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CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

3132704908

CO-ORDINATED SCIENCES **0654/63**

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.

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1 A student investigates respiration in peas.

(a) The student assembles the airtight apparatus shown in Figure 1.1.

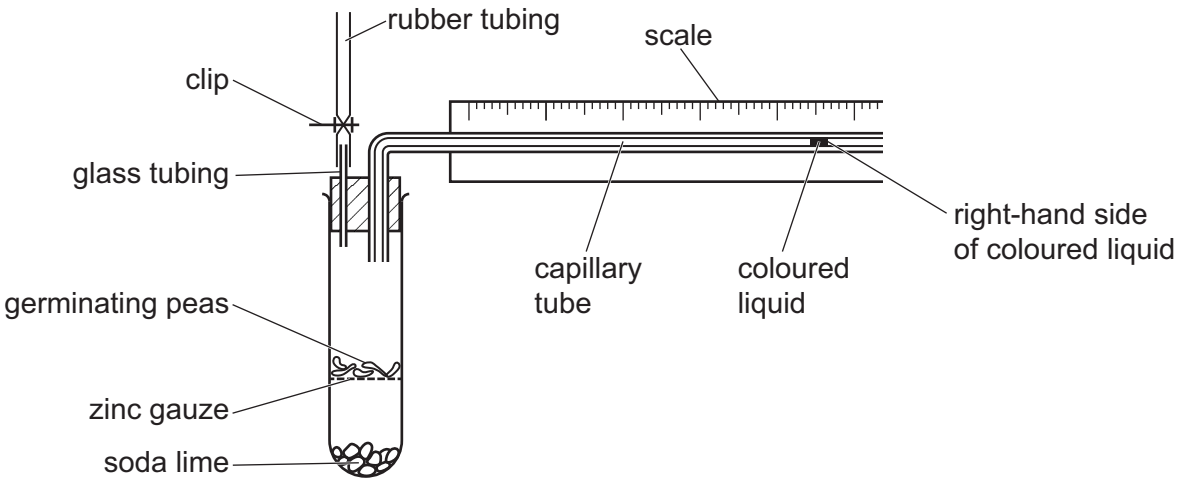


Figure 1.1

The student:

- ensures the clip is closed
- records the position of the drop of coloured liquid every 15 minutes for 60 minutes.

Figure 1.2 shows the position of the drop of coloured liquid at 0 minutes and at 60 minutes.



0 minutes 60 minutes

Figure 1.2

Measure the position of the right-hand side of the drop of coloured liquid at 0 minutes and at 60 minutes.

Record in Table 1.1 your values in cm to the nearest 0.1 cm.

Table 1.1

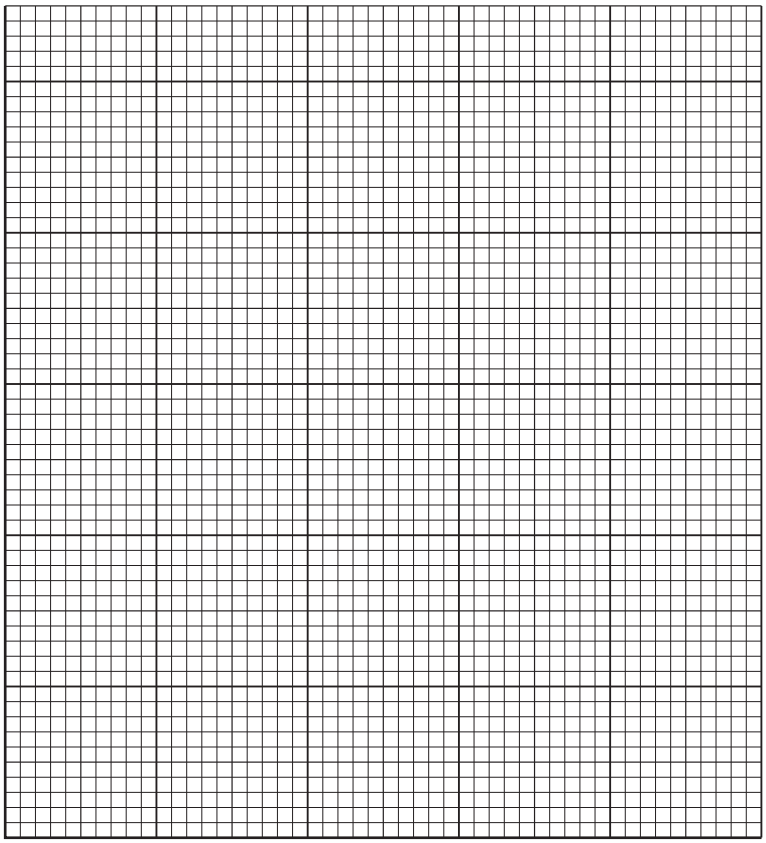
time / minutes	position of coloured liquid / cm
0	
15	2.0
30	2.8
45	3.7
60	

