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CO-ORDINATED SCIENCES

0654/63

Paper 6 Alternative to Practical

May/June 2022

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.

1 Catalase is an enzyme found in living cells such as celery cells.

Catalase speeds up the breakdown of hydrogen peroxide into water and oxygen gas.

The catalase is not used up in the reaction.

A student investigates the breakdown of hydrogen peroxide using celery.

Procedure

The student:

- adds 2 cm³ of hydrogen peroxide solution to some celery in a test-tube
- assembles the apparatus shown in Fig. 1.1 to collect the oxygen gas made

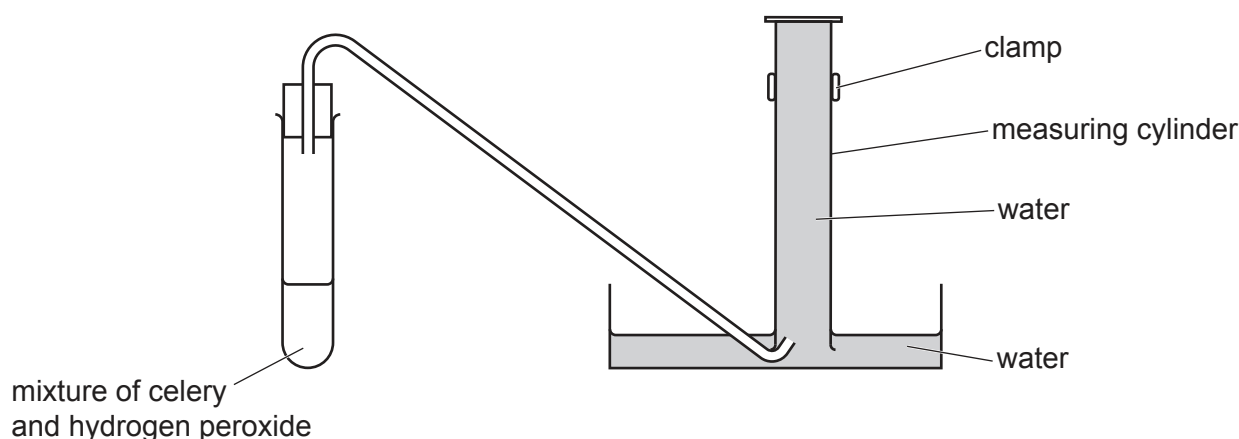


Fig. 1.1

- records in Table 1.1 for trial 1, the volume of gas in the measuring cylinder every 2 minutes for 10 minutes.

The student repeats the procedure, recording the values for trial 2.

Table 1.1

time / minutes	volume of gas collected / cm ³		
	trial 1	trial 2	average
0	0.0	0.0	0.0
2	14.0	13.5	13.8
4	18.5	17.5	
6	19.2	18.8	19.0
8	20.5	19.5	20.0
10	20.5	19.5	20.0

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

..... [1]

(b) The hydrogen peroxide solution is corrosive.

It is labelled with the symbol shown in Fig. 1.2.

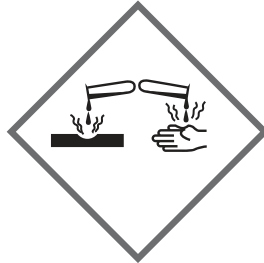


Fig. 1.2

State **and** explain a safety precaution that the student needs to take when doing the procedure.

