Cambridge Assessment International Education

# Cambridge IGCSE™

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**COMBINED SCIENCE** **0653/62**

Paper 6 Alternative to Practical **February/March 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 [ ].

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

**1** When acid is added to milk, the milk clots, forming lumps.

A student investigates the effect of varying the concentration of the acid.

**Procedure**

The student:

**Step 1** puts 5 $cm^3$ of milk into each of five labelled test-tubes, **A**, **B**, **C**, **D**, and **E**

**Step 2** sets up a water-bath at 30 °C

**Step 3** puts the five test-tubes of milk into the water-bath

**Step 4** adds 1 $cm^3$ of 0.4 M hydrochloric acid to test-tube **A** and swirls to mix

(Note: M is a unit of concentration where 2 M is twice as concentrated as 1 M.)

**Step 5** repeats **Step 4** with the four other test-tubes, using the different concentrations of hydrochloric acid as shown in Table 1.1

**Table 1.1**

| test-tube | concentration of hydrochloric acid / M |
|---|---|
| **A** | 0.4 |
| **B** | 0.3 |
| **C** | 0.2 |
| **D** | 0.1 |
| **E** | 0.0 |

**Step 6** removes test-tube **A** from the water-bath and observes the contents

**Step 7** decides on the clotting score using the scale in Table 1.2

**Table 1.2**

| clotting score | description |
|---|---|
| 1 | no clotting |
| 2 | small lumps |
| 3 | large lumps |
| 4 | almost all solid |
| 5 | all solid |

**Step 8** repeats **Step 6** and **Step 7** with the four other test-tubes.

The student's results are shown in Fig. 1.1.

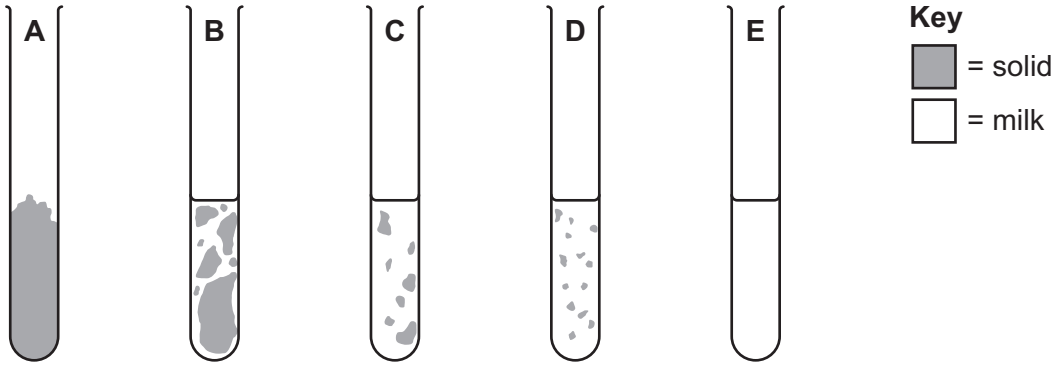



**Fig. 1.1**

**(a) (i)** Use Fig. 1.1 and Table 1.2 to determine the clotting score for each test-tube.

Record in Table 1.3 the clotting score for each test-tube.

**Table 1.3**

| test-tube | concentration of hydrochloric acid / M | clotting score |
|---|---|---|
| **A** | 0.4 | |
| **B** | 0.3 | |
| **C** | 0.2 | |
| **D** | 0.1 | |
| **E** | 0.0 | |

[3]

**(ii)** State the relationship between the concentration of hydrochloric acid and the clotting score of the milk.

.....

..... [1]

**(iii)** Hydrochloric acid changes the shape of protein molecules making them stick together.

Use this information and your results from Table 1.3 to state a conclusion for this investigation in terms of the milk and protein.

.....

.....

..... [1]

**(iv)** The student measures the final temperature of the water-bath.

Fig. 1.2 shows the reading on the thermometer.

