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

May/June 2013

1 hour

Candidates answer on the Question Paper.

No Additional Materials are required.

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

UNIVERSITY *of* CAMBRIDGE
International Examinations

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[Turn over

1 A student heats some sodium hydrogencarbonate in the apparatus shown below. The reaction produces carbon dioxide.

$$2NaHCO_3 \rightarrow Na_2CO_3 + CO_2 + H_2O$$

A

sodium hydrogencarbonate

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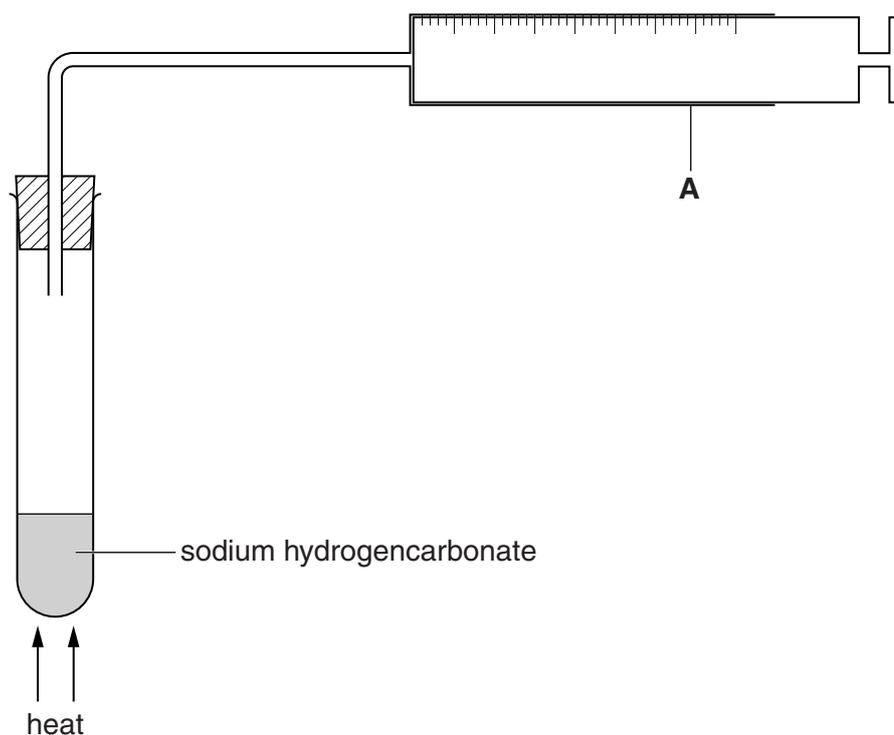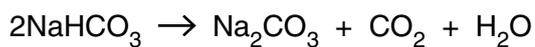
(a) Name apparatus **A**.

.... [1]

(b) Give a test for carbon dioxide.

....[1]

(c) The diagram below shows apparatus **A** at the completion of the reaction. The carbon dioxide collected is at room temperature and pressure.

20   40   60   80   100
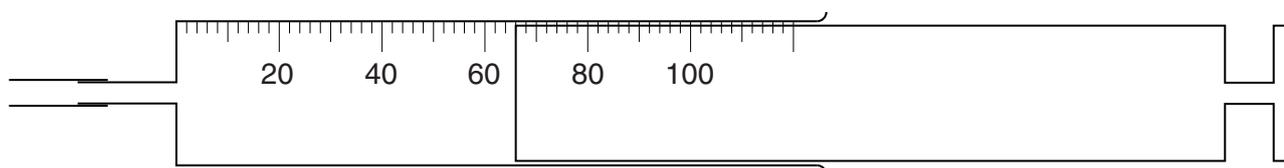
What volume of carbon dioxide is collected?

....cm^3 [1]

(d) Using your answer to **(c)**, calculate the number of moles of carbon dioxide collected, measured at room temperature and pressure.
(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)** calculate the number of moles of sodium hydrogencarbonate used in the experiment.

