Cambridge Assessment International Education

# Cambridge IGCSE™ (9–1)

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

*4678186681*

**CHEMISTRY** **0971/62**

Paper 6 Alternative to Practical **October/November 2023**

**1 hour**

You must answer on the question paper.

No additional materials are needed.

**INSTRUCTIONS**

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

**INFORMATION**

- The total mark for this paper is 40.
- The number of marks for each question or part question is shown in brackets [ ].
- Notes for use in qualitative analysis are provided in the question paper.

This document has **16** pages. Any blank pages are indicated.

**1** Some seashells contain a mixture of the insoluble compounds calcium carbonate and silicon(IV) oxide only.

Calcium carbonate reacts with dilute hydrochloric acid to form the soluble salt calcium chloride. Silicon(IV) oxide does **not** react with or dissolve in dilute hydrochloric acid.

A student wants to find the percentage of silicon(IV) oxide in a seashell. The first four steps of the method the student uses are shown.

**step 1** The student grinds the seashell to form a powder.

**step 2** The student finds the mass of the powdered seashell.

**step 3** The student adds the powdered seashell to an excess of dilute hydrochloric acid and heats while stirring with a glass rod as shown in Fig. 1.1.

**step 4** The student filters the mixture as shown in Fig. 1.2.

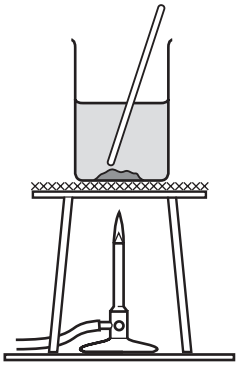

**Fig. 1.1**

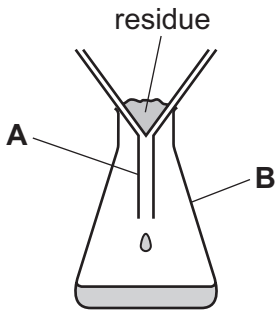


**Fig. 1.2**

**(a)** Name the apparatus used to grind the seashell to form a powder in **step 1**.

..... [1]

**(b)** Explain why it is important that the dilute hydrochloric acid is in excess in **step 3**.

.....

..... [1]

**(c)** Name the items of apparatus labelled **A** and **B** in Fig. 1.2.

**A** .....

**B** .....

[2]

**(d)** The residue obtained in **step 4** is not pure.

**(i)** Identify **one** substance, other than water, that is in the residue and prevents it from being pure.

..... [1]

**(ii)** The student washes the residue.

Describe **two** additional steps the student must now take to find the percentage of silicon(IV) oxide in the seashell.

.....

.....

.....

..... [2]

[Total: 7]

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**2** A student investigates the temperature change when aqueous sodium hydroxide neutralises dilute hydrochloric acid. The equation for the reaction is shown.

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

The student does six experiments.

Experiment 1

- Fill a burette with dilute hydrochloric acid.
- Run some of the dilute hydrochloric acid out of the burette so that the level of the dilute hydrochloric acid is on the burette scale.
- Fill a second burette with aqueous sodium hydroxide.
- Run some of the aqueous sodium hydroxide out of the burette so that the level of the aqueous sodium hydroxide is on the burette scale.
- Run 1.0 $cm^3$ of dilute hydrochloric acid from the burette into a boiling tube.
- Run 9.0 $cm^3$ of aqueous sodium hydroxide from the second burette into the same boiling tube.
- Stir the mixture with a thermometer and measure the highest temperature reached.
- Measure the pH of the mixture in the boiling tube.
- Rinse out the boiling tube with distilled water.

Experiment 2

- Run 2.0 $cm^3$ of dilute hydrochloric acid from the burette into the boiling tube.
- Run 8.0 $cm^3$ of aqueous sodium hydroxide from the second burette into the same boiling tube.
- Stir the mixture with a thermometer and measure the highest temperature reached.
- Measure the pH of the mixture in the boiling tube.
- Rinse out the boiling tube with distilled water.

Experiment 3

- Repeat Experiment 2 using 3.0 $cm^3$ of dilute hydrochloric acid and 7.0 $cm^3$ of aqueous sodium hydroxide.

