Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

8503280329

COMBINED SCIENCE **5129/31**

Paper 3 Experimental Skills and Investigations **October/November 2025**

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.

[Turn over

1 A student investigates the combustion of different foods.

procedure

The student:

- places 20 cm^3 of water in a boiling tube
- measures and records the starting temperature of the water
- places a piece of burning biscuit under the boiling tube as shown in Fig. 1.1
- measures and records the final temperature of the water when the biscuit stops burning.

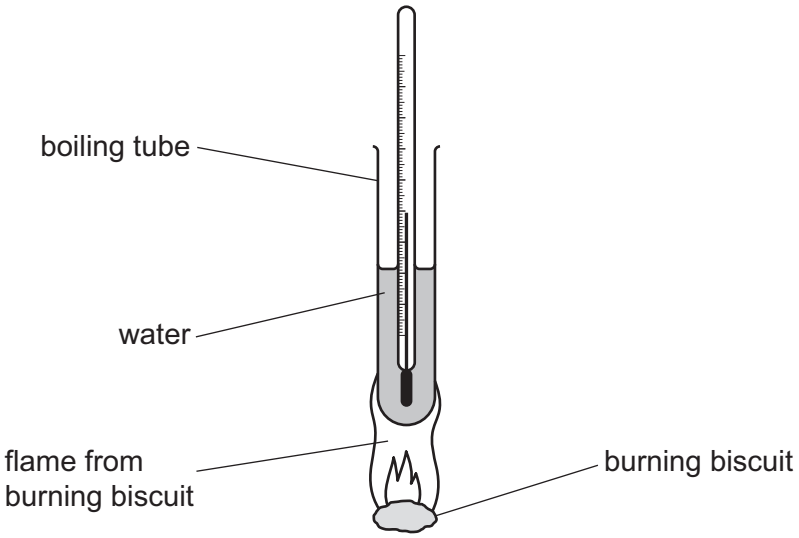

Fig. 1.1

The student repeats the procedure, first using a piece of burning popcorn and then using a piece of burning nut.

The student's results are shown in Fig. 1.2.

biscuit starting temperature 15.5 °C final temperature 28.0 °C

popcorn starting temperature 15.5 °C final temperature 18.0 °C

nut starting temperature 16.0 °C final temperature 33.5 °C

Fig. 1.2

(a) (i) Complete Table 1.1 by using the student's results from Fig. 1.2 and calculating the change in temperature of the water for each food.

Record your calculated values to a suitable number of significant figures.

Table 1.1

food	starting temperature of water / °C	final temperature of water / °C	change in temperature of water / °C
biscuit			
popcorn			
nut			

[3]

(ii) State the name of the apparatus that the student uses to measure the temperature.

..... [1]

(iii) State the additional measurement that must be made to determine the temperature change of the water per gram of food.

..... [1]

(iv) Explain why the student should repeat the procedure at least two more times for each food.

.....

..... [1]

(b) Theory suggests that the true values of the temperature changes of the water are much larger than the temperature changes determined by the student.

(i) Explain why the temperature changes determined by the student are much lower than the true values.

.....

.....

..... [1]

(ii) Suggest **one** improvement to the procedure, other than repeating it, that will ensure that the student obtains temperature changes closer to the true values.

.....

..... [1]

(c) The student tests each food for the presence of protein.

State the name and the initial colour of the chemical used to test for protein and the final colour of the chemical that shows that protein is present in a food.

name of chemical .....

initial colour .....

final colour .....

[3]

[Total: 11]

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2 A student investigates a mixture of a green solid and a white solid.

procedure

The student:

- adds the mixture of solids to water and stirs
- filters the mixture of solids and water
- tests the filtrate with universal indicator paper
- does a flame test on the filtrate
- mixes the filtrate with aqueous barium nitrate
- adds dilute sulfuric acid to the residue, and collects and tests the gas that is produced
- adds aqueous sodium hydroxide to the mixture of dilute sulfuric acid and the residue until the aqueous sodium hydroxide is in excess.

