Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

0123456789

COMBINED SCIENCE **5129/03**

Paper 3 Experimental Skills and Investigations **For examination from 2023**

SPECIMEN PAPER **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 [ ].

1 The enzyme catalase breaks down hydrogen peroxide into water and oxygen gas.

hydrogen peroxide $\rightarrow$ water + oxygen

The bubbles of oxygen produced during the reaction form a foam on the surface of the solution.

A student investigates the effect of pH on catalase activity.

The student:
- places 5 cm^3 of hydrogen peroxide solution at pH 5 into a test-tube
- adds 2 cm^3 of catalase solution
- measures the height of the foam formed after 30 seconds.

The result of the experiment is shown in Fig. 1.1. The higher the foam, the more oxygen gas has been produced.

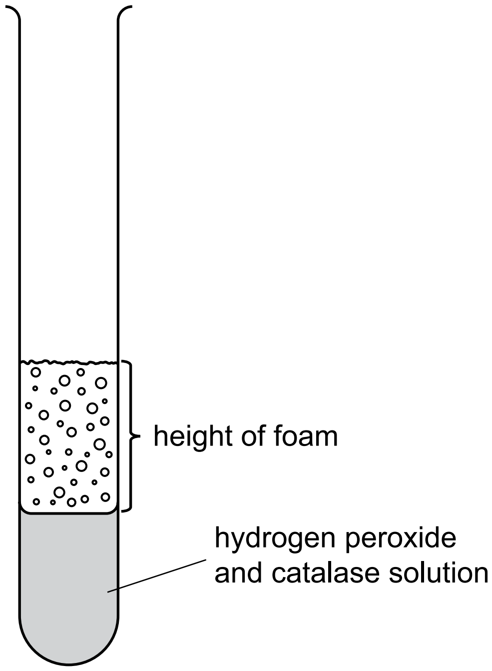

Fig. 1.1

The student repeats the method using hydrogen peroxide solution at pH 6, pH 7, pH 8 and pH 9.

The results are shown in Fig. 1.2.

