CAMBRIDGE International Education

Cambridge IGCSE™

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

CO-ORDINATED SCIENCES **0654/62**

Paper 6 Alternative to Practical **May/June 2026**

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. Do **not** use correction fluid or tape.
- 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 [ ].
- Notes for use in qualitative analysis are provided in the question paper.

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

DC (PQ/FC) 357961/3

[Turn over

1 A student investigates the effect of enzyme volume on an enzyme-controlled reaction.

Plant cells such as celery cells contain the enzyme catalase.

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

The oxygen gas released forms a foam when mixed with detergent.

(a) Procedure

The student:

- stirs a sample of celery puree (liquidised celery)
- puts 2 cm^3 of celery puree into a clean boiling tube
- adds a drop of detergent to the boiling tube
- adds 2 cm^3 of aqueous hydrogen peroxide to the boiling tube
- records in Table 1.1 for trial 1 the total height *h* of the celery puree mixture and any foam at 90 seconds as shown in Figure 1.1.

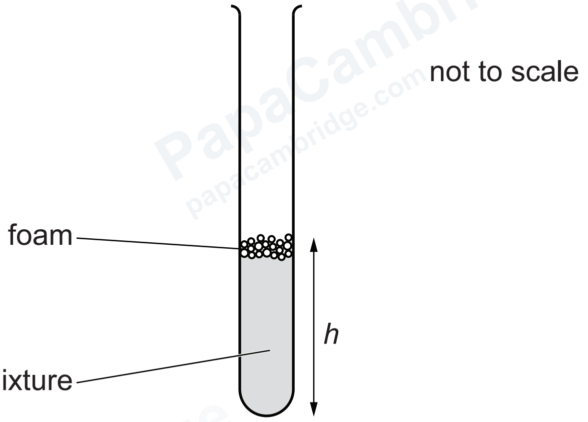


Figure 1.1

The student repeats the same procedure with a second sample of celery puree for trial 2.

The student then repeats the procedure two more times but uses 1 cm^3 of celery puree and 1 cm^3 of water instead of the 2 cm^3 of celery puree.

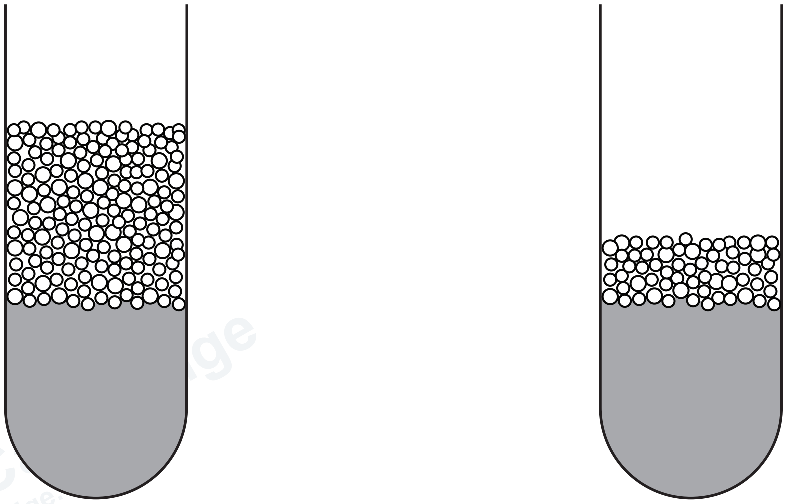
Table 1.1 shows the student's results for trial 1.

Table 1.1

volume of celery puree / cm^3	volume of water / cm^3	height *h* / cm		average height *h* / cm
		trial 1	trial 2	
2	0	5.3		
1	1	3.2		

(i) Figure 1.2 shows the boiling tubes for trial 2.

These are drawn actual size.



2 cm^3 volume of celery puree   1 cm^3 volume of celery puree

Figure 1.2

Record in Table 1.1 these heights to the nearest 0.1 cm. [3]

(ii) Complete Table 1.1 by calculating the average height *h* for each volume of celery puree. [1]

(iii) Use the results in Table 1.1 to state the relationship between enzyme volume and height.

....

.... [1]

(iv) Use the results in Table 1.1 to state the relationship between enzyme volume and rate of reaction.

....

.... [1]

(v) The rate of reaction decreases when the temperature decreases.

A student repeats the investigation with celery puree and aqueous hydrogen peroxide from a refrigerator at 4 °C.

Suggest how the results are different from those in Table 1.1.

....

.... [1]

(b) (i) Suggest why it is important to stir and mix the celery puree in the procedure in **1(a)**.

....

.... [1]

(ii) The celery puree is prepared by mashing and adding water to small pieces of celery stem.

