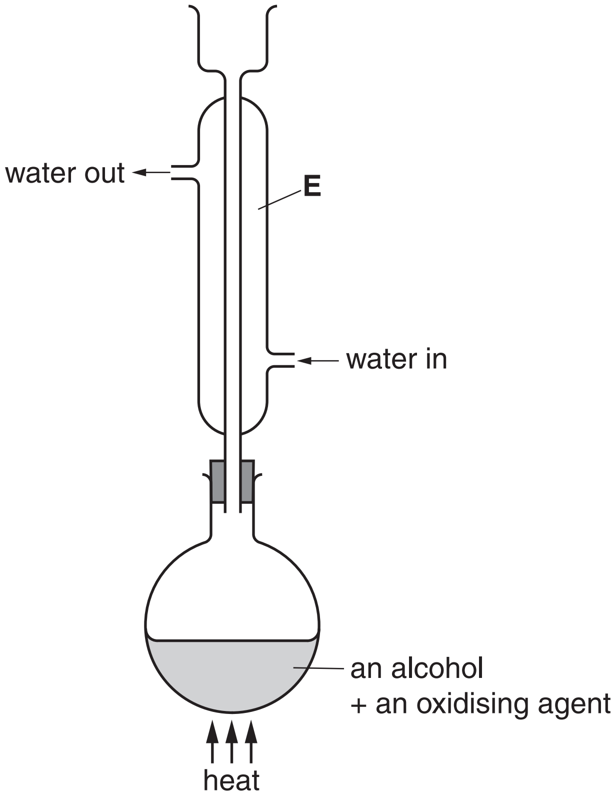
.... [1]

(ii) Why is the safety item used?

.... [1]

[Total: 3]

2 A student uses the apparatus shown below to prepare ethanoic acid, CH_3CO_2H.



(a) **(i)** Name the apparatus **E**.

.... [1]

(ii) Why is it used in this preparation?

....

.... [1]

(b) A small volume of an alcohol is placed in the flask together with an oxidising agent. The mixture is warmed and a colour change observed in the flask.

(i) Name and give the formula of the alcohol which is used to produce ethanoic acid.

name ....

formula .... [1]

(ii) Suggest a suitable oxidising agent and state the colour change which is seen.

oxidising agent ....

the colour changes from .... to .... [2]

(iii) What piece of apparatus should the student use to heat the mixture? Explain your choice.

....

....

.... [2]

(c) A student compares some of the properties of ethanoic acid with those of sulfuric acid.

A few drops of universal indicator are added to 2 cm^3 of 1.0 mol/dm^3 solutions of each acid.

(i) What are the final colours of the indicator in

ethanoic acid, ...

sulfuric acid? .... [2]

(ii) A piece of magnesium ribbon is added to 2 cm^3 of each acid.

State what is seen and compare and explain the speeds of the two reactions.

....

....

....

.... [2]

(d) A mixture of ethanol and ethanoic acid is warmed with a few drops of concentrated sulfuric acid.

Name and give the structure of the organic product which is formed and state the homologous series of compounds of which it is a member.

name ....

structure ....

series .... [3]

[Total: 14]

3 A student adds 50 cm^3 of 1.50 mol/dm^3 barium nitrate to 100 cm^3 of 1.00 mol/dm^3 sodium sulfate.

Barium sulfate is produced.

(a) **(i)** Describe the appearance of barium sulfate in the resulting mixture.

....[1]

(ii) How does the student produce a pure sample of barium sulfate from the original mixture?

....

....

....[3]

(b) The equation for the reaction is

$$Ba(NO_3)_2 + Na_2SO_4 \rightarrow BaSO_4 + 2NaNO_3$$

(i) Calculate the number of moles of barium nitrate present in 50 cm^3 of 1.50 mol/dm^3 solution.

.... moles [1]

(ii) Calculate the number of moles of sodium sulfate in 100 cm^3 of 1.00 mol/dm^3 solution.

.... moles [1]

(iii) Deduce the number of moles of barium sulfate produced.

.... moles [1]

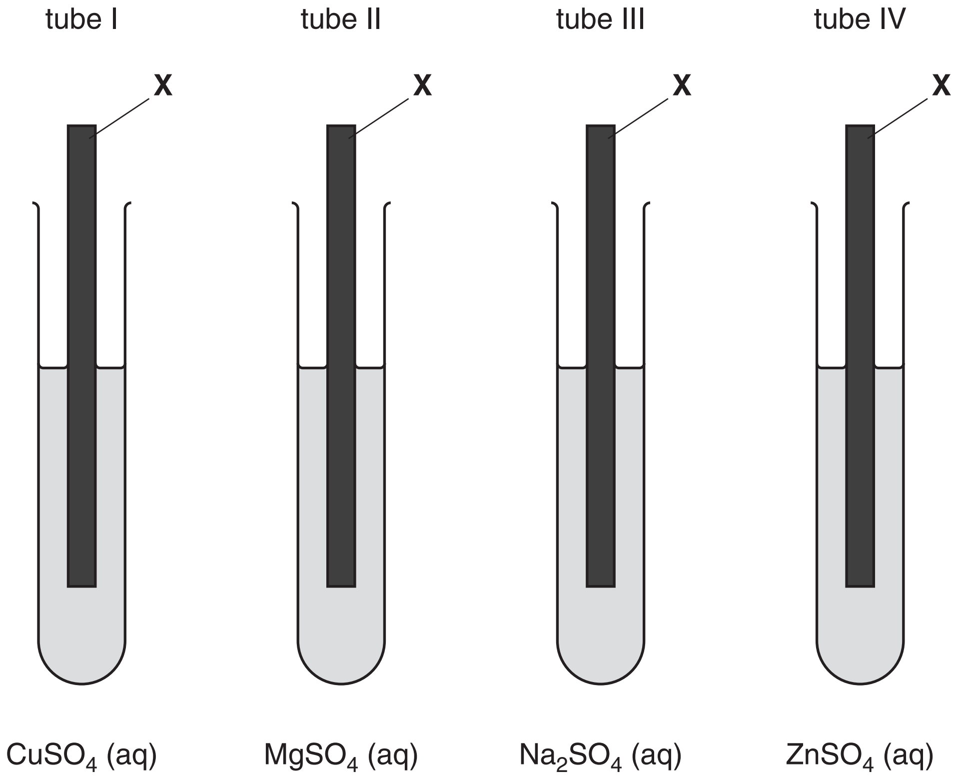
(iv) Calculate the mass of barium sulfate produced.
[A_r: O,16; S,32; Ba,137]

....g [2]

[Total: 9]

In questions **4** to **8** inclusive, place a tick (✓) in the box against the correct answer.

4 Separate strips of a metal **X** are placed in test-tubes containing aqueous solutions of salts as shown in the diagrams.



A deposit is formed on metal **X** in only two of the test-tubes.

In which two test-tubes is a metal deposit formed?

(a) I and II ☐

(b) I and IV ☐

(c) II and III ☐

(d) II and IV ☐ [1]

[Total: 1]

5 Pieces of calcium are added to a test-tube containing water coloured green by Universal indicator.

A gas is given off and the indicator changes colour.

The gas is tested.

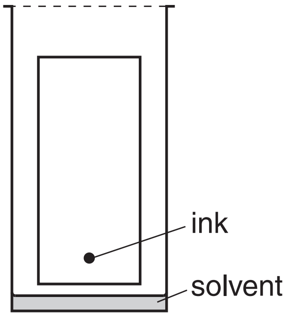
Which pair of observations is correct?

	final colour of solution	test on gas		
(a)	purple	relights a glowing splint	☐	
(b)	red	pops in a flame	☐	
(c)	purple	pops in a flame	☐	
(d)	red	relights a glowing splint	☐	[1]

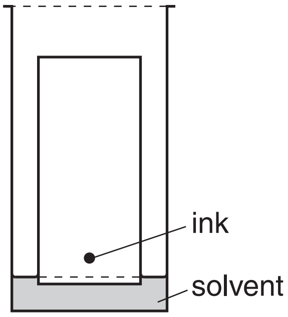
[Total: 1]

6 Chromatography can be used to separate the dyes present in black ink.

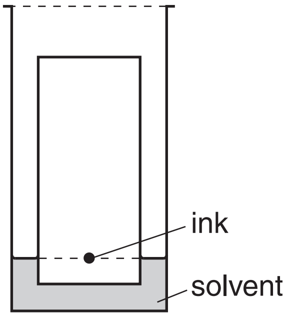
Which diagram shows the correct arrangement at the beginning of the experiment?



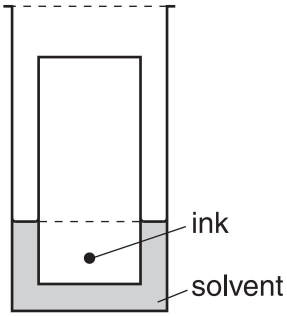
(a) ☐



(b) ☐



(c) ☐



(d) ☐

[1]

[Total: 1]

7 The organic compound **T** contains 85.7% carbon and 14.3% hydrogen.

What is its empirical formula?
[A_r : H,1; C,12]

(a) CH ☐

(b) CH_2 ☐

(c) CH_3 ☐

(d) CH_4 ☐ [1]

[Total: 1]

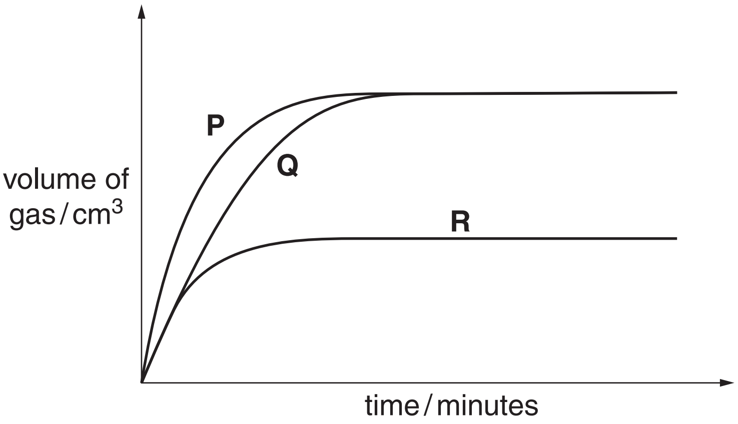
8 A student does three experiments in which three different solutions of hydrochloric acid are added to equal masses of calcium carbonate.

The calcium carbonate is in excess.

The gas produced is collected in a syringe and the volume is recorded at one minute intervals.

The temperature of the acid is the same in each experiment.

The results are used to plot the graphs shown below.



The three solutions are

(I) 25.0 cm^3 of 1.0 mol / dm^3 hydrochloric acid,

(II) 25.0 cm^3 of 2.0 mol / dm^3 hydrochloric acid,

(III) 50.0 cm^3 of 1.0 mol / dm^3 hydrochloric acid.

Which curve corresponds to which solution?

	(I)	**(II)**	**(III)**	
(a)	**P**	**Q**	**R**	☐
(b)	**R**	**Q**	**P**	☐
(c)	**Q**	**R**	**P**	☐
(d)	**R**	**P**	**Q**	☐

[1]

[Total: 1]

9 A student is given a sample of a metal hydroxide, **M**OH, and asked to determine the relative atomic mass of **M** by titrating an aqueous solution of **M**OH with 0.095 mol / dm^3 sulfuric acid, solution **S**.

(a) A sample of **M**OH is placed in a previously weighed container, which is then reweighed.

mass of container + **M**OH = 11.58 g
mass of container = 8.89 g

Calculate the mass of **M**OH used in the experiment.

.... g [1]

(b) The student transfers the sample of **M**OH to a beaker, adds about 100 cm^3 of distilled water and stirs the mixture until all the solid has dissolved. The contents of the beaker are then transferred to a volumetric flask.
The solution is made up to 250 cm^3 with distilled water.
This is solution **G**.
25.0 cm^3 of **G** is transferred to a conical flask.
A few drops of methyl orange indicator are added to the conical flask.

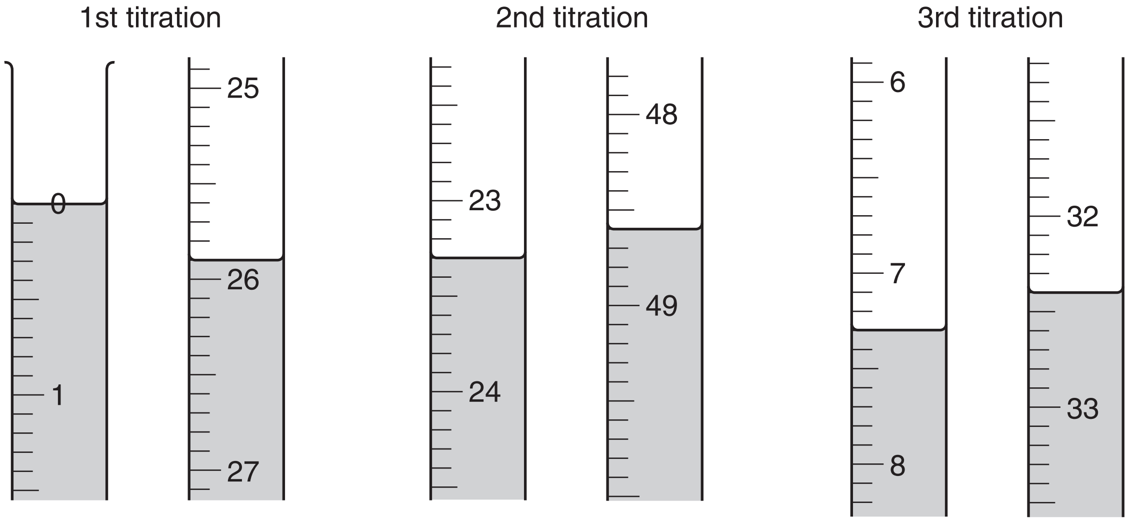
S is put into a burette and added to the solution in the conical flask until an end-point is reached.

What is the colour of the solution in the conical flask

(i) before **S** is added, ...

(ii) at the end-point? ....[1]

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



Use the diagrams to complete the following table.

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

Summary

Tick (✓) the best titration results.

Using these results the average volume of **S** is

.... cm^3 [4]

(d) Calculate the number of moles of sulfuric acid in the average volume of 0.095 mol / dm^3 sulfuric acid, **S**, from **(c)**.

.... moles [1]

(e) Using your answer to **(d)** and the equation, calculate the number of moles of **M**OH in 25.0 cm^3 of **G**.

$$2\mathbf{M}OH + H_2SO_4 \rightarrow \mathbf{M}_2SO_4 + 2H_2O$$

.... moles [1]

(f) Using your answer to **(e)** calculate the number of moles of **M**OH in 250 cm^3 of **G**.

.... moles [1]

(g) Using your answers to **(a)** and **(f)** calculate the mass of one mole of **M**OH.

.... [1]

(h) Using your answer to **(g)** calculate the relative atomic mass of **M**.
[A_r: H,1; O,16]

.... [1]

[Total: 11]

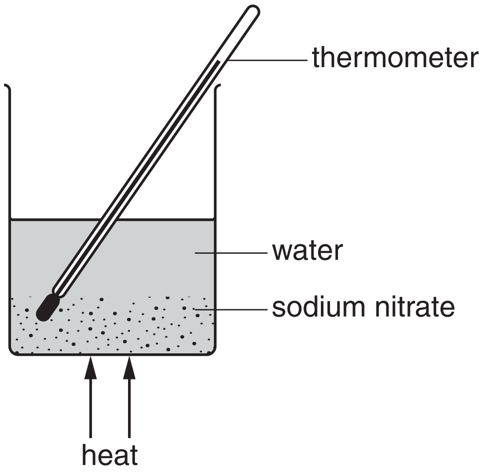
10 **V** is a compound which contains two ions.

Complete the table by adding the observations for **(a)**, **(b)(i)**, **(b)(ii)** and **(c)**, and the test and observation for **(d)**.

test	observation	conclusion
(a) **V** is dissolved in water and the solution divided into three parts for use in **(b)**, **(c)** and **(d)**.		**V** is probably not a compound of a transition metal.
(b) **(i)** To the first part, aqueous sodium hydroxide is added until a change is seen.		
(ii) An excess of aqueous sodium hydroxide is added to the mixture from **(i)**.		**V** may contain Ca^{2+} ions.
(c) To the second part, aqueous ammonia is added until a change is seen.		The presence of Ca^{2+} in **V** is confirmed.
(d)		The presence of Cl^- in **V** is confirmed.

[Total: 7]

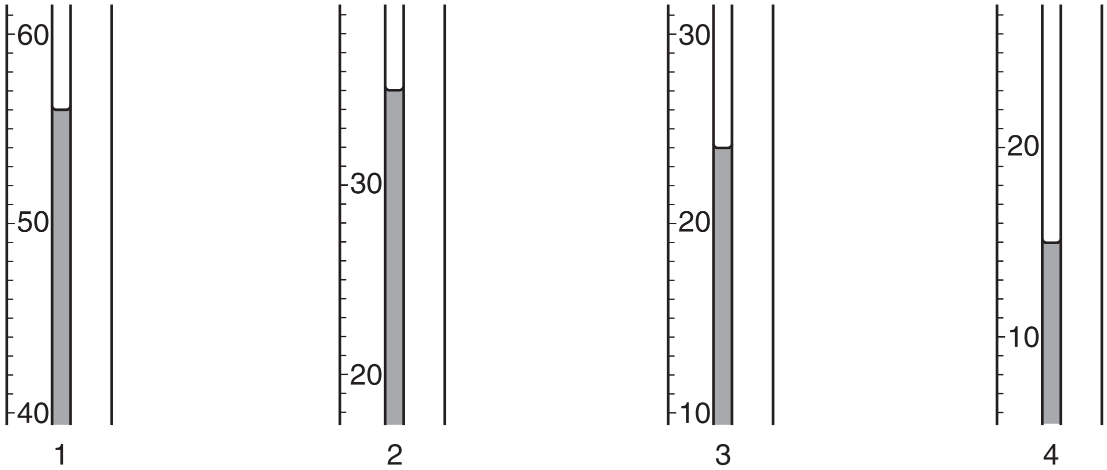
11 A student does four experiments to find how the solubility of sodium nitrate varies with temperature.



10.0 g of sodium nitrate is put into a beaker and 10.0 cm^3 of water is added.
The beaker is heated and the contents stirred until all the solid dissolves.
The beaker is allowed to cool slowly. The temperature at which crystals first appear is noted.

A further 10.0 cm^3 of water is added and the process repeated.
The experiment is repeated for two further 10.0 cm^3 additions of water.

The diagrams below show parts of the thermometer stem indicating the temperature at which crystals appear for total volumes of 10.0, 20.0, 30.0 and 40.0 cm^3.