.... moles [1]

(ii) Calculate the relative formula mass of sodium hydrogencarbonate.
[A_r: H,1; C,12; O,16; Na, 23]

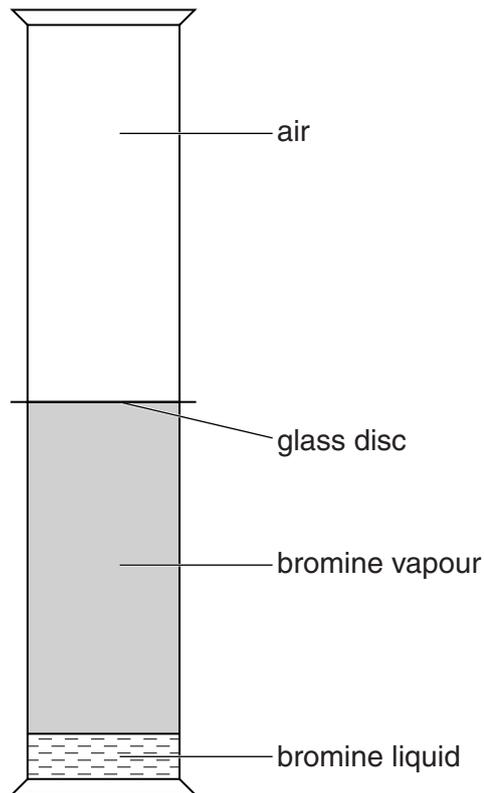..[1]

(iii) Using your answers to **(e)(i)** and **(e)(ii)** calculate the mass of sodium hydrogencarbonate used in the experiment.

.... g [1]

[Total: 7]

2 A student does an experiment as shown in the diagram below.

air

glass disc

bromine vapour

bromine liquid

(a) What colour is bromine vapour?

.... [1]

(b) He carefully removes the glass disc to allow the contents to mix.

(i) What change, if any, is seen in the apparatus immediately after the disc is removed?

....[1]

(ii) Describe the appearance of the contents of the gas jars after a few minutes.

....[1]

(iii) Name the process taking place in the apparatus.

.... [1]

5

(c) (i) Draw an unbranched and a branched structure of the alkene, C_4H_8, showing all the bonds between the atoms.

unbranched

branched

[2]

(ii) How do the two structures in **(c)(i)** show that alkenes are unsaturated?

....[1]

(d) (i) How will aqueous bromine show that a compound is unsaturated?

....

....

....[1]

(ii) Construct an equation for the reaction between C_4H_8 and aqueous bromine.

....[1]

[Total: 9]

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

3   Which of the following reactions involving ethanol is **not** correct?

   (a) Ethanol can be produced by the catalytic addition of steam to ethene. ☐

   (b) Complete combustion of ethanol produces carbon dioxide and water. ☐

   (c) Ethanoic acid is formed by the reduction of ethanol. ☐

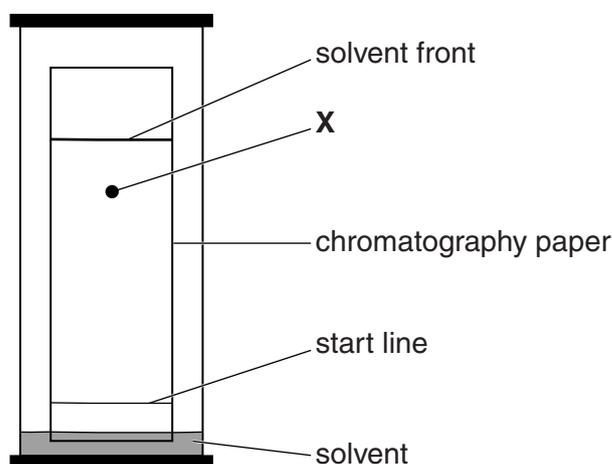   **(d)** Ethanol reacts with carboxylic acids to produce esters. ☐

[Total: 1]

4   Which gas changes the colour of acidified potassium dichromate(VI) from orange to green?

   (a) ammonia ☐

   (b) chlorine ☐

   (c) hydrogen ☐

   (d) sulfur dioxide ☐

[Total: 1]

5   The diagram below shows the result of a paper chromatography experiment to find the R_f value of substance **X**.

From this experiment, the R_f value of **X** is approximately

   (a) 0.2. ☐

   (b) 0.5. ☐
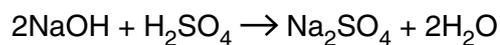
   (c) 0.8. ☐

   (d) 1.0. ☐

[Total: 1]

6 A student finds that a hydrocarbon contains 88.9% by mass of carbon.
What is its empirical formula?
[A_r: H, 1; C, 12]

(a) CH_2 ☐

(b) CH_3 ☐

(c) C_2H_3 ☐

(d) C_2H_5 ☐

[Total: 1]

7 Aqueous sodium hydroxide reacts with sulfuric acid.

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

Which of the following aqueous solutions of sodium hydroxide will produce 1.42 g of sodium sulfate when reacting with excess sulfuric acid?
[M_r: Na_2SO_4, 142]