Suggest why it is necessary to liquidise the celery in this way.

....

.... [1]

(iii) Identify **one** source of error when measuring the total height of the mixture and foam in the boiling tube.

Suggest an improvement to overcome this error.

source of error ....

....

improvement ....

....
[2]

(iv) State the name of a piece of apparatus suitable for measuring $2\,cm^3$ of aqueous hydrogen peroxide.

.... [1]

(v) Describe how you can test the liquidised celery for the presence of reducing sugar.

....

.... [1]

[Total: 13]

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Turn over

2 When a person exercises, their pulse rate increases from their resting pulse rate.

The time it takes for the pulse rate to return to the resting pulse rate after exercise is called the recovery time.

Plan an investigation to determine the relationship between the height of a person and their recovery time.

You may use any common laboratory apparatus.

Include in your plan:

- the apparatus you will need
- a brief description of the method
- what you will measure
- the variables you will control
- how you will process your results to reach a conclusion.

You may include a labelled diagram in your answer.

You may include a results table in your answer. You are **not** required to enter any readings in the table.

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[7]

3 A student determines the value of **x** in the formula of washing soda, $Na_2CO_3{\bullet}\mathbf{x}H_2O$.

When washing soda crystals are heated, they release water from the crystals.

The crystals form dry sodium carbonate powder as shown in the equation.

$$\underset{\text{crystals}}{Na_2CO_3{\bullet}\mathbf{x}H_2O} \rightarrow \underset{\text{powder}}{Na_2CO_3} + \mathbf{x}H_2O$$

The crystals lose mass as the water, $\mathbf{x}H_2O$, is given off as steam.

(a) Procedure

The student:

- uses a balance to find the mass of an empty evaporating basin
- records this mass M_1 in Table 3.1
- adds washing soda crystals to the evaporating basin
- uses a balance to find the mass of the evaporating basin and washing soda crystals
- records this mass M_2 in Table 3.1
- heats the crystals until they form the dry sodium carbonate powder
- lets the evaporating basin cool
- uses a balance to find the mass of the evaporating basin and dry sodium carbonate powder
- records this mass M_3 in Table 3.1.

Table 3.1

mass of empty evaporating basin, M_1 / g	42.1
mass of evaporating basin and washing soda crystals $Na_2CO_3{\bullet}\mathbf{x}H_2O$ before heating, M_2 / g	
mass of evaporating basin and dry sodium carbonate powder Na_2CO_3, M_3 / g	

(i) Several students are sharing the same balance for this procedure.

State what each student does to the balance to ensure their values of mass are as accurate as possible.

....

.... [1]

(ii) The student heats the evaporating basin with a blue Bunsen burner flame.

A blue Bunsen burner flame is hotter than a yellow flame.

State **one** other reason why the student uses a blue Bunsen burner flame.

....

.... [1]

(iii) Figure 3.1 shows the readings on the balance for M_2 and M_3.

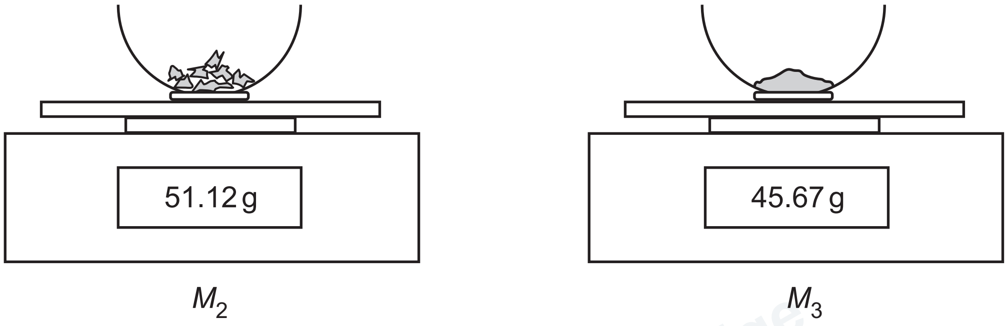

Figure 3.1

Record in Table 3.1 these values to **three** significant figures. [2]

(b) (i) Calculate the mass of water lost by the washing soda crystals.

Use the equation shown.

$$\text{mass of water} = M_2 - M_3$$

mass of water = ... g [1]

(ii) Calculate the amount of water in the washing soda crystals.

Use the equation shown.

$$\text{amount of water} = \frac{\text{mass of water}}{18}$$

amount of water = ... mol [1]

(iii) Calculate the mass of dry sodium carbonate powder.