The solubility of sodium nitrate at each temperature is calculated by using the formula

$$\text{solubility in g/100 cm}^3\text{ water} = \frac{\text{mass of sodium nitrate}}{\text{volume of water}} \times 100$$

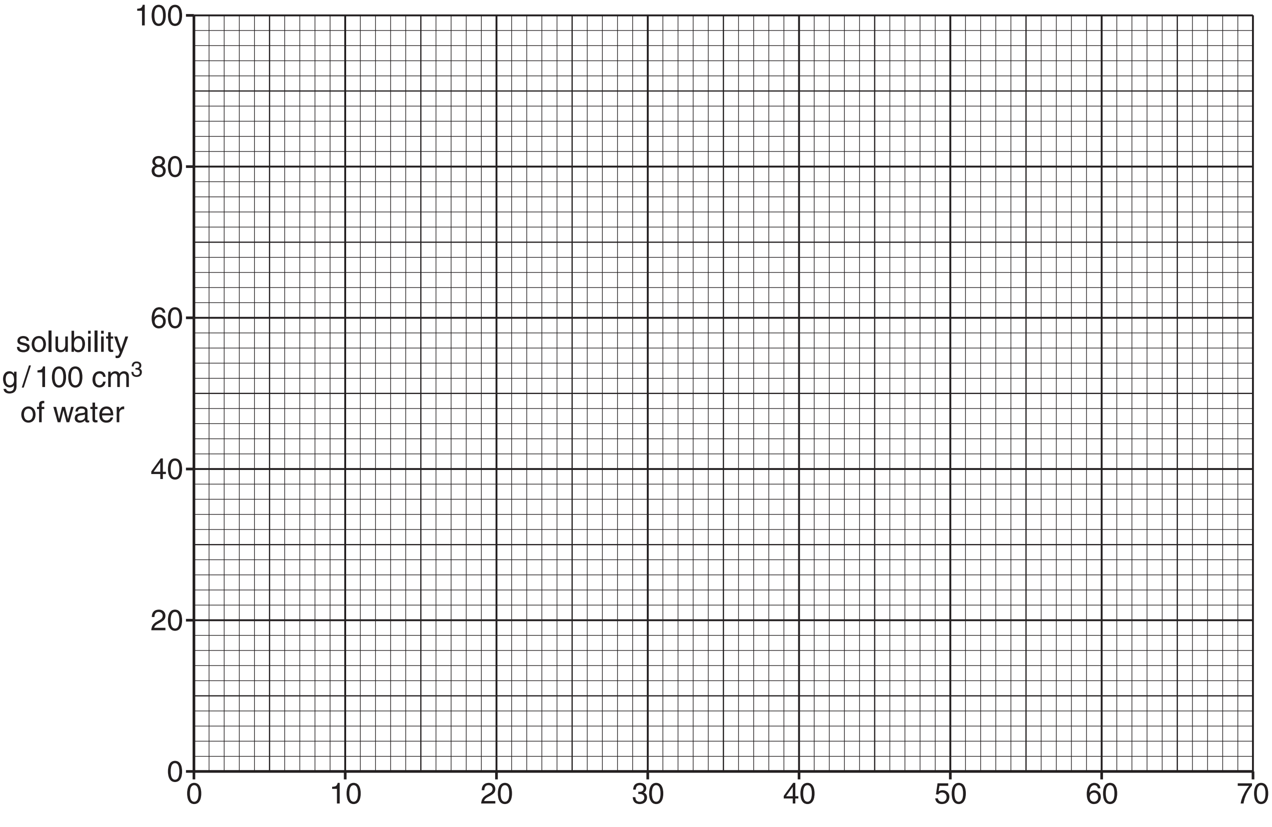
(a) Complete the temperature column of the table using the temperatures shown in the diagram.

Complete the solubility column of the table using the formula shown above.

experiment	total volume of water in solution / cm^3	temperature at which crystals appear / °C	solubility / g /100 cm^3 of water.
1	10.0		100
2	20.0		
3	30.0		33
4	40.0		

[2]

(b) Plot the results on the grid below and draw a smooth curve through the points. Extend the curve to meet the vertical axis.



[3]

(c) Use the graph to answer the following questions.

What is the solubility of sodium nitrate at

(i) 0 °C,

.............................g / 100 cm^3 water

(ii) 40 °C?

.............................g / 100 cm^3 water
[2]

(d) What is the lowest temperature at which 50 cm^3 of water will dissolve 35 g of sodium nitrate?

.... °C [2]

(e) A hot solution of 150 g of sodium nitrate in 100 cm^3 of water is cooled to 50 °C. What mass of sodium nitrate crystallises out?

....g [2]

[Total: 11]

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Ordinary Level

CANDIDATE NAME	

CENTRE NUMBER							CANDIDATE NUMBER					

CHEMISTRY **5070/42**

Paper 4 Alternative to Practical **October/November 2012**

1 hour

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Write your answers in the spaces provided in the Question Paper.
The number of marks is given in brackets [ ] at the end of each question or part question.
At the end of the examination, fasten all your work securely together.

For Examiner's Use

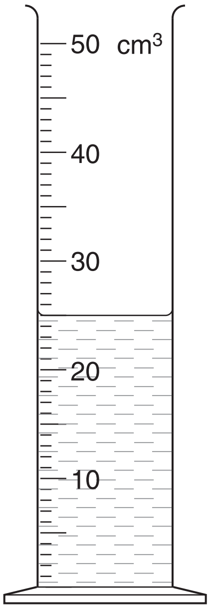
This document consists of **18** printed pages and **2** blank pages.

DC (NF/CGW) 42248/4

[Turn over

For Examiner's Use

1 **(a)** A student pours aqueous silver nitrate into a measuring cylinder.



What is the volume of aqueous silver nitrate in the measuring cylinder?

.... cm^3 [1]

(b) The student transfers the aqueous silver nitrate into a beaker containing excess aqueous potassium iodide. A precipitate of silver iodide is formed.
What colour is silver iodide?

.... [1]

(c) The student separates the silver iodide precipitate from the solution.
Name the separation process.

.... [1]

(d) The student dries and weighs the silver iodide.

mass of silver iodide = 4.70 g

Calculate the number of moles of silver iodide in this mass.
[A_r: Ag, 108; I, 127]

.... moles [1]

(e) The concentration of aqueous potassium iodide used is 1.00 mol/dm^3. It reacts with aqueous silver nitrate according to the following equation.

$$AgNO_3 + KI \rightarrow AgI + KNO_3$$

Using your answer from **(d)**, deduce the number of moles of silver nitrate used in the reaction.

.... moles [1]

(f) Using your answers to **(a)** and **(e)** calculate the concentration of the aqueous silver nitrate.

.... mol/dm^3 [1]

[Total: 6]

2 A student is given some copper powder.

(a) The student heats the copper in air to form copper(II) oxide.

Give the formula and colour of copper(II) oxide.

formula ....

colour .... [2]

(b) The student adds dilute sulfuric acid to the copper(II) oxide. A reaction takes place. Construct the equation for the reaction.

.... [1]

(c) Name the coloured compound present in the aqueous solution formed and give its colour.

name ....

colour .... [1]

(d) Half of the solution from **(b)** is poured into a beaker. Some powdered zinc is added to this solution and left for a while.
Describe what is seen.

....

....

....

.... [3]

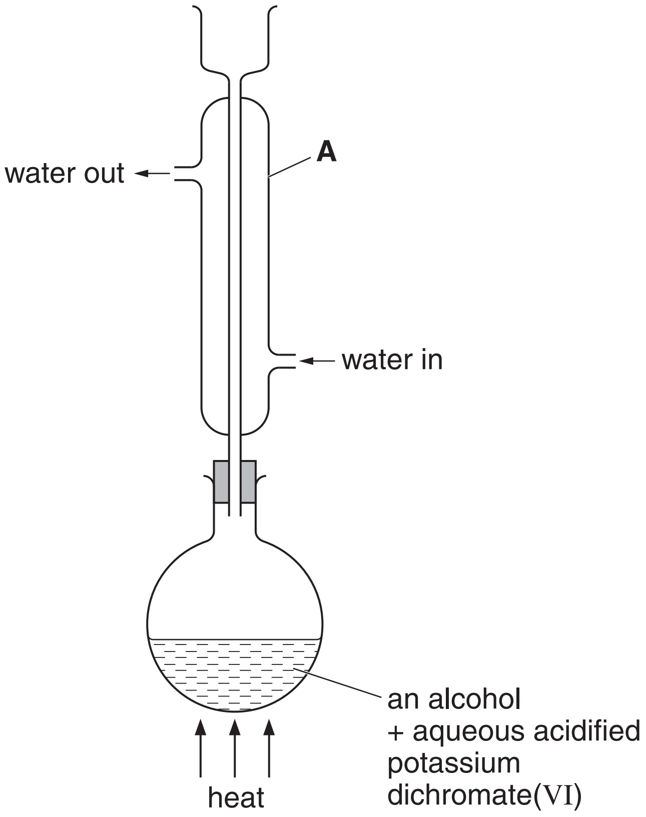
(e) A metal is added to the other half of the solution from **(b)**. No reaction is observed.

Suggest the name of this metal.

.... [1]

[Total: 8]

3 A student prepares propanoic acid by oxidising an alcohol with acidified potassium dichromate(VI) in the apparatus shown below.



(a) **(i)** Name and give the formula of the alcohol used to prepare propanoic acid.

alcohol ....

formula .... [2]

(ii) Name apparatus **A** and suggest why it is used in this preparation.

name ....

use ....

.... [2]

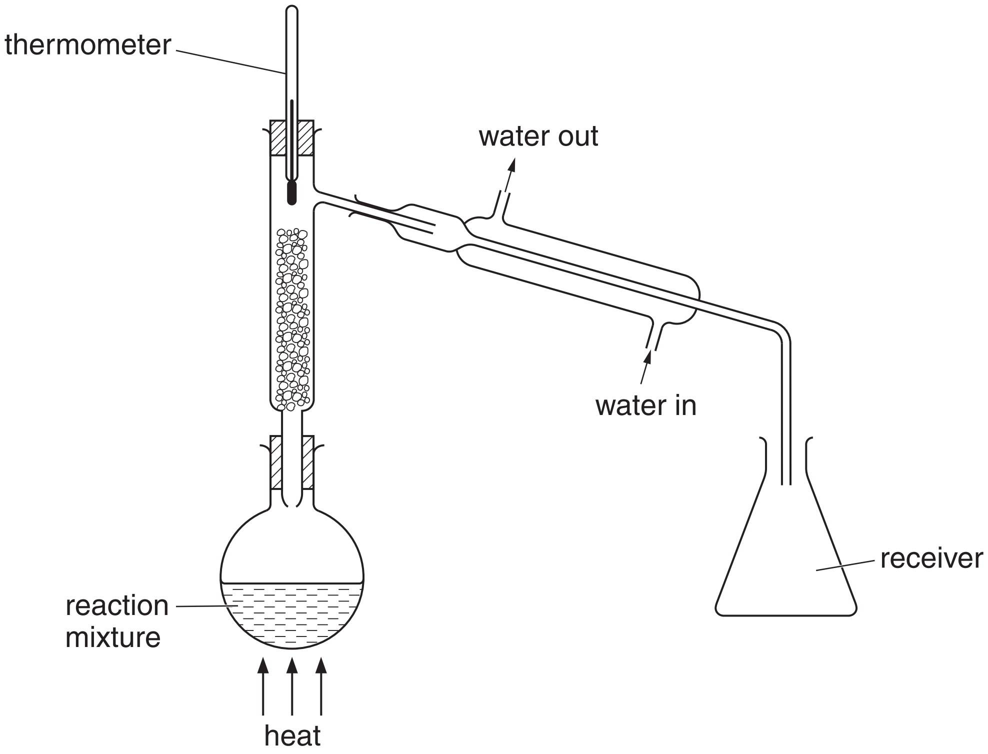
(iii) Explain which is the better choice to heat the flask; an electric heater or a Bunsen burner.

....

....

.... [1]

(b) When all the alcohol has been oxidised the student uses the apparatus shown below to produce a pure sample of propanoic acid (boiling point, 140 °C).



(i) Water will initially distil over into the receiver flask.
What is the reading on the thermometer when the water is distilling over?

.... °C [1]

(ii) How does the student know when propanoic acid begins to distil over?

.... [1]

(iii) Why should the top of the receiver flask remain open?

.... [1]

[Total: 8]

In questions **4** to **7** inclusive, place a tick (✓) in the box against the correct answer.

4 How many of the following salts are insoluble in water?

barium sulfate
calcium carbonate
potassium nitrate
sodium chloride

(a) 1 ☐

(b) 2 ☐

(c) 3 ☐

(d) 4 ☐

[1]

5 $C_{14}H_{30}$ is a long chain hydrocarbon and is a member of the alkane homologous series. When heated strongly in the presence of a catalyst ethene is one of the products.

This reaction is an example of

(a) combustion ☐

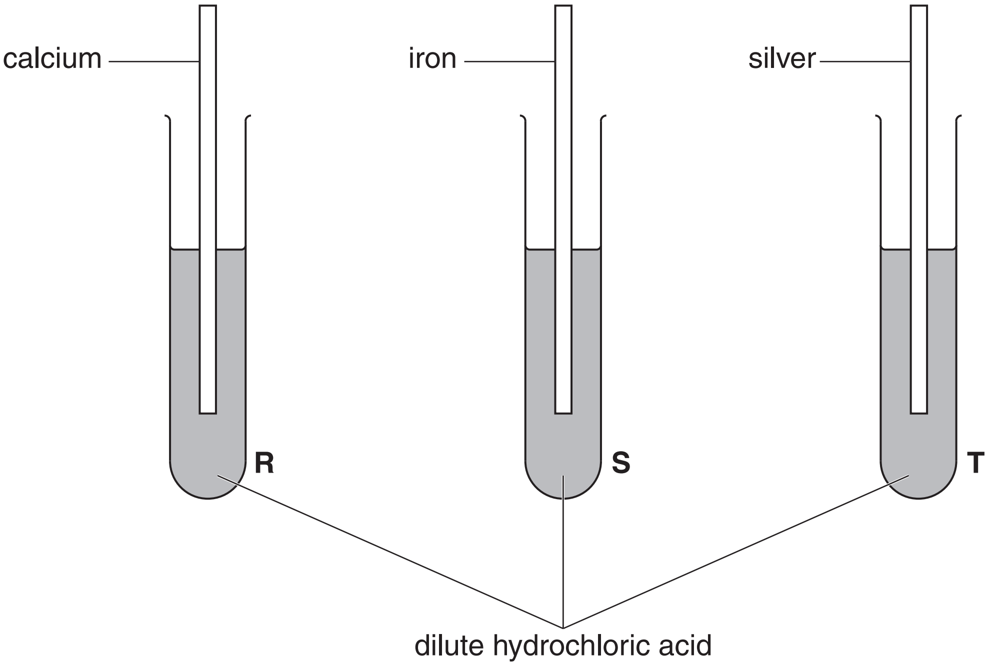
(b) cracking ☐

(c) polymerisation ☐

(d) saturation ☐

[1]

6 A student places each of three metals in tubes containing dilute hydrochloric acid.



In which tubes is hydrogen produced?

(a) **R** and **S** only, ☐

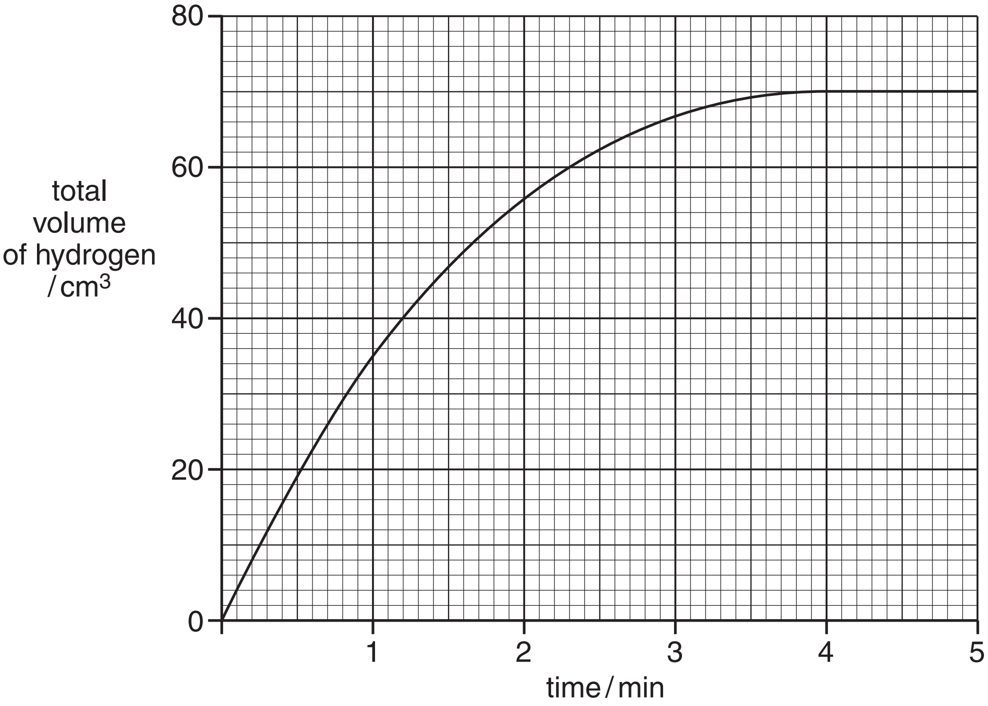
(b) **R** and **T** only, ☐

(c) **S** and **T** only, ☐

(d) **R** and **S** and **T**. ☐

[1]

7 A student measures the speed of a reaction between a given mass of zinc and an excess of hydrochloric acid by recording the volume of hydrogen produced.
The results are shown on the graph.



How long does it take for half of the zinc to react?

(a) 1.0 min ☐

(b) 1.5 min ☐

(c) 2.0 min ☐

(d) 2.5 min ☐

[1]

8 A student is given a sample of an organic acid, **G**, and asked to

- determine its relative molecular mass
- suggest its formula.

(a) A sample of the acid is placed in a previously weighed container and reweighed.

mass of container + **G** = 8.55 g
mass of container = 6.94 g

Calculate the mass of **G** used in the experiment.

.... g [1]

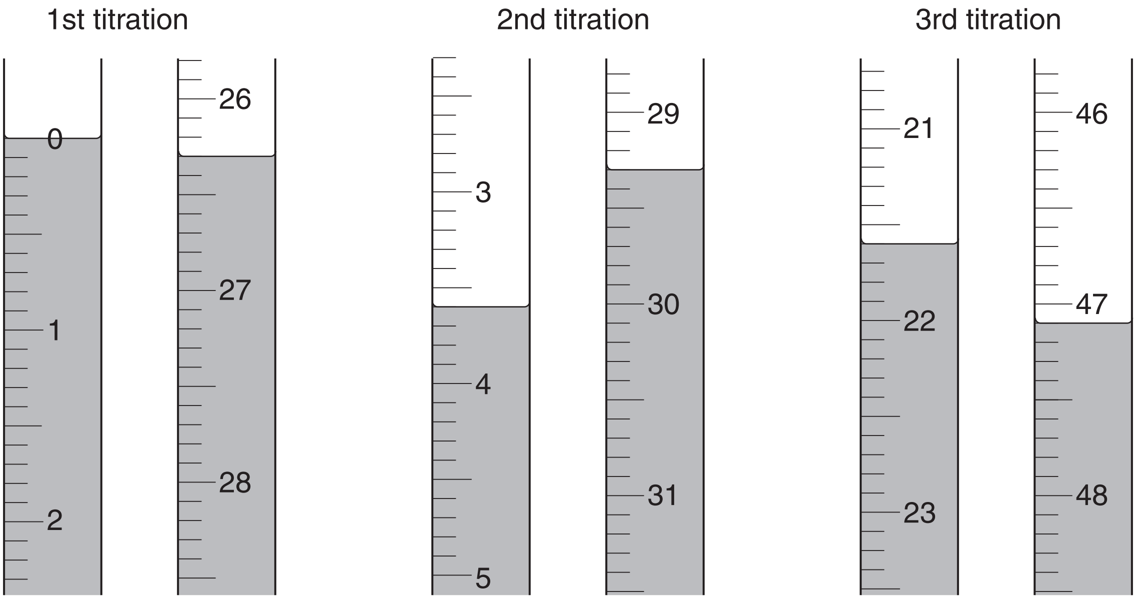
(b) The student transfers the sample to a beaker and adds 50.0 cm^3 of 1.00 mol/dm^3 sodium hydroxide, an excess. The contents of the beaker are allowed to react and then transferred to a volumetric flask. The solution is made up to 250 cm^3 with distilled water. This is solution **H**.
25.0 cm^3 of **H** is transferred into a conical flask.
A few drops of phenolphthalein indicator are added to the conical flask.
0.100 mol/dm^3 hydrochloric acid is put into a burette and added to the solution in the conical flask until an end-point is reached.
Phenolphthalein is colourless in acidic solution and pink in alkaline solution.

