* 0000800000001 *

Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME

CENTRE NUMBER | CANDIDATE NUMBER

* 2 6 6 2 6 5 2 0 4 1 *

CO-ORDINATED SCIENCES **0654/61**

Paper 6 Alternative to Practical **October/November 2024**

1 hour 30 minutes

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 60.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **24** pages. Any blank pages are indicated.

DC (CE/FC) 336601/4

1 A student investigates an enzyme-controlled reaction.

Catalase is an enzyme found inside living cells such as yeast cells. It catalyses the breakdown of hydrogen peroxide, releasing oxygen gas.

When a suspension of yeast cells is mixed with hydrogen peroxide solution the oxygen released produces a foam.

(a) Procedure

The student:

- stirs a suspension of yeast cells in water
- puts 4 cm^3 of yeast cell suspension into a test-tube
- adds 2 cm^3 of 6% hydrogen peroxide solution to the test-tube
- starts a stop-watch
- at 2 minutes measures the height *h* as shown in Fig. 1.1.

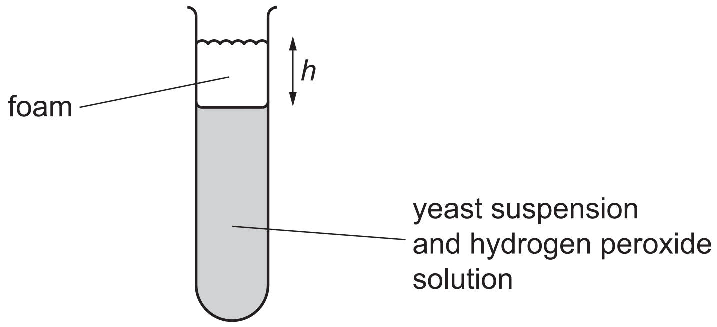
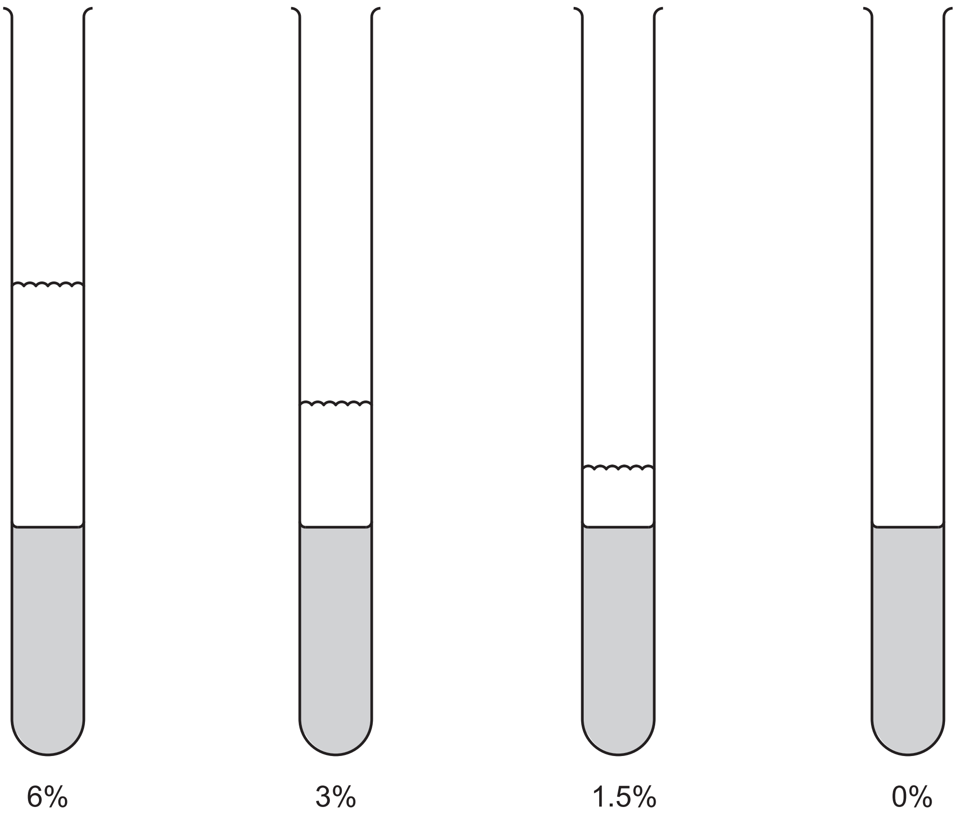


Fig. 1.1

The student repeats the procedure with 3%, 1.5% and 0% hydrogen peroxide solution.