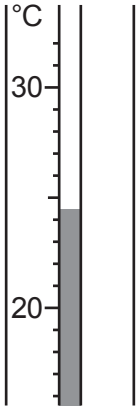



**Fig. 1.2**

Record this temperature to the nearest 0.5 °C.

temperature = ..... °C [1]

**(v)** The starting temperature of the water-bath was 30 °C.

Suggest if temperature is a source of error in this investigation.

Tick (✓) the appropriate box.

- temperature **is not** a source of error ☐
- temperature **is** a source of error ☐

Give a reason for your answer.

.....

..... [1]

**(vi)** Identify **one other** possible source of error in this investigation.

.....

..... [1]

**(b)** The student filters the contents of each test-tube and measures the mass of any solid in the filter paper.

The results are shown in Table 1.4.

**Table 1.4**

| test-tube | concentration of hydrochloric acid / M | mass of solid / g |
|---|---|---|
| **A** | 0.4 | 4.9 |
| **B** | 0.3 | 3.4 |
| **C** | 0.2 | 2.8 |
| **D** | 0.1 | 1.2 |
| **E** | 0.0 | 0.0 |

**(i)** Calculate the percentage of milk clotted in test-tube **B**.

Use the equation shown where 5.1 is the mass (g) of the 5 $cm^3$ of milk.

$$\text{percentage of milk clotted} = \frac{\text{mass of solid in test-tube } \mathbf{B}}{5.1} \times 100$$

percentage clotted = ..... [1]

**(ii)** Suggest if the results in Table 1.4 support the relationship in **(a)(ii)**.

Explain your answer.

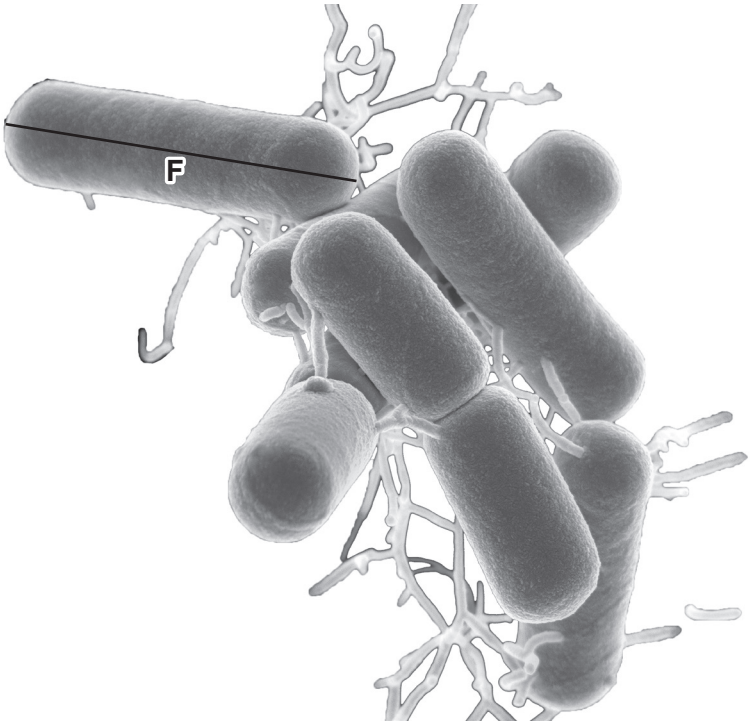
.....

..... [1]

**(c)** A student notices that milk removed from a refrigerator clots after several days.

Fig. 1.3 shows bacteria growing in the milk when viewed using a microscope.

Line **F** on Fig. 1.3 is the length of one bacterium.




**magnification = ×15 000**

**Fig. 1.3**

**(i)** Measure the length of line **F** on Fig. 1.3.

length = ..... mm [1]

**(ii)** Calculate the actual length of the bacterium.

Use the equation shown.

$$\text{actual length} = \frac{\text{length on Fig. 1.3}}{\text{magnification}}$$

Give your answer to **two** significant figures.

actual length = ..... mm [2]

[Total: 13]

**2** A student investigates the properties of aqueous sodium hydroxide.

**(a) Procedure**

The student:

**Step 1** pours 15.0 $cm^3$ of aqueous sodium hydroxide into a glass beaker

**Step 2** records in Table 2.1 the temperature of the aqueous sodium hydroxide to the nearest 0.5 °C

**Step 3** fills a burette to the 0.0 $cm^3$ mark with dilute hydrochloric acid as shown in Fig. 2.1

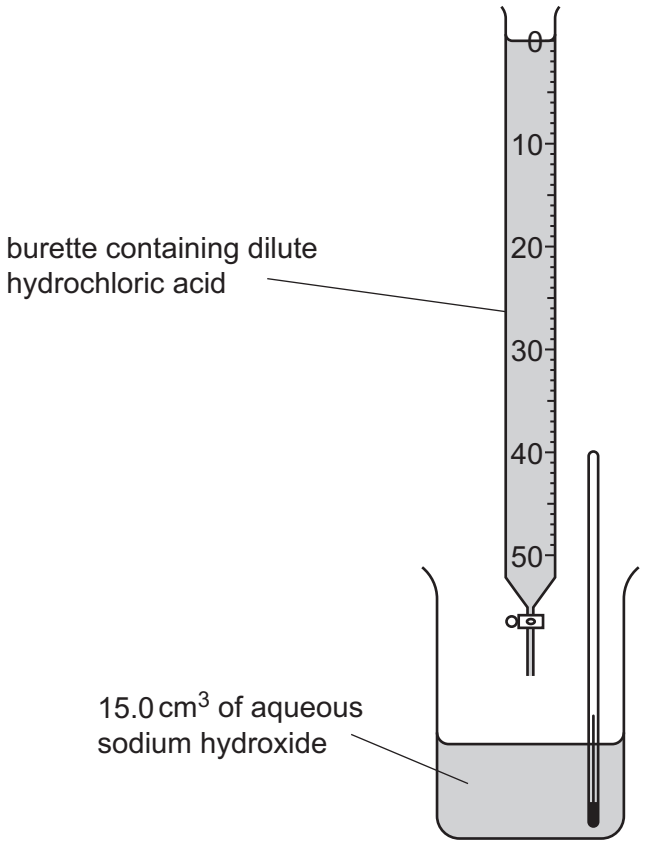



**Fig. 2.1**

**Step 4** adds 5.0 $cm^3$ of dilute hydrochloric acid from the burette to the beaker containing aqueous sodium hydroxide

**Step 5** stirs the mixture

**Step 6** records in Table 2.1 the temperature of the contents of the beaker to the nearest 0.5 °C

**Step 7** repeats **Step 4** to **Step 6** until a total of 25.0 $cm^3$ of dilute hydrochloric acid is added.

**(i)** Fig. 2.2 shows the thermometer reading in **Step 2**.

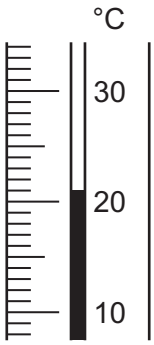



**Fig. 2.2**

Record in Table 2.1 this temperature to the nearest 0.5 °C.