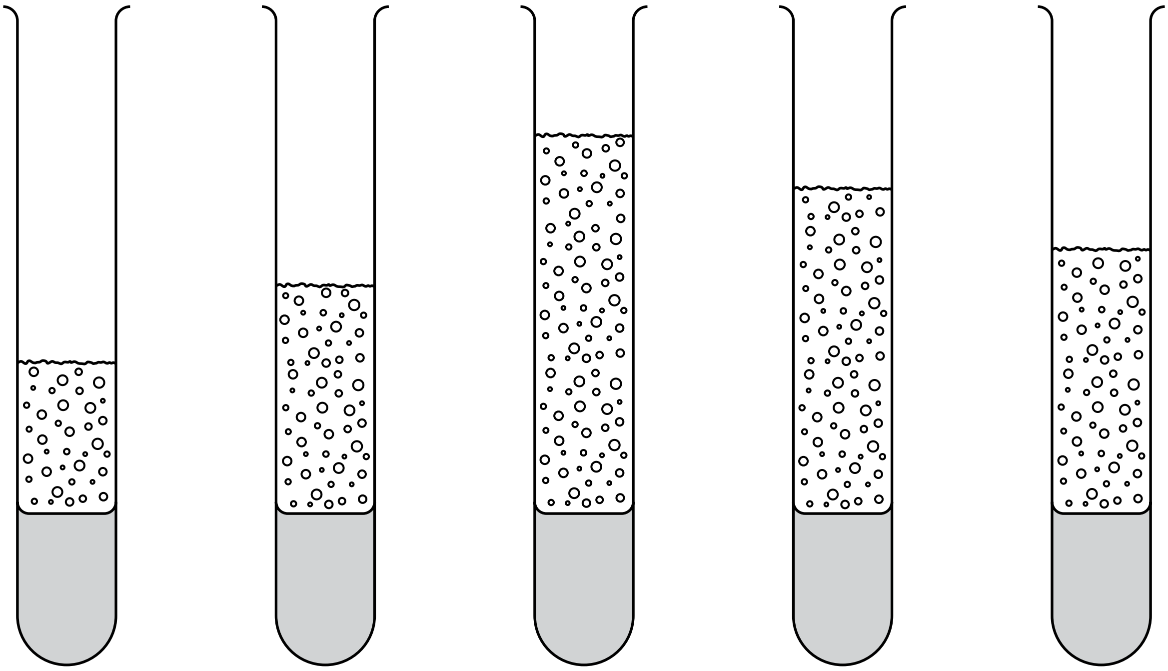

Fig. 1.2

(a) Prepare a table to record the height of the foam produced at each pH.

On Fig. 1.2 measure the height of the foam on the top of the solution in each test-tube.

Record your results in the table.

[4]

The student uses a water-bath to keep all of the test-tubes at the same temperature throughout the investigation.

(b) State the name of the apparatus that the student uses to **measure** the temperature of the solutions.

.... [1]

(c) Temperature and the volumes of solutions are variables that are kept constant.

State **two** other variables that need to be kept constant in this investigation.

1 ....

2 ....
[2]

(d) Use your results in **(a)** to describe how the activity of catalase is affected by changes in pH.

....

....

....

.... [2]

(e) Catalase is a protein.

State the chemical test for a protein and the observation for a positive result.

test ....

observation ....
[2]

[Total: 11]

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2 **(a)** A student has four aqueous solutions **A**, **B**, **C** and **D**.

Each solution contains only one of the following compounds:

K_2CO_3 NaBr NaC*l* Na_2CO_3

The student tests the four solutions to identify the compound in each solution.

The student:

- places 5 cm^3 of **A** in a test-tube
- adds 1 cm^3 of dilute nitric acid
- adds a few drops of aqueous silver nitrate to the same test-tube
- records the observations in Table 2.1
- repeats the process using **B**, **C** and **D** instead of **A**.

Table 2.1

test	observations			
	A	**B**	**C**	**D**
dilute nitric acid	effervescence	no change	no change	effervescence
aqueous silver nitrate	no change	white precipitate	cream precipitate	no change

(i) Deduce the identity of the compound in **B** and the compound in **C**.

B ....

C .... [2]

(ii) State a test to distinguish between the sodium and potassium ions.

Give the observation for each ion.

test ....

observations ....

.... [2]

(b) The student wants to use solid copper carbonate to prepare a pure dry sample of copper sulfate crystals.

Copper carbonate is insoluble in water.

The student measures 25 cm^3 of dilute sulfuric acid and adds it to a beaker.

(i) Name a piece of apparatus used to measure the volume of the dilute sulfuric acid.

.... [1]

The student adds copper carbonate to the dilute sulfuric acid in the beaker and stirs the mixture.

The student stops adding copper carbonate when it is in excess.

(ii) Explain why the student stirs the mixture.

.... [1]

(iii) Describe how the student knows when an excess of copper carbonate has been added.

.... [1]

The student filters the mixture and collects the filtrate.

(iv) Draw a diagram of the apparatus used to filter the mixture.

Label the apparatus.

[2]

The student:

- heats the filtrate until half the water has evaporated
- leaves the filtrate to cool
- removes the crystals that form.

(v) Suggest an additional step that improves the purity of the crystals.

Explain why this step is needed.

step ....

explanation ....

....
[2]

[Total: 11]

3 A student uses different loads to investigate the extension of a spring.

(a) Fig. 3.1 is a full-sized diagram of the spring before it is extended.

Measure the length l_1 of the spring shown in Fig. 3.1.

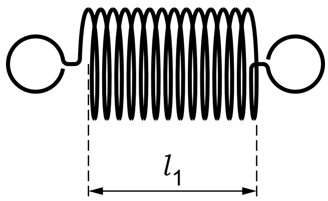

Fig. 3.1

l_1 = ... mm [1]

(b) The student attaches one end of the spring to a stand and the other end to a force meter as shown in Fig. 3.2.