(a) $100\,cm^3$ of $0.100\,mol/dm^3$ of sodium hydroxide ☐

(b) $50\,cm^3$ of $0.200\,mol/dm^3$ of sodium hydroxide ☐

(c) $50\,cm^3$ of $0.400\,mol/dm^3$ of sodium hydroxide ☐

(d) $100\,cm^3$ of $0.050\,mol/dm^3$ of sodium hydroxide ☐

[Total: 1]

8 Iron(II) sulfate crystals have the formula $FeSO_4.xH_2O$, where **x** is a whole number.

A student determines the value of **x** using aqueous $0.0200 \, mol/dm^3$ potassium manganate(VII), **F**.

Potassium manganate(VII), which is purple, oxidises iron(II) ions to iron(III) ions.

(a) A sample of iron(II) sulfate crystals is added to a previously weighed container which is then reweighed.

mass of container + crystals = 10.94 g
mass of container = 5.98 g

Calculate the mass of iron(II) sulfate crystals used in the experiment.

.... g [1]

(b) The student transfers the sample of iron(II) sulfate crystals to a beaker and adds $100 \, cm^3$ of dilute sulfuric acid. The solution is made up to $250 \, cm^3$ with distilled water and mixed well.

This is solution **G**.

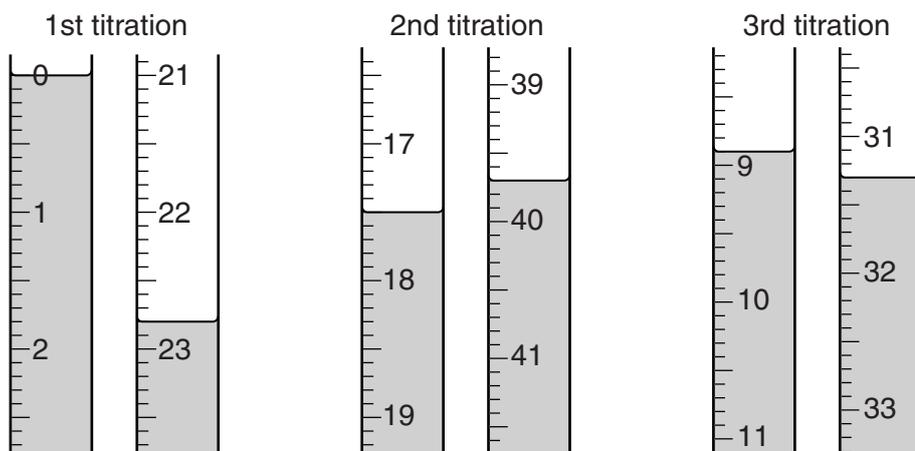Using a pipette, $25.0 \, cm^3$ of **G** is measured into a conical flask.

F is put into a burette and run into the conical flask containing **G**.

What is the colour of the solution in the flask

(i) before **F** 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 results table.

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

Summary

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

F is 0.0200 mol/dm^3 potassium manganate(VII), $KMnO_4$.

(d) Calculate the number of moles of $KMnO_4$ present in the average volume of **F**.

.... moles [1]

(e) Five moles of $FeSO_4$ react with one mole of $KMnO_4$.
Calculate the number of moles of $FeSO_4$ present in 25.0 cm^3 of **G**.

.... moles [1]

(f) Calculate the number of moles of $FeSO_4$ present in 250 cm^3 of **G**.

.... moles [1]

(g) Using your answer to **(f)**, calculate the mass of $FeSO_4$ in the original sample of $FeSO_4.\mathbf{x}H_2O$.
[A_r: O, 16; S, 32; Fe, 56]

.... g [1]

(h) Using your answers to **(a)** and **(g)**, calculate the mass of water in the sample of $FeSO_4.xH_2O$.

.... g [1]

(i) Using your answer to **(h)**, calculate the number of moles of water in the sample of $FeSO_4.xH_2O$.
[A_r: H, 1; O, 16]

.... moles [1]

(j) Using your answers to **(f)** and **(i)**, calculate the number of moles of water combined with one mole of $FeSO_4$.

.... moles [1]

(k) State the value of **x** in the formula of $FeSO_4.xH_2O$.

....[1]

(l) When iron(II) sulfate crystals are left to stand in air a yellow solid forms on the surface of the crystals.

   (i) Suggest the identity of the yellow solid.