Experiment 4

- Repeat Experiment 2 using 6.0 $cm^3$ of dilute hydrochloric acid and 4.0 $cm^3$ of aqueous sodium hydroxide.

Experiment 5

- Repeat Experiment 2 using 7.0 $cm^3$ of dilute hydrochloric acid and 3.0 $cm^3$ of aqueous sodium hydroxide.

Experiment 6

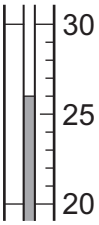
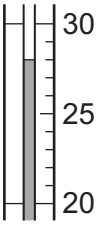
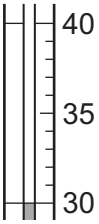
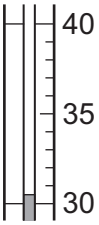
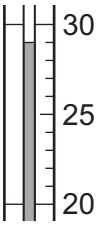
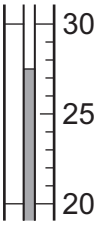
- Repeat Experiment 2 using 8.0 $cm^3$ of dilute hydrochloric acid and 2.0 $cm^3$ of aqueous sodium hydroxide.



**[Turn over**

**(a)** Use the description of the experiments and the thermometer diagrams to complete Table 2.1.

**Table 2.1**

| experiment | volume of dilute hydrochloric acid / $cm^3$ | volume of aqueous sodium hydroxide / $cm^3$ | thermometer diagram when highest temperature reached | highest temperature reached / °C | pH |
|---|---|---|---|---|---|
| 1 | 1.0 | |   | | 11 |
| 2 | 2.0 | |   | | 11 |
| 3 | 3.0 | |   | | 11 |
| 4 | 6.0 | |   | | 1 |
| 5 | 7.0 | |   | | 1 |
| 6 | 8.0 | |   | | 1 |

[4]

**(b)** Add a suitable scale to the *y*-axis in Fig. 2.1. **Your scale should extend by 2 °C above your highest temperature in Table 2.1.**
Plot your results from Experiments 1 to 6 on the grid.
Draw **two** straight lines through your points, one through the first three points and one through the last three points. Extend your straight lines so that they cross.

