Cambridge
O Level

**Cambridge International Examinations**
Cambridge Ordinary Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER



**CHEMISTRY** **5070/41**

Paper 4 Alternative to Practical **May/June 2014**

**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 an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

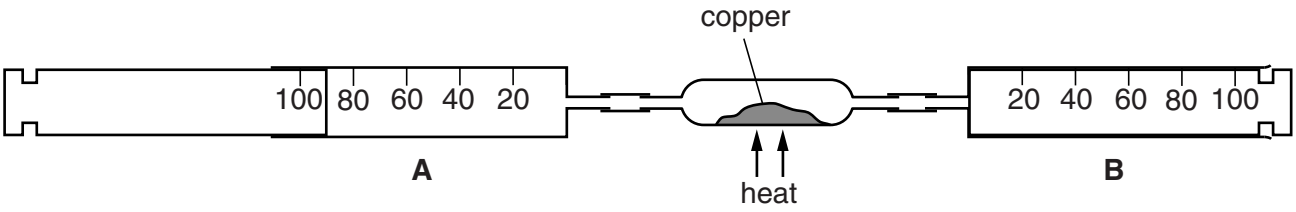
Answer **all** questions.
Electronic calculators may be used.
Write your answers in the spaces provided in the Question Paper.
At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

This document consists of **16** printed pages.

DC (CW/SW) 71956/4


CAMBRIDGE International Examinations

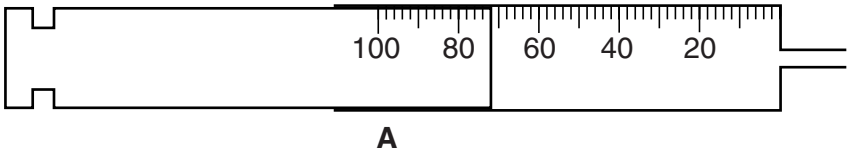
**1** A student determines the oxygen content of air using the apparatus shown.




Syringe **A** contains 90 $cm^3$ of air. The air is forced over heated copper into syringe **B**. The air is then forced back over the heated copper into syringe **A**.

The process is repeated several times until the volume of gas forced back into syringe **A** is constant. The apparatus is allowed to cool to room temperature.

The diagram below shows the volume of gas in syringe **A** after the experiment is finished.




**(a)** Copper reacts with oxygen in the air to produce copper(II) oxide.

**(i)** Construct the equation for this reaction.

.....[1]

**(ii)** What colour is copper(II) oxide?

.....[1]

**(b) (i)** What is the volume of gas remaining in syringe **A**?

..... $cm^3$ [1]

**(ii)** Name the major component of the gas remaining in syringe **A**.

.....[1]

**(iii)** Calculate the volume of oxygen that reacts with the copper.

..... $cm^3$ [1]

**(iv)** Using your answer to **(b)(iii)**, calculate the number of moles of oxygen that react with the copper.
[One mole of a gas occupies 24 000 $cm^3$ at room temperature and pressure.]

..... moles [1]

**(v)** Using your equation in **(a)(i)** and your answer to **(b)(iv)** calculate the mass of copper that reacts with the oxygen.
[$A_r$: Cu, 64]

.....g [1]

**(c)** In another experiment 60 $cm^3$ of oxygen is required to react with all the copper.
Calculate the volume of air required to provide this volume of oxygen.

..... $cm^3$ [1]

[Total: 8]

**2** **(a)** Hydrogen chloride is dissolved in water and a few drops of litmus solution are added.

**(i)** Describe the colour of the litmus in aqueous hydrogen chloride.

..... [1]

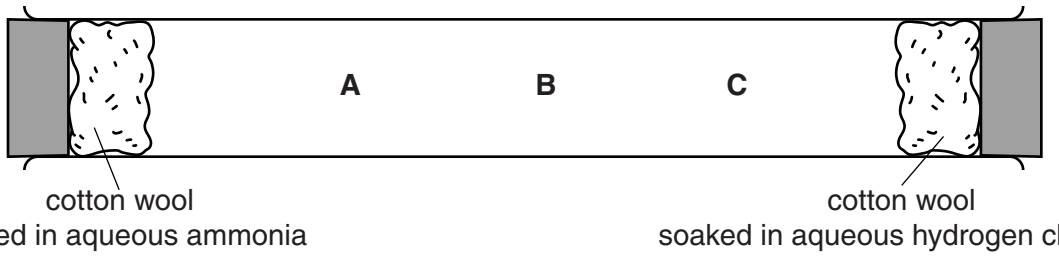
**(ii)** By what name is aqueous hydrogen chloride more commonly known?