   ....[1]

   (ii) Why is it formed?

   ....[1]

   (iii) The yellow solid is dissolved in water. Aqueous sodium hydroxide is added.
   What is seen?

   ....[1]

[Total: 17]

9 **W** is a compound which contains two ions.
Complete the table by adding the conclusion for test **(a)**, the observations for tests **(b)** and **(c)** and both the test and observation 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)**.	A coloured solution is formed.	
(b) **(i)**	To the first part, aqueous sodium hydroxide is added until a change is seen.		**W** contains Cu^{2+} ions.
(ii)	An excess of aqueous sodium hydroxide is added to the mixture from **(i)**.		
(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 Cu^{2+} ions is confirmed.
(d)			**W** contains Cl^- ions.

Conclusion: the formula of **W** is ....

[Total: 9]

10 A student investigates the rise in temperature when different masses of magnesium are added to 50 cm^3 of hydrochloric acid.
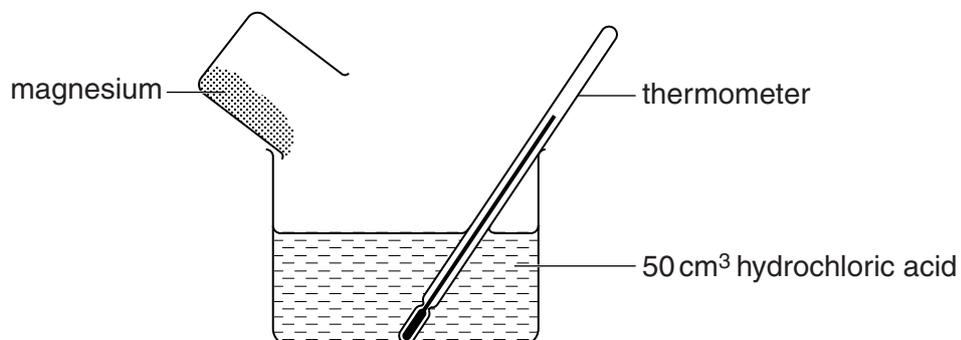
The equation for the reaction is

$$Mg + 2HCl \rightarrow MgCl_2 + H_2$$
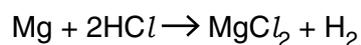
(a) What general name is given to reactions in which there is a rise in temperature?

....[1]

50 cm^3 of hydrochloric acid is poured into a beaker. A thermometer is placed in the acid. The initial temperature of the acid is 20.0 °C.

0.10 g of magnesium is added to the hydrochloric acid and the highest temperature reached is recorded.

The experiment is repeated for different masses of magnesium.

The diagrams below show parts of the thermometer stem giving the highest temperature reached after each addition of magnesium.
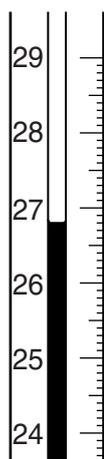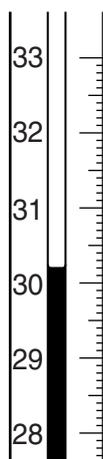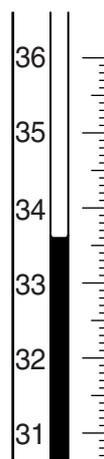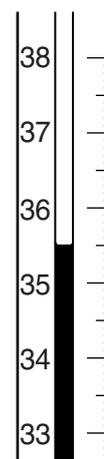

0.20 g Mg   0.30 g Mg   0.40 g Mg   0.50 g Mg

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

mass of magnesium / g	initial temperature of hydrochloric acid / °C	highest temperature of mixture / °C	rise in temperature / °C
0.10	20.0	23.4	3.4
0.20	20.0	27.0	7.0
0.30	20.0	30.5	10.5
0.40	20.0	34.5	14.5
0.50	20.0	35.5	15.5
0.60	20.0	35.5	15.5

[2]

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(c) Plot the results on the grid.
Draw two intersecting straight lines through the points.