[2]

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(b) (i) On the grid, plot position of coloured liquid (vertical axis) against time.



[3]

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

(iii) Estimate the position of coloured liquid at 35 minutes.

Show your working on the graph.

position at 35 minutes = ... cm [2]

(c) (i) Calculate the total distance moved by the drop of coloured liquid in 60 minutes.

Use the data in Table 1.1 and the equation shown.

$$\text{total distance moved} = \text{position of coloured liquid at 60 minutes} - \text{position of coloured liquid at 0 minutes}$$

total distance moved in 60 minutes = ... cm [1]

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(ii) Calculate the rate of movement of the drop of coloured liquid.

Include the unit in your answer.

Use the equation shown.

$$\text{rate of movement} = \frac{\text{total distance moved in 60 minutes}}{\text{60 minutes}}$$

rate of movement = ... unit .....
[2]

(d) During respiration, the peas use up oxygen and give out carbon dioxide.

The soda lime absorbs the carbon dioxide.

Explain why the coloured liquid in the capillary tube moves towards the peas.

.....

..... [1]

(e) Suggest what happens to the drop of coloured liquid if the investigation is done with the clip open.

.....

..... [1]

[Total: 13]

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2 A student investigates how small animals respond to the presence of light and water vapour in their surroundings.

The student uses a dish with a lid (choice chamber) as shown in Figure 2.1.

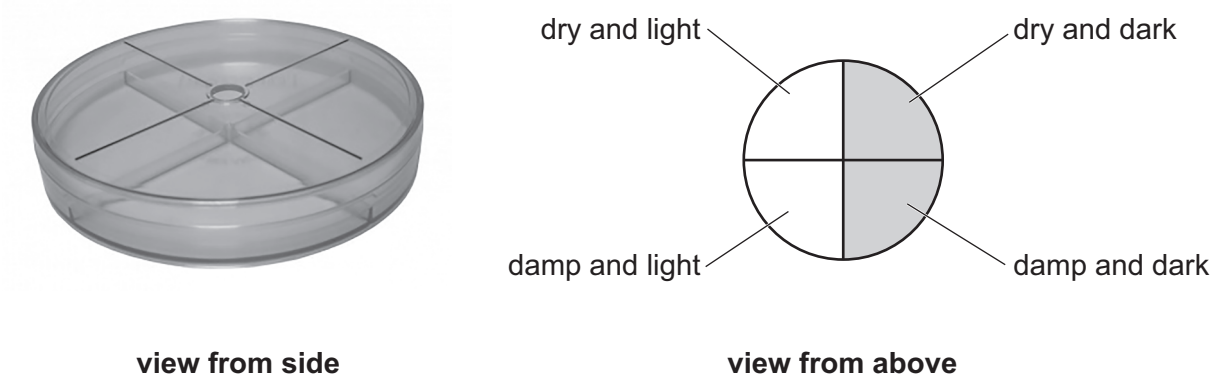


Figure 2.1

The choice chamber is divided into four areas.

