UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Ordinary Level

CANDIDATE NAME	

CENTRE NUMBER						CANDIDATE NUMBER					

CHEMISTRY **5070/41**

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.

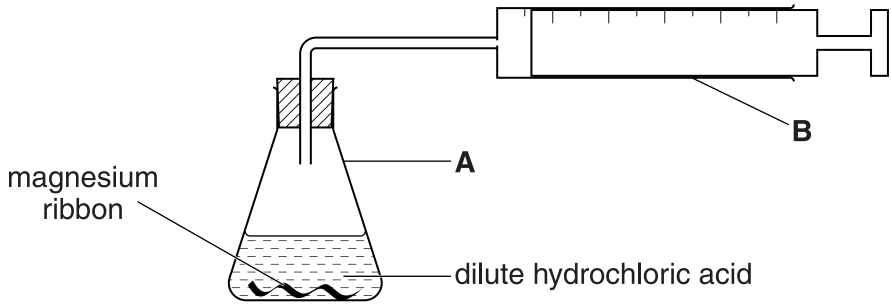
This document consists of **15** printed pages and **1** blank page.

DC (SJF/CGW) 58060/4

UNIVERSITY of CAMBRIDGE International Examinations

For Examiner's Use

1 A student adds a known mass of magnesium ribbon to 100 cm^3 of dilute hydrochloric acid (an excess) in the apparatus shown below. Hydrogen gas is evolved. The time taken to collect 48 cm^3 of gas at room temperature and pressure is measured.



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

.... [1]

(ii) Name apparatus **B**.

.... [1]

(b) **(i)** Calculate the number of moles of hydrogen in the 48 cm^3 of gas.

[1 mole of any gas occupies 24 000 cm^3 at room temperature and pressure.]

.... moles [1]

(ii) Use the equation below to deduce the mass of magnesium used in the experiment to produce 48 cm^3 of hydrogen at room temperature and pressure.

[A_r: Mg, 24]

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

.... g [1]

(c) Give a test for hydrogen gas.

.... [1]

(d) What is the effect on the **time** taken to collect the same volume of gas if,

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(i) large lumps of the same mass of magnesium are used instead of magnesium ribbon,

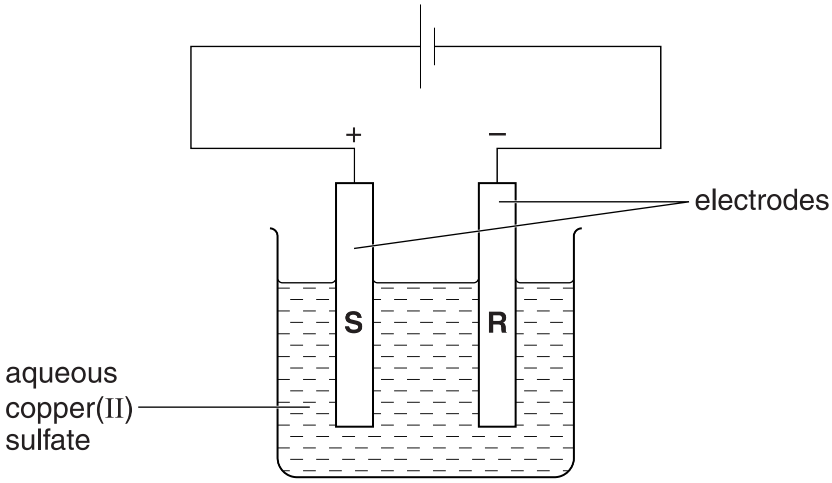
.... [1]

(ii) the reaction is carried out at a higher temperature?

.... [1]

[Total: 7]

2 **(a)** A student investigates the electrolysis of aqueous copper(II) sulfate using graphite electrodes and the apparatus shown below.



(i) What is observed at electrode **R**?

.... [1]

(ii) Construct the equation for the reaction taking place at electrode **R**.

.... [1]

(iii) When graphite electrodes are used a colour change is seen in the solution.

What is this colour change? Explain why it happens.

....

....

.... [2]

(iv) When graphite electrodes are used, a gas is evolved at one of the electrodes. Name the gas and give a test for the gas.

name ....

test ....

[2]

(v) If the graphite electrodes are replaced with copper electrodes, no colour change is seen on electrolysis of the solution. Explain why.

....

.... [1]

(b) The student does more experiments using the apparatus in **(a)** with **graphite** electrodes but, in each case, using a different electrolyte.