..... [1]

**(iii)** How can the pH value of aqueous hydrogen chloride be determined?

.....[1]

**(b)** Two pieces of cotton wool, soaked separately in aqueous solutions of ammonia ($M_r$: 17) and hydrogen chloride ($M_r$: 36.5) are placed at opposite ends of a tube, as shown in the diagram.




After a few minutes, a white solid is produced on the inside of the tube.

**(i)** Name the process by which the gases from the two solutions move along the tube.

..... [1]

**(ii)** Name and give the formula of the white solid.

name .....

formula ..... [1]

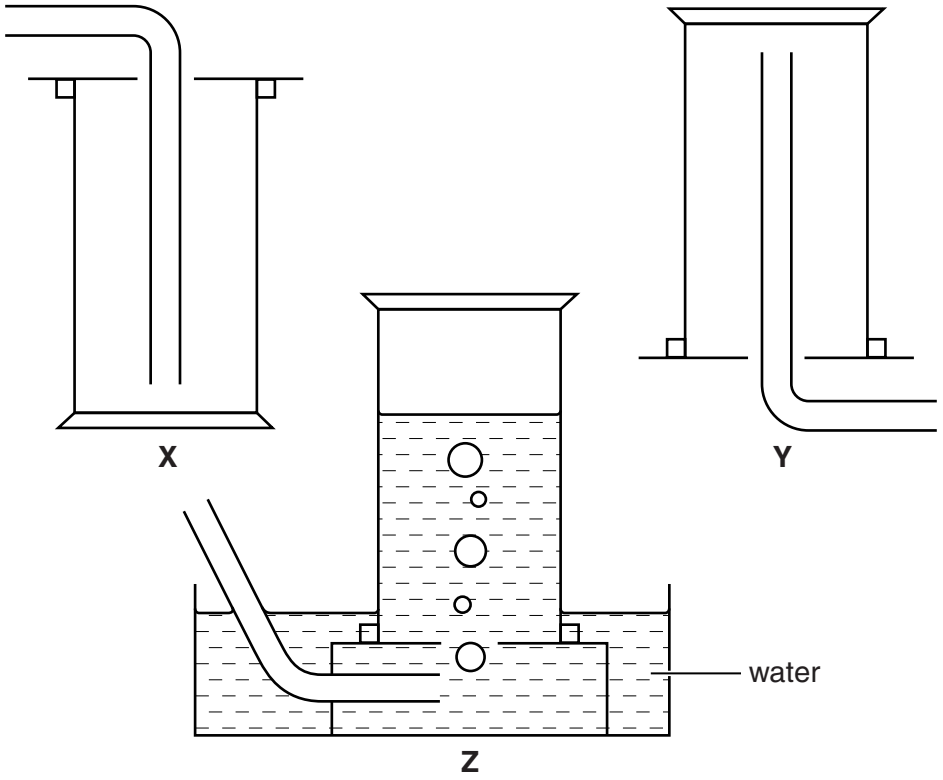
**(iii)** Nearest to which position, **A**, **B** or **C**, is the white solid formed?
Explain your answer.

position .....

explanation .....

.....[3]

**(c)** Suggest which method, **X**, **Y** or **Z**, is most suitable for the collection of each of the gases $NH_3$ and $HCl$.
Explain your answers.




$NH_3$ .....

$HCl$ .....

explanation .....

.....

.....[4]

[Total: 12]

In questions **3** to **6** inclusive place a tick (✓) in the box against the correct answer.