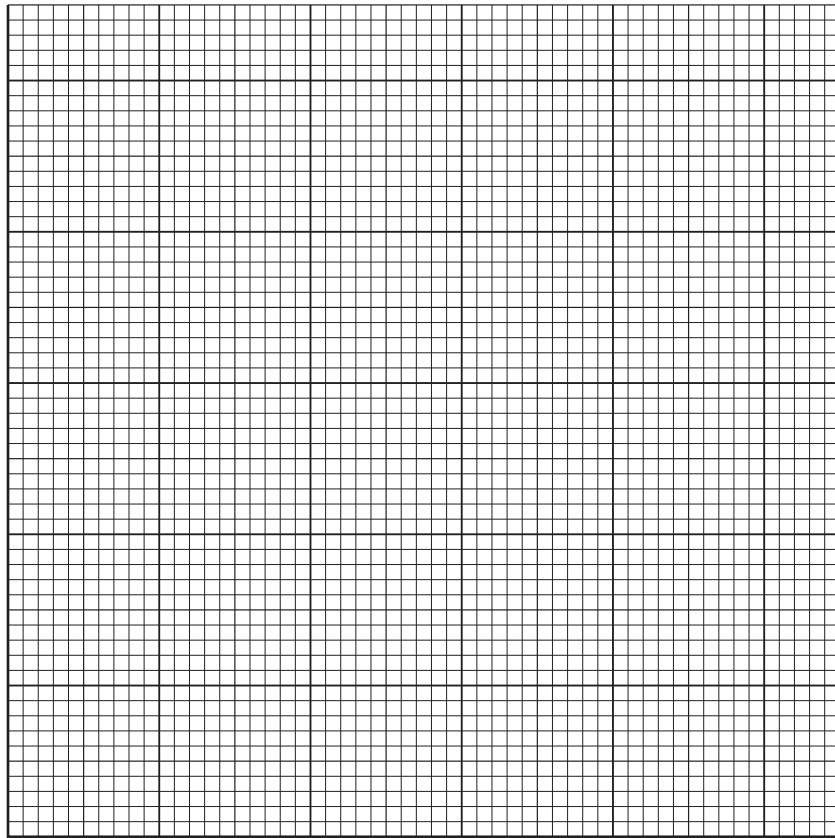
safety precaution

explanation

..... [1]

(c) Complete Table 1.1 by calculating the average volume of gas collected after 4 minutes. [1]

(d) (i) On the grid, plot a graph of average volume of gas collected (vertical axis) against time.



[3]

(ii) Draw the best-fit smooth curve.

[1]

(iii) Describe the relationship between the average volume of gas collected and time.

.....

 [2]

(iv) Explain the results between 8 and 10 minutes.

.....
 [1]

(e) State **one** variable that the student controls so that the comparison of the two trials is fair.

..... [1]

(f) Explain why repeating a procedure several times and calculating an average gives more confidence in the reliability of the results.

..... [1]

(g) Describe a test to confirm the presence of oxygen.

Include the observation for a positive result.

test

observation

[2]

[Total: 14]

- 2 A student investigates the nutrient content of celery and potato using Benedict's solution, biuret solution and iodine solution.

(a) Celery gives a positive result with the Benedict's solution.

Potato gives a positive result with the iodine solution.

All other results are negative.

Complete Table 2.1 by recording the **final colours** observed in each sample.

Table 2.1

food sample	final colour observed with Benedict's solution	final colour observed with biuret solution	final colour observed with iodine solution
celery			
potato			

[3]

(b) State the nutrients present **and** the nutrients absent in each food sample.

Use the information provided in (a).

celery:

nutrients present

nutrients absent

potato:

nutrients present

nutrients absent

[3]

[Total: 6]

- 3 A student investigates the pH of several solutions and their reactivity with sodium carbonate.

The pH scale is shown in Fig. 3.1.

pH	1		7			14	
colour	red	orange	yellow	pale green	dark green	blue	purple
description	strongly acidic		weakly acidic	neutral	weakly alkaline	strongly alkaline	

Fig. 3.1

(a) Procedure

The student:

- places 1 cm depth of dilute hydrochloric acid, orange juice, salt solution, lemon juice, soap solution, vinegar and sodium hydroxide solution into separate test-tubes
- adds four drops of universal indicator solution to each test-tube
- records in Table 3.1 the pH of each solution.

Table 3.1

solution	colour in universal indicator	pH	description
dilute hydrochloric acid		1	
orange juice		5	
salt solution		7	
lemon juice		3	
soap solution		9	
vinegar		4	
sodium hydroxide solution		14	

- (i) Record in Table 3.1 the colour of each solution with the universal indicator.

Use the pH scale in Fig. 3.1. [2]

- (ii) Record in Table 3.1 a description of each solution. Use information from Fig. 3.1. [2]

- (iii) Suggest why it might be difficult for the student to estimate the pH of orange juice.

.....
 [1]

(iv) When acids and alkalis react together, a neutral solution can be made.

Substances which are strongly acidic and strongly alkaline can burn the skin.

A student is stung by a bee. A bee sting contains a liquid with a pH of approximately 5.

State which substance in Table 3.1 can be used to neutralise the liquid in the bee sting.

Explain your answer.

substance

explanation

.....

[1]

(b) Procedure

The student:

- Step 1 places 3 cm depth of dilute hydrochloric acid into a boiling tube
 Step 2 adds 2 spatula loads of sodium carbonate to the dilute hydrochloric acid and starts a stop-watch
 Step 3 stops the stop-watch when the reaction stops fizzing
 Step 4 records in Table 3.2 this time to the nearest second.