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Complete the table below.

electrolyte	product at the anode (+ electrode)	observations at the anode (+ electrode)	product at the cathode (– electrode)	observations at the cathode (– electrode)
(i) dilute sulfuric acid		bubbles of colourless gas		
(ii) concentrated aqueous potassium iodide				bubbles of colourless gas
(iii) molten lead bromide				silvery grey liquid

[9]

[Total: 16]

In questions **3** to **7** inclusive place a tick (✓) in the box against the correct answer.

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3 A compound contains 0.48 g of carbon, 0.08 g of hydrogen and 0.64 g of oxygen.

[A_r: H, 1; C, 12; O, 16]

What is the empirical formula of the compound?

(a) CHO ☐

(b) CHO_2 ☐

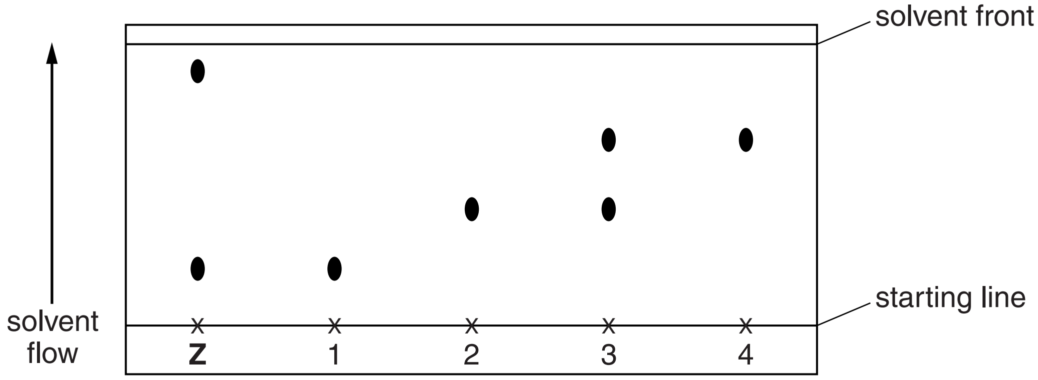
(c) CH_2O ☐

(d) CH_2O_2 ☐

[Total: 1]

4 A student does a chromatography experiment to identify the components of **Z**, a sample of ink containing a mixture of coloured dyes.

The chromatogram below contains a sample of **Z** as well as individual dyes, which are labelled 1, 2, 3 and 4.



Z contains

(a) dyes 1 and 2. ☐

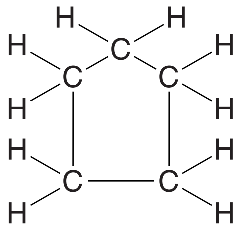
(b) dyes 1 and 3. ☐

(c) dyes 2 and 4. ☐

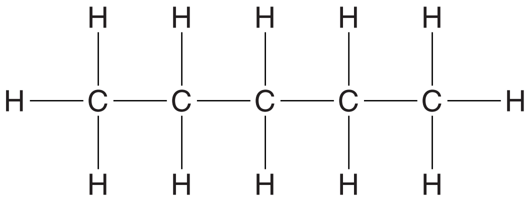
(d) dye 1 plus a dye which cannot be identified from the experiment. ☐

[Total: 1]

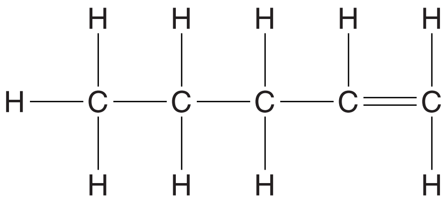
5 Which two of the following compounds are isomers?



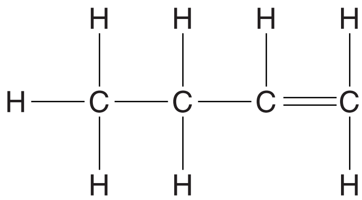
A



B



C



D

(a) **A** and **B** ☐

(b) **B** and **C** ☐

(c) **C** and **D** ☐

(d) **A** and **C** ☐

[Total: 1]