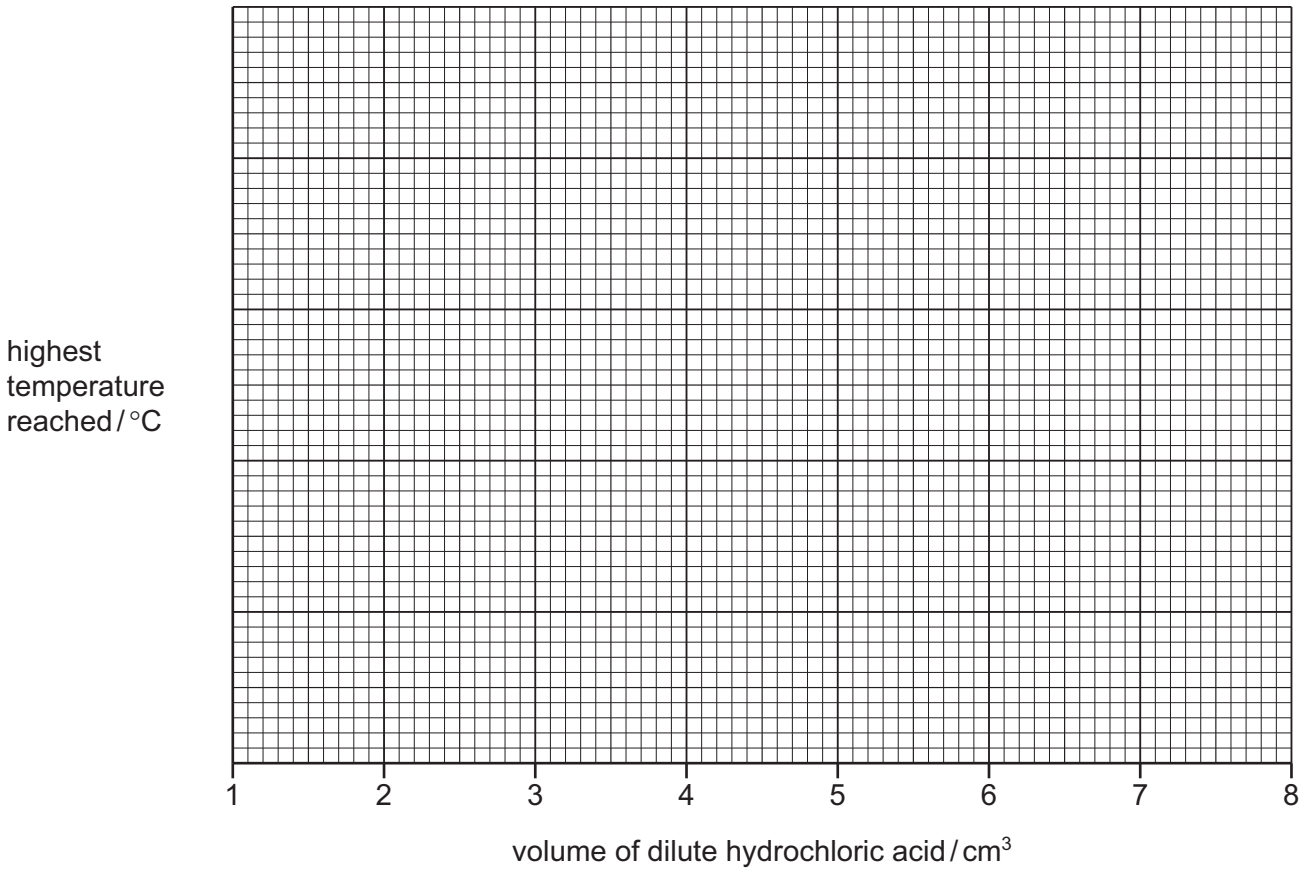



**Fig. 2.1**

[5]

**(c)** The point on the graph where the two straight lines cross is where all of the aqueous sodium hydroxide reacts with all of the dilute hydrochloric acid to form a neutral solution.

**(i)** **Use your graph** in Fig. 2.1 to deduce the volume of dilute hydrochloric acid and the volume of aqueous sodium hydroxide that react together to produce a neutral solution.
Show your working **on Fig. 2.1**.

volume of dilute hydrochloric acid = ..... $cm^3$

volume of aqueous sodium hydroxide = ..... $cm^3$
[3]

**(ii)** Predict the pH of the solution in the boiling tube when the volumes in **(c)(i)** are mixed together.

pH = ..... [1]



**[Turn over**

**(iii)** Deduce which solution, dilute hydrochloric acid or aqueous sodium hydroxide, is the most concentrated.

Use your answer to **(c)(i)** to explain why.

most concentrated solution .....

explanation .....

.....

[1]

**(d)** State how the pH and temperature recorded in each experiment would differ, if at all, if a polystyrene cup is used in place of the boiling tube.

Explain any differences.

pH .....

temperature .....

explanation .....

.....

[3]

**(e)** The volumes of the solutions used in these experiments were measured using a burette.

Explain why a volumetric pipette could **not** be used instead of a burette in this experiment.

..... [1]

[Total: 18]

**3** A student tests two substances: solid **K** and solid **L**.

**Tests on solid K**

The student dissolves solid **K** in water to form solution **K**. The student divides solution **K** into four portions.
Table 3.1 shows the tests and the student's observations for solution **K**.

**Table 3.1**

| tests | observations |
|---|---|
| **test 1**<br><br>To the first portion of solution **K**, add a few drops of aqueous ammonia. | white precipitate |
| **test 2**<br><br>To the second portion of solution **K**, add a few drops of acidified aqueous potassium manganate(VII). | pale purple solution |
| **test 3**<br><br>To the third portion of solution **K**, add 1 $cm^3$ of dilute nitric acid followed by a few drops of aqueous silver nitrate. | cream precipitate |
| **test 4**<br><br>To the fourth portion of solution **K**, add aqueous chlorine. | the solution becomes orange |

**(a) (i)** Identify **two** cations that **test 1** shows could be in solid **K**.

.....

..... [2]

**(ii)** Describe an additional test that could be carried out on solution **K** to confirm which of the two cations you have identified in **(a)(i)** is in solid **K**.

Explain how the test will show which of these two cations is in solid **K**.

test .....

explanation .....

.....
[2]

**(b)** Identify the anion in solid **K**.

..... [1]

**Tests on solid L**

Solid **L** is barium nitrate.