The student repeats the procedure in (b) using orange juice, salt solution, lemon juice, soap solution, vinegar and sodium hydroxide solution instead of dilute hydrochloric acid.

Table 3.2

solution	time for fizzing to stop/s
dilute hydrochloric acid	10
orange juice	
salt solution	no reaction
lemon juice	21
soap solution	no reaction
vinegar	
sodium hydroxide solution	no reaction

- (i) Fig 3.2 shows the readings on the stop-watch when the fizzing stops for orange juice and vinegar.

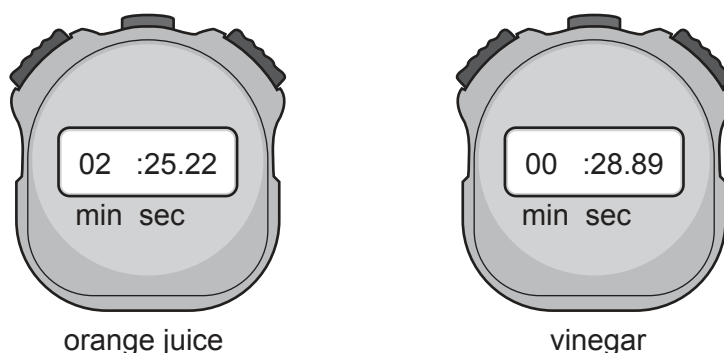


Fig. 3.2

Record in Table 3.2 these times to the nearest second. [3]

- (ii) The reaction which took the least time to finish fizzing is the fastest.
List the solutions in order of rate of reaction starting with the most reactive.
If the solutions do **not** react, place them together at the bottom of the list.

most reactive



least reactive

[1]

- (c) Look at the pH column in Table 3.1 and the rate of reaction in (b)(ii).

Describe the relationship between pH and rate of reaction with sodium carbonate.

.....

.....

.....

..... [2]

(d) The gas given off is carbon dioxide.

State the test for carbon dioxide gas. Include the observation for a positive result.

test

observation

[1]

[Total: 13]

4 Solid sodium carbonate does not decompose when it is heated.

Sodium carbonate solid dissolves in water to form sodium carbonate solution.

Sodium carbonate **solution** does not decompose when it is heated.

Sodium carbonate solution reacts with acid to give carbon dioxide gas.

You are going to plan an experiment to find out which sodium carbonate solution, **A**, **B** or **C**, contains the most dissolved solid sodium carbonate.

You are provided with three different sodium carbonate solutions, **A**, **B** and **C**.

You may use any common laboratory apparatus.

Include in your plan:

- the apparatus needed
- a brief description of the method, explaining any safety precautions
- the measurements you will make including how to make them as accurate as possible
- the variables you will control
- how you will process your results to draw a conclusion.

You may include a labelled diagram if you wish.

You may include a results table if you wish. You are **not** required to include any results.

5 A student investigates the oscillations of a pendulum.

The student sets up the pendulum in a clamp as shown in Fig. 5.1.

Fig. 5.1 is drawn one-fifth full size.

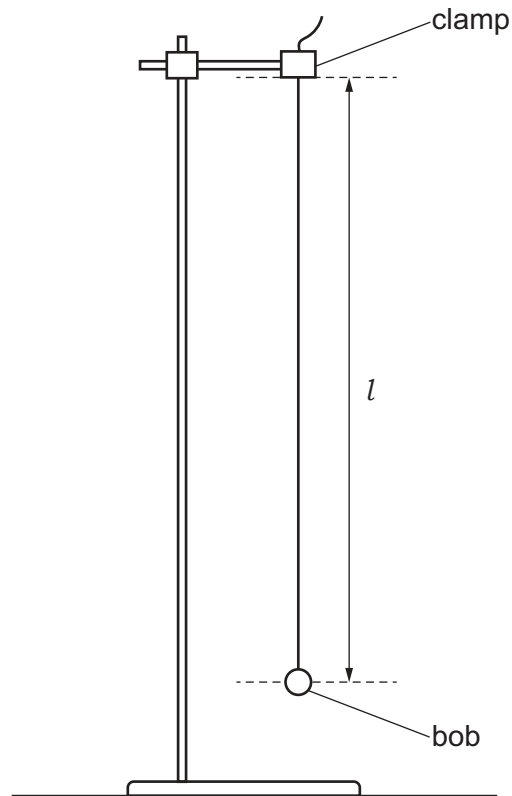


Fig. 5.1

The length l of the pendulum is the distance from the bottom of the clamp to the centre of the pendulum bob.