(a) Fig. 2.1 shows the filtration of the mixture and water.

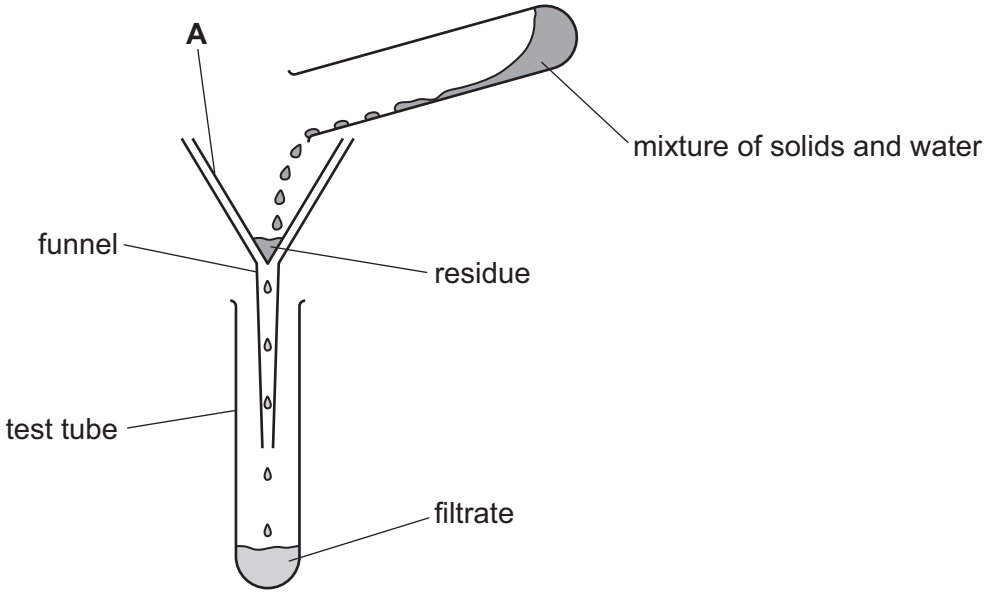

Fig. 2.1

State the name of apparatus **A**.

..... [1]

(b) The residue is the green solid from the original mixture.

Explain why the residue does not contain any of the white solid.

.....

..... [1]

(c) The student looks at the universal indicator paper and concludes that the filtrate has a pH value of 2.

Describe what the student observes that leads to this conclusion.

.....

..... [1]

(d) When the student does the flame test on the filtrate, the flame turns yellow.

When barium nitrate is added to the filtrate, a white precipitate is formed.

Use these observations and the conclusion made in **(c)** to identify **three** ions that are present in the filtrate.

1 .....

2 .....

3 ..... [3]

(e) The teacher tells the student that the green residue is copper carbonate.

(i) Describe the observation that shows that a gas is produced when dilute sulfuric acid is added to the residue.

.....

..... [1]

(ii) Aqueous sodium hydroxide is now added to the mixture of dilute sulfuric acid and the residue until the aqueous sodium hydroxide is in excess.

Describe what the student observes.

.....

..... [2]

(f) State the name of the gas produced in **(e)(i)** and describe the test and observation used to identify this gas.

name of gas .....

test and observation .....

.....

[2]

[Total: 11]

3 A student investigates the speed of a ball on a track.

procedure

The student:

- makes a sloping track, using two one-metre rules and a block of modelling clay
- places a glass ball at the 100 cm mark on the rule as shown in Fig. 3.1
- measures the height *h* of the centre of the ball above the bench
- releases the ball so that it rolls down the track
- starts a stopwatch when the ball begins to roll down the track
- stops the stopwatch when the ball reaches the bottom of the track.

The student repeats the procedure with the ball placed at the 80 cm, 60 cm, 40 cm and 20 cm marks on the rule.

