



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS  
General Certificate of Education Ordinary Level

CANDIDATE  
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**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.

**For Examiner's Use**

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



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

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(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]

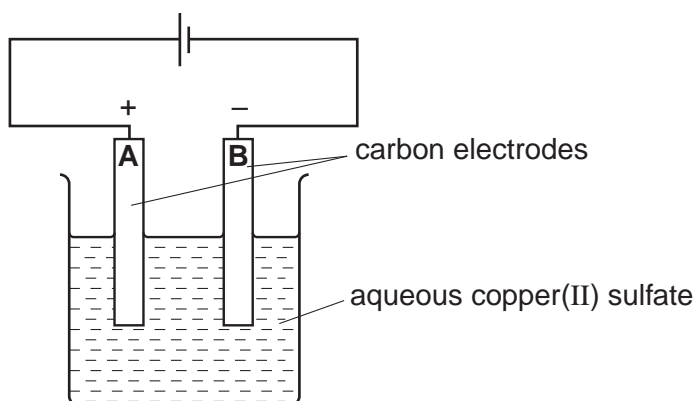
(ii) an excess of aqueous ammonia was added to the solution from (i)?

..... [2]

[Total: 5]

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

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Use



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]

- 3 A student was given some hydrated iron(II) sulfate crystals,  $\text{FeSO}_4 \cdot x\text{H}_2\text{O}$ . They were placed in a previously weighed crucible which was reweighed.

For  
Examiner's  
Use

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,  $\text{FeSO}_4$ .

[ $A_r$ : 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  $\text{FeSO}_4 \cdot x\text{H}_2\text{O}$  can be found using the following formula.

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

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]

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

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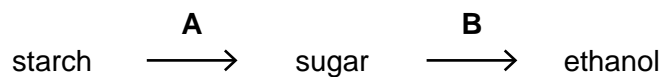
4 Ethene, C<sub>2</sub>H<sub>4</sub>, reacts with bromine water.  
Which of the following observations is correct?

- (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**.



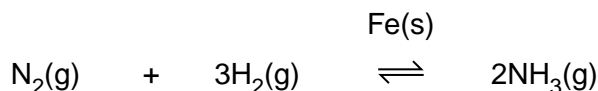
What type of reaction takes place in each of stages **A** and **B**?

	<b>A</b>	<b>B</b>	
(a)	reduction	esterification	<input type="checkbox"/>
(b)	hydrolysis	fermentation	<input type="checkbox"/>
(c)	fermentation	reduction	<input type="checkbox"/>
(d)	oxidation	hydrolysis	<input type="checkbox"/>

[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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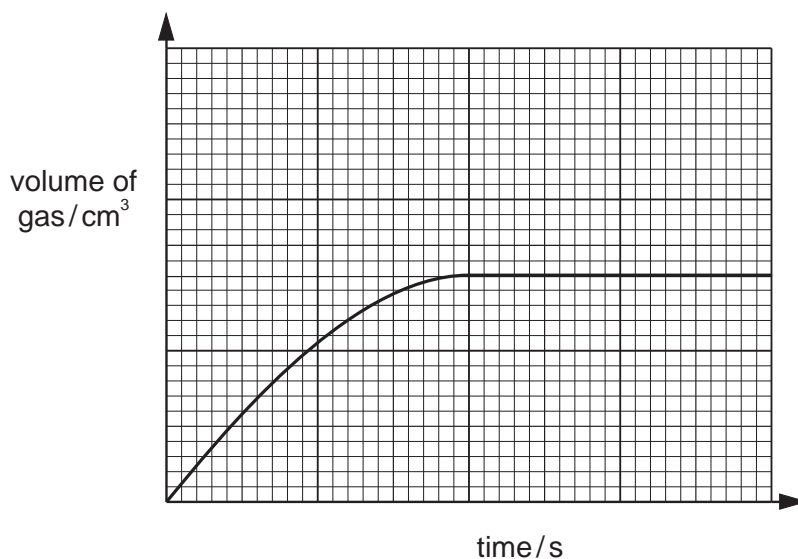
Which of the following statements regarding iron is correct?

