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 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.

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1 Iron(II) sulfate crystals have the formula $FeSO_4.xH_2O$, 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.

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..... 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]

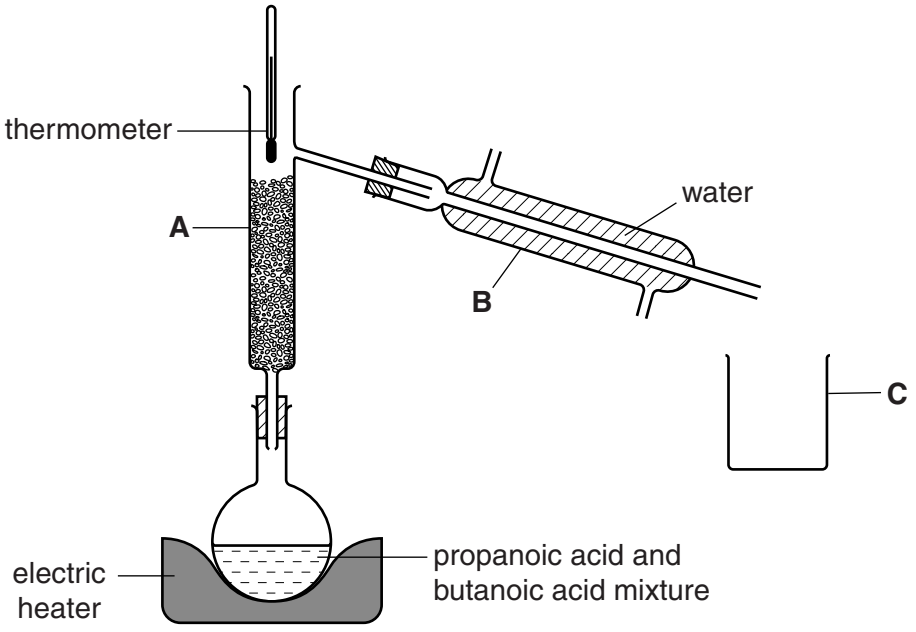
(iii) Suggest an oxidising agent that can be used and the colour change seen during the course of the reaction in **(ii)**.

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.

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(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.

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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. ☐

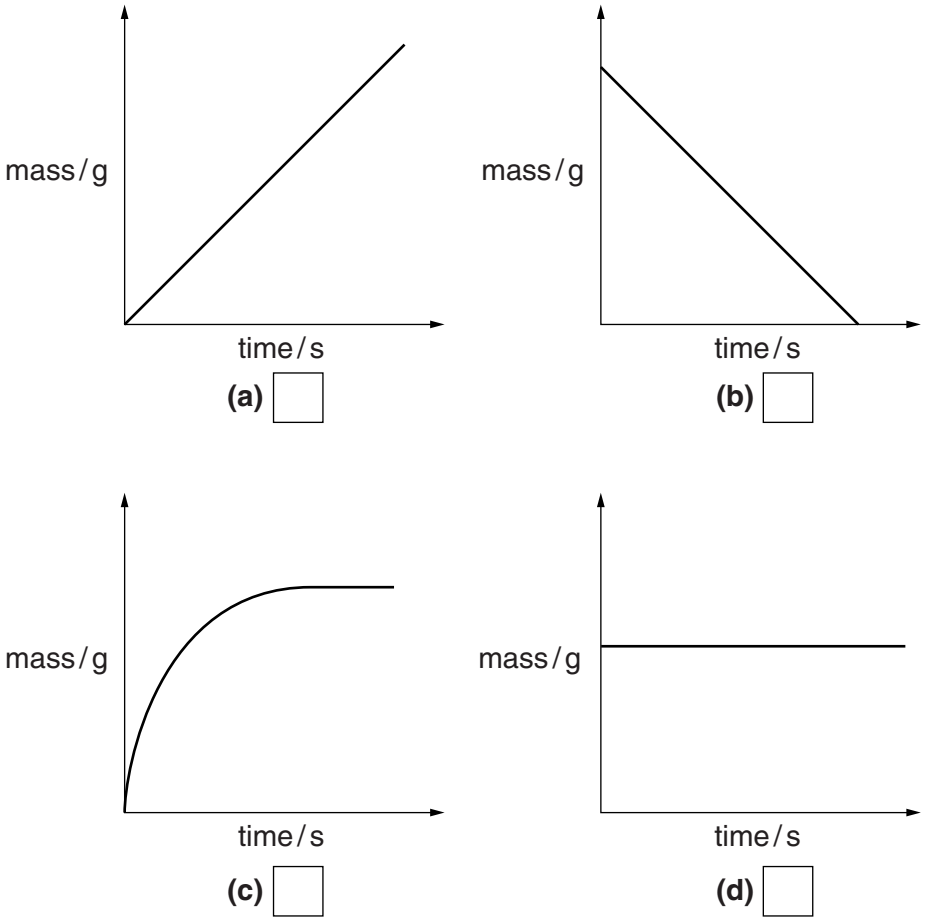
(d) It is produced at the cathode during the electrolysis of aqueous sodium chloride. ☐

