Cambridge Assessment International Education

# Cambridge IGCSE™ (9–1)

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

*7945567173*

**CHEMISTRY** **0971/51**

Paper 5 Practical Test **May/June 2021**

**1 hour 15 minutes**

You must answer on the question paper.

You will need: The materials and apparatus listed in the confidential instructions

**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.

| For Examiner's Use | |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| Total | |

This document has **12** pages. Any blank pages are indicated.

**1** You are going to investigate the temperature decrease when sodium hydrogencarbonate reacts with dilute hydrochloric acid.

**Read all of the instructions carefully before starting the experiments.**

**Instructions**
You are going to do six experiments.

**(a)** *Experiment 1*

- Use a measuring cylinder to pour 25 $cm^3$ of dilute hydrochloric acid into a conical flask.
- Use a thermometer to measure the initial temperature of the acid. Record the initial temperature in the table.
- Add the 1 g sample of sodium hydrogencarbonate to the conical flask. At the same time start the stop-clock.
- Continually stir the acid and sodium hydrogencarbonate mixture in the conical flask using the thermometer.
- Measure the temperature reached by the mixture after 1 minute. Record the temperature of the mixture in the table.
- Calculate and record the temperature decrease in the table.
- Rinse the conical flask with distilled water.

*Experiment 2*

- Repeat Experiment 1 using 2 g of sodium hydrogencarbonate instead of 1 g.

*Experiment 3*

- Repeat Experiment 1 using 3 g of sodium hydrogencarbonate instead of 1 g.

*Experiment 4*

- Repeat Experiment 1 using 5 g of sodium hydrogencarbonate instead of 1 g.

*Experiment 5*

- Repeat Experiment 1 using 6 g of sodium hydrogencarbonate instead of 1 g.

*Experiment 6*

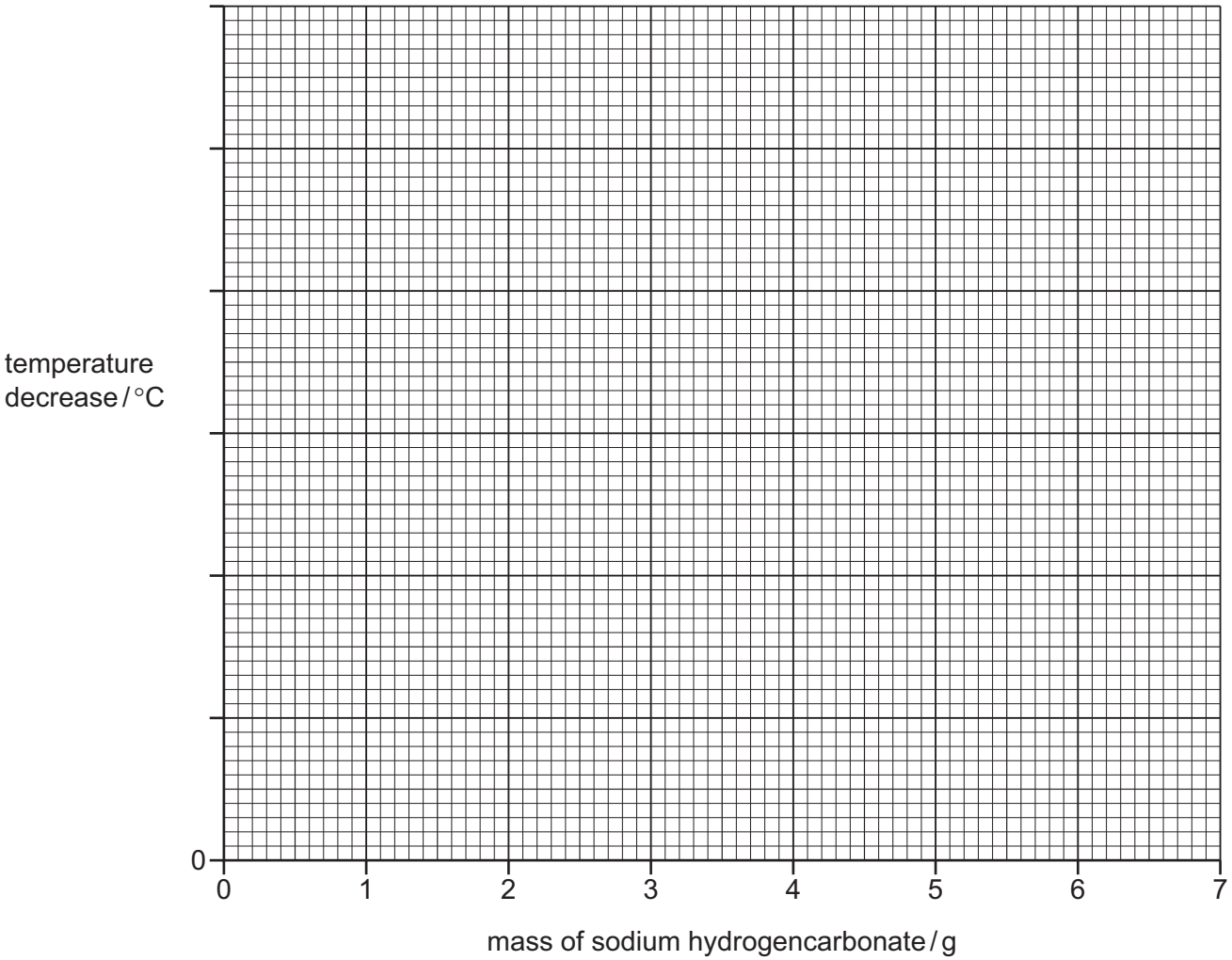
- Repeat Experiment 1 using 7 g of sodium hydrogencarbonate instead of 1 g.