- (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<sup>3</sup> of 1.0 mol/dm<sup>3</sup> 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<sup>3</sup> of 2.0 mol/dm<sup>3</sup> 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]

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

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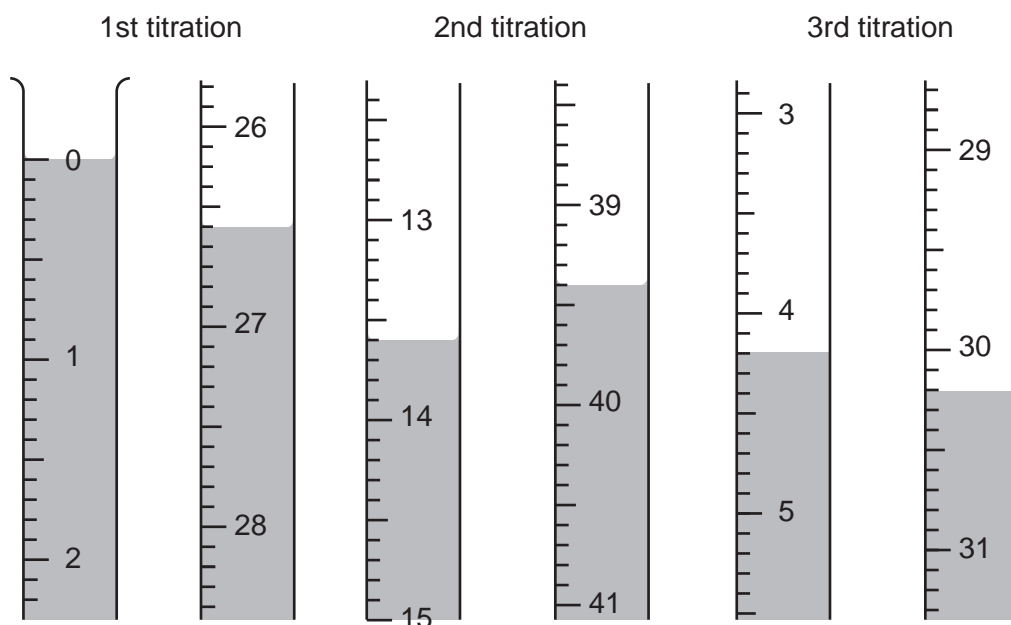
$25.0\text{cm}^3$  of **S** was transferred into a conical flask and a few drops of phenolphthalein indicator were added. (Phenolphthalein is colourless in acid and pink in alkali.)

**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 / $\text{cm}^3$			
initial burette reading / $\text{cm}^3$			
volume of <b>R</b> / $\text{cm}^3$			
best titration results (✓)			

### Summary

Tick (✓) the best titration results.

Using these results, the average volume of **R** was .....  $\text{cm}^3$ . [4]



- (c) Calculate the number of moles of sodium hydroxide in 25.0 cm<sup>3</sup> of **S**.

For  
Examiner's  
Use

..... 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<sup>3</sup> of **R**.

..... moles [1]

- (f) Using your answer to (e) and the information that **R** contains 8.50 g/dm<sup>3</sup> of the acid, calculate the relative molecular mass of the acid.

..... [1]

- (g) (i) The general formula of an organic acid is C<sub>n</sub>H<sub>2n+1</sub>CO<sub>2</sub>H.

Calculate the value of n in the formula for the organic acid in **R**.

[A<sub>r</sub>: 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]

- (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.

For  
Examiner's  
Use

- (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**.

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)**.

