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 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.

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

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[Turn over

1 A student was given two test-tubes, one containing aqueous ammonia; the other aqueous copper(II) sulfate.

(a) A few drops of litmus solution were added to aqueous ammonia.
What colour is litmus solution in aqueous ammonia?

..... [1]

(b) What colour is aqueous copper(II) sulfate?

..... [1]

(c) What observations were made when

(i) a few drops of aqueous ammonia were added to aqueous copper(II) sulfate,

..... [1]

(ii) an excess of aqueous ammonia was added to the solution from **(i)**?

..... [2]

[Total: 5]

2 A student electrolysed aqueous copper(II) sulfate, using carbon electrodes. The apparatus is shown below.

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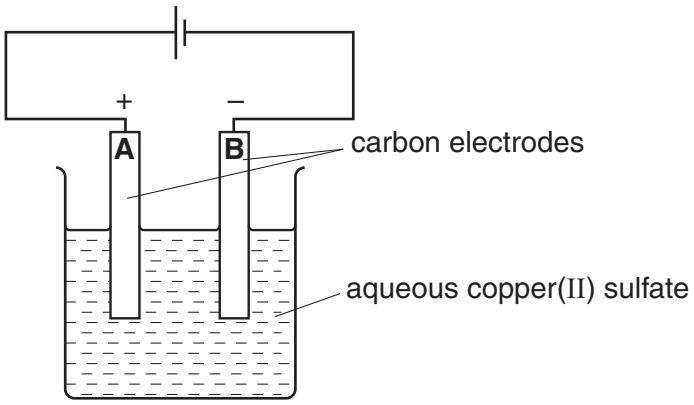

After a few minutes, a pink solid was deposited on one electrode and a gas was evolved at the other electrode.

(a) (i) At which electrode, **A** or **B**, was the pink solid deposited? Explain your answer.

.....

..... [1]

(ii) Name the pink solid.

..... [1]

Eventually, no more pink solid was formed. Instead, a gas was produced at this electrode.

(b) (i) Name this gas.

..... [1]

(ii) Give a positive test for this gas.

..... [1]

(c) (i) Name the gas evolved at the other electrode.

..... [1]

(ii) Give a positive test for this gas.

..... [1]

(d) (i) How does the colour of the electrolyte change during the electrolysis?

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

(ii) Explain why this colour change takes place.

..... [1]

[Total: 8]

[Turn over

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3 A student was given some hydrated iron(II) sulfate crystals, $FeSO_4.xH_2O$. They were placed in a previously weighed crucible which was reweighed.

Mass of crucible + iron(II) sulfate crystals = 10.45 g
Mass of crucible = 6.60 g

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

..... g [1]

(b) The crystals were gently heated until no more water vapour was given off.

(i) What word describes the iron(II) sulfate now that it has lost all of its water of crystallisation?

..... [1]

The crucible and contents were reweighed.

Mass of crucible + iron(II) sulfate after heating = 8.90 g

(ii) Calculate the mass of iron(II) sulfate which remained after heating.

..... g [1]

(iii) Calculate the mass of water lost from the crystals.

..... g [1]

(c) **(i)** Calculate the relative formula mass of iron(II) sulfate, $FeSO_4$.

[A_r: Fe, 56; S, 32; O, 16]

.....

(ii) Calculate the relative formula mass of water.

[A_r: H, 1; O, 16]

.....
[1]

(d) Using your answers to **(b)(ii)** and **(iii)**, and **(c)(i)** and **(ii)**, calculate

(i) how many moles of iron(II) sulfate remained after heating,

..... [1]

(ii) how many moles of water were lost during heating.

..... [1]

(e) The value of **x** in the formula $FeSO_4.\mathbf{x}H_2O$ can be found using the following formula.

$$\mathbf{x} = \frac{\text{answer to } \mathbf{(d)(ii)}}{\text{answer to } \mathbf{(d)(i)}}$$

Calculate the value of **x** and hence write the formula of hydrated iron(II) sulfate.

x = ... [1]

The formula of hydrated iron(II) sulfate is ..... [1]

[Total: 9]

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

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4 Ethene, C_2H_4, reacts with bromine water.
Which of the following observations is correct?