Each area has different conditions:

- black paper provides dark conditions
- damp filter paper provides water vapour.

The animals are free to move between any of the four areas.

(a) The student adds 20 small animals to the choice chamber and leaves them for 30 minutes.

After 30 minutes, the student records the positions of the small animals.

(i) Figure 2.2 shows the student's notebook for trial **1**.

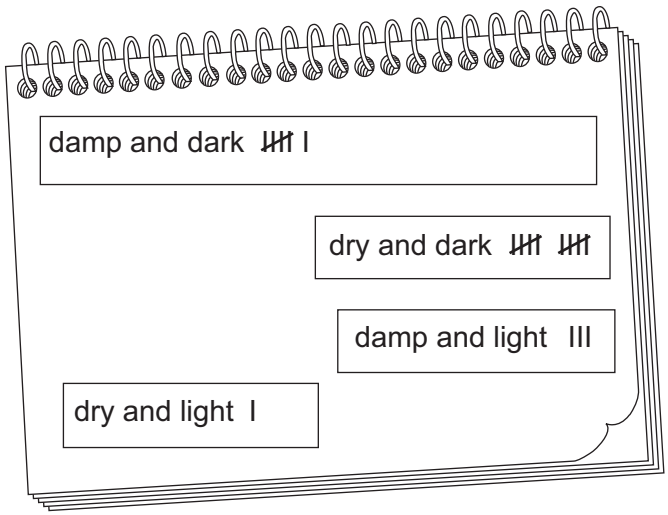


Figure 2.2

Record in Table 2.1 the number of small animals in each area for trial **1**.

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Table 2.1

conditions in each area	number of small animals counted		average number of small animals
	trial **1**	trial **2**	
dry and dark			
damp and dark			
damp and light			
dry and light			

[1]

(ii) Figure 2.3 shows the choice chamber and animals for trial **2**.

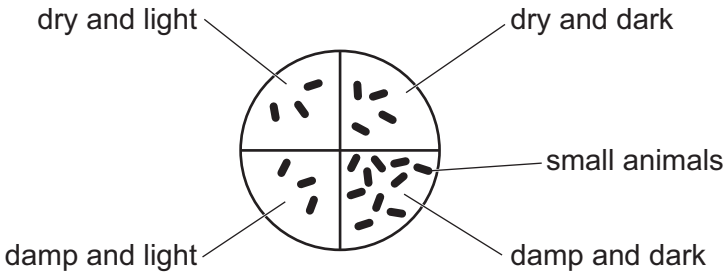


Figure 2.3

Record in Table 2.1 the number of small animals in each area for trial **2**. [1]

(iii) Calculate the average number of small animals in each area.

Record these values in Table 2.1. [1]

(b) (i) State which area of the choice chamber the small animals appear to prefer.

..... [1]

(ii) Suggest where the student places the small animals when they first put them into the choice chamber.

Explain your answer.

suggestion .....

.....

explanation .....

.....

[2]

(iii) Suggest why the student needs to do a third trial.

.....

.....

..... [1]

[Total: 7]

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3 A student investigates the temperature changes when substances dissolve in water.

(a) Procedure

The student:

- uses a measuring cylinder to add 25 cm^3 of water to a boiling tube
- records, in Table 3.1, the initial temperature of the water
- adds some potassium carbonate to the water
- stirs the mixture until it all dissolves
- records, in Table 3.1, the final temperature of the solution.

The student repeats the procedure for magnesium chloride and for ammonium nitrate.

(i) Draw a diagram of the assembled apparatus the student uses in the procedure.

[2]

(ii) Figure 3.1 shows part of the measuring cylinder used to measure the volume of water.

On Figure 3.1, draw the level of the liquid that shows a reading of 25.0 cm^3.