**3** A compound contains 26.7% carbon, 2.2% hydrogen and 71.1% oxygen by mass.
What is its empirical formula?

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

**(a)** CHO ☐

**(b)** $C_2H_2O$ ☐

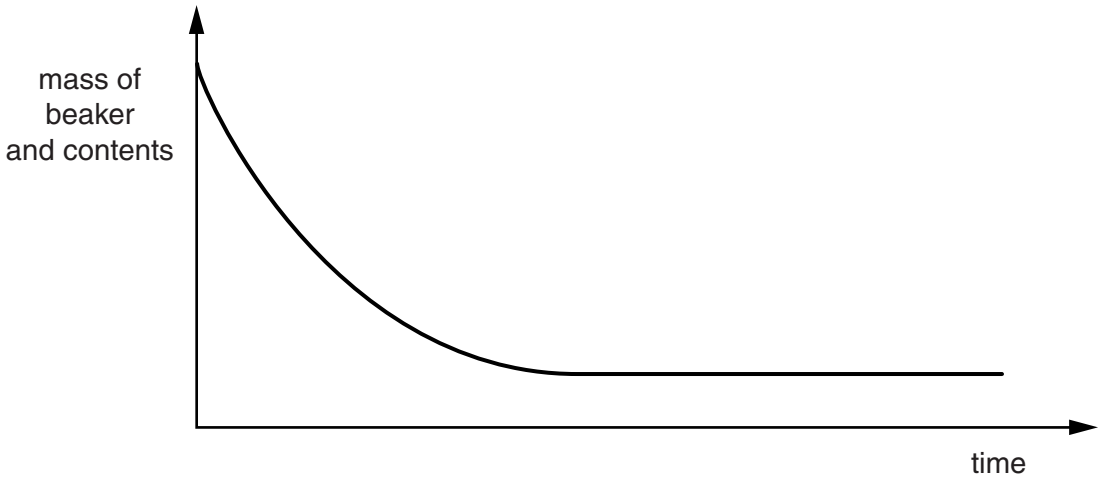
**(c)** $CH_2O$ ☐

**(d)** $CHO_2$ ☐

[Total: 1]

**4** Two solutions are mixed in a beaker and the mass of the beaker and contents is recorded at various times after mixing.

The graph shows the results.




The two solutions could be

**(a)** aqueous copper(II) sulfate and aqueous ammonia. ☐

**(b)** aqueous sodium carbonate and dilute nitric acid. ☐

**(c)** aqueous potassium hydroxide and aqueous zinc sulfate. ☐

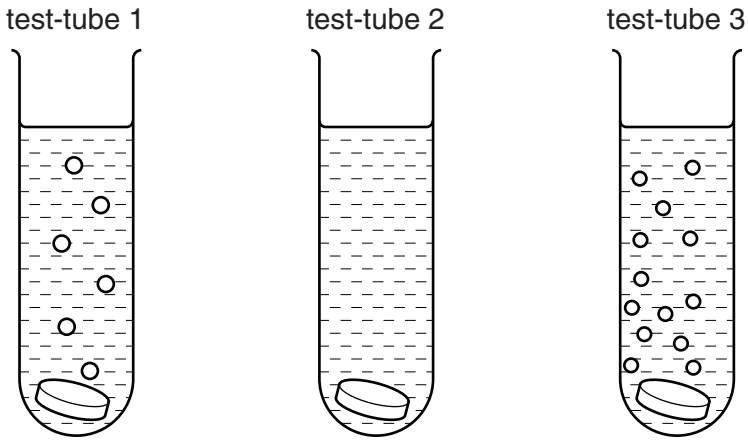
**(d)** aqueous sodium hydroxide and dilute hydrochloric acid. ☐

[Total: 1]

**5** A student does an experiment in which three different metals are placed separately in test-tubes containing hydrochloric acid.

The diagrams below show the test-tubes during the experiments.