(a) A brown gas is evolved. ☐

(b) Effervescence occurs. ☐

(c) The colour of the bromine water changes from brown to colourless. ☐

(d) The product of the reaction is a solid. ☐

[Total: 1]

5 A student converted starch into ethanol by a two-stage process.
An acid was used in stage **A** and yeast in stage **B**.

$$\text{starch} \xrightarrow{\textbf{A}} \text{sugar} \xrightarrow{\textbf{B}} \text{ethanol}$$

What type of reaction takes place in each of stages **A** and **B**?

	A	**B**	
(a)	reduction	esterification	☐
(b)	hydrolysis	fermentation	☐
(c)	fermentation	reduction	☐
(d)	oxidation	hydrolysis	☐

[Total: 1]

6 In the Haber process nitrogen and hydrogen are reacted together in the presence of iron to produce ammonia.

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$$N_2(g) + 3H_2(g) \overset{Fe(s)}{\rightleftharpoons} 2NH_3(g)$$

Which of the following statements regarding iron is correct?

(a) It increases the yield of ammonia. ☐

(b) Its mass decreases as the experiment proceeds. ☐

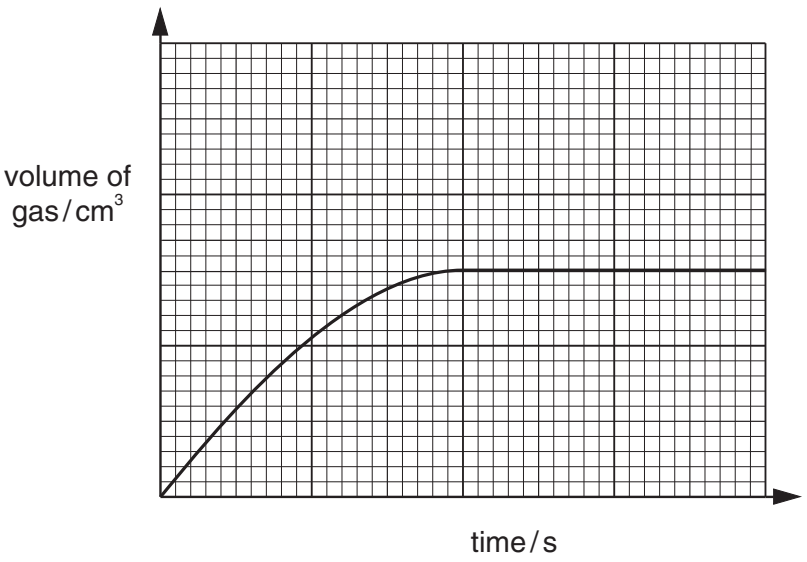
(c) It increases the rate at which ammonia is produced. ☐

(d) It reacts with nitrogen and hydrogen. ☐

[Total: 1]

7 A student reacted 10 cm^3 of 1.0 mol/dm^3 hydrochloric acid with excess powdered zinc and collected the gas evolved in a gas syringe.

The graph below shows the volume of gas produced against time for this experiment.



The student repeated the experiment, this time reacting 10 cm^3 of 2.0 mol/dm^3 hydrochloric acid with excess powdered zinc, and collected the gas.

On the same grid, draw a graph to show the volume of gas produced against time for the second experiment.

[Total: 2]

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8 A student did an experiment to find the relative molecular mass of an organic acid. He titrated solution **R**, an aqueous solution containing 8.50 g/dm^3 of the organic acid, with solution **S**, containing 0.100 mol/dm^3 of sodium hydroxide.