Fig. 1.2 shows the student's test-tubes after 2 minutes.



actual size

Fig. 1.2

(i) Draw a table to record the results of this experiment.

[2]

(ii) Measure and record in your table in **(a)(i)** the height *h* for each hydrogen peroxide concentration in Fig. 1.2 in millimetres to the nearest millimetre. [3]

(iii) Describe in detail the relationship between the concentration of the hydrogen peroxide solution and the height *h* of the foam produced.

....

....

.... [2]

(iv) Suggest why it is **not** possible to measure *h* using this apparatus with 18% hydrogen peroxide solution.

....

.... [1]

(v) Name a piece of apparatus suitable for measuring $2\,cm^3$ of hydrogen peroxide solution.

.... [1]

(vi) Explain why repeating the procedure allows the student to have more confidence in their results.

....

.... [1]

(vii) Suggest why it is easier for the student to measure height h rather than height H as shown in Fig. 1.3.

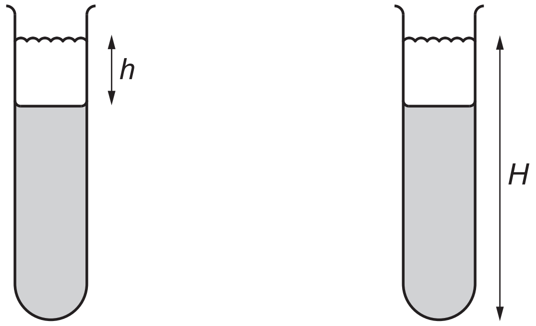


Fig. 1.3

....

.... [1]

(viii) Suggest a piece of apparatus that can be used to measure the amount of gas produced in a reaction more accurately.

....

.... [1]

(b) The amount of hydrogen peroxide in a solution of hydrogen peroxide is described as a percentage.

The student has a solution of 10% hydrogen peroxide.

Calculate the volumes of water and 10% hydrogen peroxide solution needed to make 10 cm^3 of 6% hydrogen peroxide solution.

volume of 10% hydrogen peroxide solution .... cm^3

volume of water .... cm^3 [1]

[Total: 13]

2 The pH of saliva in the mouth is approximately 7.

Eating and drinking lowers the pH of saliva in the mouth. This can cause tooth decay.

Mouthwash is sometimes used to raise the pH of saliva in the mouth.

Plan an investigation to determine the relationship between the volume of mouthwash used and the pH of saliva.

You are provided with:

- mouthwash
- a solution of saliva at pH 3.

You may use any laboratory apparatus.

In your plan include:

- the apparatus needed
- a brief description of the method
- the measurements you will make
- the variables you will control
- how you process your results to draw a conclusion.

[7]

3 A student investigates the reactivity of metals by heating some metal carbonates.

Some metal carbonates break down and release carbon dioxide when they are heated.

The carbonate of a more reactive metal takes a longer time to break down than the carbonate of a less reactive metal.

(a) **Procedure**

The student:

- puts some copper carbonate into a clean hard-glass test-tube
- assembles the apparatus as shown in Fig. 3.1

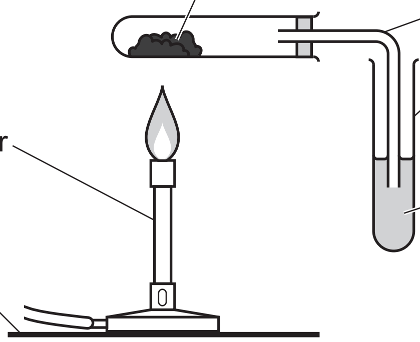


Fig. 3.1

- heats the copper carbonate and starts the stop-watch
- stops the stop-watch when the limewater starts to go milky
- takes the delivery tube out of the limewater then stops heating
- records in Table 3.1 this time for trial 1 to the nearest second.

The student repeats the procedure and records the time for trial 2.

The student then repeats the procedure for two trials each with iron carbonate, magnesium carbonate and zinc carbonate instead of the copper carbonate.