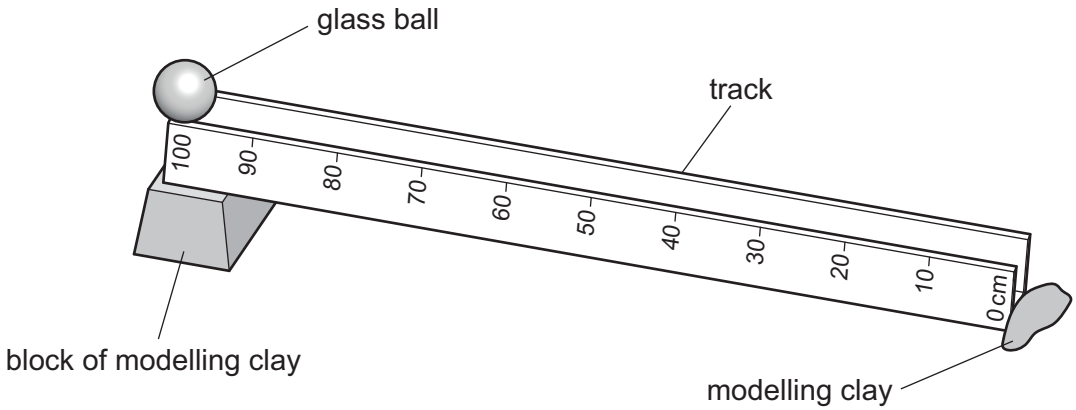

Fig. 3.1

(a) The student places a ruler on the bench as shown in Fig. 3.2.

Part of the scale of the ruler is shown.

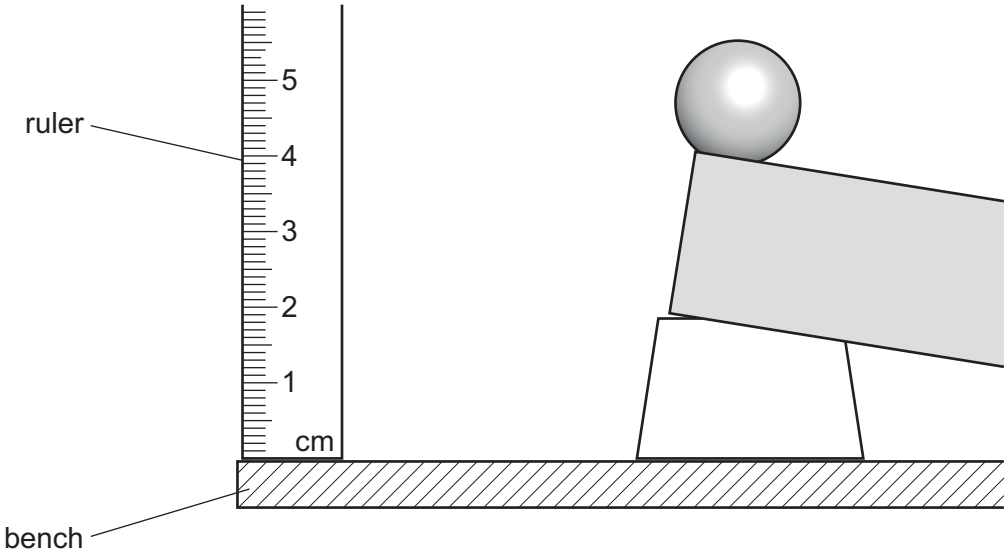

Fig. 3.2

(i) State the precision of the ruler in Fig. 3.2.

..... [1]

(ii) The centre of the ball in Fig. 3.2 is at height *h* above the bench.

On Fig. 3.2, draw a straight line from the centre of the ball to the bench to show the height *h*. Label the line with an *h*.

Use the ruler shown in Fig. 3.2 to measure the height *h*.

Record your measurement of the height *h* here and in Table 3.1 on page 10.

h = ... mm [2]

(iii) The value of *h* obtained by the student is not accurate.