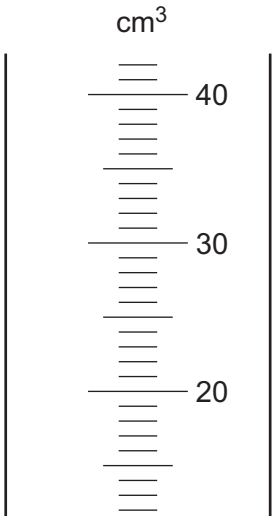


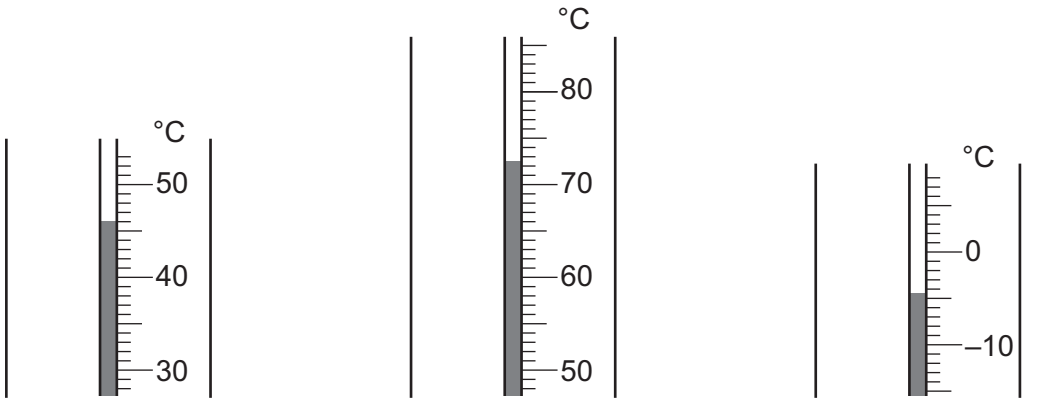
Figure 3.1

[1]

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(iii) Figure 3.2 shows the readings on the thermometer for the final temperatures of each solution.



potassium carbonate **magnesium chloride** **ammonium nitrate**

Figure 3.2

Record, in Table 3.1, these temperatures to the nearest 0.5 °C.

Table 3.1

substance	initial temperature of water / °C	final temperature of solution / °C	temperature change / °C
potassium carbonate	21.5		
magnesium chloride	20.5		
ammonium nitrate	21.0		

[3]

(iv) Calculate the temperature change for each substance.

Record your values in Table 3.1.

Include a + sign where the temperature has increased and a – sign where the temperature has decreased. [2]

(v) Suggest why the procedure in **(a)** does **not** allow the temperature changes to be compared fairly.

.....

..... [1]

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(b) All of the temperature changes are smaller than expected.

(i) State why the temperature changes for potassium carbonate and magnesium chloride are smaller than expected.

.....

..... [1]

(ii) State why the temperature change for ammonium nitrate is smaller than expected.

.....

..... [1]

(iii) Suggest **one** change to the apparatus to increase the value of the temperature change for potassium carbonate.

.....

..... [1]

(c) Another student repeats the procedure but the outside of each boiling tube is wet.

When the student dissolves ammonium nitrate in water, the wet boiling tube sticks to the test-tube rack.

Explain why the boiling tube sticks to the test-tube rack.

.....

..... [1]

[Total: 13]

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Turn over

4 When manganese(IV) oxide powder is added to aqueous hydrogen peroxide, the hydrogen peroxide decomposes and forms oxygen gas.

hydrogen peroxide → oxygen + water

Plan an investigation to determine the relationship between the **rate** of this reaction and the initial temperature of the aqueous hydrogen peroxide.

You are provided with an unlimited supply of:

- aqueous hydrogen peroxide
- manganese(IV) oxide powder.

You may use any common laboratory apparatus.