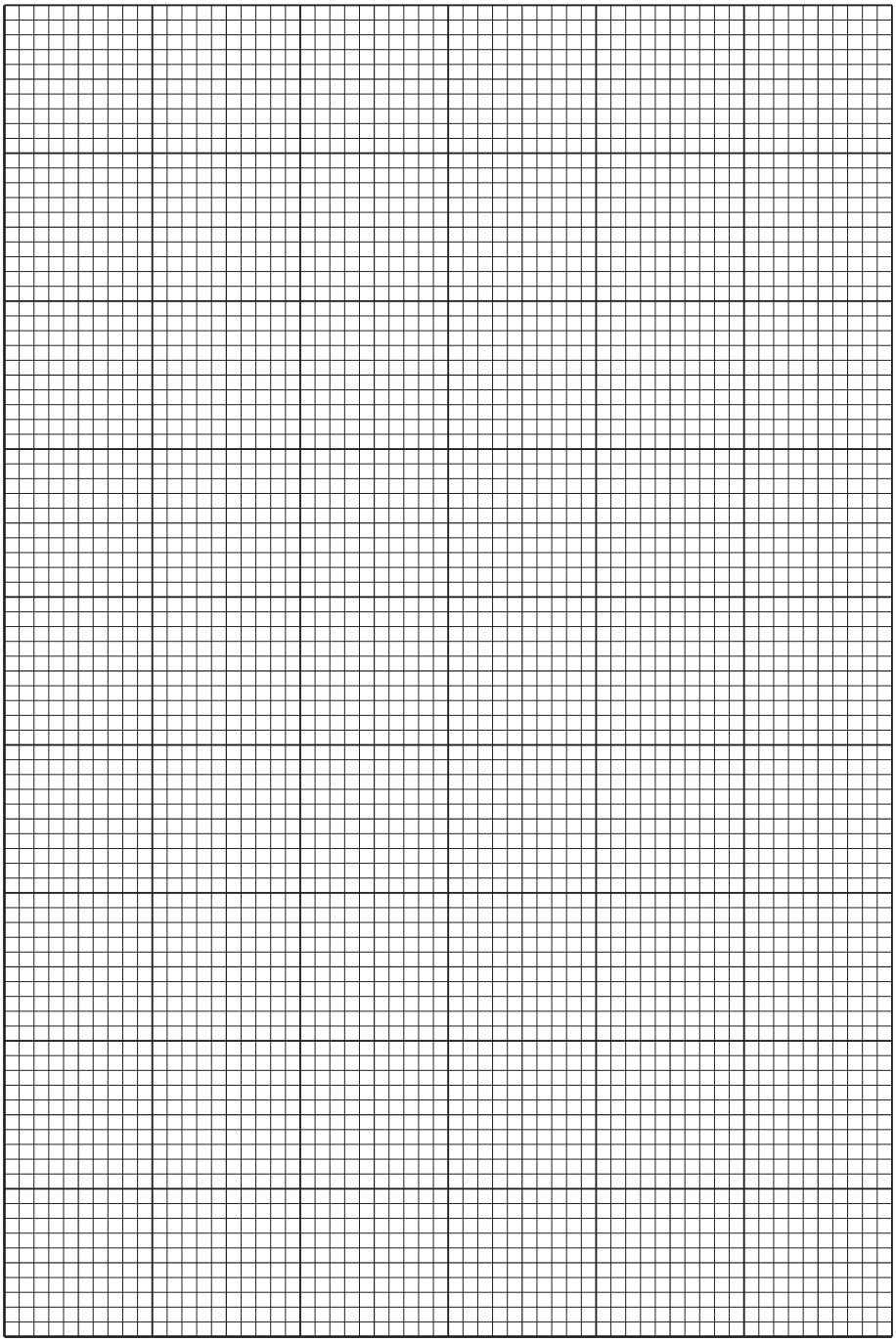
**Table 2.1**

| total volume of hydrochloric acid added / $cm^3$ | temperature of reaction mixture / °C |
|---|---|
| 0.0 | |
| 5.0 | 28.0 |
| 10.0 | 32.0 |
| 15.0 | 34.5 |
| 20.0 | 33.0 |
| 25.0 | 31.5 |

[1]

**(ii)** On the grid, plot a graph of temperature of reaction mixture (vertical axis) against the total volume of hydrochloric acid added.

Do **not** start the temperature scale at 0 °C.



[3]

**(iii)** Draw the curve of best fit. [1]

**(iv)** Describe the relationship between the temperature of the reaction mixture and the total volume of hydrochloric acid added.

.....

.....

..... [2]

**(v)** Explain why in **Step 5** the mixture in the beaker is stirred before the temperature is measured.

..... [1]

**(vi)** Another student repeats the investigation.

This student uses a measuring cylinder to measure each of the 5.0 $cm^3$ volumes of dilute hydrochloric acid instead of a burette.

Explain **one** advantage of using a burette other than the precision of measurement.

.....

..... [1]

**(vii)** Thermal energy (heat) is lost from the reaction mixture during the experiment.

Describe **one** change in the apparatus to reduce this loss of thermal energy.