The student extends the spring by pulling the force meter in the direction shown.

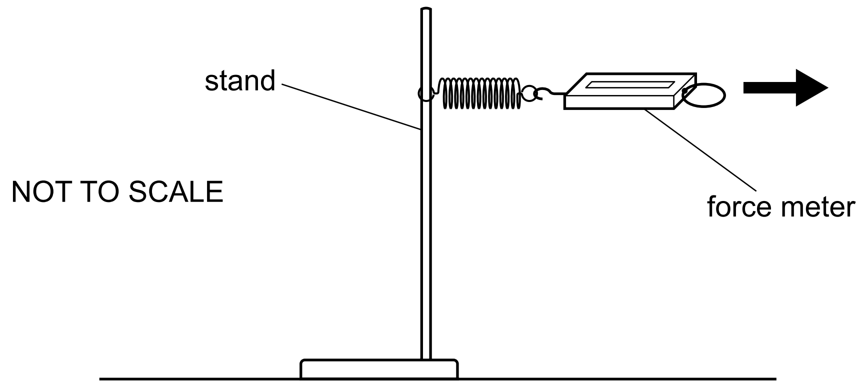

Fig. 3.2

(i) Describe one hazard when using the apparatus arranged as shown in Fig. 3.2.

....

.... [1]

(ii) Describe how to change the arrangement of the apparatus to remove the hazard described in **(b)(i)**.

....

.... [1]

(c) The student changes the apparatus so that it can be used safely.

He uses the force meter to apply a force F on the spring.

(i) Fig. 3.3 is a full-sized diagram of the extended spring.

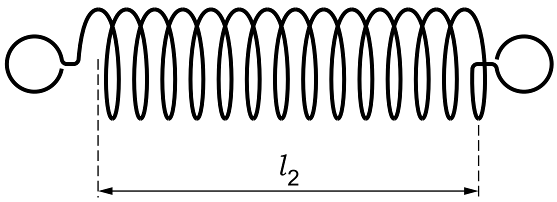

Fig. 3.3

Measure and record the extended length l_2 of the spring.

Calculate the extension x of the spring using the equation:

$$x = l_2 - l_1$$

Show your working.

l_2 = ... mm

x = ... mm
[2]

(ii) Fig. 3.4 shows the reading on the scale of the force meter due to the force F applied to the spring.

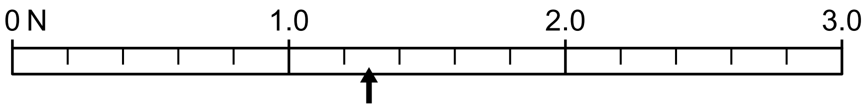

Fig. 3.4

Determine the force F.

F = ... N [1]

(iii) Use the equation:

$$k = \frac{F}{x}$$

and your values of x from **(c)(i)** and F from **(c)(ii)** to calculate the spring constant k.

Give your answer to an appropriate number of significant figures.

k = ... N / mm [2]

(d) The student repeats the experiment using a different spring.

He varies the force and measures each extension of the spring.

He plots a graph of his results as shown in Fig. 3.5.