Which metal is placed in each test-tube?




| | test-tube 1 | test-tube 2 | test-tube 3 | |
|---|---|---|---|---|
| **(a)** | iron | silver | magnesium | ☐ |
| **(b)** | iron | magnesium | silver | ☐ |
| **(c)** | magnesium | silver | iron | ☐ |
| **(d)** | silver | iron | magnesium | ☐ |

[Total: 1]

**6** A student decomposes aqueous hydrogen peroxide using manganese(IV) oxide, $MnO_2$, as a catalyst.

The equation for the reaction is

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

$100\,cm^3$ of hydrogen peroxide is allowed to completely decompose and $120\,cm^3$ of oxygen is produced.
[One mole of a gas occupies $24\,000\,cm^3$ at room temperature and pressure.]

The concentration of the hydrogen peroxide is

**(a)** $0.01\,mol/dm^3$ ☐

**(b)** $0.10\,mol/dm^3$ ☐

**(c)** $0.05\,mol/dm^3$ ☐

**(d)** $0.50\,mol/dm^3$ ☐

[Total: 1]

**7** A student is given a sample of a carbonate, $\mathbf{M}_2CO_3$, where **M** is a metal.
He is asked to determine the relative atomic mass of **M**.

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

| | | |
|---|---|---|
| mass of beaker + $\mathbf{M}_2CO_3$ | = | 7.69 g |
| mass of beaker | = | 5.99 g |

Calculate the mass of $\mathbf{M}_2CO_3$.

..... g [1]

**(b)** The student transfers the sample of $\mathbf{M}_2CO_3$ to a beaker and adds $50.0\,cm^3$ of $1.00\,mol/dm^3$ hydrochloric acid (an excess).

A gas is produced.

Name the gas and describe a test for this gas.

gas .....

test .....[2]

**(c)** When the reaction has finished, the solution in the beaker is transferred to a volumetric flask and made up to 250 $cm^3$ with distilled water. This is solution **G**.

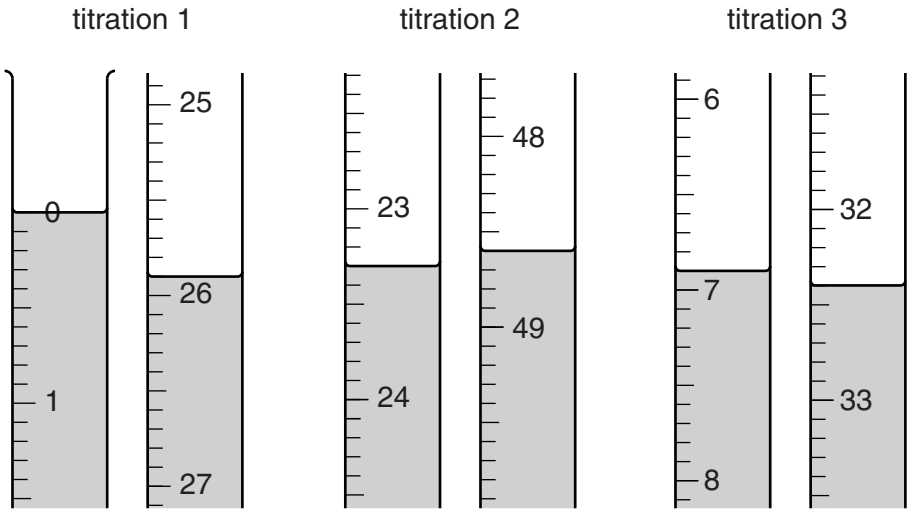
Using a pipette, 25.0 $cm^3$ of **G** is transferred to a conical flask and a few drops of methyl orange indicator are added.

A burette is filled with 0.100 $mol/dm^3$ sodium hydroxide. Aqueous sodium hydroxide is run into the conical flask until an end-point is reached.

What is the colour change of the methyl orange during the titration?

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

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.




**(d)** Use the diagrams to complete the following table.

| titration number | 1 | 2 | 3 |
|---|---|---|---|
| final reading / $cm^3$ | | | |
| initial 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]

**(e)** Calculate the number of moles of sodium hydroxide in the average volume of 0.100 mol / $dm^3$ sodium hydroxide in **(d)**.