What is the colour of the solution in the conical flask

(i) before the acid is added ....

(ii) at the end-point? .... [1]

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



Use the diagrams to complete the following table.

titration number	1	2	3
final reading / cm^3			
initial reading / cm^3			
volume of 0.100 mol / dm^3 hydrochloric acid used / cm^3			
best titration results (✓)			

Summary

Tick (✓) the best titration results.

Using these results, the average volume of 0.100 mol / dm^3 hydrochloric acid is

.... cm^3 [4]

(d) Calculate the number of moles of hydrochloric acid in the average volume of 0.100 mol / dm^3 hydrochloric acid from **(c)**.

.... moles [1]

(e) Construct the equation for the reaction between hydrochloric acid and sodium hydroxide.

.... [1]

(f) Using your equation and the answer from **(d)**, deduce the number of moles of sodium hydroxide present in 25.0 cm^3 of **H**.

.... moles [1]

(g) Using your answer from **(f)** calculate the number of moles of sodium hydroxide in 250 cm^3 of **H**.

.... moles [1]

(h) Calculate the number of moles of sodium hydroxide in 50.0 cm^3 of 1.00 mol / dm^3 sodium hydroxide.

.... moles [1]

(i) By subtracting your answer in **(g)** from your answer in **(h)**, calculate the number of moles of sodium hydroxide that reacts with the original sample of the organic acid, **G**.

.... moles [1]

(j) **One** mole of **G** reacts with **two** moles of sodium hydroxide. Deduce the number of moles of **G** in the sample.

.... moles [1]

(k) Using your answers from **(a)** and **(j)** calculate the relative molecular mass of the acid **G**.

.... [1]

(l) The acid **G** contains two carboxylic acid groups and has the formula

$$HO_2CC_{\mathbf{x}}H_{\mathbf{y}}CO_2H$$

where **x** and **y** are whole numbers.

Deduce the values of **x** and **y** in the formula.
[A_r: H, 1; C, 12; O, 16]

x ....

y .... [2]

[Total: 16]

9 **M** is a compound which contains three ions.
Complete the table by adding the conclusion for **(a)**, the observations for **(b)(i)**, **(ii)** and **(iii)**, and both the test and observation for **(c)**.

test	observations	conclusions
(a) **M** is dissolved in water and the resulting solution divided into two parts for use in tests **(b)**, **(c)**.	A coloured solution is formed.	
(b) **(i)** To the first part, aqueous sodium hydroxide is added until a change is seen. **(ii)** An excess of aqueous sodium hydroxide is added to the mixture from **(i)**. **(iii)** This mixture is heated.		**M** contains Fe^{2+} ions. **M** contains Fe^{2+} ions. **M** contains NH_4^+ ions.
(c)		**M** contains SO_4^{2-} ions.

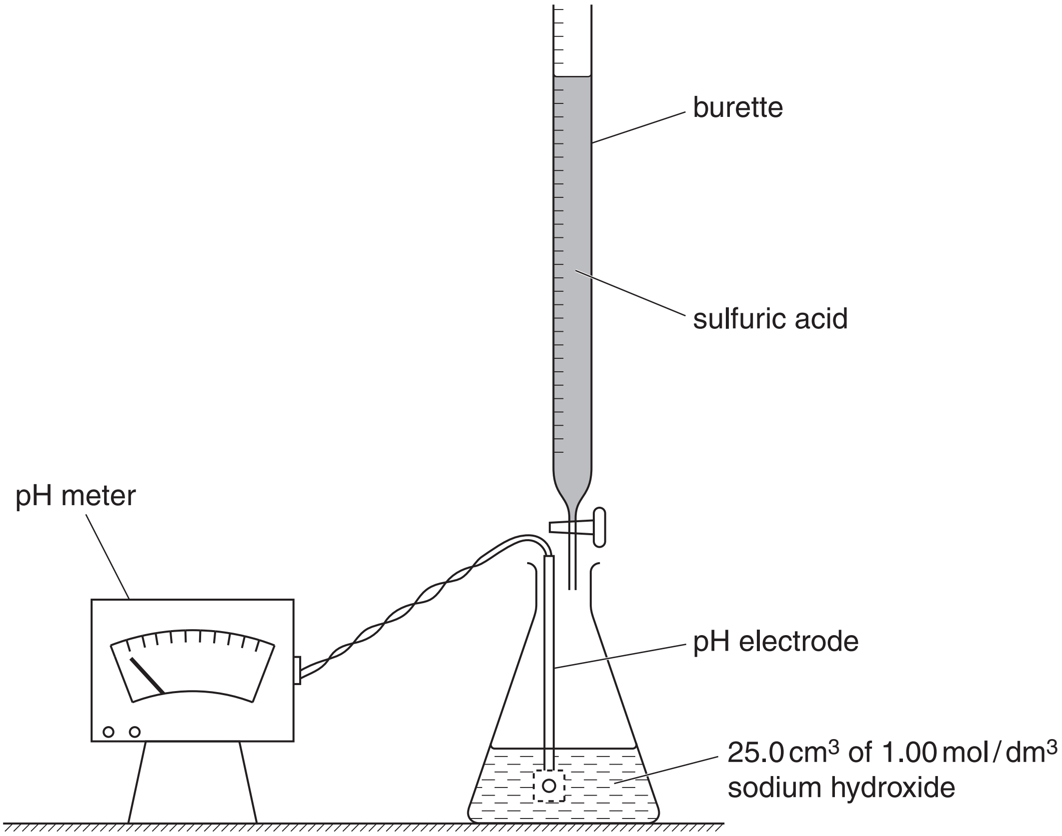
[Total: 8]

TURN OVER FOR QUESTION 10

10 A student prepares a sample of the salt, sodium sulfate.

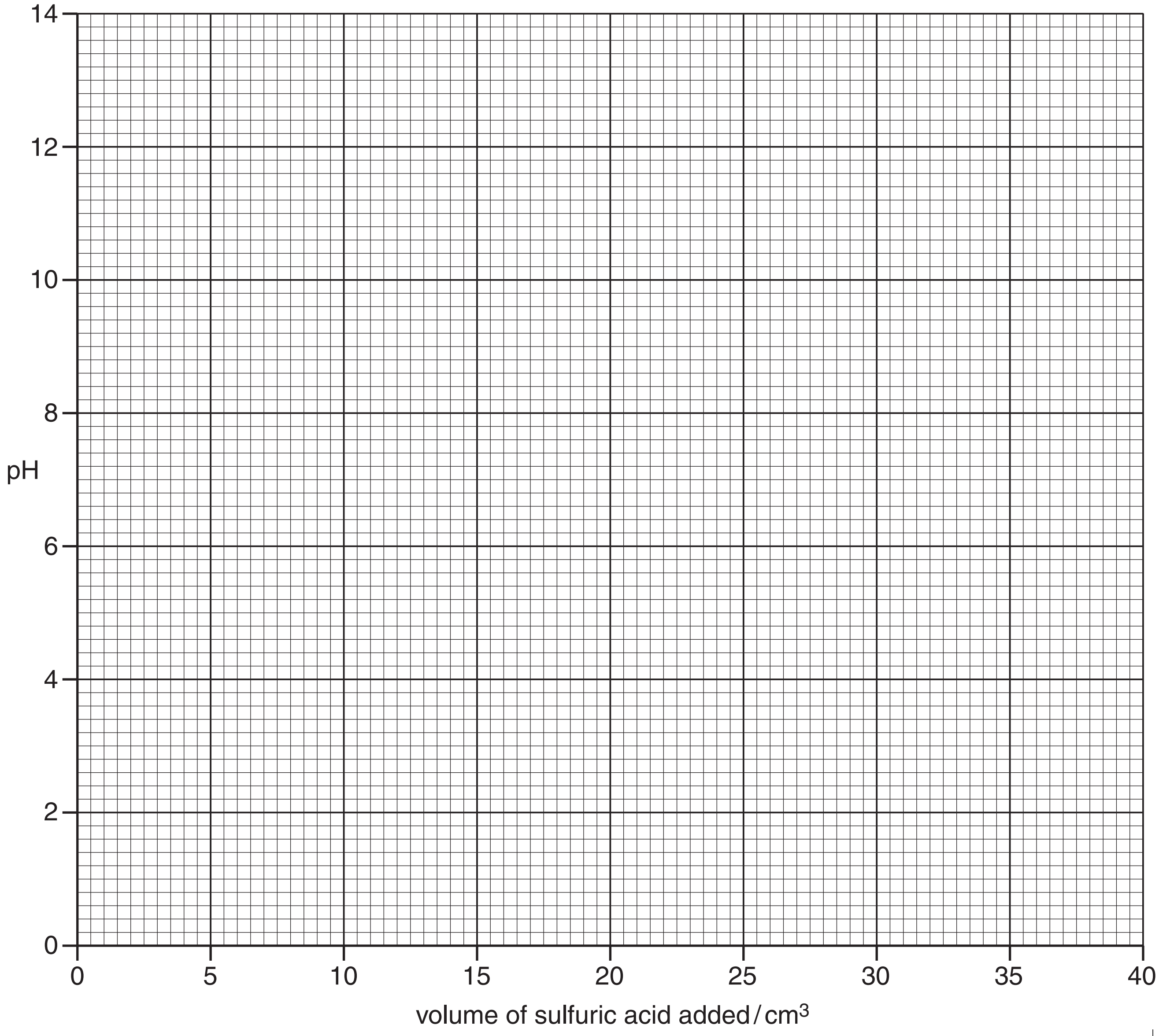
25.0 cm^3 of 1.00 mol / dm^3 sodium hydroxide is transferred to a conical flask and sulfuric acid is added from a burette.

After each addition of sulfuric acid, the pH of the solution is recorded. The apparatus and table of results are shown below.



pH value	volume of acid added / cm^3
13.6	5.0
13.4	10.0
12.2	20.0
11.8	22.0
11.2	24.0
10.0	26.0
4.2	28.0
3.0	30.0
1.2	40.0

(a) On the grid plot a graph of pH against the volume of acid added and draw a smooth curve through all of the points.



[2]

(b) Use the graph to answer the following questions.

(i) What is the pH of the solution when 15.0 cm^3 of acid is added?

.... [1]

(ii) Suggest the pH of the solution at the end-point.

.... [1]

(iii) Using your answer to **(ii)**, what volume of acid is required to neutralise 25.0 cm^3 of 1.00 mol / dm^3 sodium hydroxide?

.... cm^3 [1]

(c) **(i)** Construct the equation for the reaction between sulfuric acid and sodium hydroxide.

.... [1]

(ii) Using the equation and your answer from **(b)(iii)** calculate the concentration of the sulfuric acid used.

.... mol / dm^3 [1]

(d) In a separate experiment the volume of sulfuric acid calculated in **(b)(iii)** is added to 25.0 cm^3 of 1.00 mol / dm^3 sodium hydroxide. The resulting solution is used to produce sodium sulfate crystals.
Describe briefly how the student makes good quality sodium sulfate crystals from this solution.

....

....

....

....

.... [3]

[Total: 10]

BLANK PAGE

BLANK PAGE

O

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Ordinary Level

CANDIDATE NAME	

CENTRE NUMBER						CANDIDATE NUMBER					

CHEMISTRY **5070/42**

Paper 4 Alternative to Practical **May/June 2011**

1 hour

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

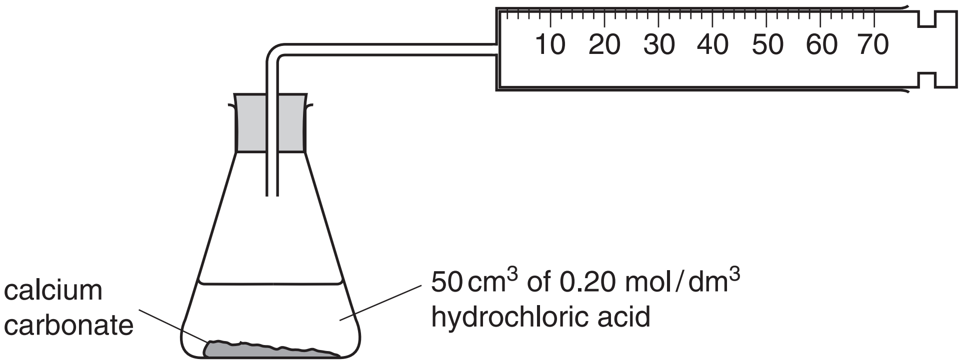
Answer **all** questions.
Write your answers in the spaces provided in the Question Paper.
At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use

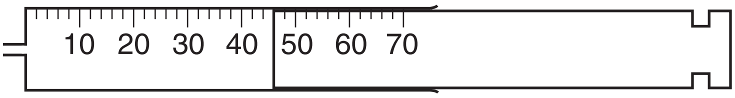
This document consists of **14** printed pages and **2** blank pages.

DC (LEO/SW) 32755/4

1 A student adds hydrochloric acid to calcium carbonate to produce carbon dioxide.



The diagram below shows the gas syringe containing the volume of carbon dioxide collected in one minute.



(a) What volume of carbon dioxide is collected in one minute?

....cm^3 [1]

(b) Will the volume collected during the second minute be less than, the same, or more than the volume collected during the first minute? Explain your answer.

....

....

.... [2]

The equation for the reaction is

$$CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$$

(c) 50 cm^3 of 0.20 mol/dm^3 hydrochloric acid is added to an excess of calcium carbonate.

(i) Calculate the number of moles in 50 cm^3 of 0.20 mol/dm^3 hydrochloric acid.

.... moles [1]

(ii) Calculate the relative formula mass of calcium carbonate.
[A_r: C,12; O,16; Ca, 40.]

.... [1]

(iii) Using your answers to **(c)(i)** and **(c)(ii)** and the equation for the reaction, calculate the mass of calcium carbonate required to completely react with 50 cm^3 of 0.20 mol/dm^3 hydrochloric acid.

.... cm^3 [1]

(iv) Calculate the maximum volume of carbon dioxide that is produced when 50 cm^3 of 0.20 mol/dm^3 of hydrochloric acid reacts completely with the excess calcium carbonate.
[1 mole of a gas occupies a volume of 24 dm^3 at room temperature and pressure.]

.... cm^3 [1]

(d) Suggest how the speed of this reaction can be **increased** by changing

(i) the particle size of calcium carbonate,

.... [1]

(ii) the concentration of hydrochloric acid.

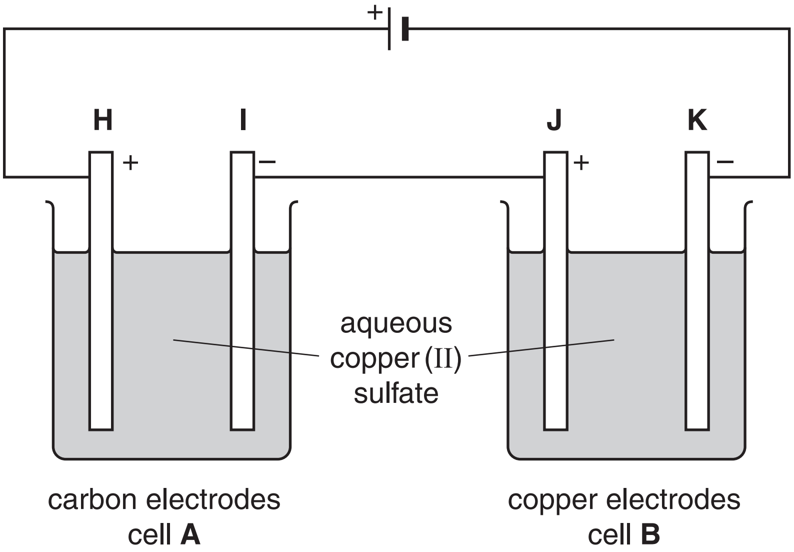
.... [1]

(e) Suggest another way in which the student can increase the speed of the reaction.

.... [1]

[Total: 10]

2 The apparatus below is used to compare the results of passing a current through aqueous copper(II) sulfate using different electrodes.



(a) What colour is aqueous copper(II) sulfate?

.... [1]

(b) (i) In which cell, **A** or **B**, is a colour change **not** seen in the solution?

.... [1]

(ii) Describe what is seen at each electrode in this cell, as the electrolysis proceeds?

....

.... [2]

(iii) Explain why a colour change is **not** seen in the solution in this cell.

.... [1]

(c) (i) What colour change is seen in the solution in the other cell?

.... [1]

(ii) At which electrode **H**, **I**, **J or K** is a gas produced?

.... [1]

(iii) Name this gas.

.... [1]

Give a test for this gas

test ....

observation .... [1]

(iv) What is seen at the other electrode in this cell?

.... [1]

[Total: 10]

For questions **3** to **7** inclusive, place a tick (✓) in the box against the correct answer.

3 A sample of zinc sulfate contains zinc powder as an impurity.
Which of the following methods will produce zinc sulfate crystals?

(a) Shake with water, filter and crystallise the filtrate. ☐

(b) Shake with ethanol, filter and crystallise the filtrate. ☐

(c) Shake with water, filter, wash the residue with water and dry it. ☐

(d) Shake with ethanol, filter, wash the residue with ethanol and dry it. ☐

[1]

4 5.00 g of an organic compound **G** contains 2.73 g of carbon, 0.45 g of hydrogen, and 1.82 g oxygen.
[A_r: H,1; C,12; O,16]

Its empirical formula is

(a) CHO ☐

(b) CH_4O ☐

(c) C_2H_4O ☐

(d) C_2H_2O ☐

[1]

5 A student is given some propanol.
He reacts half of it with acidified potassium dichromate(VI) to produce an acid.
He then adds this acid to the remaining propanol, together with a few drops of concentrated sulfuric acid, to make an ester.
The formula for the ester is

(a) $CH_3CO_2C_2H_5$ ☐

(b) $C_2H_5CO_2C_2H_5$ ☐

(c) $C_2H_5CO_2C_3H_7$ ☐

(d) $C_3H_7CO_2C_2H_5$ ☐

[1]

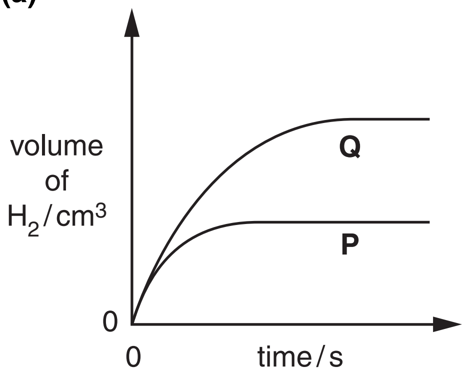
For Examiner's Use

6 A student adds 5.0 cm^3 of 0.20 mol/dm^3 hydrochloric acid to an excess of zinc pieces. The volume of hydrogen evolved is recorded at regular time intervals until no more gas is produced.
This is experiment **P**.