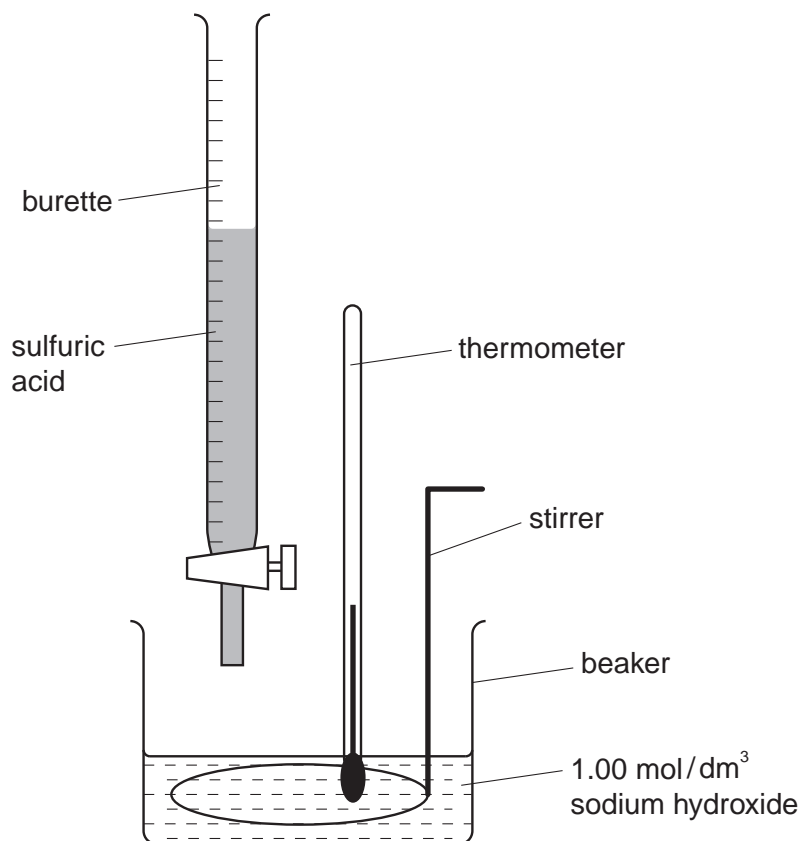
For  
Examiner's  
Use

test	observations	conclusions
<b>(a)</b> <b>W</b> was dissolved in water and the resulting solution divided into three parts for tests <b>(b)</b> , <b>(c)</b> and <b>(d)</b> .		Transition metal ions are not present in the solution of <b>W</b> .
<b>(b)</b> <b>(i)</b>  <b>(ii)</b>		<b>W</b> may contain $Al^{3+}$ ions or $Zn^{2+}$ ions.
<b>(c)</b> <b>(i)</b> To the second part aqueous ammonia was added until a change was seen. <b>(ii)</b> An excess of aqueous ammonia was added to the mixture from <b>(i)</b> .		The presence of $Zn^{2+}$ ions was confirmed.
<b>(d)</b>		<b>W</b> contains $Cl^{-}$ ions.

[Total: 9]

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

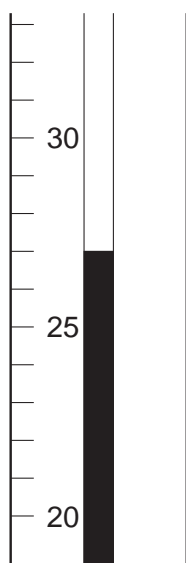
For  
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Use



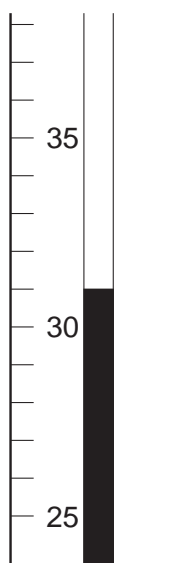
$20.0 \text{ cm}^3$  of  $1.00 \text{ mol/dm}^3$  sodium hydroxide was poured into a beaker. The temperature of both this solution and the sulfuric acid was  $25^\circ\text{C}$ .

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

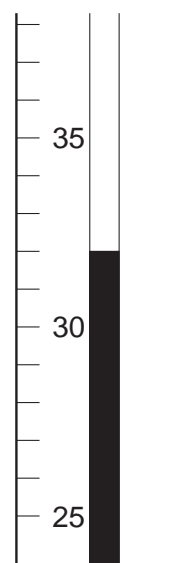
The diagrams below show parts of the thermometer stem giving the temperature after the addition of  $5.0$ ,  $15.0$  and  $25.0 \text{ cm}^3$  of sulfuric acid.