Use the equation shown.

$$\text{mass of dry sodium carbonate powder} = M_3 - M_1$$

mass of dry sodium carbonate powder = ... g [1]

(iv) Calculate the amount of dry sodium carbonate powder.

Use the equation shown.

$$\text{amount of dry sodium carbonate powder} = \frac{\text{mass of dry sodium carbonate powder}}{106}$$

amount of dry sodium carbonate powder = ... mol [1]

(v) Use the answers to **3(b)(ii)** and **3(b)(iv)** to calculate the value of **x** in $Na_2CO_3 \cdot \mathbf{x}H_2O$.

Use the equation shown.

$$\mathbf{x} = \frac{\text{amount of water}}{\text{amount of dry sodium carbonate powder}}$$

Give your answer to **one** significant figure.

x = ... [2]

(c) Another student repeats the procedure.

They obtain a value for the mass of dry sodium carbonate powder which is larger than expected.

Suggest why the value is larger than expected.

Explain what the student does to reduce this error.

suggestion ....

....

explanation ....

....
[1]

(d) Sodium carbonate powder is dissolved in water to make aqueous sodium carbonate.

Describe how sodium carbonate crystals are made from aqueous sodium carbonate.

....

....

.... [1]

(e) Describe a chemical test for water.

Give the observations for a positive result.

reagent added ....

colour change from .... to ....

[2]

(f) Metal **J** forms a carbonate with the formula $JCO_3 \bullet \mathbf{y}H_2O$.

When heated, the carbonate decomposes to give the oxide, steam and carbon dioxide gas.

The equation for this reaction is shown.

$$JCO_3 \bullet \mathbf{y}H_2O \rightarrow JO + \mathbf{y}H_2O + CO_2$$

Compare this equation to the equation for heating washing soda crystals.

$$Na_2CO_3 \bullet \mathbf{x}H_2O \rightarrow Na_2CO_3 + \mathbf{x}H_2O$$

Explain why the procedure in **3(a)** is **not** used to determine the value of **y** in $JCO_3 \bullet \mathbf{y}H_2O$.

....

.... [1]

[Total: 15]

4 A student identifies the ions present in aqueous **L**.

Procedure

The student:

- adds approximately 1 cm depth of aqueous **L** into each of three test-tubes
- completes the tests described in Table 4.1
- records the observations in Table 4.1.

Table 4.1

test number	test	observations
1	add a few drops of aqueous sodium hydroxide add excess aqueous sodium hydroxide	white ppt. colourless solution
2	add dilute nitric acid followed by a few drops of aqueous silver nitrate	yellow ppt.
3	add dilute nitric acid followed by aqueous barium nitrate	white ppt.

(a) State the identity of the ions present in aqueous **L**.

.... [1]

(b) Suggest why nitric acid is added in tests **2** and **3**.

....

.... [1]

(c) Suggest why hydrochloric acid is **not** used instead of nitric acid in test **2**.

....

.... [1]

(d) A student does a flame test on a sample of aqueous **L**.

Describe how the student does the flame test.

....

....

....

.... [2]

[Total: 5]

Turn over

5 A student does an experiment to find the spring constant, k, of a spring.

Procedure

The student:

- assembles the apparatus as shown in Figure 5.1; the mass hanger has a mass, m, of 100 g

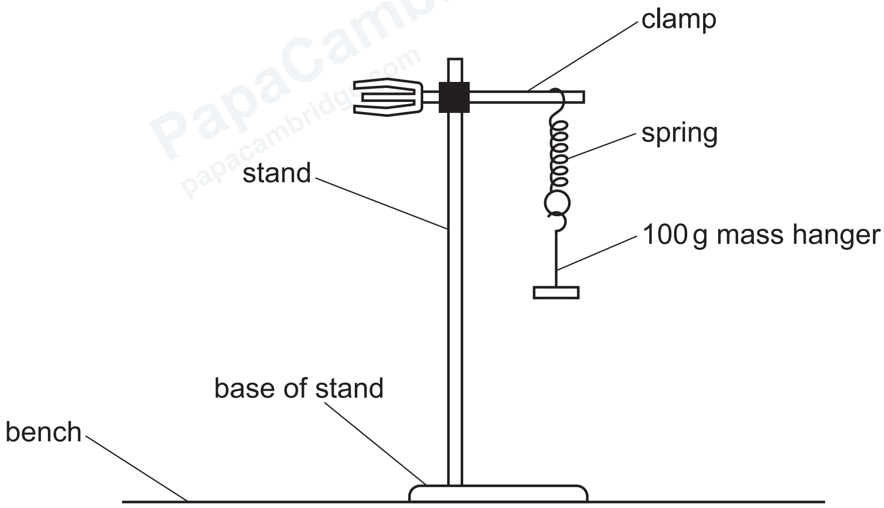

Figure 5.1

- gently pulls down on the 100 g mass hanger so the spring oscillates up and down
- measures the time taken, t, for 10 oscillations
- records in Table 5.1 this value to the nearest 0.1 second.