The experiment is repeated using 20.0 cm^3 of 0.10 mol/dm^3 hydrochloric acid and an excess of zinc powder.
This is experiment **Q**.

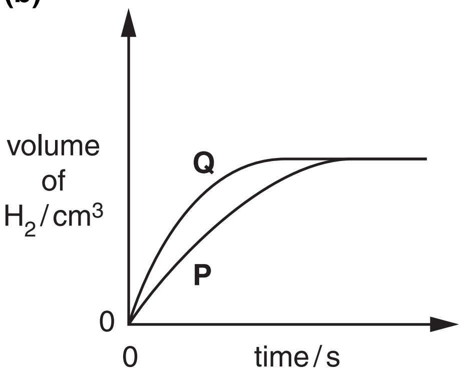
Which one of the following is obtained?

(a)



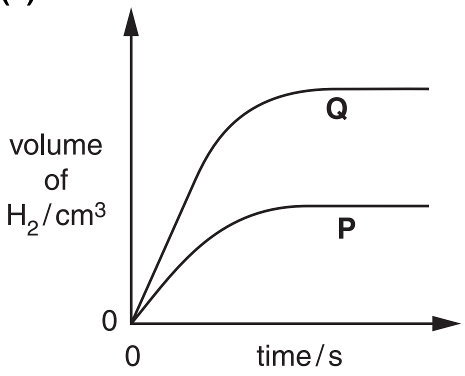
☐

(b)



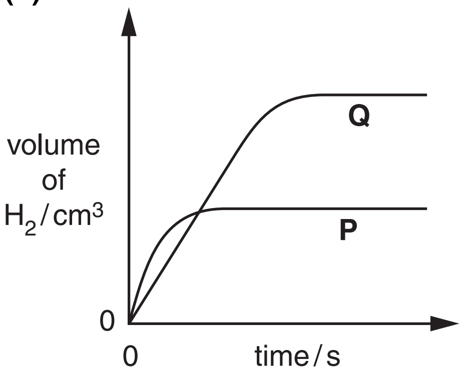
☐

(c)



☐

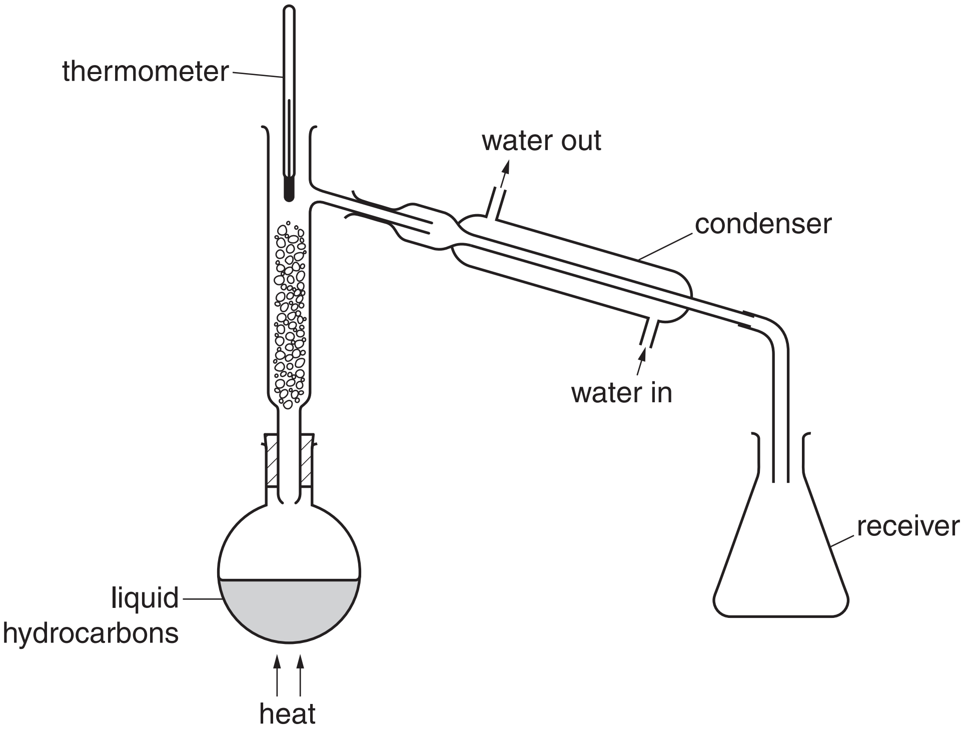
(d)



☐

[1]

7 A student sets up the apparatus shown below in order to separate two hydrocarbons by fractional distillation.



What error is the student making in setting up the apparatus?

(a) The thermometer is in the wrong position. ☐

(b) There should be a bung in the top of the fractionating column. ☐

(c) There should be a bung in the top of the receiver. ☐

(d) The water enters the condenser in the wrong place. ☐

[1]

8 **M** is a mixture of iron(II) sulfate and iron(III) sulfate.
A student determines the mass of iron(II) sulfate in the mixture using 0.0180 mol/dm^3 aqueous potassium manganate(VII), solution **S**.

(a) Potassium manganate(VII), which is purple, oxidises the iron(II) ions in the mixture.

Why does potassium manganate(VII) not react with iron(III) ions?

....[1]

(b) A sample of **M** is added to a previously weighed container, which is then reweighed.

mass of container + **M** = 17.01 g
mass of container = 11.93 g

Calculate the mass of **M** used in the experiment.

.... g [1]

(c) The sample of **M** is placed in a flask, dissolved in 100 cm^3 of dilute sulfuric acid and mixed thoroughly. The solution is made up to 250 cm^3 with distilled water. This is solution **P**.

25.0 cm^3 of **P** is transferred into a conical flask.

What piece of apparatus should be used to transfer 25.0 cm^3 of **P**?

....[1]

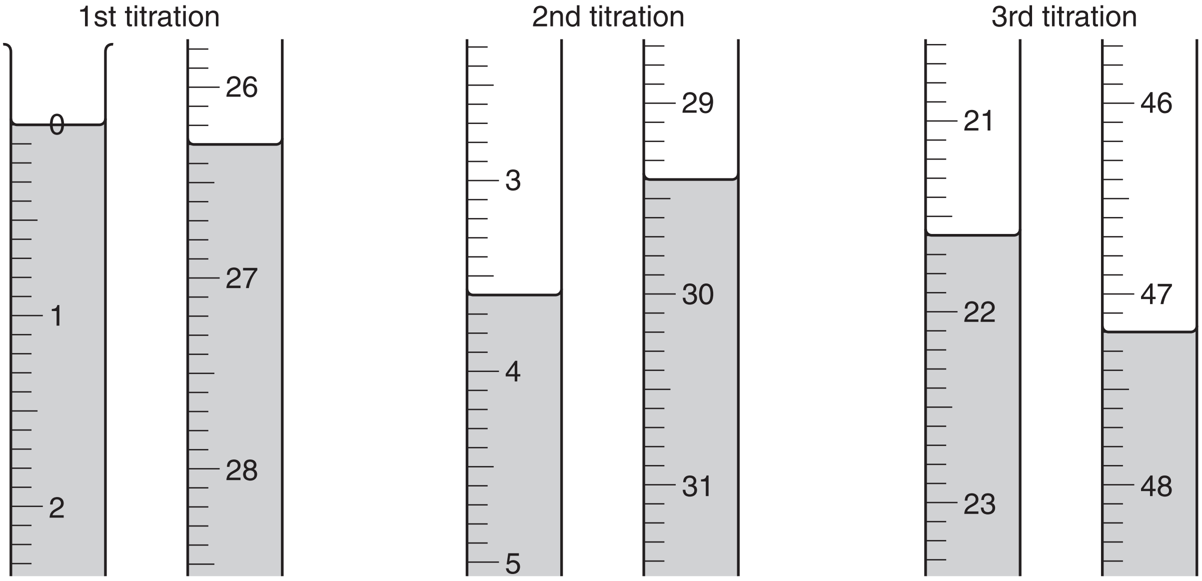
(d) Solution **S** is put into a burette and run into the conical flask containing **P** until the end-point is reached.

What is the colour of the solution in the conical flask

(i) before **S** is added, ...

(ii) at the end-point when **S** is just in excess? .... [1]

(e) Three titrations are done. The diagrams below show parts of the burette with the liquid levels at the beginning and end of each titration.



Use the diagrams to complete the following table.

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

Summary

Tick (✓) the best titration results.

Using these results, the average volume of **S** used is

....cm^3. [4]

(f) **S** is 0.0180 mol/dm^3 potassium manganate(VII).

Calculate the number of moles of potassium manganate(VII) in the average volume of **S** in **(e)**.

.... moles [1]

(g) **One** mole of potassium manganate(VII) reacts with **five** moles of iron(II) sulfate.

Deduce the number of moles of iron(II) sulfate in 25.0 cm^3 of **P**.

.... moles [1]

(h) Calculate

(i) the number of moles of iron(II) sulfate in 250 cm^3 **P**,

.... moles [1]

(ii) the mass of iron(II) sulfate in 250 cm^3 of **P**.
[M_r: $FeSO_4$, 152]

.... g [1]

(i) Using your answers to **(b)** and **(h)(ii)**, calculate the mass of iron(II) sulfate in 1000 g of **M**.

.... g [1]

[Total: 13]

9 The following table shows the tests a student does on compound **V** and the conclusions made from observations.
Complete the table by stating the conclusion in test **(a)**, the observation in test **(c)** and suggest both the tests and observations that lead to the conclusions in tests **(b)** and **(d)**.

test	observation	conclusion
(a) V is dissolved in water and the solution divided into three parts for tests **(b)**, **(c)** and **(d)**.	A colourless solution is obtained.	
(b)(i)		**V** may contain Al^{3+}, Ca^{2+} or Zn^{2+} ions,
(ii)		**V** may contain Ca^{2+} ions.
(c) To the second part aqueous ammonia is added until a change was seen.		The presence of Ca^{2+} ions in **V** is confirmed.
(d)		**V** contains NO_3^- ions.

[Total: 10]

10 **(a)** The reaction between aqueous barium chloride and dilute sulfuric acid produces a precipitate of barium sulfate.

State the colour of this precipitate.

....[1]

A series of experiments are done to find the mass of precipitate when different volumes of dilute sulfuric acid are added to a fixed volume of aqueous barium chloride.

Solution **J** is 1.00 mol/dm^3 barium chloride.
Solution **K** is sulfuric acid of unknown concentration.

10 cm^3 of **J** is put into each of six test-tubes. Increasing volumes of **K** are added to each test-tube. The mixtures are filtered and the precipitates washed with water, dried and placed in a previously weighed container which is reweighed.

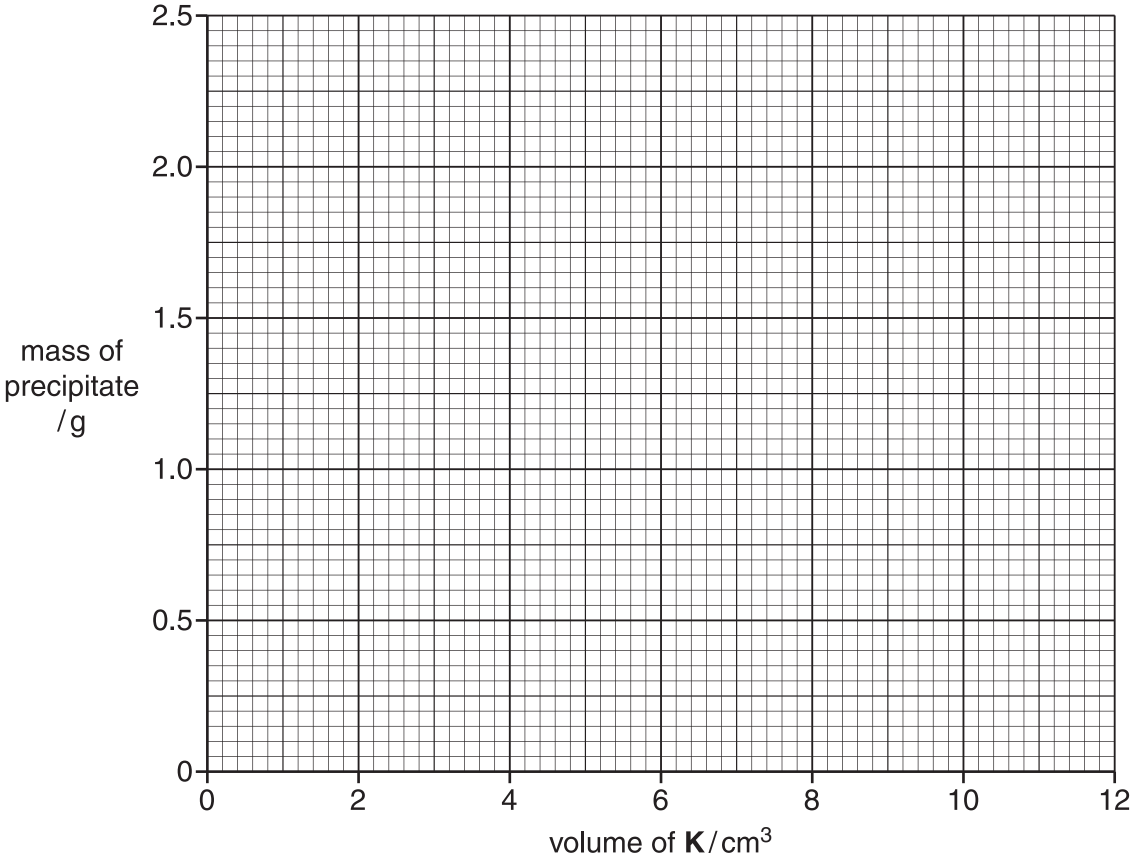
(b) The table below shows the results of these experiments.

Complete the final column.

volume of **J** /cm^3	volume of **K** /cm^3	mass of empty container / g	mass of container + precipitate / g	mass of precipitate / g
10.0	2.0	3.50	4.08	
10.0	4.0	3.50	4.55	
10.0	6.0	3.50	5.25	
10.0	8.0	3.50	5.83	
10.0	10.0	3.50	5.83	
10.0	12.0	3.50	5.83	

[2]

(c) Plot the mass of precipitate against the volume of **K** on the grid. Join the points with **two** best fit straight lines.



[3]

(d) One of the results is incorrect. Circle this result on your grid and suggest what the correct result should be.

.... g [1]

(e) Use the data on your grid to deduce

(i) the volume of **K** which would produce 1.50 g of precipitate,

....cm^3 [1]

(ii) the maximum mass of precipitate that is produced,

.... g [1]

(iii) the minimum volume of **K** which reacts completely with the maximum mass in **(ii)**.

....g [1]

(f) Write the equation for the reaction between barium chloride and sulfuric acid.

.... [1]

(g) Using your answers to **(e)(iii)** and **(f)**, calculate the concentration of the sulfuric acid, **K**, used in the experiment.

...................................mol / dm^3 [1]

[Total: 12]

BLANK PAGE

BLANK PAGE

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Ordinary Level

CANDIDATE NAME	

							CANDIDATE NUMBER				
CENTRE NUMBER											

1331047203

CHEMISTRY **5070/42**

Paper 4 Alternative to Practical **October/November 2011**

1 hour

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Write your answers in the spaces provided in the Question Paper.

The number of marks is given in brackets [ ] at the end of each question or part question.
At the end of the examination, fasten all your work securely together.

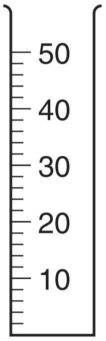
For Examiner's Use

This document consists of **17** printed pages and **3** blank pages.

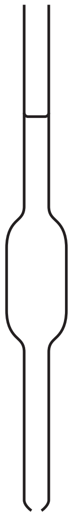
DC (NF/DJ) 27261/3

1

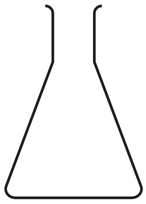
A



B



C



(a) Which of the above apparatus **A**, **B** or **C,** is used for measuring out a fixed volume of liquid for a titration experiment?

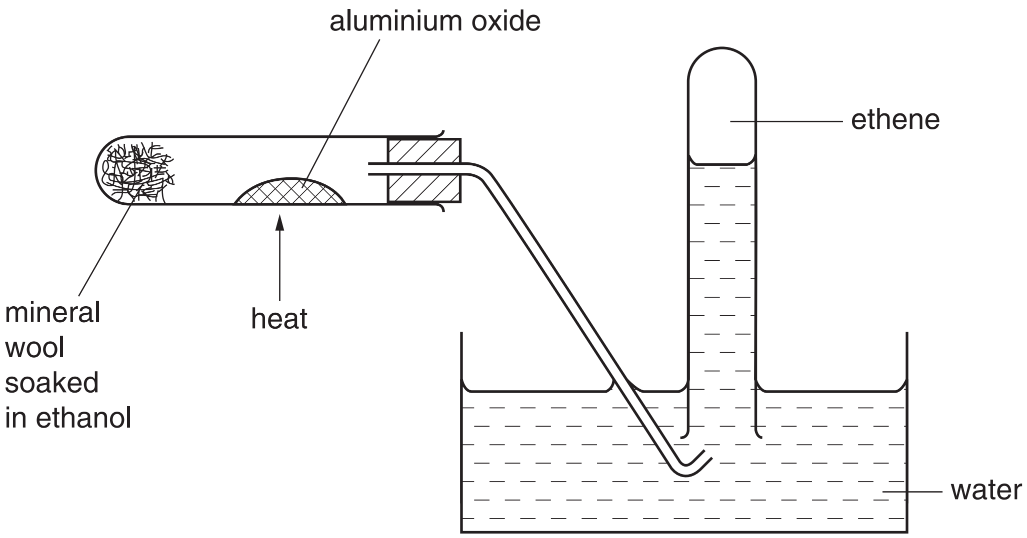
.... [1]

(b) Name this apparatus.

.... [1]

[Total: 2]

2 Ethene is an alkene.
It is made from ethanol in the apparatus shown below.



(a) **(i)** The gas is collected over water.
What does this show about the solubility of ethene in water?

.... [1]

(ii) Suggest the purpose of the aluminium oxide.

.... [1]

(iii) Draw the structure of ethene.

[1]

(b) The apparatus is altered to pass the ethene into aqueous bromine.

What is the colour of aqueous bromine

(i) before ethene is bubbled through it,

.... [1]

(ii) after ethene is bubbled through it?

.... [1]

(iii) What type of reaction occurs between bromine and ethene?

.... [1]

(c) The structure of a different alkene is shown below.

$$CH_3\ CH = CH\ CH_3$$

(i) Name this alkene.

.... [1]

(ii) Draw the structure of an isomer of this alkene.

[1]

[Total: 8]

3 **(a)** A student measures the boiling point of rain water and sea water.
Which has the higher boiling point?
Explain your answer.