..... [1]

**(b) Procedure**

The student:

- puts some aqueous sodium hydroxide into a clean test-tube
- adds about 20 drops of an unknown solution **G** to the aqueous sodium hydroxide.

**(i)** The student observes a green precipitate.

(Circle) the metal ion present in solution **G**.

**aluminium** **calcium** **iron(II)** **iron(III)** **zinc** [1]

**(ii)** The student does **not** measure the volumes of the two solutions.

Explain why measuring the volumes is **not** important in this procedure.

.....

..... [1]

**(iii)** The student repeats the procedure but this time uses 20 drops of aqueous copper(II) sulfate instead of solution **G**.

Describe what the student observes in the test-tube.

..... [1]

[Total: 13]

**3** A student investigates the extension of a spring as different loads are suspended from the spring.

The student uses the apparatus shown in Fig. 3.1.

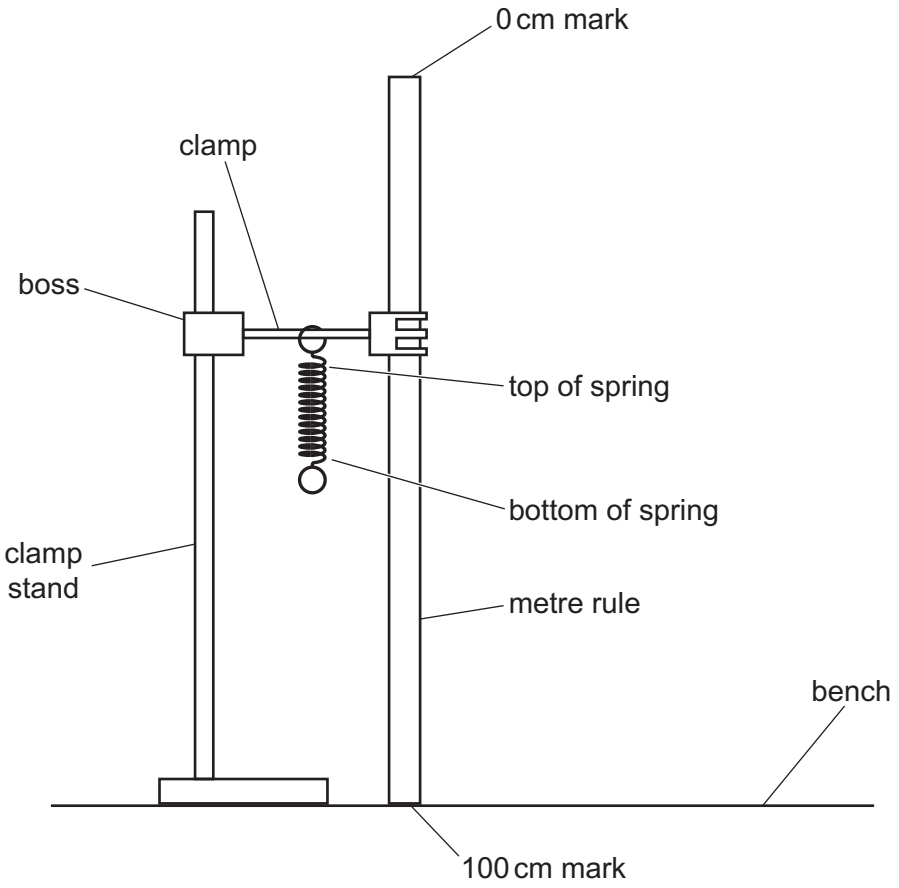



**Fig. 3.1**

The student measures the length of the spring, $l_0$, with no load suspended from it.

$$l_0 = 23\,\text{mm}$$

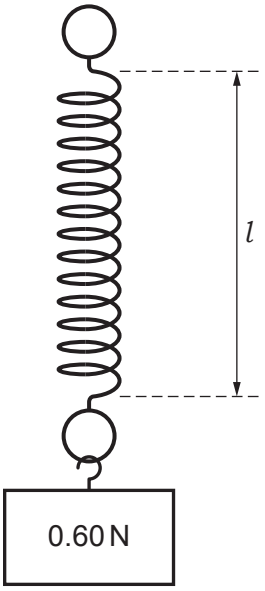
**(a)** State **one** practical precaution that the student takes to ensure that the value of $l_0$ is as accurate as possible.