Complete the expected observations.

**(c)** The student carries out a flame test on solid **L**.

observations ..... [1]

The student dissolves the remaining solid **L** in water to form solution **L**.

The student divides solution **L** into three portions.

**(d)** To the first portion of solution **L**, the student adds a piece of aluminium foil and 5 $cm^3$ of aqueous sodium hydroxide and warms the mixture. The student tests for any gas produced.

observations .....

..... [1]

**(e)** To the second portion of solution **L**, the student adds 1 $cm^3$ of dilute nitric acid and a few drops of aqueous silver nitrate.

observations .....

..... [1]

**(f)** To the third portion of solution **L**, the student adds 1 $cm^3$ of dilute sulfuric acid.

observations .....

..... [1]

[Total: 9]

**4** The solubility of solid sodium sulfate in water changes as the temperature of the water changes.

Plan an experiment to find out how the solubility of sodium sulfate in water changes with temperature.

You are provided with sodium sulfate, distilled water and common laboratory apparatus.

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..... [6]

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**Notes for use in qualitative analysis**

**Tests for anions**

| anion | test | test result |
|---|---|---|
| carbonate, $CO_3^{2-}$ | add dilute acid, then test for carbon dioxide gas | effervescence, carbon dioxide produced |
| chloride, $Cl^-$ [in solution] | acidify with dilute nitric acid, then add aqueous silver nitrate | white ppt. |
| bromide, $Br^-$ [in solution] | acidify with dilute nitric acid, then add aqueous silver nitrate | cream ppt. |
| iodide, $I^-$ [in solution] | acidify with dilute nitric acid, then add aqueous silver nitrate | yellow ppt. |
| nitrate, $NO_3^-$ [in solution] | add aqueous sodium hydroxide, then aluminium foil; warm carefully | ammonia produced |
| sulfate, $SO_4^{2-}$ [in solution] | acidify with dilute nitric acid, then add aqueous barium nitrate | white ppt. |
| sulfite, $SO_3^{2-}$ | add a small volume of acidified aqueous potassium manganate(VII) | the acidified aqueous potassium manganate(VII) changes colour from purple to colourless |

**Tests for aqueous cations**

| cation | effect of aqueous sodium hydroxide | effect of aqueous ammonia |
|---|---|---|
| aluminium, $Al^{3+}$ | white ppt., soluble in excess, giving a colourless solution | white ppt., insoluble in excess |
| ammonium, $NH_4^+$ | ammonia produced on warming | – |
| calcium, $Ca^{2+}$ | white ppt., insoluble in excess | no ppt. or very slight white ppt. |
| chromium(III), $Cr^{3+}$ | green ppt., soluble in excess | green ppt., insoluble in excess |
| copper(II), $Cu^{2+}$ | light blue ppt., insoluble in excess | light blue ppt., soluble in excess, giving a dark blue solution |
| iron(II), $Fe^{2+}$ | green ppt., insoluble in excess, ppt. turns brown near surface on standing | green ppt., insoluble in excess, ppt. turns brown near surface on standing |
| iron(III), $Fe^{3+}$ | red-brown ppt., insoluble in excess | red-brown ppt., insoluble in excess |
| zinc, $Zn^{2+}$ | white ppt., soluble in excess, giving a colourless solution | white ppt., soluble in excess, giving a colourless solution |

## Tests for gases

| gas | test and test result |
|---|---|
| ammonia, $NH_3$ | turns damp red litmus paper blue |
| carbon dioxide, $CO_2$ | turns limewater milky |
| chlorine, $Cl_2$ | bleaches damp litmus paper |
| hydrogen, $H_2$ | ‘pops’ with a lighted splint |
| oxygen, $O_2$ | relights a glowing splint |
| sulfur dioxide, $SO_2$ | turns acidified aqueous potassium manganate(VII) from purple to colourless |

## Flame tests for metal ions

| metal ion | flame colour |
|---|---|
| lithium, $Li^+$ | red |
| sodium, $Na^+$ | yellow |
| potassium, $K^+$ | lilac |
| calcium, $Ca^{2+}$ | orange-red |
| barium, $Ba^{2+}$ | light green |
| copper(II), $Cu^{2+}$ | blue-green |