In your plan, include:

- the apparatus you will need
- a brief description of the method
- the measurements you will make, including how you will make them as accurate as possible
- the variables you will control
- how you will use 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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5 A student investigates how the angle of a ramp affects the time taken for a toy car to travel down the ramp.

Procedure

The student:

- assembles the apparatus shown in Figure 5.1

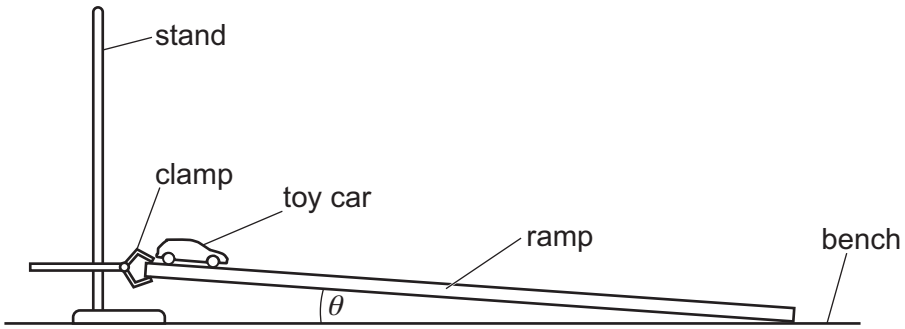


Figure 5.1

- measures the angle θ between the bottom of the ramp and the bench
- pushes the car to start it moving down the ramp
- immediately starts a stopwatch
- stops the stopwatch when the car gets to the bottom of the ramp
- records this time *t* in Table 5.1
- adjusts the height of the clamp to change the angle θ
- resets the stopwatch.

The student repeats the procedure until they have 6 sets of results.

Table 5.1

θ/°	*t*/s
29	
40	
52	
60	
70	

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(a) (i) Figure 5.2 shows the student's first value of θ.

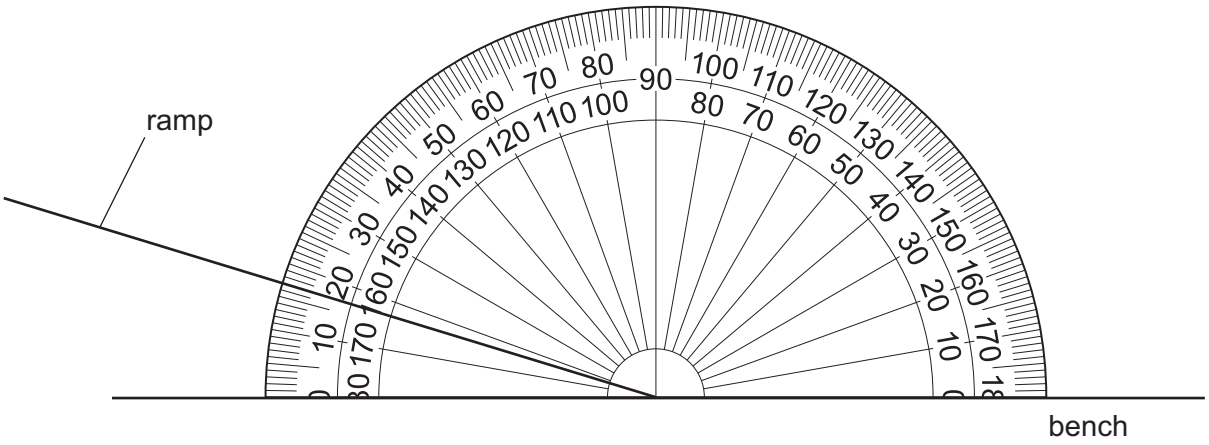
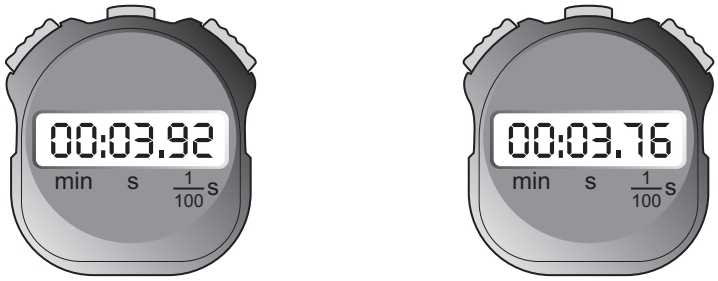