.....

..... [1]

**(b)** The student suspends loads of 0.20 N, 0.40 N, 0.60 N and 0.80 N from the spring. For each load, L, the length, $l$, is measured and recorded in Table 3.1.

**(i)** Fig. 3.2 shows the spring with a load of 0.60 N suspended from it.




(drawn actual size)

**Fig. 3.2**

Measure the length, $l$, of the spring.

Record $l$ in Table 3.1.

**Table 3.1**

| $L$ / N | $l$ / mm | $e$ / mm | $k$ / N per mm |
|---|---|---|---|
| 0.00 | 23 | 0 | – |
| 0.20 | 27 | 4 | 0.05 |
| 0.40 | 35 | 12 | 0.03 |
| 0.60 | | | |
| 0.80 | 49 | 26 | 0.03 |

[1]

**(ii)** Calculate the extension $e$ of the spring for the load of 0.60 N.

Use the equation shown.

$$e = l - l_0.$$

Record this value of $e$ in Table 3.1.

[1]

**(iii)** The spring constant, $k$, of the spring is a measure of its elastic stiffness.

Calculate the spring constant, $k$, for the load of 0.60 N.

Use the equation shown.

$$k = \frac{L}{e}$$

Record this value of $k$ in Table 3.1.

[1]

**(c)** One of the values of $k$ is anomalous.

State which value is anomalous. Give a reason for your answer.

anomalous value ..... N per mm

reason .....

.....

[2]

**(d)** Suggest what the student can do to have more confidence in their values of $l$.

.....

..... [1]

[Total: 7]

**4** Plan an investigation to find out how much (electrical) energy is required to increase the temperature of different liquids.

You are provided with:

- four different liquids: water, salt solution, vegetable oil and vinegar
- an electric heater and power supply, assembled as shown in Fig. 4.1.

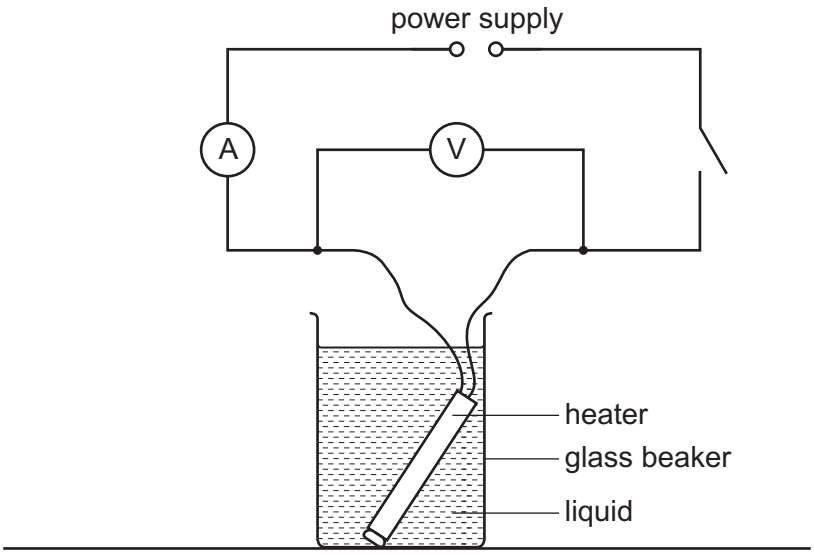



**Fig. 4.1**

The energy, $E$, transferred by the heater is calculated using the equation shown

$$E = V \times I \times t$$

where $V$ is the potential difference across the heater
$I$ is the current through the heater
$t$ is the time in seconds that the heater is switched on

You may use any common laboratory apparatus in your plan.

In your plan, include:

- any other apparatus needed
- a brief description of the method, including what you will measure and how you will make sure your measurements are accurate
- the variables you will control
- a results table to record your measurements (you do **not** need to enter any readings in the table)
- how you will process your results to draw a conclusion.

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..... [7]

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