addition of  
 $5.0 \text{ cm}^3$  of  
sulfuric acid



addition of  
 $15.0 \text{ cm}^3$  of  
sulfuric acid



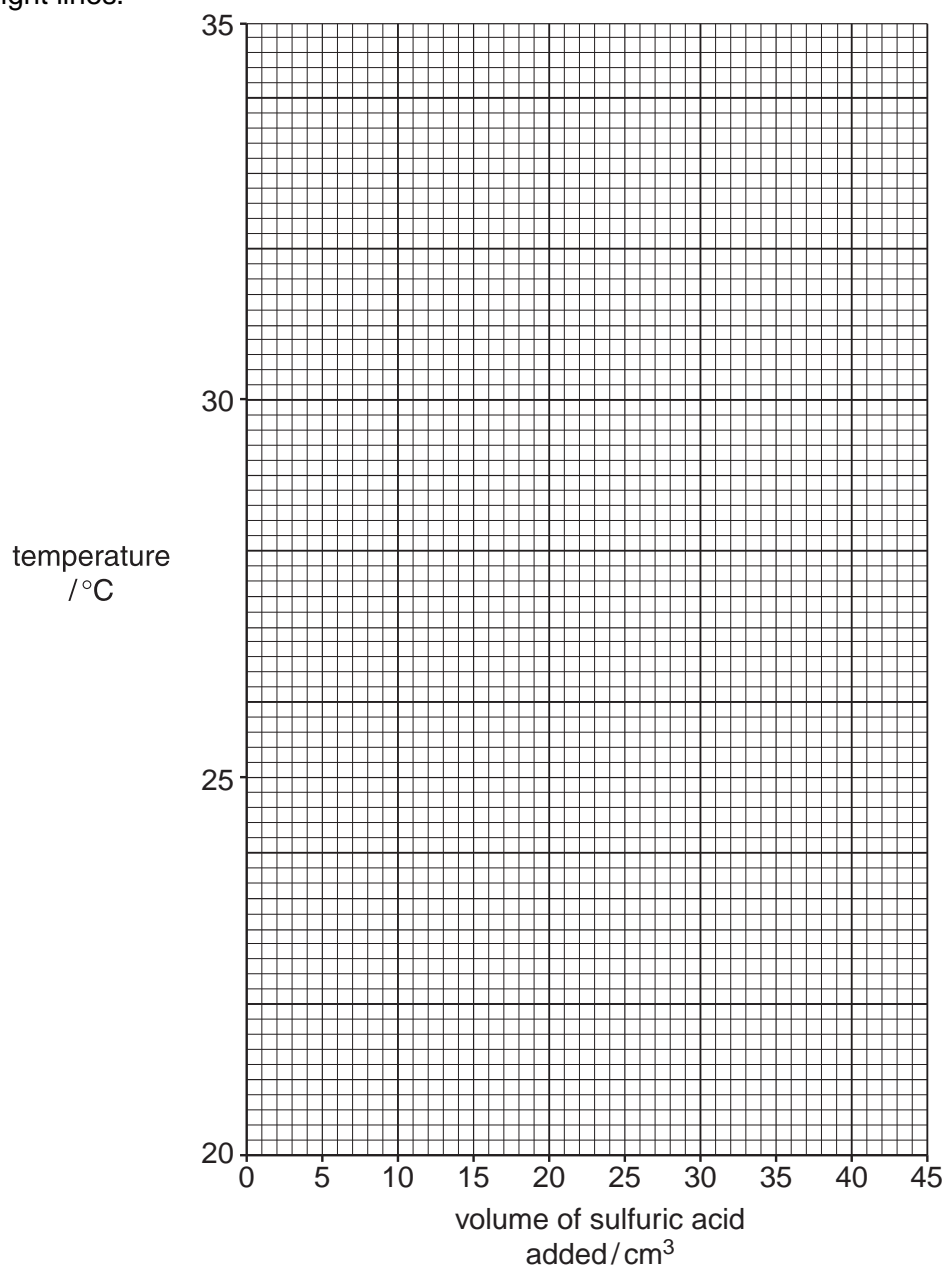
addition of  
 $25.0 \text{ cm}^3$  of  
sulfuric acid

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

volume of sulfuric acid / cm <sup>3</sup>	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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Use

(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<sup>3</sup> [1]

(d) 20.0 cm<sup>3</sup> of 1.00 mol/dm<sup>3</sup> 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<sup>3</sup> [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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