(a) (i) Measure the length l of the pendulum in centimetres to the nearest 0.1 centimetre.

$l = \dots\dots\dots$ cm [1]

(ii) Calculate the actual length L of the pendulum.

$L = \dots\dots\dots$ cm [1]

(b) Procedure

The student:

- gives the bob a small sideways displacement and releases it so that it swings to and fro
- measures the time for 20 complete oscillations
- repeats the timing for 20 oscillations two more times.

The student's results are shown.

25.4 s 25.6 s 25.3 s

- (i)** Calculate the average time t for 20 oscillations of the pendulum.

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

$$t = \dots\dots\dots \text{ s [2]}$$

- (ii)** Calculate the time T for **one** complete oscillation of the pendulum.

Use the equation shown.

$$T = \frac{t}{20}$$

$$T = \dots\dots\dots \text{ s [1]}$$

- (iii)** Calculate T^2 .

$$T^2 = \dots\dots\dots \text{ s}^2 \text{ [1]}$$

- (c) (i)** The length L in centimetres of a pendulum which has a time T for one oscillation is calculated using the equation shown.

$$L = 25.0T^2$$

Use this equation and your value of T^2 from **(b)(iii)** to calculate a value for L .

$$L = \dots\dots\dots \text{ cm [1]}$$

- (ii) Two values are considered to be equal within the limits of experimental error if they are within 10% of each other.

Compare your value of L from part (a)(ii) with the calculated value of L from (c)(i).

State if your values agree within the limits of experimental error.

Justify your answer with reference to your values.

.....
 [1]

(d) Procedure

The student:

- adjusts the string until the length L of the pendulum is double the length of L in (a)(ii)
- repeats (b)(i) and (b)(ii).

The student's results are shown.

$$t = \dots\dots\dots 35.9 \dots\dots\dots \text{ s}$$

$$T = \dots\dots\dots 1.80 \dots\dots\dots \text{ s}$$

The student states that the time T for one oscillation of a pendulum is proportional to the length of the pendulum.

Compare the values of T in (b)(ii) and (d) to state if you agree with the student.

Give a reason for your answer.

statement

reason

..... [1]

- (e) The student holds the rule close to the pendulum to measure its length.

Explain why this gives a more accurate value for the length of the pendulum.

.....
 [1]

[Total: 10]

- 6 A student investigates the temperature of the air at different distances from a lamp.

The student sets up the apparatus shown in Fig. 6.1.

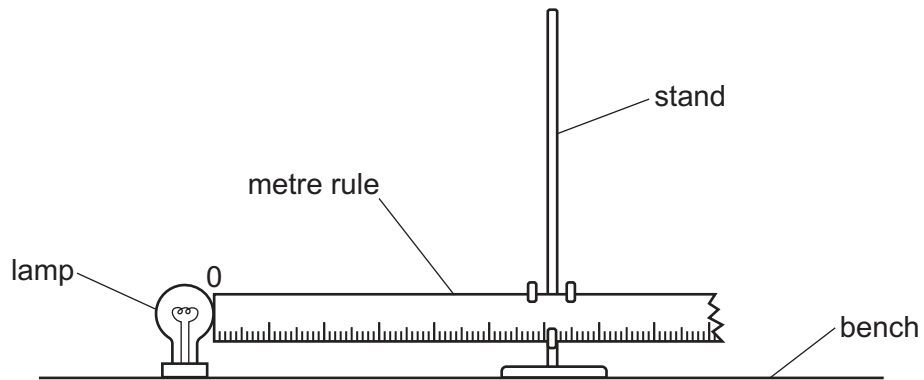


Fig. 6.1

- (a) The student measures the room temperature.

The thermometer used is shown in Fig. 6.2.