rise in
temperature
/ °C
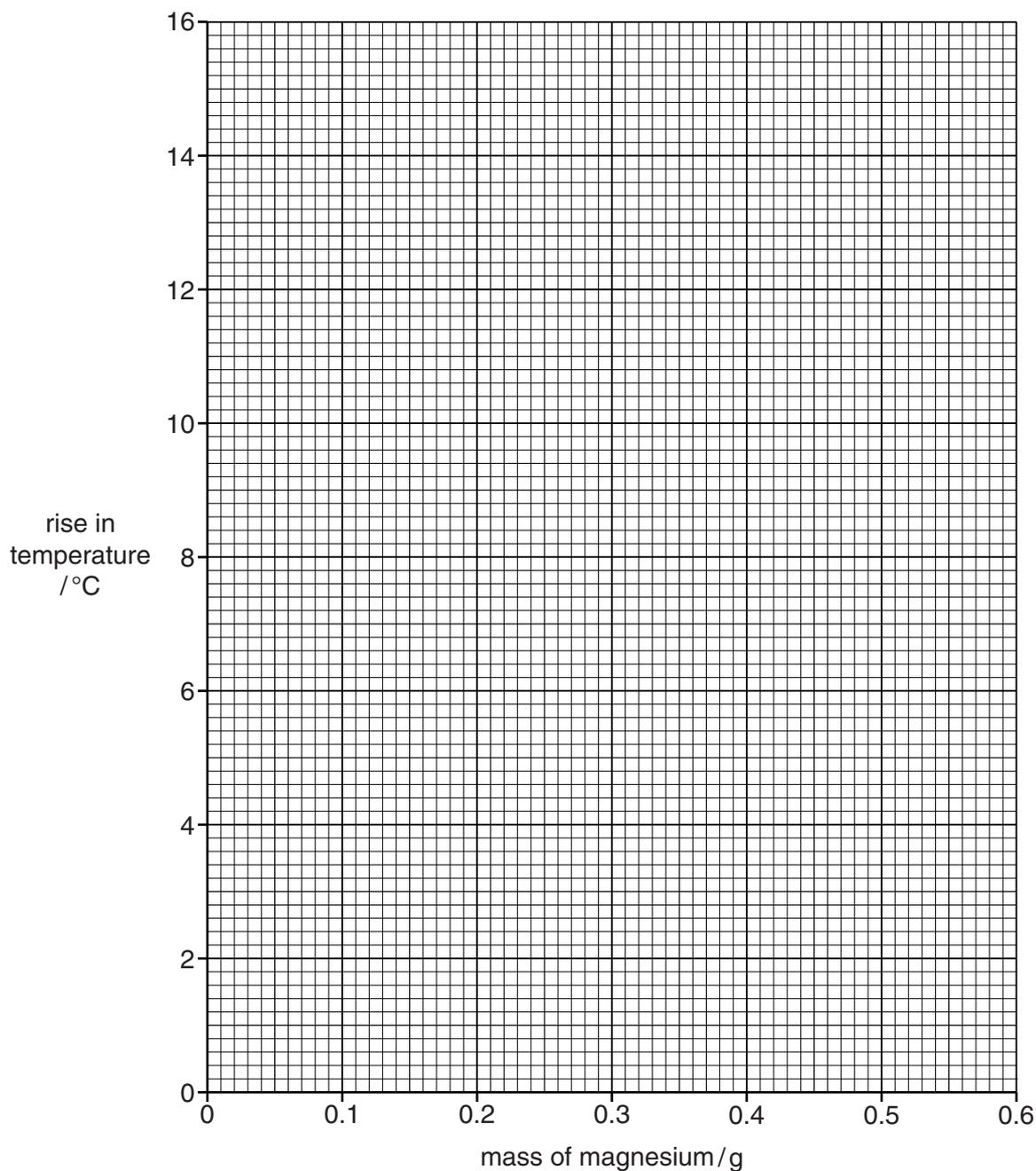
mass of magnesium / g

[3]

Use your graph to answer the following questions.

(d) (i) What is the rise in temperature when 0.25 g of magnesium is added to 50 cm^3 of hydrochloric acid?

....°C [1]

(ii) What is the highest temperature of the solution when 0.35 g of magnesium is added to 50 cm^3 of hydrochloric acid?

....°C [1]

(e) Why are the last two rises in temperature the same?

....[1]

(f) **(i)** From your graph, what mass of magnesium is required to neutralise $50 \, cm^3$ of the hydrochloric acid used in the experiment?
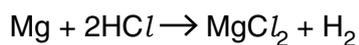
.... g [1]

(ii) Using your answer to **(f)(i)**, calculate the number of moles of magnesium required to neutralise the hydrochloric acid.
[A_r: Mg, 24]

.... moles [1]

(iii) Using your answer to **(f)(ii)** and the equation for the reaction, calculate the concentration in mol/dm^3 of the hydrochloric acid used in the experiment.

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

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

[Total: 13]

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