The student repeats the procedure with the values of m shown in Table 5.1.

Table 5.1

m / g	t / s	T / s	T^2 / s^2
100	4.2	0.42	0.18
200			
300			
400	8.1	0.81	0.66
500	9.1	0.91	0.83

(a) **(i)** Figure 5.2 shows the readings on the stop-watch for m = 200 g and m = 300 g.

200 g

300 g

Figure 5.2

Record in Table 5.1 these readings to the nearest 0.1 second. [2]

(ii) Calculate the time T for one oscillation for m = 200 g and m = 300 g.

Use the equation shown.

$$T = \frac{t}{10}$$

Record your values in Table 5.1. [1]

(iii) Calculate T^2 for m = 200 g and m = 300 g.

Record in Table 5.1 your values to **two** decimal places. [1]

(b) **(i)** On the grid, plot T^2 (vertical axis) against m.

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

[3]

(ii) Draw the straight line of best fit. [1]

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

Show your working on the graph.

gradient = ... [2]

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(iv) Calculate the spring constant, k.

Use the equation shown.

$$k = \frac{0.039}{\text{gradient}}$$

k = ... N/m [1]

(v) The student suggests T^2 is proportional to m.

Explain if the student's results support the suggestion.

....

....

.... [1]

(c) Explain why measuring the time taken for 20 oscillations is more accurate than measuring the time for 10 oscillations.

....

.... [1]

[Total: 13]

6 A student investigates the temperature changes when hot and cold water are mixed.

Procedure

The student:

- pours 100 cm^3 of cold water into a 250 cm^3 beaker
- pours 50 cm^3 of hot water into a 100 cm^3 beaker
- measures the temperatures of the hot and cold water and records these in Table 6.1
- immediately pours the hot water into the 250 cm^3 beaker of cold water
- stirs the mixture
- measures the temperature of the mixture of hot and cold water and records this in Table 6.1.

Table 6.1

	temperature / °C
cold water	19.0
hot water	
mixture of hot and cold water	

(a) Figure 6.1 shows the thermometer readings for the hot water and the mixture of hot and cold water.

hot water

mixture of hot and cold water

Figure 6.1

Record in Table 6.1 these temperatures to the nearest 0.5 °C. [2]

(b) Calculate the change in temperature of the cold water.

Use the equation shown.

change in temperature = temperature of mixture – temperature of cold water

change in temperature = ... °C

Calculate the change in temperature of the hot water.

Use the equation shown.

change in temperature = temperature of hot water – temperature of mixture

change in temperature = ... °C
[1]

(c) The student suggests the change in temperature of the hot water is double the change in temperature of the cold water.

State if the student's results support the suggestion.

Explain your answer.

....

.... [1]

(d) State **one** safety hazard the student encounters when following the procedure.

Describe the precaution the student takes to reduce the risk of this hazard.

hazard ....

precaution ....

....
[1]

(e) Figure 6.2 shows a thermometer being used by the student to measure the temperature of the water.

Suggest **two** mistakes the student makes.

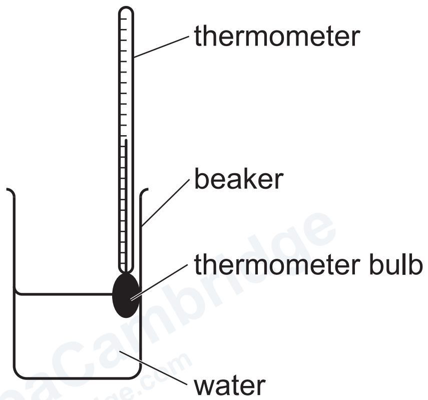

Figure 6.2

1 ....

....

2 ....

....
[1]

(f) The student takes cold water with a temperature of 4 °C directly from a refrigerator.

The student records the temperature immediately after placing the thermometer in the cold water.

Suggest a value for the reading on the thermometer.

Explain your answer.

reading on the thermometer .... °C

explanation ....

....
[1]

[Total: 7]

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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.
nitrate, NO_3^- [in solution]	add aqueous sodium hydroxide, then aluminium foil; warm carefully	ammonia produced
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
ammonium, NH_4^+	ammonia produced on warming	–
calcium, Ca^{2+}	white ppt., insoluble in excess	no ppt. or very slight white ppt.
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
copper(II), Cu^{2+}	blue-green

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