6 Which of the following mixtures produces an ester?

(a) propanoic acid, potassium dichromate(VI), sulfuric acid ☐

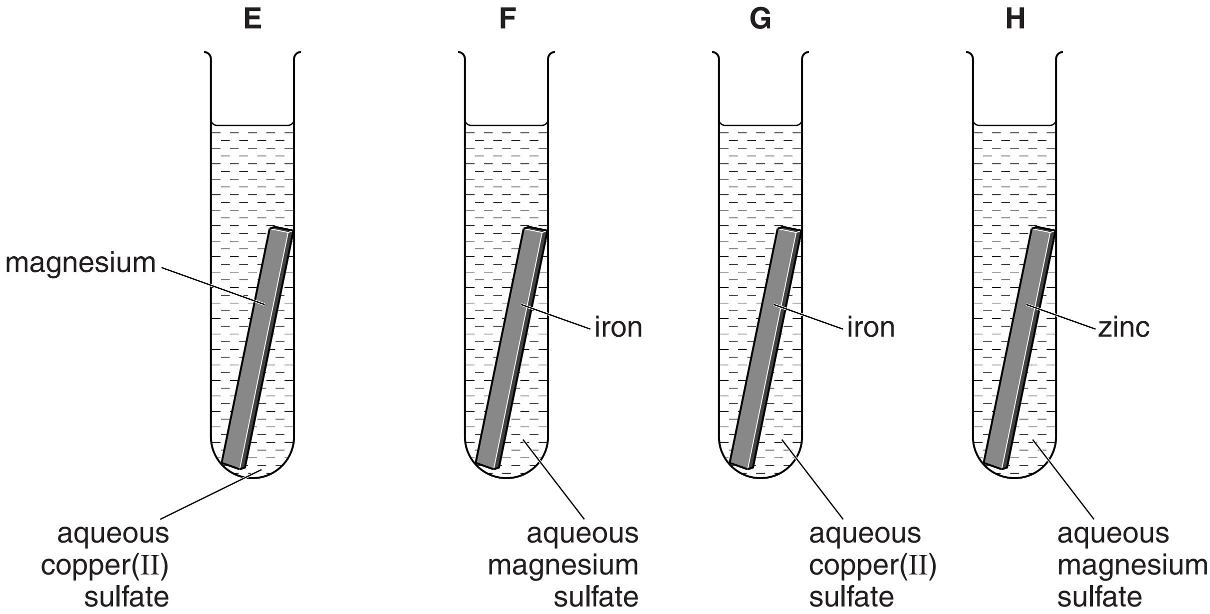
(b) ethanol, potassium dichromate(VI), sulfuric acid ☐

(c) ethanol, propanoic acid, sulfuric acid ☐

(d) ethanol, propanol, sulfuric acid ☐

[Total: 1]

7 A student sets up four test-tubes as shown in the diagram.



In which of the test-tubes would a displacement reaction take place?

(a) **E** only ☐

(b) **E** and **F** ☐

(c) **E** and **G** ☐

(d) **F**, **G** and **H** ☐

[Total: 1]

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8 A student does an experiment to determine the numerical value of **x** in the compound KIO_x. A sample of KIO_x is placed in a previously weighed container and reweighed.

mass of container + KIO_x = 7.25 g

mass of empty container = 6.44 g

(a) Calculate the mass of KIO_x used in the experiment.

.... g [1]

The student transfers the sample of KIO_x 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 250 cm^3 volumetric flask. The solution is made up to 250 cm^3 with distilled water. This is solution **J**.

A 25.0 cm^3 portion of **J** is transferred to a conical flask. A few grams of potassium iodide and 10 cm^3 of dilute hydrochloric acid are added to the conical flask. All the iodine in KIO_x is converted into iodine molecules, I_2. A few drops of a suitable indicator are added.

1 mole of KIO_x reacts with KI and produces 3 moles of iodine molecules, I_2.

(b) What apparatus should be used to transfer 25.0 cm^3 of **J** to the conical flask?

.... [1]