....

.... [1]

(b) Suggest the formula of a salt which is present in sea water.

.... [1]

(c) **(i)** Sea water may be converted into pure water in a laboratory by distillation.
Draw a sketch of the distillation apparatus.

[3]

(ii) Distillation can be used on a large scale to produce drinkable water.
Name another large scale process by which sea water can be converted into drinking water.

.... [1]

(d) Water from natural sources may contain undissolved solids. Name the process by which these solids can be removed.

.... [1]

(e) Bacteria, which are also present in water from natural sources, may be removed by passing a gas through the water.
Name and give a test for this gas.

name ....

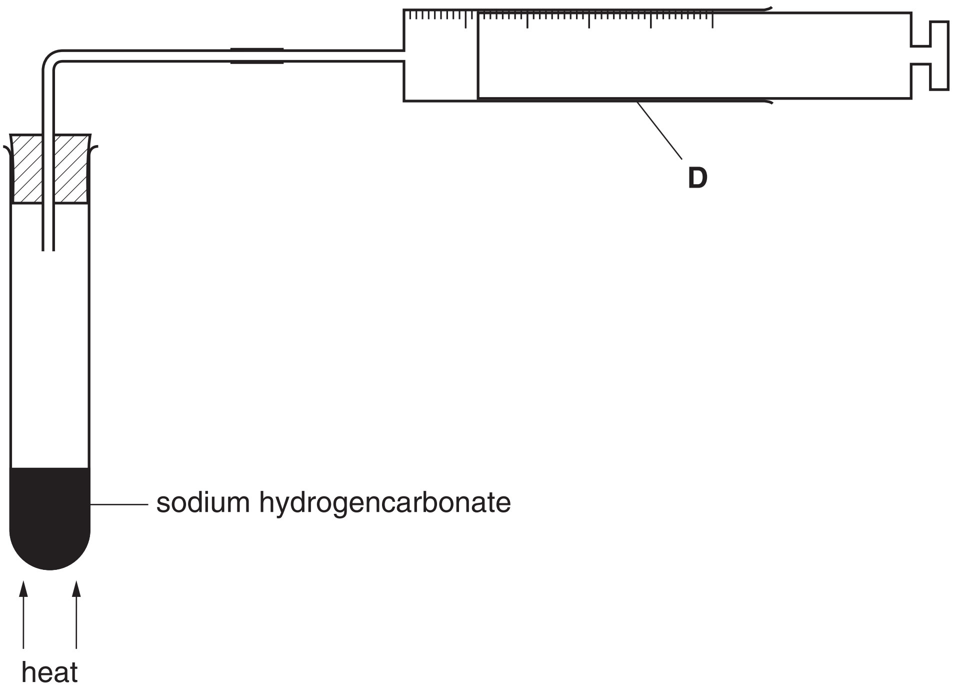
test ....

observation .... [2]

[Total: 9]

4 A student heats solid sodium hydrogencarbonate in the apparatus shown below. The carbon dioxide gas produced is collected in apparatus **D**.

$$2NaHCO_3 \rightarrow Na_2CO_3 + CO_2 + H_2O$$



(a) Name apparatus **D**.

.... [1]

(b) Give a test for carbon dioxide.

test ....

observation .... [1]

(c) On heating the sample of sodium hydrogencarbonate, 120 cm^3 of carbon dioxide is evolved. The gas is measured at room temperature and pressure.

(i) Calculate the number of moles of carbon dioxide evolved.
[1 mole of a gas occupies 24 dm^3 at room temperature and pressure.]

.... moles [1]

(ii) Using your answer to **(c)(i)** and the equation for the reaction, deduce the number of moles of sodium hydrogencarbonate decomposed.

.... moles [1]

(iii) Using your answer to **(c)(ii)**, calculate the mass of sodium hydrogencarbonate decomposed.
[A_r: H,1; C,12; O,16; Na, 23]

.... g [1]

[Total: 5]

In questions **5** to **9** inclusive, place a tick (✓) in the box against the best answer.

5 Which of the following changes can occur when the first named substance reacts with acidified potassium dichromate(VI)?

(a) ethanoic acid ⟶ ethanol ☐

(b) ethanol ⟶ ethyl ethanoate ☐

(c) ethyl ethanoate ⟶ ethanol ☐

(d) ethanol ⟶ ethanoic acid ☐ [1]

6 A sample of air taken from a busy industrial city contains a number of gases. The sample is bubbled through water containing a few drops of litmus solution. The litmus turns red.

Which of these gases causes this change?

(a) ammonia ☐

(b) carbon monoxide ☐

(c) methane ☐

(d) sulfur dioxide ☐ [1]

7 A student does some tests on substance **M**.

M has a high melting point.

Solid **M** does not conduct electricity.

What could substance **M** be?

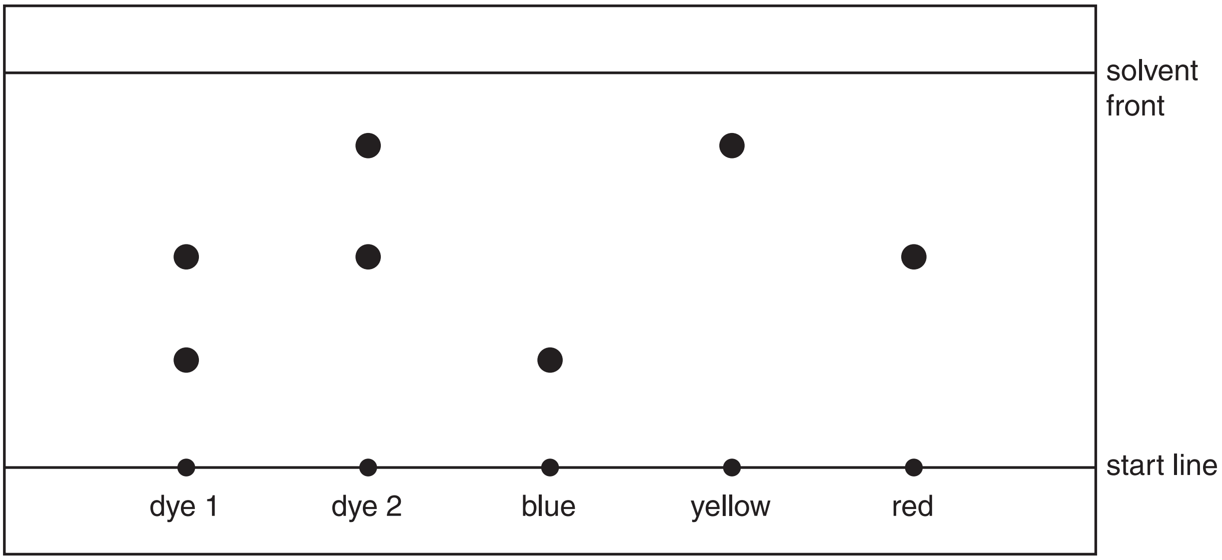
(a) iodine ☐

(b) iron ☐

(c) sodium chloride ☐

(d) sugar ☐ [1]

8 The following diagram is obtained in an experiment to compare two dyes, dye 1 and dye 2.



Which statement is correct?

(a) only one dye contains red ☐

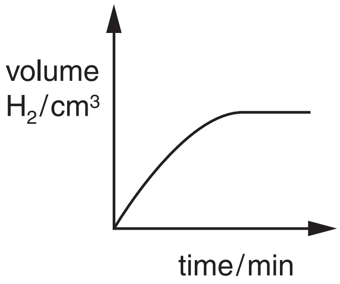
(b) only one dye contains yellow ☐

(c) both dyes contain blue ☐

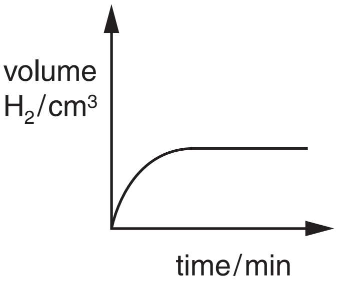
(d) both dyes contain all three colours ☐ [1]

For Examiner's Use

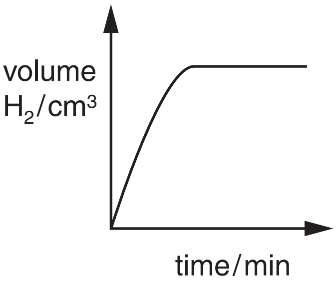
9 When excess granulated zinc is added to dilute hydrochloric acid, hydrogen gas is produced. The experiment is repeated using excess powdered zinc and the same volume of hydrochloric acid. Which **two** graphs best represent the rates of production of hydrogen gas in the two experiments?



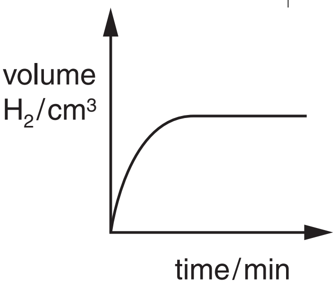
1



2



3



4

	granulated zinc	powdered zinc
(a)	**1**	**3** ☐
(b)	**2**	**3** ☐
(c)	**1**	**4** ☐
(d)	**2**	**4** ☐

[1]

BLANK PAGE

10 Vinegar contains ethanoic acid.
A student determines the concentration of ethanoic acid in a sample of vinegar by titration with 0.200 mol / dm^3 sodium hydroxide.

25.0 cm^3 of vinegar is transferred to a graduated flask and made up to 250 cm^3 with distilled water. This is solution **E**.

(a) 25.0 cm^3 of **E** is transferred to a conical flask and a few drops of bromothymol blue indicator added.

Bromothymol blue has the following colours:

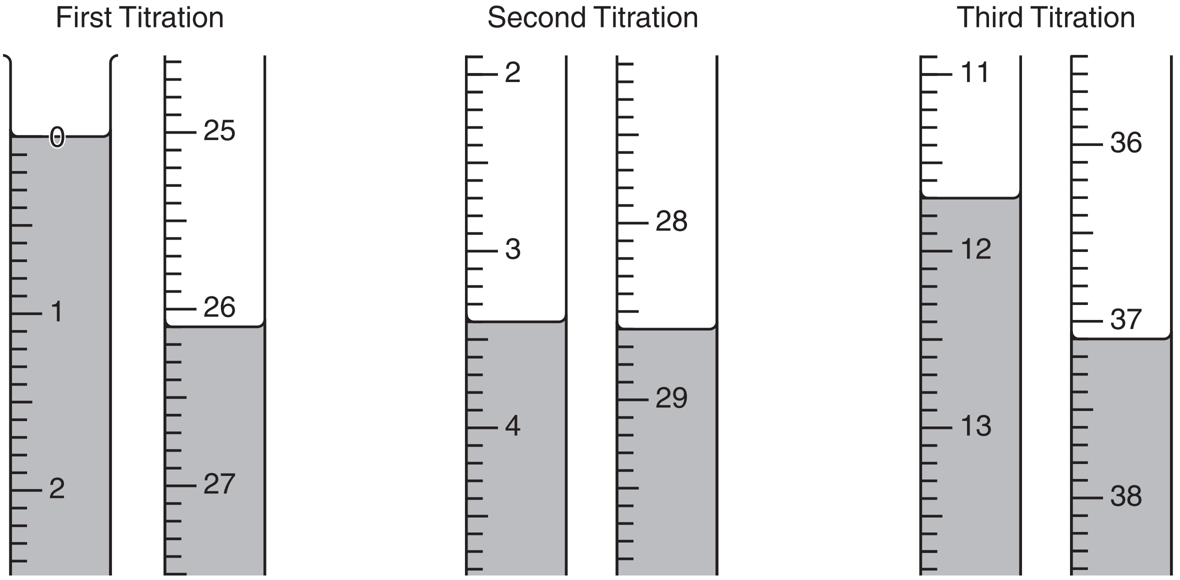
pH 5 yellow,
pH 10 blue.

0.200 mol / dm^3 sodium hydroxide is put into a burette and run into the conical flask containing **E** until the end-point is reached.

What is the colour change of the bromothymol blue at the end-point?

The colour changes from .... to .... [1]

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



Use the diagrams to complete the following results table.

titration number	1	2	3
final burette reading / cm^3			
initial burette reading / cm^3			
volume of 0.200 mol / dm^3 sodium hydroxide used / cm^3			
best titration results (✓)			

Summary:

Tick (✓) the best titration results.

Using these results, the average volume of 0.200 mol / dm^3 sodium hydroxide required is

.... cm^3. [4]

(c) Calculate the number of moles of sodium hydroxide in the average volume of 0.200 mol / dm^3 sodium hydroxide in **(b)**.

.... moles [1]

(d) Using the equation

$$CH_3CO_2H + NaOH \rightarrow CH_3CO_2Na + H_2O$$

and your answer to **(c)**, deduce the number of moles of ethanoic acid in 25.0 cm^3 of **E**.

.... moles [1]

(e) Calculate the number of moles of ethanoic acid in 250 cm^3 of **E**.

.... moles [1]

(f) **(i)** Deduce the number of moles of ethanoic acid in the original 25.0 cm^3 of vinegar.

.... moles [1]

(ii) Calculate the concentration of ethanoic acid in the vinegar in mol/dm^3.

.... mol / dm^3 [1]

[Total: 10]

11 The following table shows the tests a student does on compound **W** and the conclusions made from the observations.

Complete the table by adding the observations for tests **(a)**, **(b)** and **(c)** and both the test and observation which lead to the conclusion for test **(d).**

test	observations	conclusions
(a) **W** is dissolved in water and the solution divided into three parts for tests **(b)**, **(c)** and **(d)**.		**W** does not contain a transition metal.
(b) **(i)** To the first part aqueous sodium hydroxide is added until a change is seen. **(ii)** An excess of aqueous sodium hydroxide is added to the mixture from **(i)**.		**W** may contain Al^{3+} or Zn^{2+} ions.
(c) **(i)** To the second part aqueous ammonia is added until a change is seen. **(ii)** An excess of aqueous ammonia is added to the mixture from **(i)**.		The presence of Al^{3+} ions in **W** is confirmed.
(d)		**W** contains NO_3^- ions.

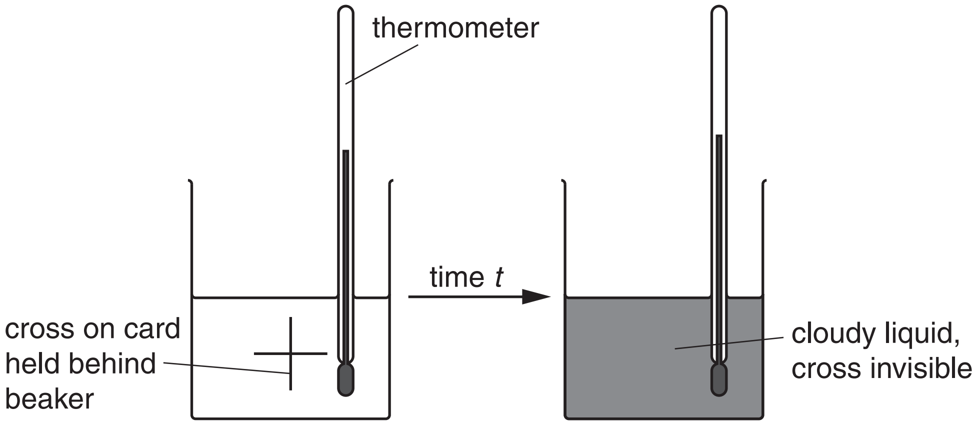
Conclusion:

The formula for **W** is ....

[Total: 10]

BLANK PAGE

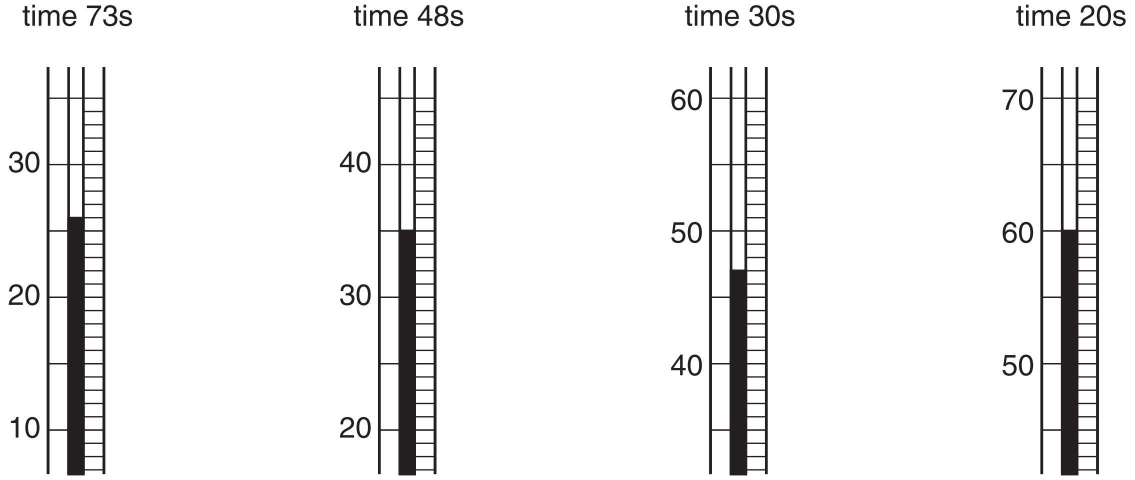
12 The reaction between aqueous sodium thiosulfate and hydrochloric acid produces a precipitate of sulfur which makes the solution go cloudy. The speed of this reaction can be investigated by measuring the length of time it takes for the solution to go cloudy.
A student does two experiments to investigate the effects of both temperature (Experiment **1**) and concentration (Experiment **2**) on the speed of the reaction.



(a) Experiment **1**

50 cm^3 of aqueous sodium thiosulfate is put into a beaker and 5.0 cm^3 of 2.0 mol / dm^3 hydrochloric acid added.
A stop watch is started and the temperature of the mixture is noted. At the moment the cross becomes invisible, the watch is stopped and the time taken recorded.
The experiment is repeated four more times, keeping the volumes and concentrations of both solutions the same but using different temperatures.

The diagrams below show parts of the thermometer stem for each of the four experiments, indicating the temperature of the mixture / °C.