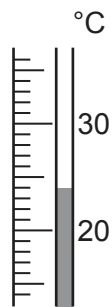


Fig. 6.2

Read the thermometer and record the room temperature θ_R to the nearest 0.5°C.

$$\theta_R = \dots\dots\dots^\circ\text{C} \quad [1]$$

(b) Procedure

The student:

- switches on the lamp
- places the thermometer bulb a horizontal distance $d_H = 10$ mm from the lamp as shown in Fig. 6.3

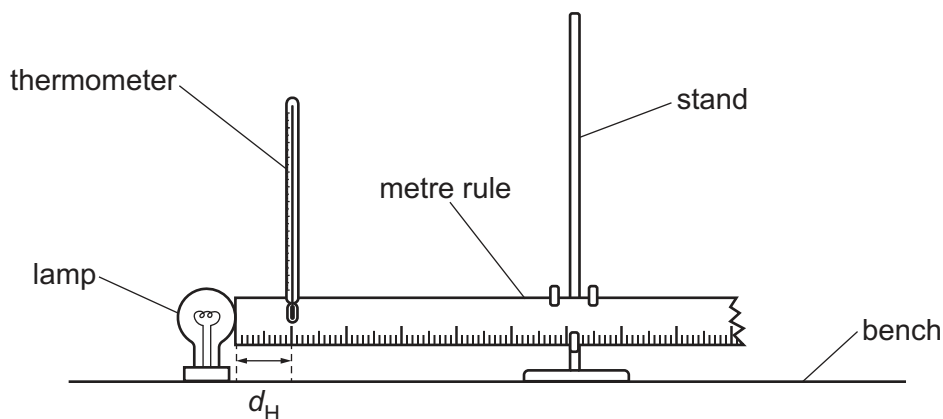


Fig. 6.3

- waits for 20 seconds
- records in Table 6.1 the distance d_H and the temperature θ_H shown by the thermometer.

The student repeats for values of $d_H = 20$ mm, 40 mm, 60 mm, 80 mm and 100 mm.

- (i) Record the d_H values in Table 6.1.

Table 6.1

d_H /.....	θ_H /.....
10	82.0
	72.5
	64.0
	58.0
	53.5
	49.0

[1]

- (ii) Complete the column headings in Table 6.1.

[1]

- (iii) Suggest why the student waits for 20 seconds before recording the temperature at each distance from the lamp.

.....
 [1]

- (c) (i) State the relationship between the air temperature θ_H and the horizontal distance d_H of the thermometer bulb away from the lamp.

.....
 [1]

- (ii) Calculate the average decrease in temperature per millimetre as the thermometer bulb is moved from $d_H = 10$ mm to $d_H = 100$ mm.

Use the equation shown.

$$\text{average decrease in temperature per mm} = \frac{\text{temperature decrease}}{\text{distance moved}}$$

$$\text{average decrease in temperature per mm} = \dots\dots\dots \text{ }^\circ\text{C/mm} \quad [2]$$

- (d) Predict the temperature reading θ when the thermometer is at a horizontal distance of 2000 mm from the lamp.

$$\theta = \dots\dots\dots \text{ }^\circ\text{C} \quad [1]$$

(e) Procedure

The student:

- adjusts the position of the thermometer in a clamp until its bulb is a vertical distance $d_V = 100\text{ mm}$ above the lamp, as shown in Fig. 6.4

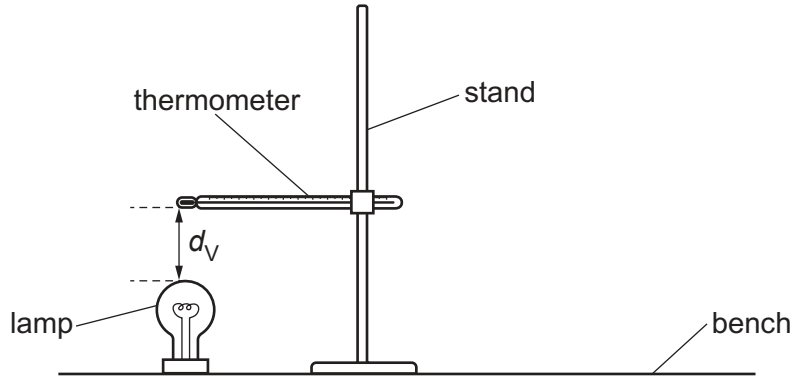


Fig. 6.4

- records the temperature θ_V .

$\theta_V = \dots\dots\dots 52.5 \dots\dots\dots \text{ }^\circ\text{C}$

Calculate the difference in temperature between θ_V and the thermometer reading θ_H at a horizontal distance of 100 mm from the lamp.

difference in temperature = $\dots\dots\dots \text{ }^\circ\text{C}$ [1]

(f) Suggest **one** safety precaution the student takes while doing this investigation.

Explain your answer.

safety precaution $\dots\dots\dots$

explanation $\dots\dots\dots$

$\dots\dots\dots$

[1]

[Total: 10]

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