State the name of the type of error that is caused by the position of the ruler shown in Fig. 3.2.

Suggest how the arrangement can be improved to obtain a more accurate value of *h*.

type of error .....

improvement .....

.....

[2]

(b) The student measures the time for the ball to roll down the track from the 100 cm mark.

The student then repeats the measurement.

Fig. 3.3 shows the stopwatch readings for both measurements.

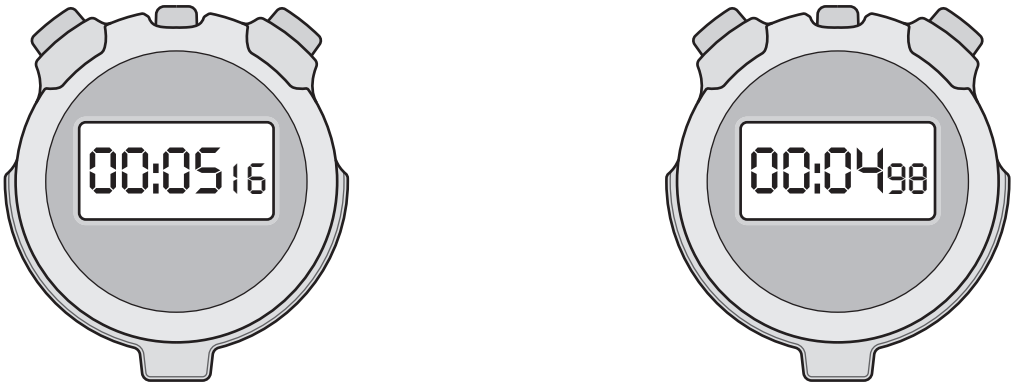

Fig. 3.3

(i) Calculate the average time t_{av} for the ball to roll down the track.

Record your answer here and in Table 3.1 on page 10.

t_{av} = ... s [1]

(ii) Calculate the average speed of the ball using the equation

$$\text{average speed} = \frac{d}{t_{av}}$$

where d, the distance the ball rolls down the track, is 100 cm and t_{av} is your answer in **(b)(i)**.

Record your answer here and in Table 3.1.

average speed = ...cm/s [1]

(c) Table 3.1 shows the student's results for d = 80 cm, 60 cm, 40 cm and 20 cm, where d is the distance the ball rolls down the track.

Table 3.1

h/mm	d/cm	t_{av}/s	$\frac{\text{average speed}}{\text{cm/s}}$
.....	100	.....	.....
42	80	4.99	16.0
38	60	4.16	14.4
35	40	3.44	11.6
31	20	2.16	9.3

(i) On the grid provided, plot a graph of h on the x-axis against average speed on the y-axis. You do **not** have to start your graph at (0, 0).

Include the value of h that you measured and the average speed that you calculated for d = 100 cm in your graph.

Draw the line of best fit through your points. [3]