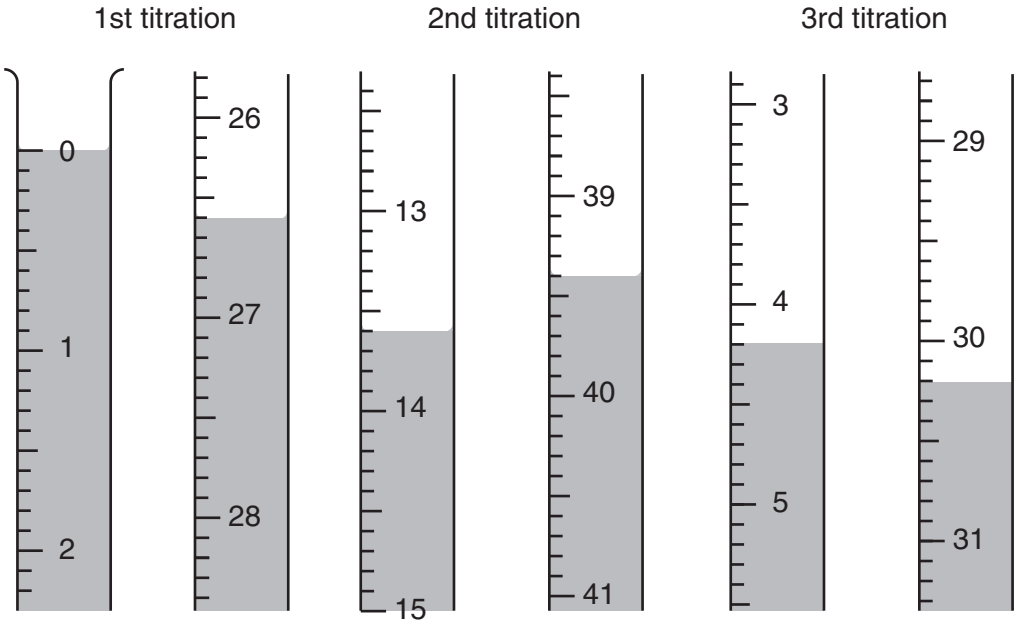
25.0 cm^3 of **S** was transferred into a conical flask and a few drops of phenolphthalein indicator were added. (Phenolphthalein is colourless in acid and pink in alkali.)

R was put into a burette and run into the conical flask containing **S** until the end-point was reached.

(a) What was the colour change at the end-point?

The colour changed from ..... to ..... [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.



(b) Use these diagrams to complete the table of results.

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

Summary

Tick (✓) the best titration results.

Using these results, the average volume of **R** was ..... cm^3. [4]

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

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..... moles [1]

(d) Given that 1 mol of acid neutralises 1 mol of sodium hydroxide, use your answer to **(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 8.50 g/dm^3 of the acid, calculate the relative molecular mass of the acid.

..... [1]

(g) (i) The general formula of an organic acid is $C_nH_{2n+1}CO_2H$.

Calculate the value of n in the formula for the organic acid in **R**.
[A_r: C, 12; O, 16; H, 1]

n = ... [1]

(ii) Deduce the formula for the organic acid in **R**.

The formula for the organic acid in **R** is ..... [1]

[Turn over

(h) A sample of the organic acid was reacted with an excess of ethanol, C_2H_5OH, in the presence of a small volume of concentrated sulfuric acid to give an organic product, **T**, and water.

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(i) Suggest the formula for **T**.

The formula for **T** is .....[1]

(ii) To which homologous series does **T** belong?

.....[1]

[Total: 13]

9 The following table shows the tests a student did on compound **W**.

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Complete the table by adding the observations for **(a)**, **(c)(i)** and **(c)(ii)** and the tests and observations for tests **(b)(i)**, **(b)(ii)** and **(d)**.

test	observations	conclusions
(a) **W** was dissolved in water and the resulting solution divided into three parts for tests **(b)**, **(c)** and **(d)**.		Transition metal ions are not present in the solution of **W**.
(b) **(i)** **(ii)**		**W** may contain Al^{3+} ions or Zn^{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 Zn^{2+} ions was confirmed.
(d)		**W** contains Cl^- ions.

[Total: 9]

10 A student investigated the rise in temperature when sulfuric acid was added to a solution containing 1.00 mol/dm^3 sodium hydroxide, using the apparatus shown below.