Figure 5.2

Record, in Table 5.1, this angle in degrees to the nearest 1°. [1]

(ii) Figure 5.3 shows the readings on the stopwatch for the student's first angle and for θ = 29°.



first angle **θ = 29°**

Figure 5.3

Record, in Table 5.1, these times in seconds to the nearest 0.1 second. [2]

(iii) The student records the other results in a notebook.

Figure 5.4 shows the results.

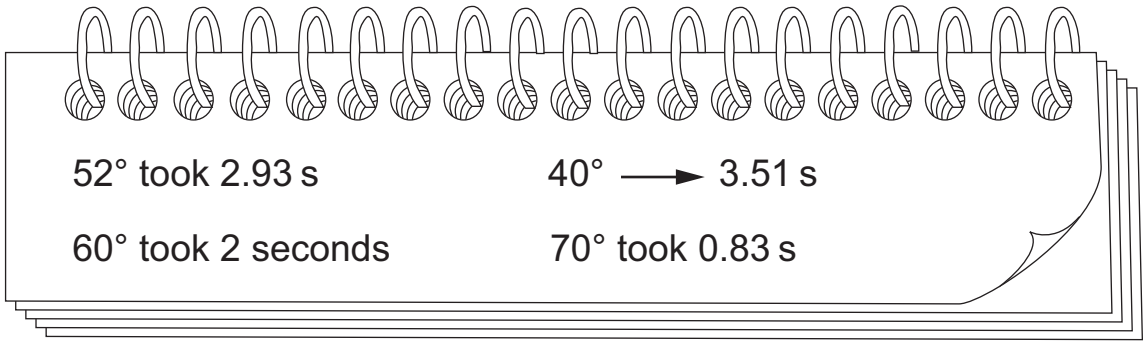


Figure 5.4

Record, in Table 5.1, these results to the nearest 0.1 second. [1]

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(iv) Describe the relationship between the angle θ of the ramp and the time t taken for the toy car to travel down the ramp.

.....

..... [1]

(b) (i) Describe how the student uses the protractor to measure accurately the angle between the bottom of the ramp and the bench.

.....

.....

..... [1]

(ii) The student has a choice of **two** ramps to use in the investigation.

Ramp **A** is 200 cm long.
Ramp **B** is 50 cm long.

The student chooses ramp **A** because it is longer.

Explain why ramp **A** gives more accurate values of t.

.....

..... [1]

(iii) There is an error in the procedure.

Identify the error.

Suggest an improvement to overcome this error.

error .....

suggestion .....

.....
[1]

[Total: 8]

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Turn over

6 A student does an experiment to determine the density of the glass used to make marbles.

(a) (i) Figure 6.1 shows 5 identical glass marbles.

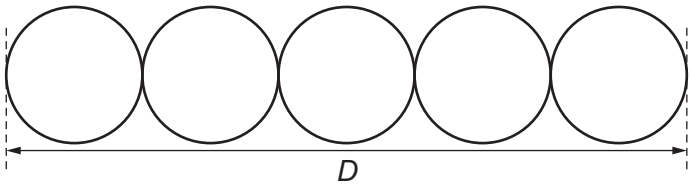


Figure 6.1

Record the distance D in cm to the nearest 0.1 cm.

D = ... cm [1]

(ii) Calculate the radius r of one glass marble.

Use the equation shown.

$$r = \frac{D}{10}$$

r = ... cm [1]

(iii) Calculate the volume V of one glass marble.