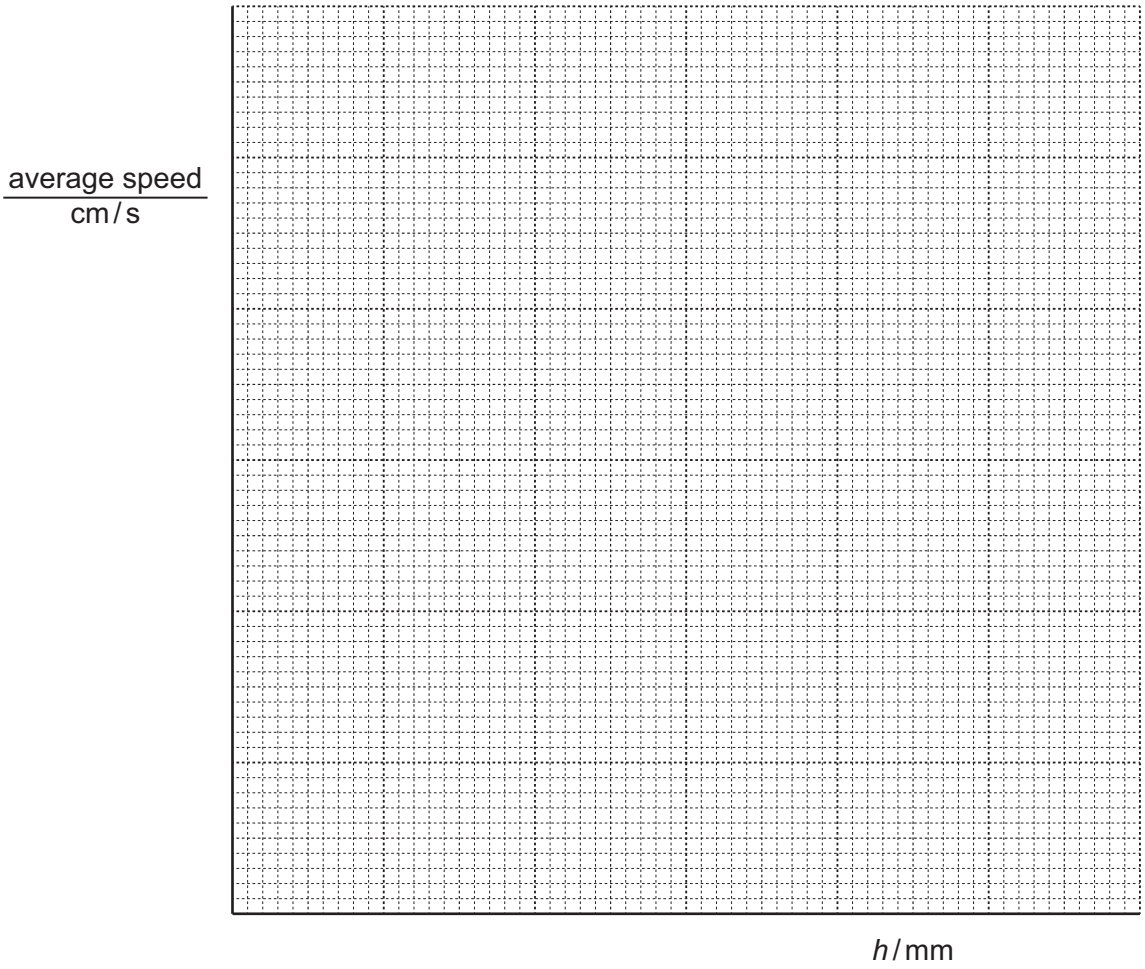

Fig. 3.4

(ii) Describe the relationship between h and average speed shown by the graph.

.....

..... [1]

[Total: 11]

4 An indicator is mixed with milk, and the colour of the mixture of indicator and milk changes from white to pink.

If a specific enzyme is now added to the mixture of milk and indicator, the fat in the milk is digested after a period of time and the colour of the mixture changes back to white from pink.

A student states:

'As the temperature of the mixture of milk and indicator increases, the time taken for the colour of the mixture to change back to white from pink decreases.'

Plan an investigation to test whether the student's statement is correct.

You are provided with the indicator, the enzyme and some milk.

Any other apparatus commonly found in a school laboratory is also available for you to use in your plan.

Include in your answer:

- a brief description of the method including the apparatus you use
- the measurements you make
- the variables to keep constant and the variable to change
- how you use your results to draw a conclusion.

A diagram of apparatus and a results table are **not** required but you may include them if it helps to explain your plan.

.....

.....

.....

[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.
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
aluminium, Al^{3+}	white ppt., soluble in excess, giving a colourless solution	white ppt., insoluble in excess
ammonium, NH_4^+	ammonia produced on warming	–
calcium, Ca^{2+}	white ppt., insoluble in excess	no ppt. or very slight white ppt.
chromium(III), Cr^{3+}	green ppt., soluble in excess	green ppt., insoluble in excess
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