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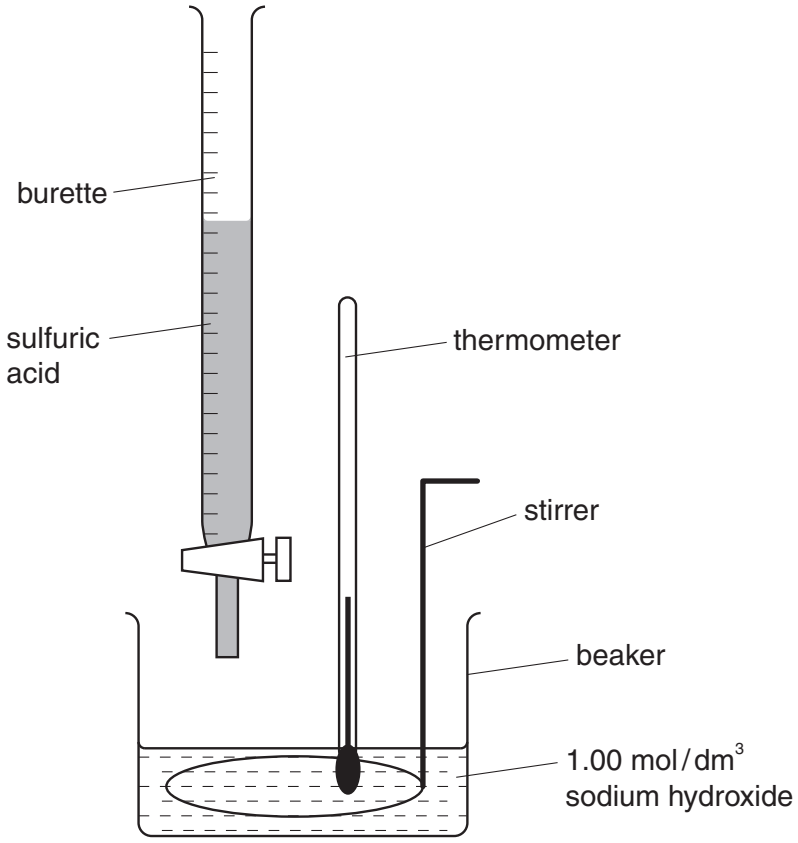
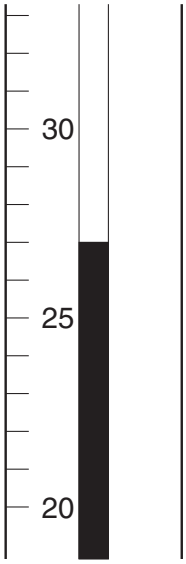


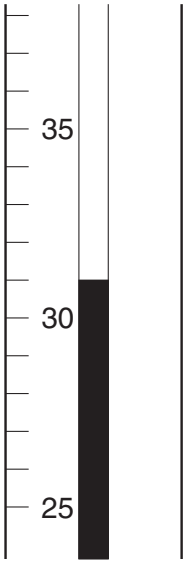
20.0 cm^3 of 1.00 mol/dm^3 sodium hydroxide was poured into a beaker. The temperature of both this solution and the sulfuric acid was 25°C.

Following successive additions of 5.0 cm^3 volumes of sulfuric acid from the burette, further temperature readings were taken.

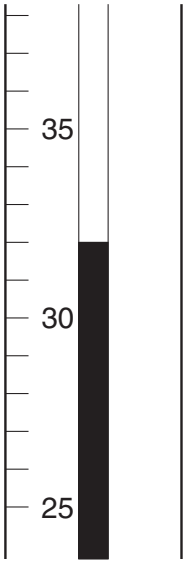
The diagrams below show parts of the thermometer stem giving the temperature after the addition of 5.0, 15.0 and 25.0 cm^3 of sulfuric acid.



addition of 5.0 cm^3 of sulfuric acid



addition of 15.0 cm^3 of sulfuric acid



addition of 25.0 cm^3 of sulfuric acid

(a) Use the diagrams to complete the following table of results.