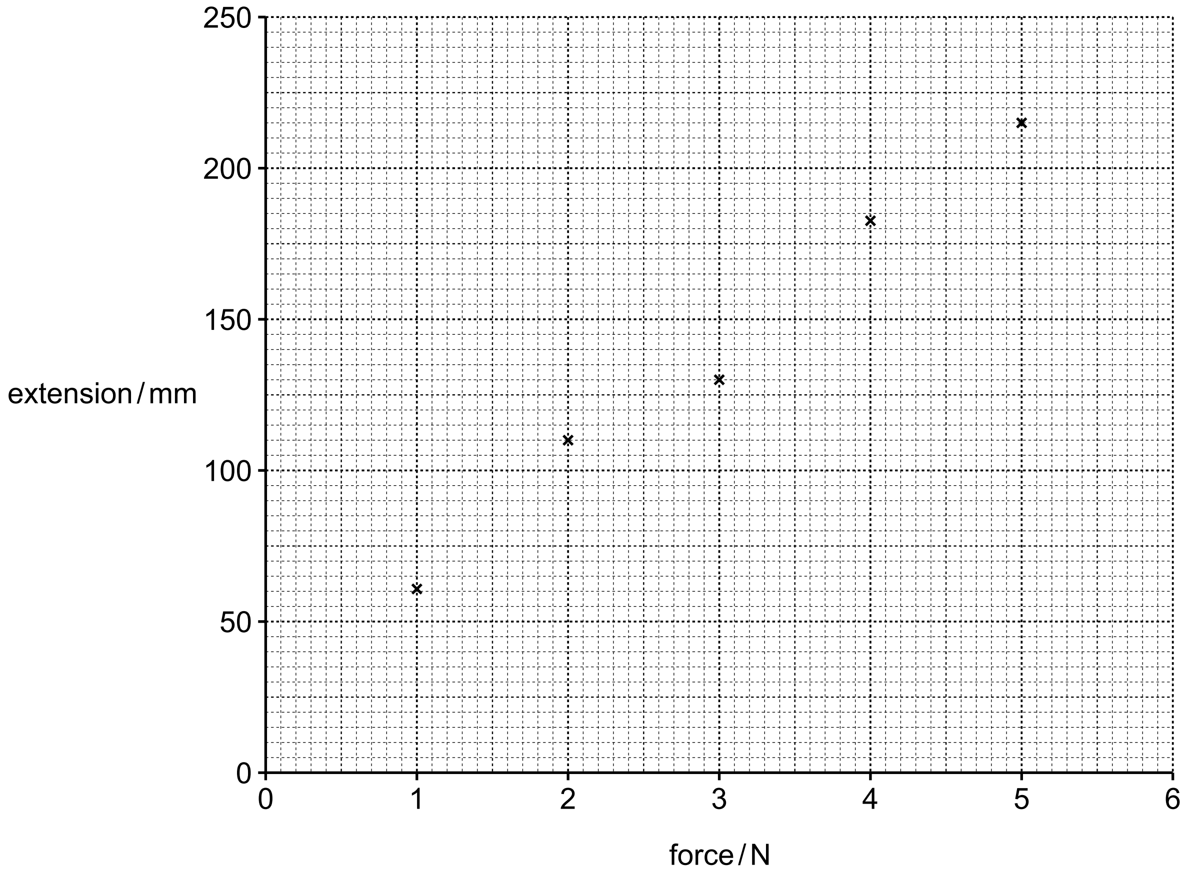

Fig. 3.5

(i) On Fig. 3.5, draw the straight line of best fit.

Your line must pass through (0, 0). [1]

(ii) Calculate the gradient of the line of best fit.

On Fig. 3.5, show the method that you use to determine the gradient.

Show your calculation.

gradient = ... [2]

[Total: 11]

4 When solid sodium hydroxide is added to water, it dissolves and the temperature of the solution rises.

A student states: 'As the mass of sodium hydroxide added to the water is increased, the temperature rise also increases.'

Plan an investigation to test whether this statement is correct.

You are provided with solid sodium hydroxide which is corrosive, an insulated cup and common laboratory apparatus.

Include in your answer:

- the apparatus you will use
- a brief description of the method, including any safety precautions
- the measurements you will make
- what you will keep constant and what you will change
- how you will use your results to draw a conclusion.

A diagram of apparatus and a results table are not required but you may include them if it helps to explain your plan.

....

....

....

....

....

....

....

....

....

.... [7]

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.
sulfate, SO_4^{2-} [in solution]	acidify with dilute nitric acid, then add aqueous barium nitrate	white ppt.

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, 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

Flame tests for metal ions

metal ion	flame colour
lithium, Li^+	red
sodium, Na^+	yellow
potassium, K^+	lilac

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