..... moles [1]

**(f)** Using the equation, calculate the number of moles of hydrochloric acid in 25.0 $cm^3$ of **G**.

$$NaOH + HCl \rightarrow NaCl + H_2O$$

..... moles [1]

**(g)** Calculate the number of moles of hydrochloric acid in 250 $cm^3$ of **G**.

..... moles [1]

**(h)** Calculate the number of moles of hydrochloric acid contained in the original 50.0 $cm^3$ of 1.00 mol / $dm^3$ hydrochloric acid.

..... moles [1]

**(i)** By subtracting your answer in **(g)** from your answer in **(h)**, calculate the number of moles of hydrochloric acid that reacts with the sample of $\mathbf{M}_2CO_3$.

..... moles [1]

**(j)** Using the equation, calculate the number of moles of $\mathbf{M}_2CO_3$ that reacts with the number of moles of hydrochloric acid in your answer in **(i)**.

$$\mathbf{M}_2CO_3 + 2HCl \rightarrow 2\mathbf{M}Cl + CO_2 + H_2O$$

..... moles [1]

**(k)** Using your answers in **(a)** and **(j)** calculate the relative formula mass of $\mathbf{M}_2CO_3$ and hence the relative atomic mass of **M**.
[$A_r$: C, 12; O, 16]

relative formula mass of $\mathbf{M}_2CO_3$ .....

relative atomic mass of **M** ..... [2]

[Total: 16]

**8** **H** is a compound which contains three ions.

Complete the table by adding the conclusion for **(a)**, the observations for **(b)(i)**, **(ii)** and **(iii)**, and both the test and observation for **(c)**. Any gas evolved should be tested and named.

| test | observations | conclusions |
|---|---|---|
| **(a)** **H** is dissolved in water and the resulting solution divided into two parts for use in tests **(b)** and **(c)**. | A coloured solution is formed. | |
| **(b)** **(i)** To the first part, aqueous sodium hydroxide is added until a change is seen. | | **H** contains $Fe^{2+}$ ions. |
| **(ii)** An excess of aqueous sodium hydroxide is added to the mixture from **(i)**. | | **H** contains $Fe^{2+}$ ions. |
| **(iii)** This mixture is warmed. | | **H** contains $NH_4^+$ ions. |
| **(c)** | | **H** contains $SO_4^{2-}$ ions. |

[Total: 8]

**Question 9 begins on page 14.**

**9** The reaction between aqueous solutions of silver nitrate and potassium iodide produces a precipitate of silver iodide.

**(a)** State the colour of this precipitate.

..... [1]

A series of experiments are done to find the mass of precipitate when different volumes of aqueous silver nitrate are added to a fixed volume of aqueous potassium iodide.

Solution **J** is 1.00 mol / $dm^3$ potassium iodide.
Solution **K** is aqueous silver nitrate of unknown concentration.

10.0 $cm^3$ of **J** is put into each of six test-tubes. Increasing volumes of **K** are added to each test-tube.

The mixtures are filtered and the precipitates washed with water, dried and placed in previously weighed containers which are reweighed.