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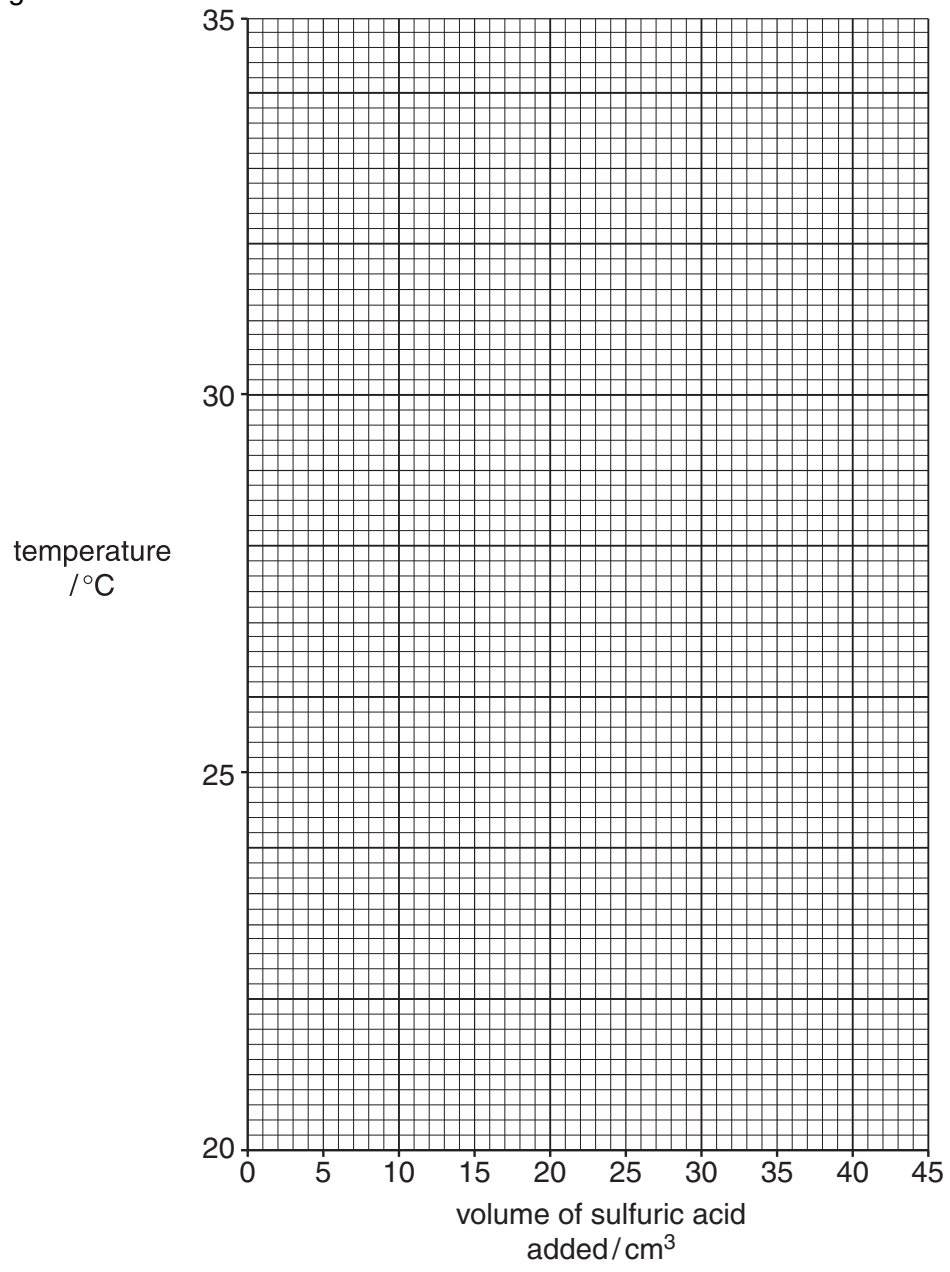
volume of sulfuric acid / cm^3	temperature / °C
0.0	25
5.0	
10.0	29
15.0	
20.0	33
25.0	
30.0	29
35.0	26

[1]

(b) Plot these results on the grid below and connect the points with **two** intersecting straight lines.



[3]

Use the graph to answer the following questions.

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(c) **(i)** State the temperature at the intersection of the two lines (highest temperature).

..... °C [1]

(ii) What volume of sulfuric acid produced this temperature?

..... cm^3 [1]

(d) 20.0 cm^3 of 1.00 mol/dm^3 sodium hydroxide was used in the experiment.

(i) Write an equation for the reaction between sodium hydroxide and sulfuric acid.

..... [1]

(ii) Using your answer to **(c)(ii)** calculate the concentration of the sulfuric acid.

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

(e) After the highest temperature was reached, explain why the temperature of the solution decreased as more sulfuric acid was added.

.....

.....

..... [2]

[Total: 11]

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