Use the equation shown.

$$V = 4.19 \times r^3$$

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

V = ... cm^3 [2]

(iv) The student measures the mass m of one glass marble using a balance.

Figure 6.2 shows the reading on the balance.

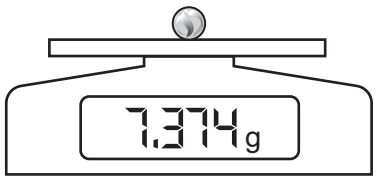


Figure 6.2

Record m in g to the nearest 0.1 g.

m = ... g [1]

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(v) Calculate the density ρ of the glass used to make the marble.

Use your answers from **6(a)(iii)** and **6(a)(iv)** and the equation shown.

$$\rho = \frac{m}{V}$$

ρ = ... g/cm^3 [1]

(b) (i) Optical glass has a range of values of density from 2.8 g/cm^3 to 6.2 g/cm^3.

The limit of experimental accuracy is 10%.

State whether the glass marble used in the experiment is made of optical glass.

Justify your answer with a calculation.

.....

.....

..... [2]

(ii) Another student measures the diameter of one glass marble and uses two blocks of wood to make the measurement more accurate.

Figure 6.3 shows the marble and blocks of wood.

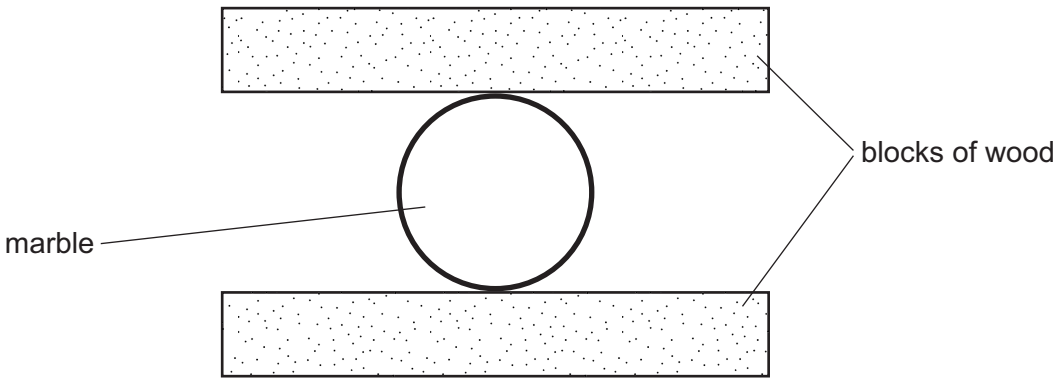


Figure 6.3

Explain why the blocks of wood must be parallel to one another.

.....

..... [1]

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(c) Another student uses a displacement method to calculate the density of the plastic used to make a solid plastic ball.

The ball floats in water, as shown in Figure 6.4.

The student uses a measuring cylinder to find the volume of the ball.

The measuring cylinder is shown in Figure 6.4.

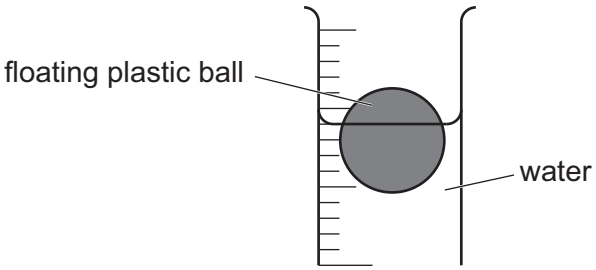


Figure 6.4

(i) State why the volume measured in this displacement experiment is **not** equal to the actual volume of the ball.

Explain the effect this has on the calculated value of the density of the plastic.

statement .....

.....

effect on density .....

.....

[2]

(ii) Suggest **how** the student modifies the displacement experiment to measure the actual volume of the ball.

.....

..... [1]

[Total: 12]

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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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