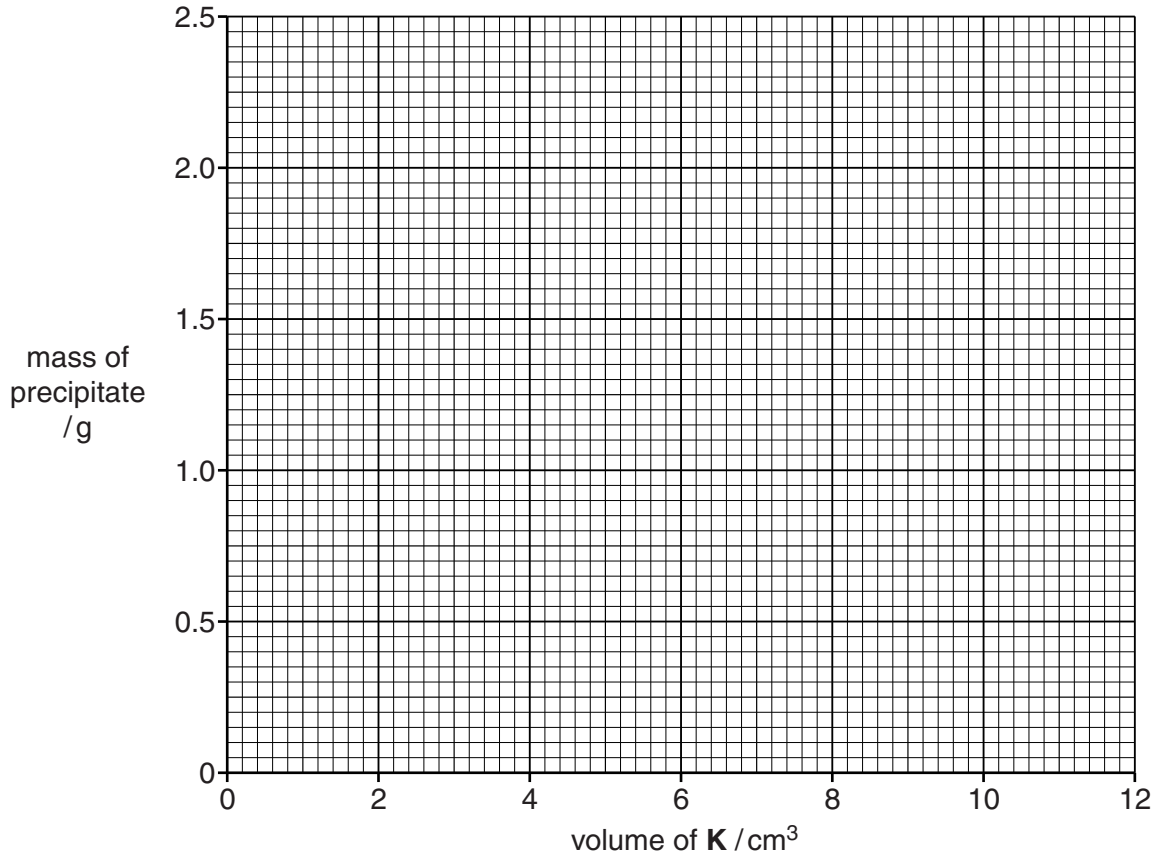
**(b)** The table below shows the results of these experiments.

Complete the final column.

| volume of **J** / $cm^3$ | volume of **K** / $cm^3$ | mass of empty container / g | mass of container + precipitate / g | mass of precipitate / g |
|---|---|---|---|---|
| 10.0 | 2.0 | 3.20 | 3.84 | |
| 10.0 | 4.0 | 3.20 | 4.47 | |
| 10.0 | 6.0 | 3.20 | 5.11 | |
| 10.0 | 8.0 | 3.20 | 5.55 | |
| 10.0 | 10.0 | 3.20 | 5.55 | |
| 10.0 | 12.0 | 3.20 | 5.55 | |

[1]

**(c)** On the grid, plot the mass of precipitate against the volume of **K**. Using these points, draw two intersecting straight lines.




[3]

**(d)** Using the graph deduce

**(i)** the volume of **K** which would produce 1.00 g of precipitate,

..... $cm^3$ [1]

**(ii)** the maximum mass of precipitate that is produced,

.....g [1]

**(iii)** the minimum volume of **K** which produces the maximum mass in **(ii)**.

..... $cm^3$ [1]

**(e)** Construct an equation for the reaction between potassium iodide and silver nitrate.

.....[1]

**(f)** **J** is 1.00 mol / $dm^3$ potassium iodide.

Using your answers to **(d)(iii)** and **(e)**, calculate the concentration of the silver nitrate in **K**.

..... mol / $dm^3$ [1]

**(g)** The student repeats the experiment, substituting 10.0 $cm^3$ of 1.00 mol / $dm^3$ potassium chloride for 10.0 $cm^3$ of 1.00 mol / $dm^3$ potassium iodide.

Calculate the maximum mass of silver chloride produced.
[$A_r$: C*l*, 35.5; Ag, 108]

.....g [2]

[Total: 12]