Table 3.1

metal carbonate	time for the limewater to go milky / s			rate of reaction per 100 s
	trial 1	trial 2	average	
copper carbonate				
iron carbonate		159		
magnesium carbonate	396	425	411	0.243
zinc carbonate	176	160	168	0.595

(i) Fig. 3.2 shows the readings on the stop-watch for copper carbonate and iron carbonate.

copper carbonate trial 1

copper carbonate trial 2

iron carbonate trial 1

Fig. 3.2

Record in Table 3.1 these times to the nearest second. [3]

(ii) Explain why a hard-glass test-tube instead of a thin-glass test-tube is used in the procedure.

....

.... [1]

(iii) The student does **not** stop heating the metal carbonate until the delivery tube is taken out of the limewater.

Explain why this is safer than stopping heating the test-tube while the delivery tube is still in the limewater.

....

.... [1]

(iv) Copper carbonate is a green powder.

When heated, copper carbonate decomposes to form copper oxide which is a black powder.

The teacher says that not all of the copper carbonate decomposes when it is heated.

Suggest the observation the student makes to show that the teacher is correct.

....

.... [1]

(b) **(i)** Calculate the average time for the limewater to go milky for copper carbonate and for iron carbonate.

Record these values in Table 3.1. [2]

(ii) Calculate the rate of reaction for copper carbonate and iron carbonate.

Use the equation shown.

$$\text{rate} = \frac{100}{\text{time}}$$

Record in Table 3.1 your answers to **three** significant figures. [2]

(c) Using the results in Table 3.1, place the metals copper, iron, magnesium and zinc in order of reactivity, starting with the most reactive.

most reactive ....

....

....

least reactive .... [1]

(d) The student heats the metal carbonate using a blue Bunsen burner flame.

Explain why a blue Bunsen burner flame is used instead of a yellow flame.

....

.... [1]

(e) Suggest **one** improvement to the procedure to give more confidence in the order of reactivity of the metals given in **(c)**. Do **not** include repeating the experiment.

....

.... [1]

[Total: 13]

BLANK PAGE

4 A student investigates the reactivity of metals by measuring the voltage in electrochemical cells.

When two different metals are dipped into an aqueous salt solution they produce a voltage.

The larger the difference between the reactivity of the two metals the greater the voltage produced.

Procedure

The student:

- half fills a beaker with aqueous salt solution
- assembles the apparatus as shown in Fig. 4.1, keeping the metals at the opposite edges of the beaker

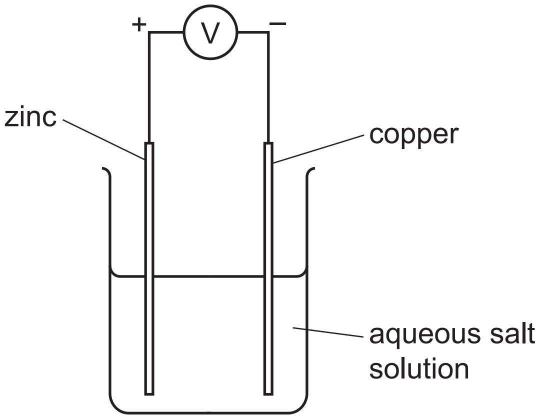


Fig. 4.1

- records in Table 4.1 the reading on the voltmeter.

The student repeats the procedure using copper, magnesium and then iron instead of the zinc.

Table 4.1

metal	voltage produced / V
zinc	1.1
copper	0.0
magnesium	2.7
iron	0.8

(a) Explain why it is important that the metals do not touch while they are in the beaker.

....

.... [1]

(b) Using the results in Table 4.1 place the metals copper, iron, magnesium and zinc in order of reactivity, starting with the most reactive.

Explain your answer.

most reactive ....

....

....

least reactive ....

explanation ....

....

[2]

(c) Question **3** and question **4** use two different procedures to determine the order of reactivity of the metals.

Suggest which procedure allows the order of reactivity to be determined with more accuracy.

Tick (✓) the box.

procedure from question **3** ☐

procedure from question **4** ☐

Explain your answer.

....

.... [1]

[Total: 4]

5 A student is given four solutions with labels **H**, **J**, **K** and **L**.

The solutions are:

aqueous copper chloride

aqueous zinc chloride

aqueous iron(II) chloride

aqueous magnesium chloride.

The student does the tests in Table 5.1 and records their observations.