[Total:1]

5 Manganese(IV) oxide, MnO_2, is used as a catalyst in the decomposition of hydrogen peroxide.

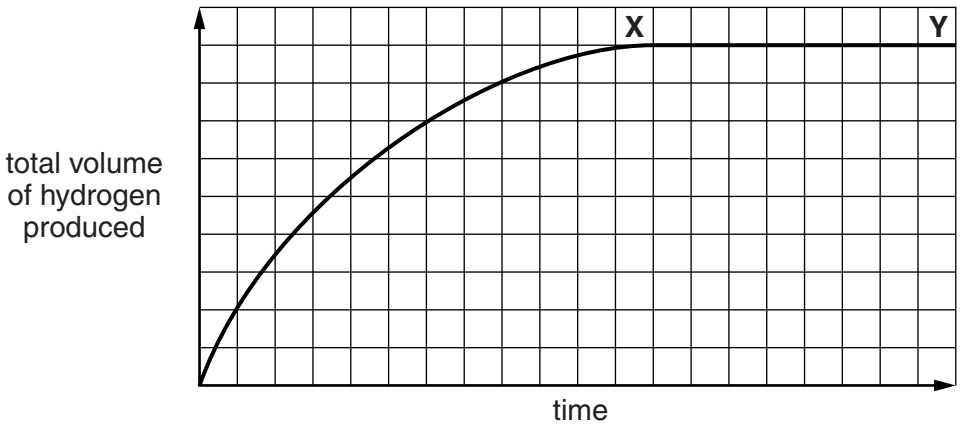
$$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$$

Which graph is obtained when the mass of manganese(IV) oxide is plotted against time as the decomposition progresses?



[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, **R**CO_3.
She is asked to determine the relative atomic mass of **R** and suggest its identity.

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(a) A sample of the metal carbonate is added to a previously weighed container which is then reweighed.

mass of container + **R**CO_3 = 12.01 g
mass of container = 10.97 g

Calculate the mass of **R**CO_3 used in the experiment.

..... g [1]

(b) The student transfers the sample of **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.

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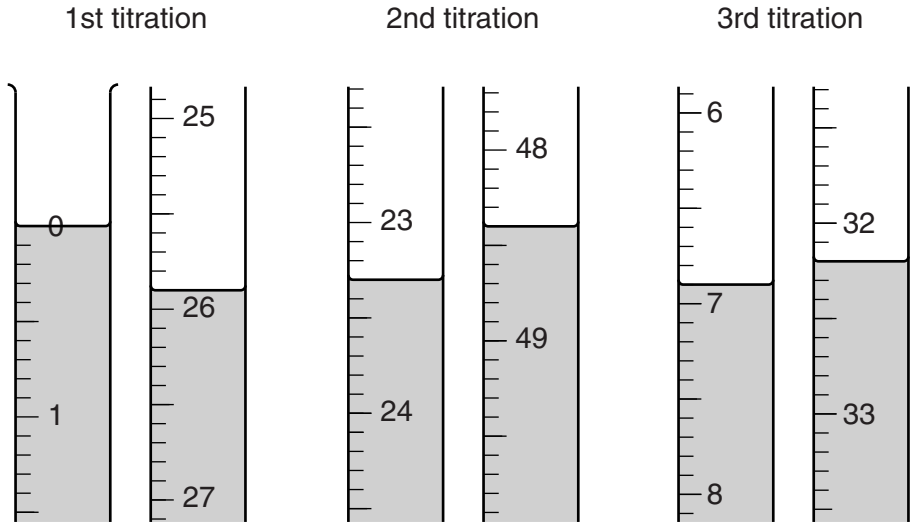

Use the diagrams to complete the following table.

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**.

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..... 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)**.

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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.	white precipitate	
(ii) An excess of aqueous sodium hydroxide is added to the mixture from **(i)**.	the precipitate dissolves	
(c) **(i)** To the second part, aqueous ammonia is added until a change is seen.	white precipitate	
(ii) An excess of aqueous ammonia is added to the mixture from **(i)**.	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.