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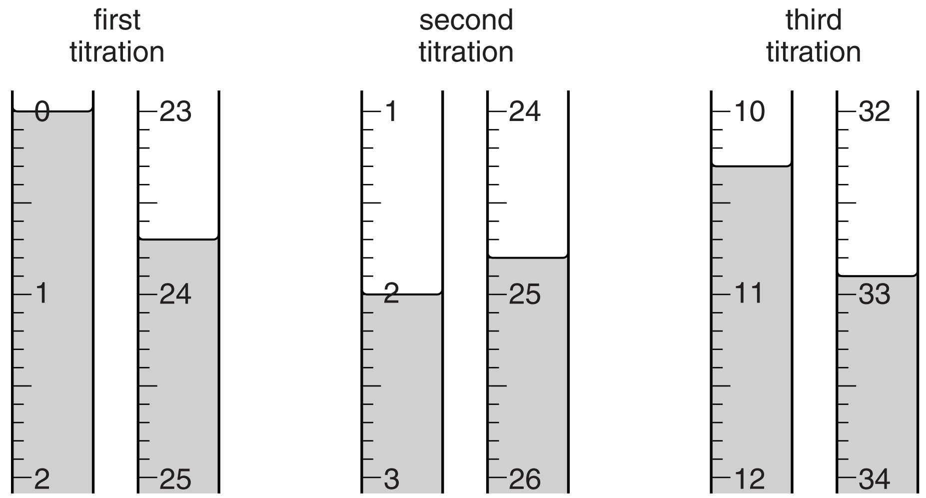
(c) 0.100 mol/dm^3 aqueous sodium thiosulfate, $Na_2S_2O_3$, is put into a burette and run into the conical flask.

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 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 thiosulfate/cm^3			
best titration results (✓)			

Summary

Tick (✓) the best titration results.

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

.... cm^3.
[4]

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

.... moles [1]

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(e) 2 moles of $Na_2S_2O_3$ react with 1 mole of I_2.

Calculate the number of moles of iodine, I_2, present in 25.0 cm^3 of the solution titrated.

.... moles [1]

(f) 1 mole of KIO_x produces 3 moles of I_2.

Using your answer to **(e)** calculate the number of moles of KIO_x in 25.0 cm^3 of solution **J**.

.... moles [1]

(g) Using your answer to **(f)** calculate the number of moles of KIO_x in 250 cm^3 of solution **J**.

.... moles [1]

(h) Using your answers to **(a)** and **(g)** calculate the relative formula mass of KIO_x.

....[1]

(i) Using your answer to **(h)** calculate the value of **x** in the formula KIO_x.
[A_r: O, 16; K, 39; I, 127]

....[1]

[Total: 12]

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9 **X** is a metal carbonate which is insoluble in water.

X reacts with dilute hydrochloric acid to form solution **K** and a gas.

(a) **(i)** Name the gas and give a test for the gas.

name ....

test .... [2]

(ii) Write the ionic equation for the reaction between a carbonate and an acid.

.... [1]

The following table shows the tests a student does on solution **K**. Complete the table by adding the conclusion for test **(b)**, the observations for tests **(c)(i)**, **(c)(ii)** and **(d)** and the test and observation for **(e)**.

test	observations	conclusion
(b) **K** is divided into two parts for tests **(c)** and **(d)**.	**K** is a colourless solution.	
(c) **(i)** To the first part, aqueous sodium hydroxide is added. **(ii)** An excess of aqueous sodium hydroxide is added to the mixture from **(c)(i)**.		**K** contains Ca^{2+} ions.
(d) To the second part, aqueous ammonia is added.		**K** contains Ca^{2+} ions.
(e)		**K** contains Cl^{-} ions.

[7]

[Total: 10]

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10 When excess zinc powder is added to aqueous copper(II) sulfate the temperature rises.

(a) **(i)** What type of reaction does the temperature rise suggest?

.... [1]

(ii) In addition to the temperature rise, suggest two observations that can be made as the reaction takes place.

....

.... [2]

A student does an experiment to determine the heat produced in the reaction.

$$Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$$

The student adds 25.0 cm^3 of 1.0 mol / dm^3 aqueous copper(II) sulfate to a glass beaker.
The temperature of the solution is 20 °C.
Excess zinc powder is added to this solution and the temperature rises rapidly.

After 1.0 minute the temperature of the solution is noted.
Further temperature readings, taken at 1.0 minute intervals as the solution cools down, are shown in the table below.

time / min	temperature / °C
1.0	31.4
2.0	30.4
3.0	29.3
4.0	28.3
5.0	27.3
6.0	26.2

(b) Plot the results on the grid. Draw a straight line through the points. Extend the line until it intersects the *y*-axis.