Table 5.1

test	**H**	**J**	**K**	**L**
initial colour of solution	colourless	pale blue	colourless	pale green
add a few drops of aqueous ammonia add excess aqueous ammonia	no reaction no reaction	pale blue ppt. dark blue solution	white ppt. colourless solution	green ppt. green ppt.
add a few drops of aqueous sodium hydroxide add excess aqueous sodium hydroxide	no reaction no reaction	pale blue ppt. pale blue ppt.	white ppt. colourless solution	green ppt. green ppt.
flame test	no colour	blue green	no colour	no colour

State the identity of solutions **J**, **K** and **L**.

Give **one** reason for each choice.

J is ....

reason ....

....

K is ....

reason ....

....

L is ....

reason ....

....
[3]

[Total: 3]

6 A student investigates the changes in potential difference V across a length of resistance wire.

The student assembles the circuit shown in Fig. 6.1.

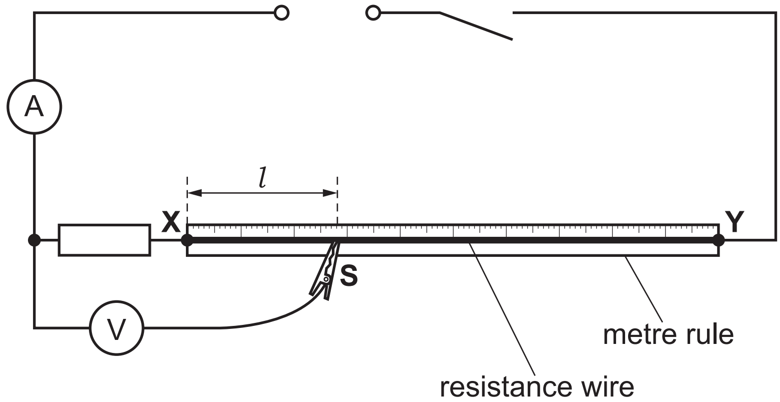


Fig. 6.1

(a) Procedure

The student:

- closes the switch
- measures the current I in the circuit
- opens the switch.

The reading on the ammeter is shown in Fig. 6.2.

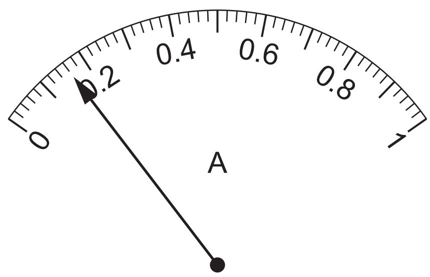


Fig. 6.2

Record the current I.

I = ... A [1]

(b) **Procedure**

The student:

- places the sliding contact **S** at a distance of l = 10.0 cm from end **X** of the resistance wire
- closes the switch
- records in Table 6.1, the reading V on the voltmeter
- opens the switch.

The reading on the voltmeter is shown in Fig. 6.3.

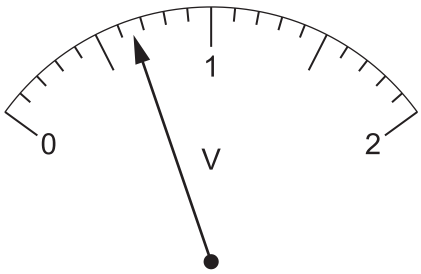


Fig. 6.3

Record in Table 6.1 the potential difference V. [1]

(c) The student repeats this procedure for values of l of 20.0 cm, 40.0 cm, 60.0 cm, 80.0 cm and 100.0 cm.

The student's results are shown in Table 6.1.

Table 6.1

l / cm	V / V
10.0	
20.0	0.75
40.0	1.00
60.0	2.10
80.0	1.40
100.0	1.65

Suggest why the student closes and opens the switch between taking readings of the potential difference across the wire.

....

....

.... [1]

(d) One of the student's values of V in Table 6.1 is anomalous.

Identify the anomalous value and suggest the error that the student makes.

anomalous value ....

error ....

....

....

[2]

(e) **(i)** On the grid, plot a graph of *V* (vertical axis) against *l*.

Start both axes from the origin (0, 0).

[3]

(ii) Draw the best-fit straight line.

.... [1]

(f) **(i)** Extend the best-fit line until it crosses the vertical axis.

Record the intercept *c* that the line makes on the vertical axis.

c = ... [1]

(ii) Calculate the numerical ratio *r*.