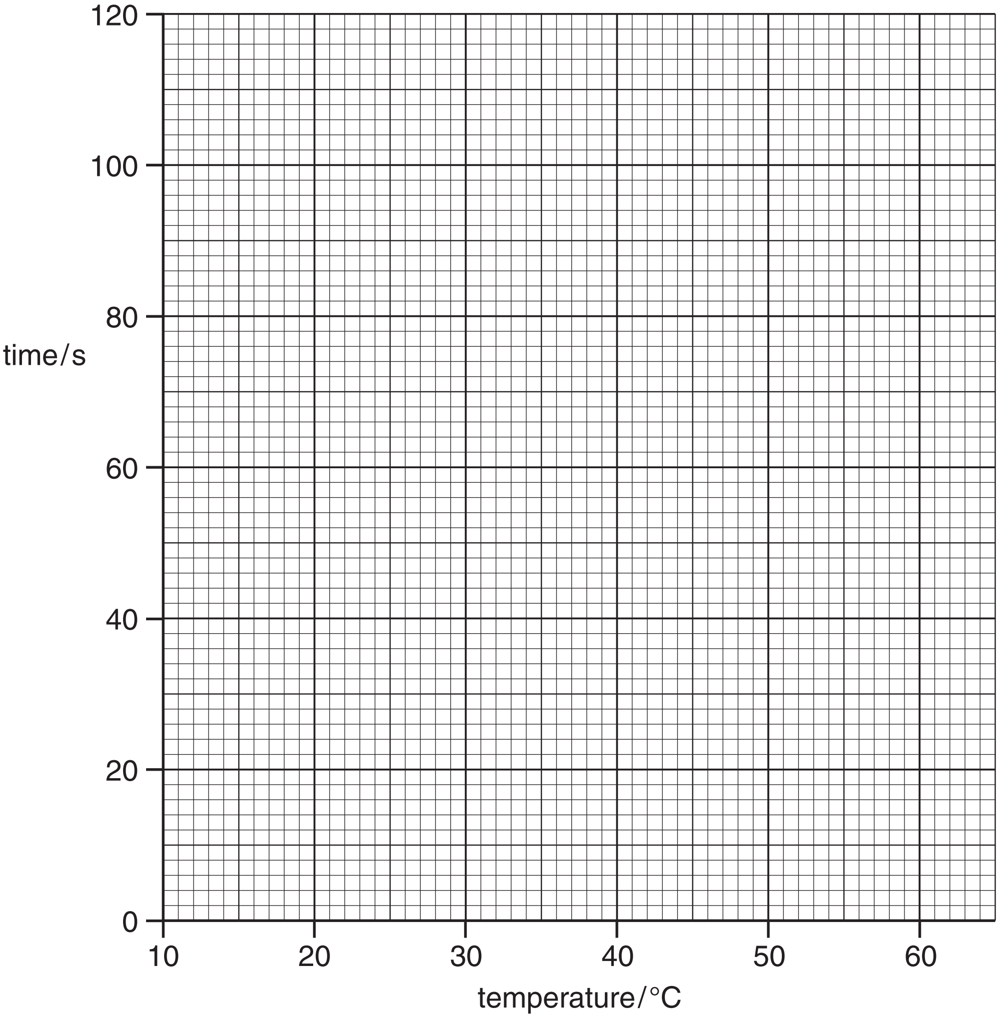


(i) Use these diagrams to complete the table below.

temperature of the mixture / °C	time / sec
20	110
	73
	48
	30
	20

[2]

(ii) Plot the results on the grid below and draw a smooth curve through the points.



[2]

(iii) Use your diagram to determine how long it would take for the cross to become invisible at 30°C.

.... s [1]

(iv) From your graph determine the temperature at which the reaction would be twice as fast as at 20 °C.

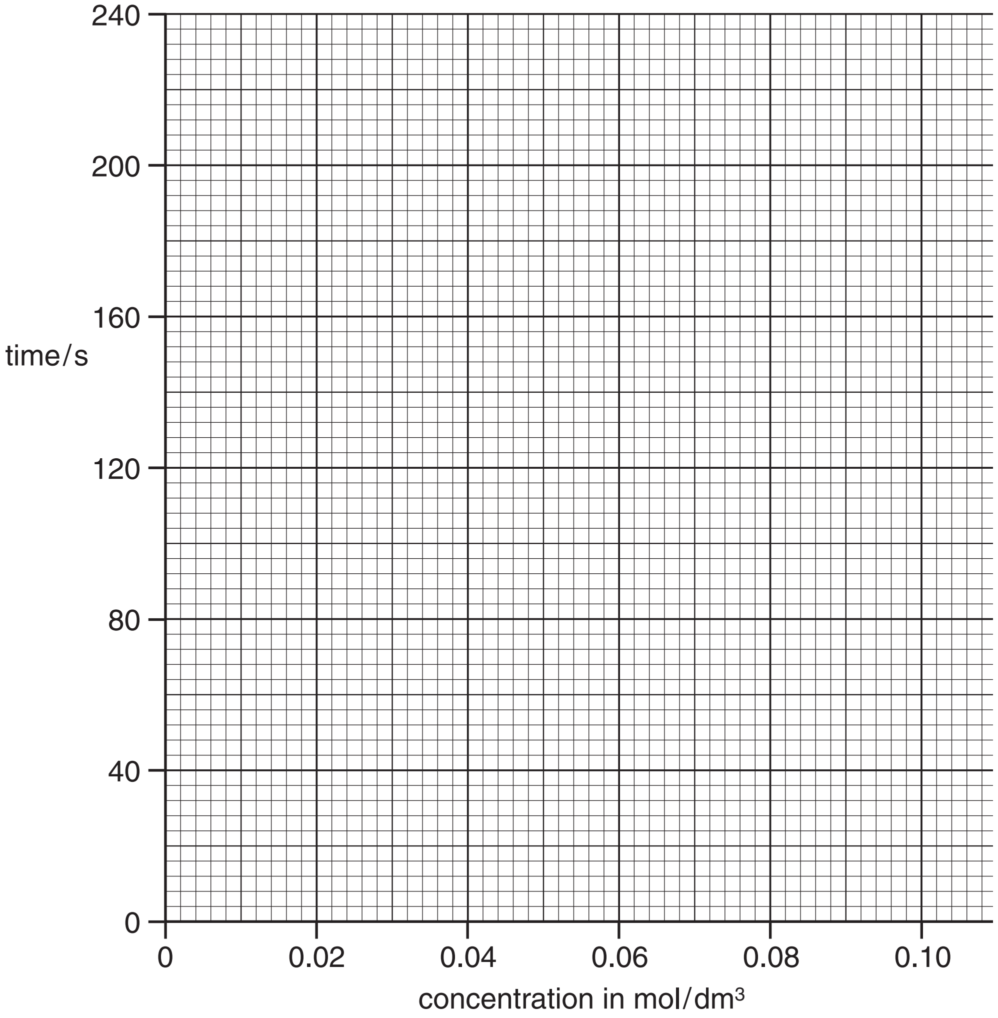
.... °C [1]

(b) Experiment **2**

5.0 cm^3 of 2.0 mol / dm^3 hydrochloric acid is added to 50 cm^3 of 0.02 mol / dm^3 sodium thiosulfate. The temperature is kept at 30 °C.
The time taken for the cross to become invisible is recorded.
The experiment is repeated four more times, keeping all volumes, concentrations and temperatures the same **except** for the concentration of sodium thiosulfate, which is altered.

concentration of sodium thiosulfate mol / dm^3	time / s
0.02	210
0.04	90
0.06	44
0.08	30
0.10	20

(i) Plot the results on the grid below and draw a smooth curve through the points.



[2]

(ii) Use your graph for Experiment **2** to determine how long it takes for the cross on the card to become invisible when the concentration of sodium thiosulfate is 0.03 mol/dm^3.

.... s [1]

(iii) Use both graphs to determine the concentration of sodium thiosulfate in the first experiment.

.... mol/dm^3 [2]

[Total: 11]

BLANK PAGE

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Ordinary Level

CANDIDATE NAME	

CENTRE NUMBER		CANDIDATE NUMBER	

1660005999

CHEMISTRY **5070/42**

Paper 4 Alternative to Practical **May/June 2010**

1 hour

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Write your answers in the spaces provided in the Question Paper.

The number of marks is given in brackets [ ] at the end of each question or part question.
At the end of the examination, fasten all your work securely together.

For Examiner's Use

This document consists of **14** printed pages and **2** blank pages.

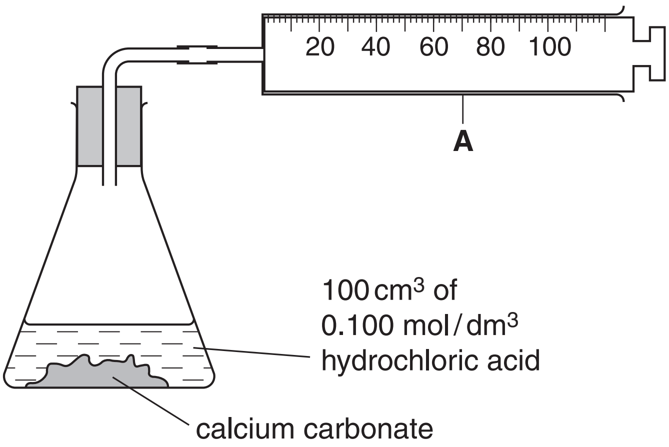
DC (LEO/KN) 21337/2

UNIVERSITY *of* CAMBRIDGE
International Examinations

1 A student added 100 cm^3 of 0.100 mol/dm^3 hydrochloric acid (an excess) to a known mass of calcium carbonate contained in a conical flask. The reaction produced carbon dioxide according to the following equation.

$$CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$$

The apparatus is shown below.



(a) Name the apparatus labelled **A**.

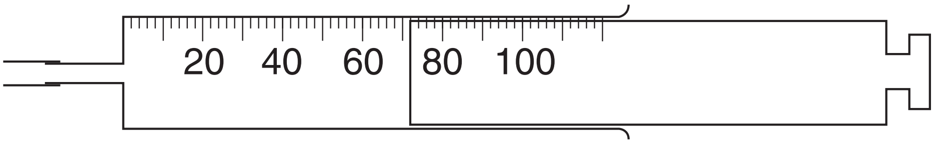
.... [1]

(b) Give a test to confirm the presence of carbon dioxide.

test ....

observation .... [1]

(c) The diagram below shows apparatus **A** at the completion of the reaction.



apparatus **A**

What volume of carbon dioxide was collected?

.... cm^3 [1]

(d) Using your answer to **(c)**, calculate the number of moles of carbon dioxide produced in the reaction.
[One mole of a gas occupies 24 000 cm^3 at room temperature and pressure.]

.... moles [1]

(e) **(i)** Using the equation for the reaction and your answer to **(d)**, suggest the number of moles of calcium carbonate that reacted with 0.100 mol/dm^3 hydrochloric acid.

.... moles [1]

(ii) Calculate the relative formula mass of calcium carbonate, $CaCO_3$.
[A_r: Ca, 40; C, 12; O, 16]

.... [1]

(iii) Using your answers to **(e)(i)** and **(ii)**, calculate the mass of calcium carbonate that reacted with 0.100 mol/dm^3 hydrochloric acid.

.... g [1]

(f) The experiment was repeated using magnesium carbonate instead of calcium carbonate. The mass of magnesium carbonate used was identical to the mass of calcium carbonate in the previous experiment.
Calculate the volume of carbon dioxide collected.
[A_r: Mg, 24; C, 12; O, 16]

.... cm^3 [2]

[Total: 9]

2 A student was given a sample of zinc and a beaker half-filled with aqueous copper(II) sulfate.

(a) Describe the appearance of

(i) zinc,

.... [1]

(ii) aqueous copper(II) sulfate.

.... [1]

When the zinc was added to the aqueous copper(II) sulfate an exothermic reaction occurred and a red solid was deposited on the base of the beaker.

(b) **(i)** How did the student know that the reaction was exothermic?

.... [1]

(ii) Name the red solid.

.... [1]

(c) Describe two **other** changes that were seen during the reaction.

1 ....

2 ....

[2]

(d) **(i)** Write an equation for the reaction between zinc and aqueous copper(II) sulfate.

.... [1]

(ii) What type of reaction is represented by this equation?

.... [1]

[Total: 8]

In questions **3** to **7** inclusive, place a tick (✓) in the box against the best answer.

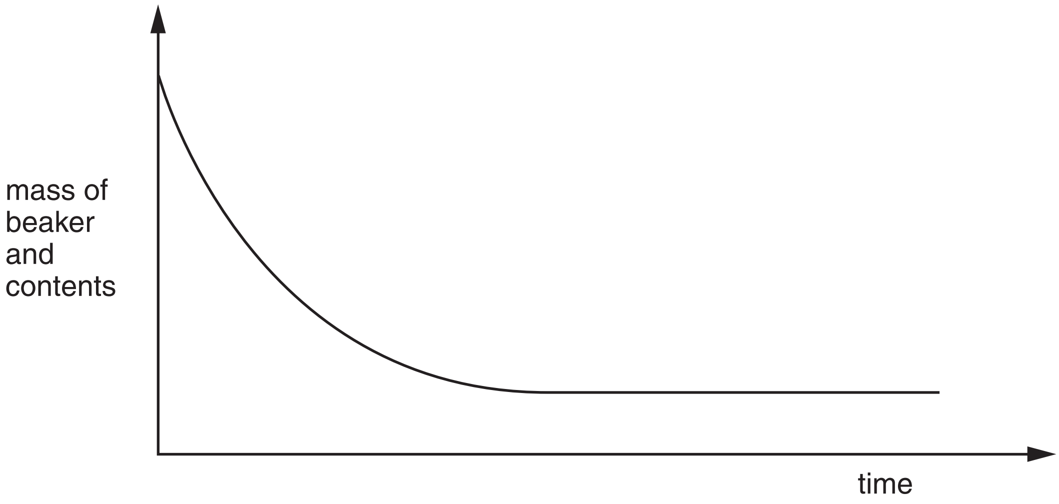
3 Which **two** of the following compounds will decolourise bromine water?

A C_2H_4
B C_2H_6
C C_3H_6
D C_3H_8

(a) **A** and **D** ☐
(b) **B** and **C** ☐
(c) **A** and **C** ☐
(d) **B** and **D** ☐ [1]

[Total: 1]

4 Two solutions were mixed in a beaker and the total mass of the beaker and contents recorded at intervals. The graph shows the results.



Which two solutions would give this graph?

(a) aqueous copper(II) sulfate and aqueous ammonia ☐
(b) aqueous sodium carbonate and dilute nitric acid ☐
(c) aqueous sodium hydroxide and aqueous zinc sulfate ☐
(d) dilute hydrochloric acid and aqueous sodium sulfate ☐ [1]

[Total: 1]

5 A small piece of each of the following metals was added to a beaker half filled with water. Which metal reacted vigorously on the surface of the water?

(a) iron ☐

(b) lead ☐

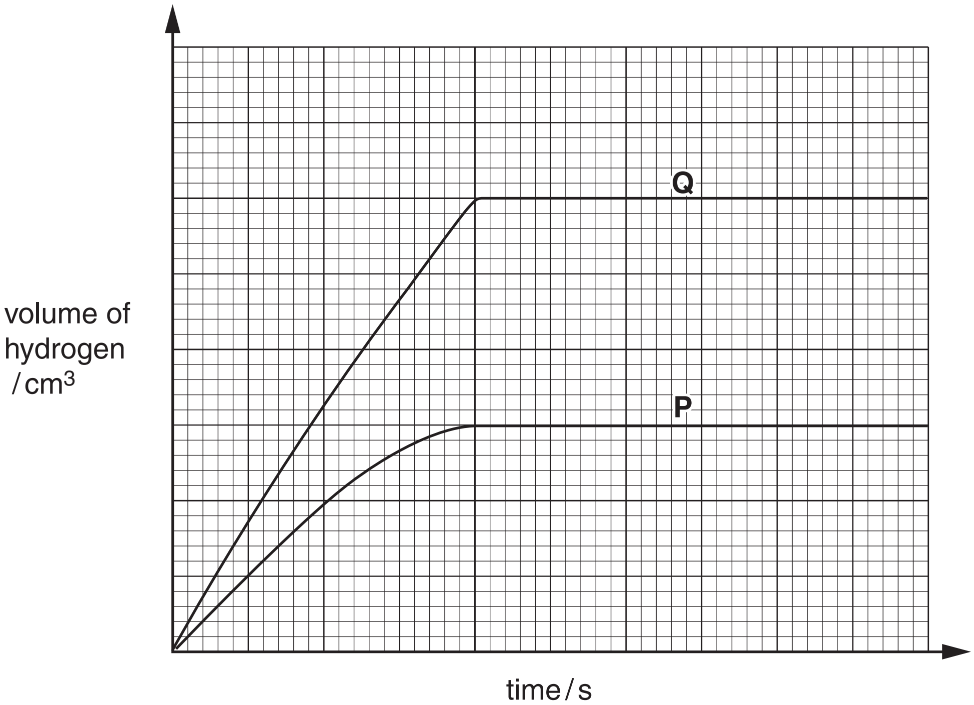
(c) sodium ☐

(d) zinc ☐ [1]

[Total: 1]

6 A student added 10.0 cm^3 of 0.100 mol/dm^3 hydrochloric acid to an excess of zinc. The volume of hydrogen produced was recorded at intervals until no more gas was produced. This was experiment **P**.
The experiment was repeated with a different acid solution, again using an excess of zinc. This was experiment **Q**.

The graphs of the two experiments are shown on the grid below.



Which acid solution would give the graph for experiment **Q**?

(a) 10 cm^3 of 0.050 mol/dm^3 hydrochloric acid ☐

(b) 10 cm^3 of 0.200 mol/dm^3 hydrochloric acid ☐

(c) 20 cm^3 of 0.100 mol/dm^3 hydrochloric acid ☐

(d) 20 cm^3 of 0.200 mol/dm^3 hydrochloric acid ☐ [1]

[Total: 1]

7 The reaction between barium chloride and sulfuric acid produces a precipitate of barium sulfate.
The equation for the reaction is

$$BaCl_2 + H_2SO_4 \rightarrow BaSO_4 + 2HCl$$

10 cm^3 of 0.100 mol/dm^3 barium chloride was added to 10 cm^3 of 0.100 mol/dm^3 sulfuric acid.
The precipitate was removed by filtration, dried and weighed.

Four more experiments were done with solutions of the same concentration.
Which experiment produced twice as much precipitate as produced in the first experiment?

(a) 10 cm^3 of $BaCl_2$ + 20 cm^3 of H_2SO_4 ☐

(b) 20 cm^3 of $BaCl_2$ + 10 cm^3 of H_2SO_4 ☐

(c) 20 cm^3 of $BaCl_2$ + 20 cm^3 of H_2SO_4 ☐

(d) 15 cm^3 of $BaCl_2$ + 15 cm^3 of H_2SO_4 ☐ [1]

[Total: 1]

8 A student was required to determine the value of x in the formula of the acid H_xA, by titrating an aqueous solution of the acid **S** with aqueous sodium hydroxide **T**.

S is 0.0450 mol/dm^3 aqueous acid, H_xA.

T is 0.0800 mol/dm^3 aqueous sodium hydroxide.

(a) 25.0 cm^3 of **T** was transferred into a conical flask.

Which piece of apparatus was used for this measurement?

.... [1]

(b) A few drops of methyl orange indicator were added.

What was the colour of the solution in the conical flask?

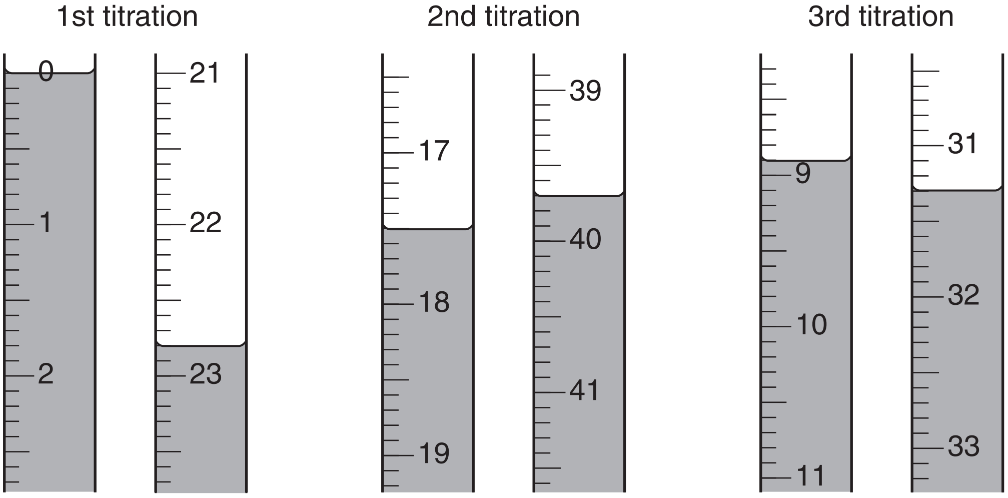
....