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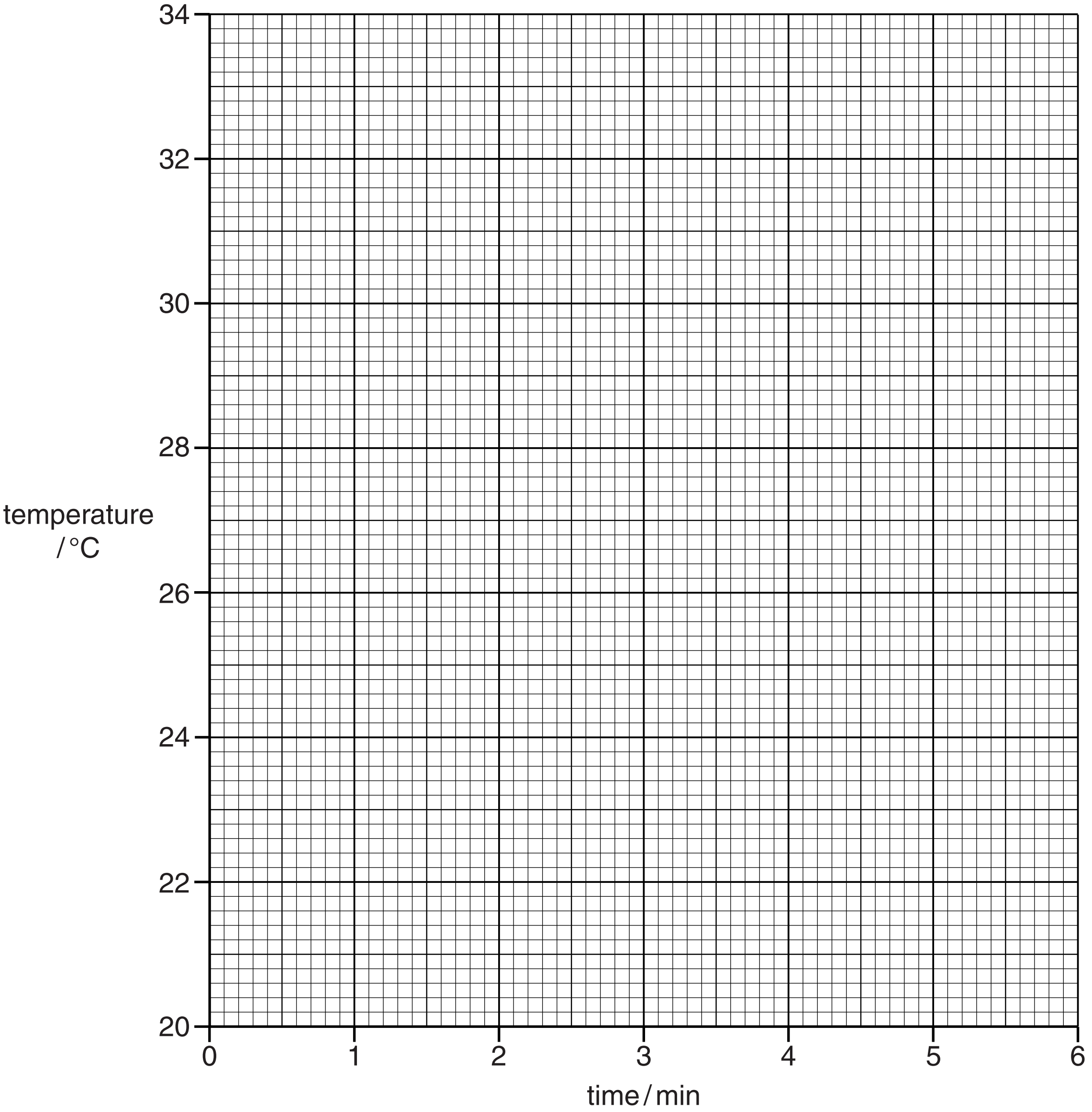

[3]

[Turn over

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(c) **(i)** Use your graph to determine the temperature at 0 minutes. This gives the maximum temperature reached by the solution.

.... °C [1]

(ii) The initial temperature of the aqueous copper(II) sulfate was 20 °C. Using your answer to **(c)(i)** calculate the maximum temperature rise.

.... °C [1]

(iii) Calculate the number of moles of copper(II) sulfate in 25.0 cm^3 of 1.0 mol/dm^3 aqueous copper(II) sulfate.

.... moles [1]

(d) Using your answers to **(c)(ii)** and **(c)(iii)** determine the heat produced in kJ/mol.

$$\text{heat produced} = \frac{25 \times 4.2 \times \text{maximum temperature rise}}{1000 \times \text{moles of copper(II) sulfate}}$$

....kJ/mol [1]

[Total: 10]