Use the equation shown, your answer to **(f)(i)** and the current I you measured in **(a)**.

$$r = \frac{c}{I}$$

r = ... [1]

(g) The teacher says that the ratio *r* in **(f)(ii)** is expected to be 3.3.

Two values are considered to be equal within the limits of experimental accuracy if they are within 10% of each other.

Compare your ratio *r* from part **(f)(ii)** with the expected ratio 3.3.

State if your value of *r* is close enough to 3.3 so that the ratios can be considered equal, within the limits of experimental accuracy.

Justify your statement with a calculation.

statement ....

....

justification ....

....

....

....
[2]

[Total: 13]

DO NOT WRITE IN THIS MARGIN

7 A student measures the density of water using two different methods.

Method 1

(a) The student measures the mass m_1 of an empty measuring cylinder using a top-pan balance.

Fig. 7.1 shows the reading on the balance.

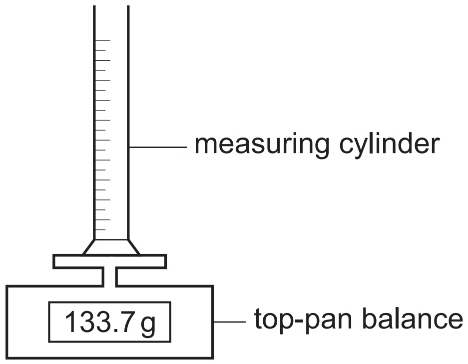


Fig. 7.1

Record the reading on the balance to the nearest gram.

m_1 = ... g [1]

(b) The student removes the measuring cylinder from the balance and pours some water into it.

Fig. 7.2 shows part of the measuring cylinder.

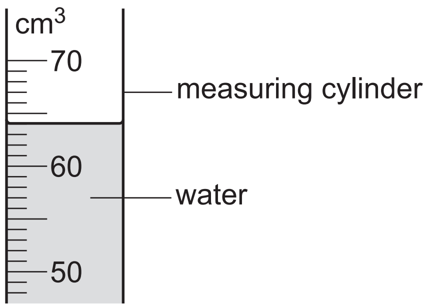


Fig. 7.2

Record the volume V_1 of water in the measuring cylinder.

V_1 = ... cm^3 [1]

(c) The student measures the mass m_2 of the measuring cylinder and water to the nearest gram.

$$m_2 = 195\,\text{g}$$

Calculate the density ρ_1 of water.

Use the equation shown.

$$\rho_1 = \frac{(m_2 - m_1)}{V_1}$$

ρ_1 = ... g/cm^3 [1]

(d) State how the student ensures that the reading of the volume of water in the measuring cylinder is as accurate as possible.

....

....

.... [1]

Method 2

(e) Procedure

The student:

- measures the mass m_3 of a test-tube to the nearest gram

$$m_3 = 20\,\text{g}$$

- lowers the test-tube into the measuring cylinder containing water until the test-tube floats

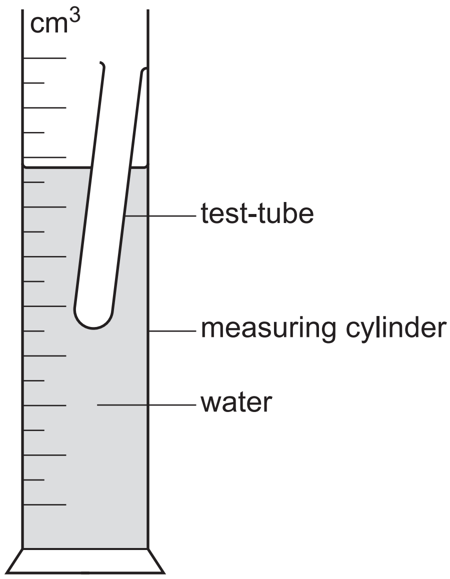


Fig. 7.3

- records the new water level V_2 in the measuring cylinder.

$$V_2 = 82\,\text{cm}^3$$

Calculate the volume V_3 of water displaced by the test-tube.

Use the equation shown.

$$V_3 = V_2 - V_1$$

V_3 = ... cm^3 [1]

(f) Calculate the density ρ_2 of the water.

Use the equation shown.

$$\rho_2 = \frac{m_3}{V_3}$$

ρ_2 = ... g/cm^3 [1]

(g) Suggest why **method 1** is done before **method 2**.

....

.... [1]

[Total: 7]

BLANK PAGE