A burette was filled with **S**, which was run into the conical flask until an end-point was reached.

What was the colour of the solution in the flask when the end-point was reached?

.... [1]

Three titrations were done. The diagrams below show parts of the burette with the liquid levels at the beginning and end of each titration.



(c) Use the diagrams to complete the following table.

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

Summary

Tick (✓) the best titration results.
Using these results, the average volume of **S** was

.... cm^3. [4]

(d) **S** is 0.0450 mol/dm^3 H_x**A**.
Using your answer to **(c)** calculate the number of moles of acid H_x**A** in the average volume of **S**.

.... moles [1]

(e) **T** is 0.0800 mol/dm^3 sodium hydroxide.
Calculate the number of moles of sodium hydroxide in 25.0 cm^3 of **T**.

.... moles [1]

(f) Using your answers to **(d)** and **(e)** calculate the number of moles of sodium hydroxide which react with one mole of H_x**A**.

.... moles [1]

(g) Using your answer to **(f)**, deduce the value of x in the formula H_x**A**.

.... [1]

(h) **(i)** Using your answer to **(g)**, suggest the chemical formula of an acid represented by H_x**A**.

.... [1]

(ii) Write an equation for the reaction between the acid suggested in **(h)(i)** and sodium hydroxide.

[1]

[Total: 12]

9 **V** is a mixture of two compounds which together contain four ions.
The following table shows the tests a student did on **V**.
Any gas produced was tested.
Complete the table by describing the conclusion in test **(a)**, the observations in test **(b)** and the tests and observations in both **(c)** and **(d)**.

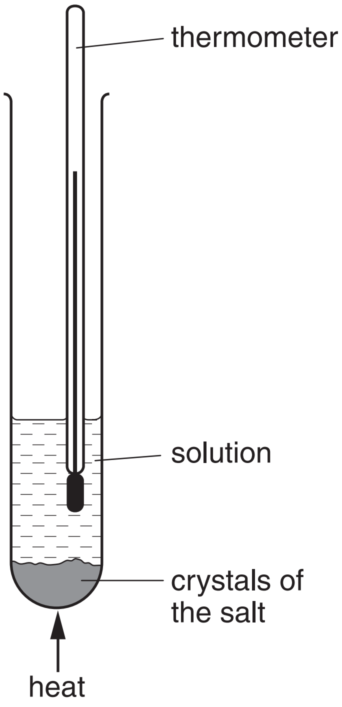
test	observations	conclusions
(a) **V** was dissolved in water and the resulting solution divided into three parts for tests **(b)**, **(c)** and **(d)**.	A coloured solution was produced.	
(b) **(i)** To the first part aqueous sodium hydroxide was added until a change was seen.		**V** may contain Fe^{2+} ions.
(ii) An excess of aqueous sodium hydroxide was added to the mixture from **(i)**.		The presence of Fe^{2+} ions in **V** is confirmed.
(iii) The mixture from **(ii)** was heated.		**V** contains NH_4^+ ions.
(c)		**V** contains SO_4^{2-} ions.
(d)		**V** contains Cl^- ions.

Suggest the formula for each of two compounds which could have been used to make up **V**.

.... and ....

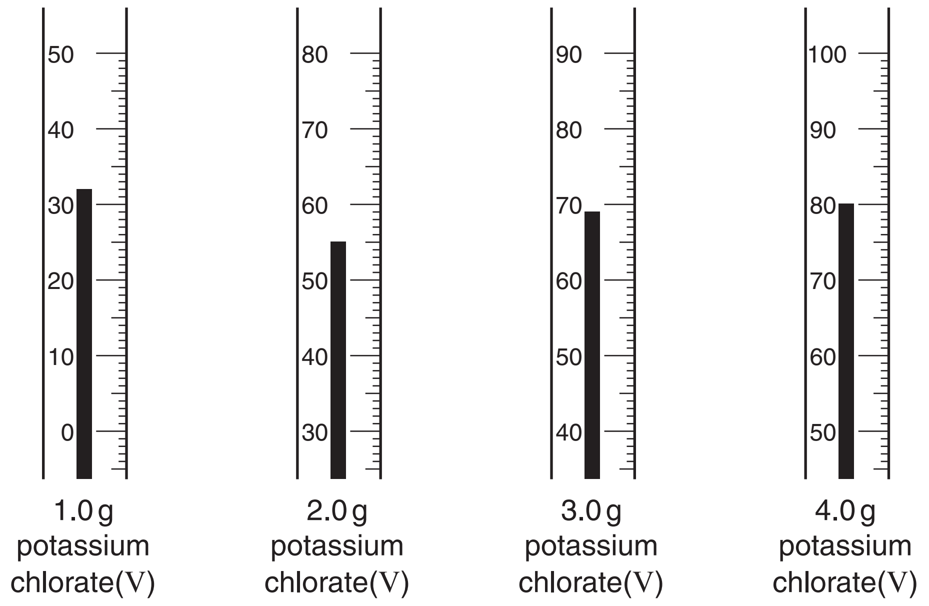
[Total: 13]

10 A student investigated the solubility in water of two salts, potassium chlorate(V) and sodium chloride.
She used the apparatus shown below.



10 g of water was transferred into a boiling-tube. To this 0.5 g of potassium chlorate(V) was added.
The tube and its contents were heated until all the solid dissolved. The tube was allowed to cool.
At the first sign of solid reappearing the temperature was noted.
The experiment was repeated using 1.0, 2.0, 3.0 and 4.0 g of potassium chlorate(V).

The diagrams below show parts of the thermometer stems giving the temperature at which the solid appeared.



(a) Use the thermometer readings to complete the following table.

mass of potassium chlorate(V) in 10 g of water /g	0.5	1.0	2.0	3.0	4.0
temperature at which potassium chlorate(V) appears / °C	10				

[2]

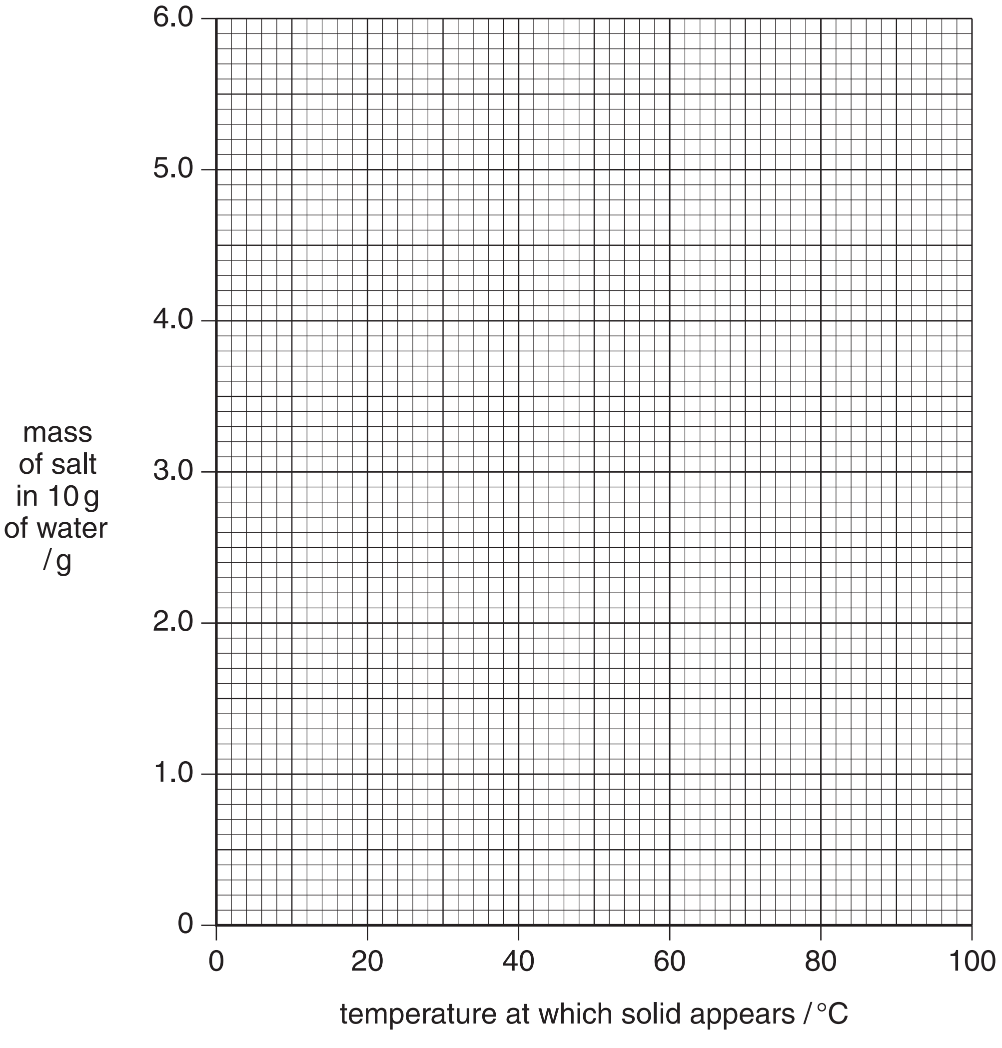
The experiment was repeated using sodium chloride, the results for which are shown in the following table.

mass of sodium chloride in 10 g of water /g	2.7	3.0	3.2	3.4
temperature at which sodium chloride appears/ °C	10	34	50	66

(b) Plot the results for both potassium chlorate(V) and sodium chloride on the grid below.

Join the points for potassium chlorate(V) with a smooth curve and those for sodium chloride with a straight line.

Extend each line in both directions so that at the lower ends each line crosses the vertical axis and at the upper ends the lines cross.



[4]

Use your graphs to answer the following questions.

(c) What is the mass of each compound that dissolves in 10 g of water at 0 °C?

(i) potassium chlorate(V)

.... g [1]

(ii) sodium chloride

.... g [1]

(d) At what temperature is the solubility of each salt the same?

....°C [1]

(e) The solubility of a salt is defined as the maximum mass of salt that will dissolve in 100 g of water at a given temperature.

Calculate the solubility of both potassium chlorate(V) and sodium chloride at the temperature you have given in **(d)**.

.... g [1]

(f) The student was given two boiling-tubes, one containing 2.0 g of potassium chlorate(V) in 10.0 g of water, the other 2.0 g of sodium chloride in 10.0 g of water, both at a temperature of 40 °C.
The mixtures were stirred.
Use the information on your graph to describe the contents of each tube.

potassium chlorate(V) ....

....

sodium chloride ....

....
[2]

(g) By referring to your graphs compare the effect of increasing the temperature on the solubility of each salt.

....

.... [1]

[Total: 13]

BLANK PAGE

BLANK PAGE

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Ordinary Level

CANDIDATE NAME			
CENTRE NUMBER		CANDIDATE NUMBER	

9870939960

CHEMISTRY **5070/42**

Paper 4 Alternative to Practical **October/November 2010**

1 hour

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Write your answers in the spaces provided in the Question Paper.
At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use

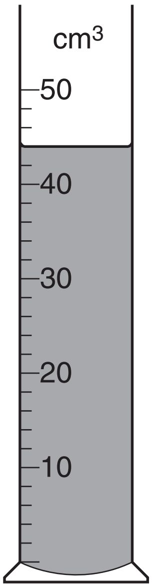
This document consists of **15** printed pages and **1** blank page.

DC (LEO/KN) 21338/3

UNIVERSITY of CAMBRIDGE International Examinations

[Turn over

1 The apparatus below contains 0.100 mol/dm^3 sulfuric acid.



(a) **(i)** Name the apparatus.

.... [1]

(ii) What is the volume of 0.100 mol/dm^3 sulfuric acid?

.... cm^3 [1]

(iii) Using your answer to **(a)(ii)**, calculate the number of moles of 0.100 mol/dm^3 sulfuric acid.

.... moles [1]

(b) **(i)** The sulfuric acid was poured into a beaker and 0.12 g of magnesium was added. The magnesium reacted with the sulfuric acid and hydrogen was produced.

How many moles of magnesium were added?
[A_r: Mg, 24]

.... moles [1]

(ii) Write the equation for the reaction between magnesium and sulfuric acid.

.... [1]

(iii) Using your answers to **(a)(iii)**, **(b)(i)** and **(b)(ii)**, suggest which reagent was in excess, magnesium or sulfuric acid?
Explain your answer.

.... [1]

(c) **(i)** Give a positive test for hydrogen gas.

test ....

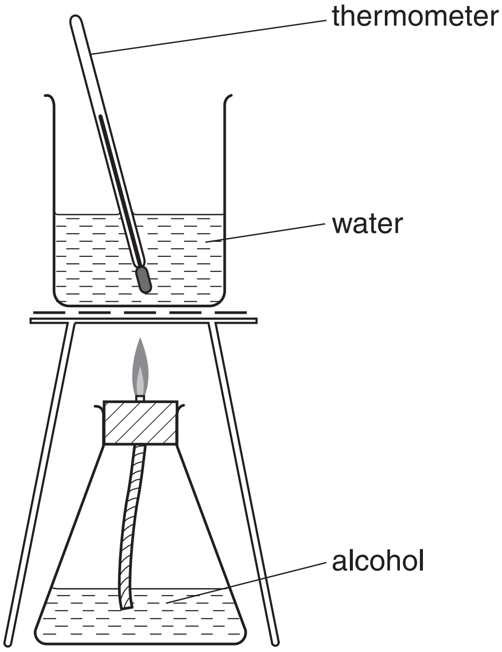
observation .... [1]

(ii) Calculate the volume of hydrogen gas produced in this reaction.
[1 mol of a gas measured at 25 °C occupies a volume of 24 dm^3.]

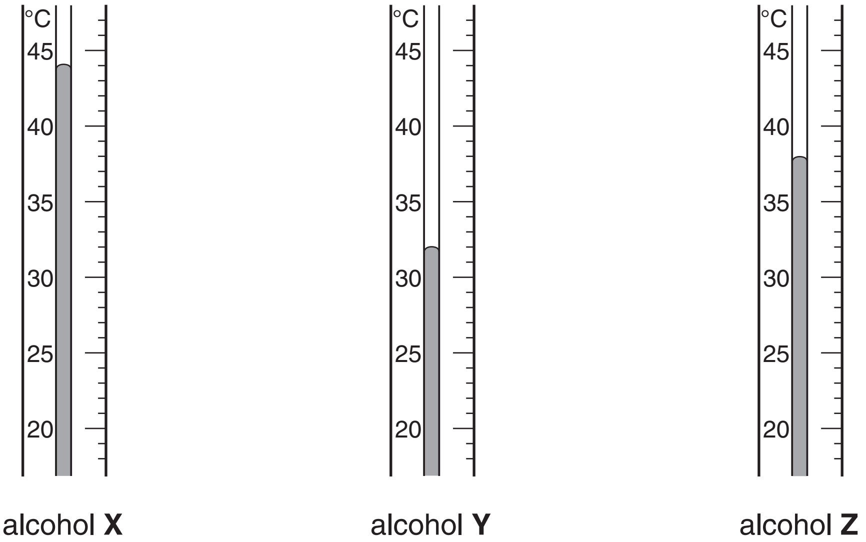
.... dm^3 [1]

[Total: 8]

2 A student used the apparatus shown below to find the energy released by the combustion of each of the alcohols, **X**, **Y** and **Z**.



(a) (i) The initial temperature of the water was, in each case, 20 °C.
The diagrams below show parts of the thermometer stem giving the temperature of the water after the burning of each alcohol.



Use the thermometer readings to complete the following table and calculate the rise in temperature for each alcohol.

	alcohol **X**	alcohol **Y**	alcohol **Z**
final temperature / °C			
initial temperature / °C	20	20	20
rise in temperature / °C			

[3]

(ii) How do these results show that all the reactions are exothermic?

.... [1]

The three alcohols are ethanol, C_2H_5OH, propanol, C_3H_7OH, and butanol, C_4H_9OH.
In each case 0.01 mol of alcohol was burnt.

(b) Deduce which alcohol is **X**, **Y**, and **Z**.

alcohol **X** is ....

alcohol **Y** is ....

alcohol **Z** is .... [2]

(c) **(i)** The student oxidised one of the alcohols to prepare an acid of formula $C_2H_5CO_2H$.

Which alcohol was used?

.... [1]

(ii) Suggest both the name of an oxidising agent that could be used and the colour change of the mixture that is seen during the reaction.

oxidising agent ....

the colour changes from .... to .... [2]

(d) **(i)** Which alcohol was reacted with the acid $C_2H_5CO_2H$ to produce $C_2H_5CO_2C_4H_9$?

.... [1]

(ii) What type of compound is $C_2H_5CO_2C_4H_9$?

.... [1]

[Total: 11]

In questions **3** to **7** inclusive, place a tick (✓) in the box against the best answer.

3 A student sterilised a sample of water by bubbling a gas through it.

The gas was

(a) carbon dioxide ☐

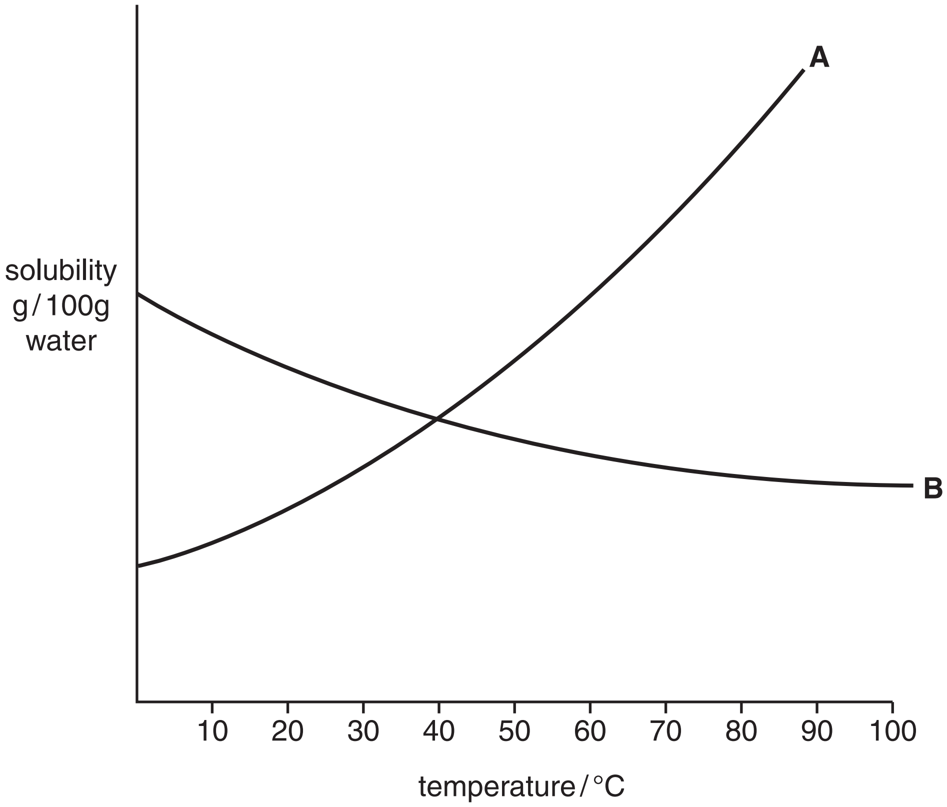
(b) chlorine ☐

(c) ethane ☐

(d) nitrogen ☐ [1]

[Total: 1]

4 A student did two experiments to find how the solubility of salts **A** and **B** varied with temperature. The results are shown on the graph below.