| experiment | mass of sodium hydrogencarbonate / g | initial temperature / °C | temperature after 1 minute / °C | temperature decrease / °C |
|---|---|---|---|---|
| 1 | 1 | | | |
| 2 | 2 | | | |
| 3 | 3 | | | |
| 4 | 5 | | | |
| 5 | 6 | | | |
| 6 | 7 | | | |

[4]

**(b)** Complete a suitable scale on the *y*-axis and plot your results from Experiments 1 to 6 on the grid.

Draw **two** best-fit straight lines through your points. The first straight line should be for the first three points and must pass through (0,0). The second straight line should be for the last three points and must be horizontal. Extend your straight lines so that they meet each other.




[5]

**(c) (i)** **From your graph**, determine the temperature decrease and mass of sodium hydrogencarbonate where your two straight lines meet. Include appropriate units in your answer.

Show clearly **on the grid** how you worked out your answer.

temperature decrease = .....

mass of sodium hydrogencarbonate = .....

[3]

**(ii)** Explain why the temperature decrease becomes constant for high masses of sodium hydrogencarbonate.

.....

..... [1]



**[Turn over**

**(d)** The investigation could be repeated with dilute hydrochloric acid of half the concentration, but the same volume.

Sketch **on the grid** the graph you would expect to obtain.

Label your line **D**. [2]

**(e)** Suggest **two** changes that could be made to the apparatus that would improve the accuracy of the results. For each change explain why it would improve the accuracy of the results.

change 1 .....

explanation 1 .....

.....

change 2 .....

explanation 2 .....

.....

[4]

[Total: 19]

**2** You are provided with one solid, solid **E**, and one solution, solution **F**.
Do the following tests on the substances, recording all of your observations at each stage.

**tests on solid E**

**(a)** Place about half of solid **E** in a hard-glass test-tube. Heat the solid gently for about 30 seconds.
Record your observations.

.....

.....

..... [2]

Transfer the remaining solid **E** to a boiling tube. Add about 10 $cm^3$ of distilled water to the boiling tube.
Place a stopper in the boiling tube and shake the tube to dissolve solid **E** and form solution **E**.
Divide solution **E** into three approximately equal portions in two test-tubes and one boiling tube.

**(b)** To the first portion of solution **E** in a test-tube, add about 1 cm depth of dilute nitric acid followed by a few drops of aqueous barium nitrate.
Record your observations.

..... [1]

**(c)** To the second portion of solution **E** in a test-tube, add excess aqueous ammonia.
Record your observations.

..... [1]

**(d)** To the third portion of solution **E** in the boiling tube, add aqueous sodium hydroxide dropwise and then in excess.

**Keep the product for use in (e).**

Record your observations.

.....

.....

..... [2]

**(e)** Gently warm the product from **(d)**. Test any gas produced.
Record your observations.

.....

..... [1]



**[Turn over**

**(f)** Identify the **three** ions contained in solid **E**.

.....

..... [3]

**tests on solution F**

**(g)** Carry out a flame test on solution **F**.
Record your observations.

..... [1]

**(h)** Divide the remaining solution **F** into two approximately equal portions in two test-tubes.

**(i)** To the first portion of solution **F** add a few drops of universal indicator solution.
Record your observations.

.....

..... [1]

**(ii)** To the second portion of solution **F** add approximately 2 cm depth of aqueous copper(II) sulfate.
Record your observations.

.....

..... [1]

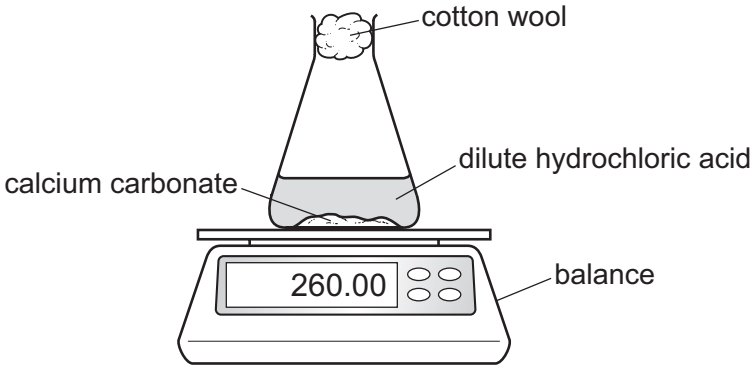
**(i)** Identify solution **F**.

.....

..... [2]

[Total: 15]

**3** Dilute hydrochloric acid reacts with calcium carbonate to make carbon dioxide gas. The apparatus shown in the diagram can be used to follow the progress of the reaction. The carbon dioxide gas leaves the flask causing the mass shown on the balance to decrease.




Plan an investigation, using the apparatus shown in the diagram, to find out how the temperature of the dilute hydrochloric acid affects the rate of the reaction. Your plan should include how your results will show how the temperature of the dilute hydrochloric acid affects the rate of the reaction.

You are provided with dilute hydrochloric acid, calcium carbonate 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 | 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, then add aqueous barium nitrate | white ppt. |
| sulfite ($SO_3^{2-}$) | add dilute hydrochloric acid, warm gently and test for the presence of sulfur dioxide | sulfur dioxide produced will turn acidified aqueous potassium manganate(VII) 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 | grey-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 | green ppt., insoluble in excess |
| 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 |
| copper(II) ($Cu^{2+}$) | blue-green |