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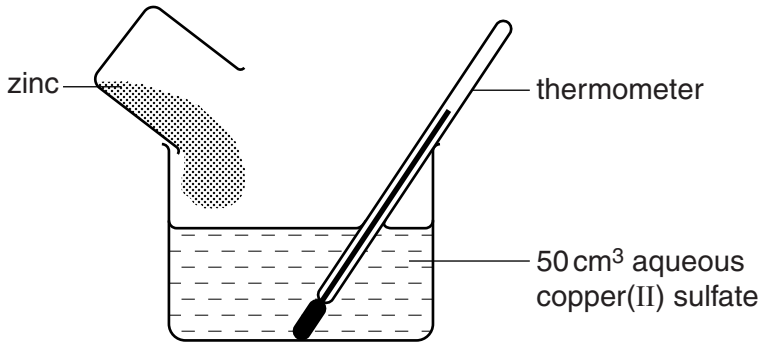
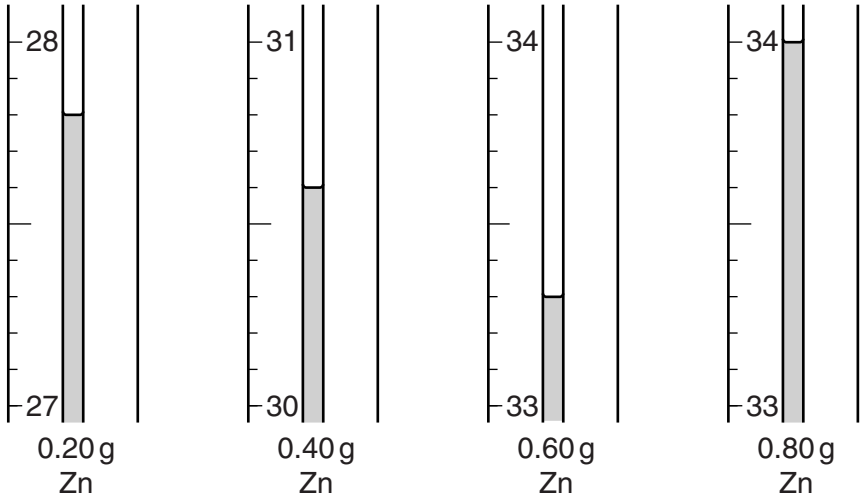
In each case the initial temperature of the aqueous copper(II) sulfate is 25.0 °C.



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.

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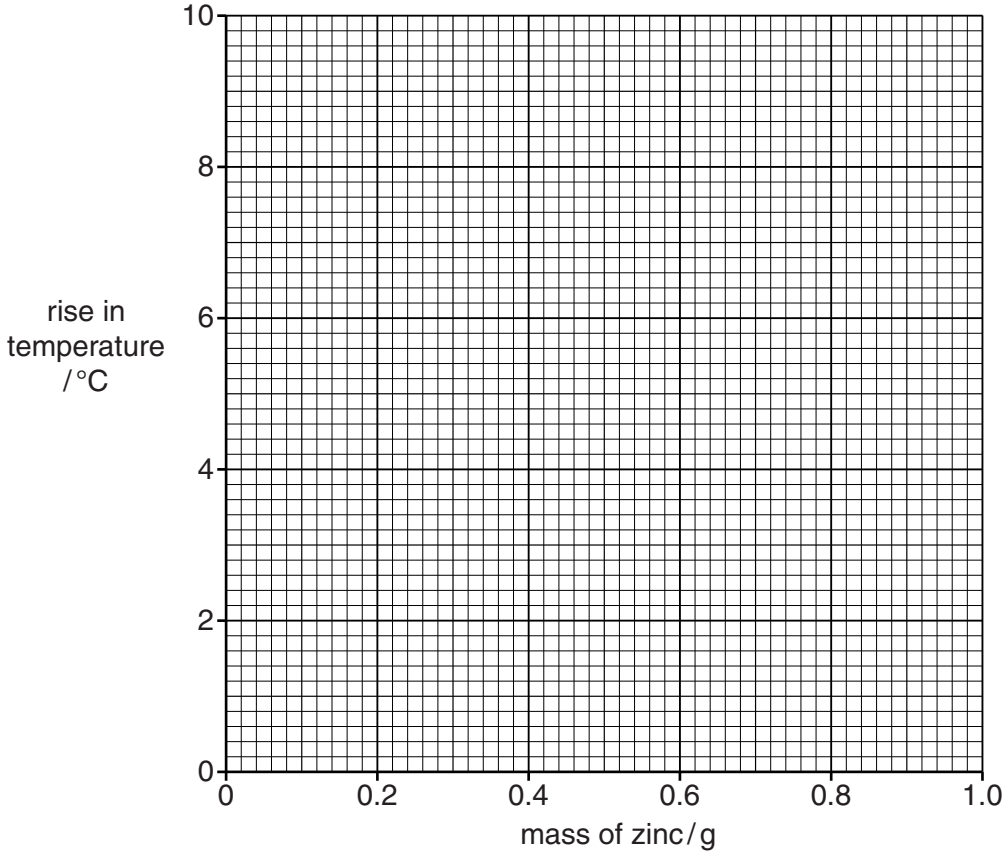

[3]

(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.

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.....

.....[2]

[Total: 12]