Which one of the following conclusions is correct?

(a) **A** is more soluble than **B** at all temperatures. ☐

(b) **B** is more soluble than **A** below 40 °C. ☐

(c) **A** is less soluble than **B** above 40 °C. ☐

(d) The solubility of both salts increases with increasing temperature. ☐ [1]

[Total: 1]

5 A student prepared some salts by adding two chemicals together. Which of the following produced a salt which could be collected as a residue by filtration?

(a) aqueous barium chloride and aqueous sulfuric acid ☐

(b) aqueous potassium hydroxide and aqueous nitric acid ☐

(c) solid copper(II) carbonate and aqueous hydrochloric acid ☐

(d) aqueous calcium chloride and aqueous potassium nitrate ☐ [1]

[Total: 1]

6 In an experiment to find the formula of the oxide of element *M*, 2.0 g of the element was burnt in oxygen.
The mass of metal oxide obtained was 2.8 g.
[A_r: *M*, 40; O,16]

What was the formula of the metal oxide?

(a) M_2O ☐

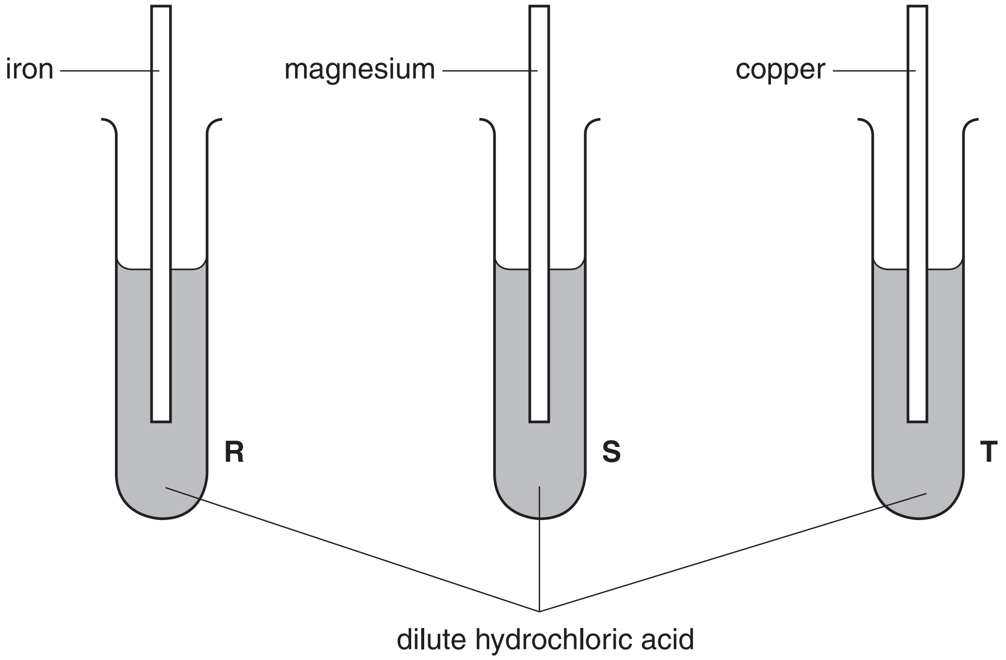
(b) MO ☐

(c) MO_2 ☐

(d) MO_3 ☐ [1]

[Total: 1]

7 Strips of different metals were placed in test-tubes half-filled with dilute hydrochloric acid.



In which test-tubes was hydrogen gas produced?

(a) **R** and **S** only ☐

(b) **R** and **T** only ☐

(c) **S** and **T** only ☐

(d) **R** and **S** and **T** ☐ [1]

[Total: 1]

8 A student was given a sample of an organic acid **V** and asked to

- determine its relative molecular mass, and
- suggest its molecular formula.

A sample of **V** was placed in a previously weighed container and reweighed.

mass of container + **V** = 9.06 g
mass of container = 5.94 g

(a) Calculate the mass of **V** used in the experiment.

.... g [1]

The student transferred the sample of **V** to a beaker and added 50.0 cm^3 of 1.00 mol/dm^3 sodium hydroxide, an excess.
The contents of the beaker were allowed to react and then transferred to a volumetric flask. The solution was made up to 250 cm^3 with distilled water. This was solution **W**.

25.0 cm^3 of **W** was transferred into a conical flask.

A few drops of phenolphthalein indicator were added to the flask.
0.100 mol/dm^3 hydrochloric acid was poured into a burette and added to the solution in the conical flask until an end-point was reached.
Phenolphthalein is colourless in acid solution and pink in alkaline solution.

(b) What was the colour of the solution in the conical flask

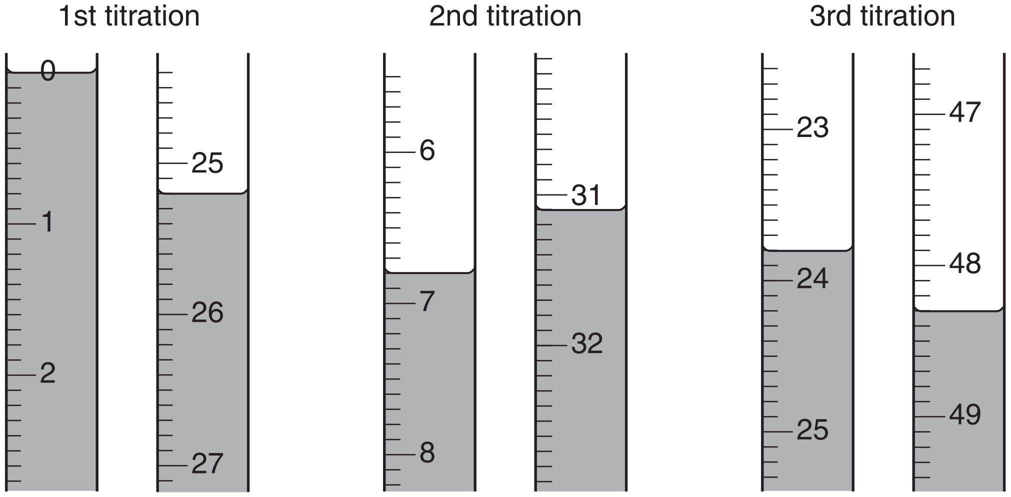
(i) before the hydrochloric acid was added,

....

(ii) at the end-point?

.... [1]

Three titrations were done. The diagrams below show parts of the burette with the liquid levels at the beginning and the end of each titration.



(c) Use the diagrams to complete the following table.

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

Summary

Tick (✓) the best titration results.
Using these results, the average volume of hydrochloric acid was

.... cm^3. [4]

(d) Calculate the number of moles of hydrochloric acid in the average volume of 0.100 mol/dm^3 hydrochloric acid calculated in **(c)**.

.... moles [1]

(e) Hydrochloric acid reacts with sodium hydroxide according to the following equation.

$$HCl + NaOH \longrightarrow NaCl + H_2O$$

Deduce the number of moles of sodium hydroxide present in 25.0 cm^3 of **W**.

....moles [1]

(f) Using your answer to **(e)**, calculate the number of moles of sodium hydroxide in 250 cm^3 of **W**.

.... moles [1]

(g) Calculate the number of moles of sodium hydroxide in 50.0 cm^3 of 1.00 mol/dm^3 sodium hydroxide.

.... moles [1]

(h) By subtracting your answer in **(f)** from your answer in **(g)**, calculate the number of moles of sodium hydroxide that reacted with the original sample of the organic acid, **V**.

.... moles [1]

(i) Given that **one** mole of **V** reacted with **one** mole of sodium hydroxide, calculate the number of moles of **V** in the sample.

.... moles [1]

(j) Using your answers to **(a)** and **(i)** calculate the relative molecular mass of the acid **V**.

.... [1]

(k) The acid **V** has the formula $C_nH_5CO_2H$, where **n** is a whole number.

Deduce the value of **n** and hence write the formula of acid **V**.
[A_r: C,12; O,16; H,1]

n ....

formula for **V** .... [2]

[Total: 15]

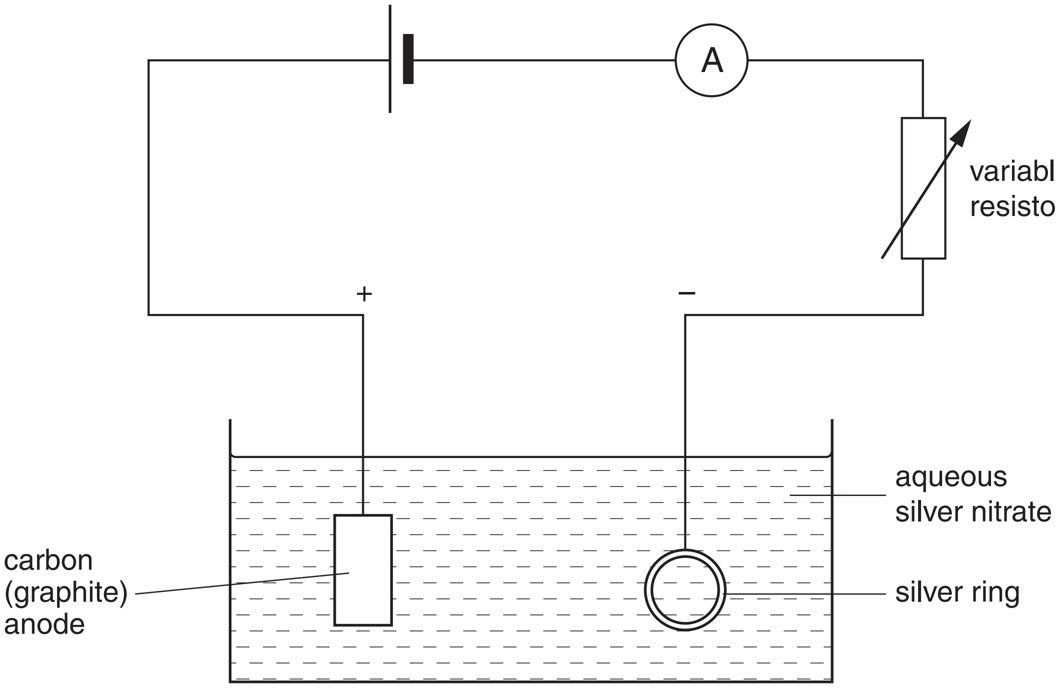
9 The following table shows the tests a student did on compound **H**. Any gas produced was tested.
Complete the table by describing the observations in tests **(a)**, **(b)** and **(c)** and the test and observations in test **(d)**.

test	observations	conclusions
(a) **H** was dissolved in water and the solution divided into three parts for tests **(b)**, **(c)** and **(d)**.		**H** is a compound of a transition element.
(b) **(i)** To the first part aqueous sodium hydroxide was added until a change was seen. **(ii)** An excess of aqueous sodium hydroxide was added to the mixture from **(i)**.		**H** may contain Cu^{2+} ions.
(c) **(i)** To the second part aqueous ammonia was added until a change was seen. **(ii)** An excess of aqueous ammonia was added to the mixture from **(i)**.		The presence of Cu^{2+} ions is confirmed.
(d)		**H** contains NO_3^- ions.

Conclusion: the formula of compound **H** is ....

[Total: 10]

10 A student plated a silver ring using the apparatus shown below.



The ring, which was the cathode, was weighed before it was placed in the aqueous silver nitrate. The circuit was completed and a current of 1.0 A was allowed to flow.

The ring was removed every ten minutes, washed, dried and weighed before being returned to the solution and reconnected to the circuit.
This was experiment **1**.

The experiment was repeated using a current of 1.5 A. This was experiment **2**.

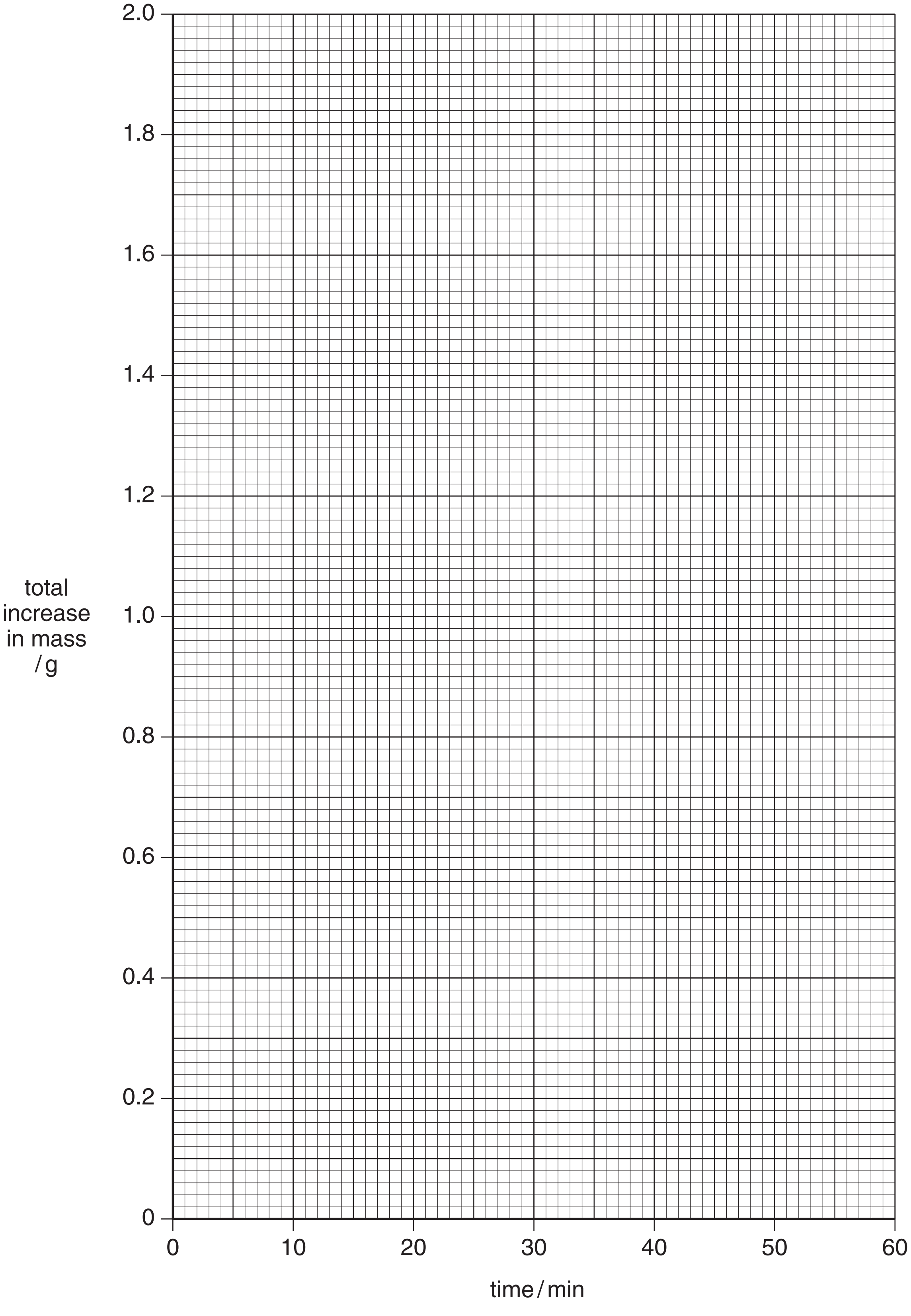
The results from both experiments are shown in the table below.

(a) Complete the table by calculating the total increase in mass after each ten minute period in both experiments.

	experiment **1**		experiment **2**	
	current 1.0 A		current 1.5 A	
time / mins	mass of ring / g	total increase in mass / g	mass of ring / g	total increase in mass / g
0	8.80	0.00	8.80	0.00
10	9.10	0.30	9.20	0.40
20	9.40	0.60	9.60	
30	9.70		10.00	
40	10.00		10.40	
50	10.30		10.40	

[1]

(b) Plot the two sets of results on the grid below. Join the points in experiment **1** by a straight line and the points in experiment **2** by two intersecting straight lines. Label the lines **1** and **2** corresponding to the two experiments.



[4]

(c) What was the time taken to deposit 1.00 g of silver in each experiment?

1 .... mins [1]

2 .... mins [1]

(d) Calculate how much more silver was deposited after 35 minutes in experiment **2** than in experiment **1**.

mass of silver deposited in 35 minutes in **2** .... g

mass of silver deposited in 35 minutes in **1** .... g

difference in mass = ... g [2]

(e) The results for experiment **2** indicate that all the silver had been deposited after 40 minutes. By extending your line for experiment **1** suggest, after how many minutes, all the silver had been deposited in this experiment.

.... mins [1]

(f) Suggest what change should be made to the experiment so that more silver could be deposited on the ring.

.... [1]

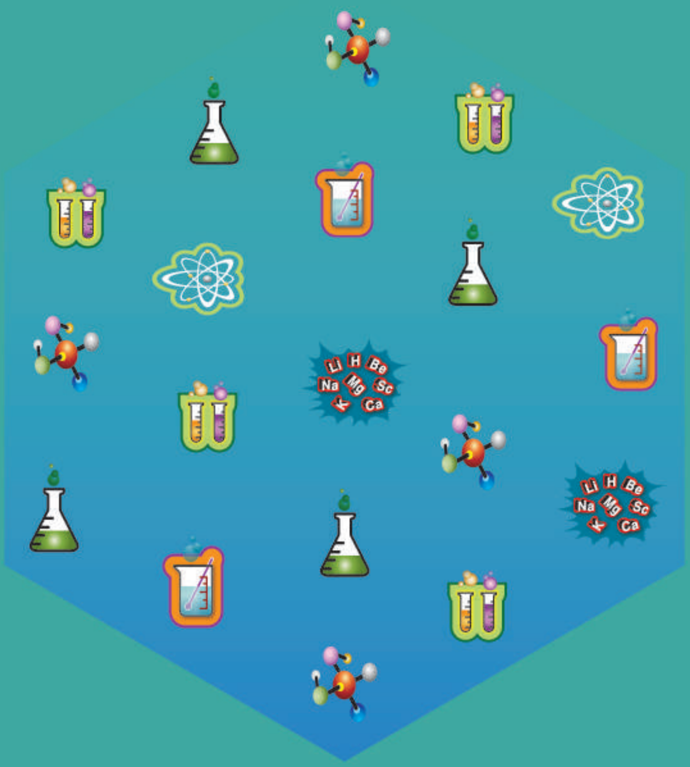
[Total: 11]

BLANK PAGE

Cambridge International O Level Chemistry

Question Papers

Paper #4



catadu.com

Non-traditional blended
learning institute.