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CAMBRIDGE
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CANDIDATE NAME	

CENTRE NUMBER		CANDIDATE NUMBER	

* 4 9 3 4 9 2 1 6 8 7 *

COMBINED SCIENCE **0653/63**

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

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. 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 40.
- 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 **16** pages. Any blank pages are indicated.

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1 (a) A student investigates the effect of changing the concentration of sugar solution on osmosis in potatoes.

The student is provided with five cylinders of potato.

One cylinder of potato with diameter D and length L is shown drawn to scale in Figure 1.1.

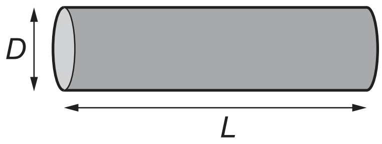

Figure 1.1

(i) Measure D and L.

Record your answers to the nearest 0.1 cm.

D = ... cm

L = ... cm
[2]

(ii) Calculate the volume of the cylinder of potato shown in Figure 1.1.

Use the equation shown.

$$\text{volume} = 0.79 \times L \times D^2$$

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

volume = ... cm^3 [2]

(b) Procedure

The student:

step 1 measures the **initial** masses of the five cylinders of potato and records these values in Table 1.1

step 2 puts one cylinder of potato into each of five different concentrations of sugar solution (0%, 5%, 10%, 20% and 30%)

step 3 leaves the cylinders of potato in the sugar solutions for 4 hours

step 4 removes the cylinders of potato from the sugar solutions and dries them with a paper towel

step 5 measures the **final** mass of each cylinder of potato and records these values in Table 1.1.

Table 1.1

percentage concentration of sugar solution	initial mass / g	final mass / g	change in mass / g
0	6.00		
5	6.10	6.19	+0.09
10	6.15	6.12	–0.03
20	5.82	5.74	–0.08
30	5.97	5.80	

(i) Figure 1.2 shows the final mass reading for the cylinder of potato from the 0% sugar solution.

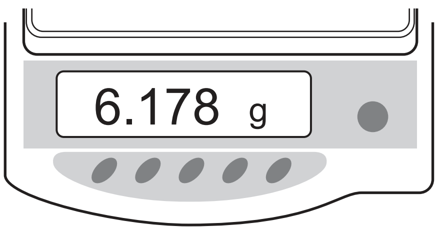

Figure 1.2

Record this final mass in Table 1.1. [1]

(ii) Calculate the change in mass for the cylinders of potato from the 30% sugar solution and the 0% sugar solution.

Record these values in Table 1.1. [2]

(iii) Estimate the concentration of sugar solution that will cause **no** change in mass to the cylinder of potato.

concentration of sugar solution = ... % [1]

(iv) Suggest a change in the procedure that allows you to have a more exact estimate in **1(b)(iii)**.

....

.... [1]

(v) Describe the effect of the percentage concentration of sugar solution on the change in mass in Table 1.1.

....

....

....

.... [2]

(c) (i) Suggest why the cylinders of potato are dried in **step 4**.

....

.... [1]

(ii) Describe how the surface area of the potatoes is controlled.

....

.... [1]

[Total: 13]

2 A student investigates the temperature increase when aqueous sodium hydroxide is added to dilute hydrochloric acid.

(a) Procedure

The student:

step 1 measures the temperature of a large volume of dilute hydrochloric acid

step 2 pours 20.0 cm^3 of the dilute hydrochloric acid into a glass beaker

step 3 adds 5.0 cm^3 of aqueous sodium hydroxide to the glass beaker

step 4 records the maximum temperature of the reaction mixture in the beaker

step 5 repeats **step 2** to **step 4** using the volumes of aqueous sodium hydroxide shown in Table 2.1.

Figure 2.1 shows the temperature readings when 10 cm^3 and 20 cm^3 of aqueous sodium hydroxide are added.

Figure 2.1

(i) Record in Table 2.1 these temperatures to the nearest 0.5 °C.

Table 2.1

volume of dilute hydrochloric acid / cm^3	volume of aqueous sodium hydroxide added / cm^3	highest temperature of the reaction mixture / °C	temperature increase / °C
20.0	5.0	26.0	5.0
20.0	10.0		
20.0	15.0	32.0	11.0
20.0	20.0		
20.0	25.0	45.5	24.5
20.0	30.0	50.5	29.5

[2]

(ii) The temperature of the hydrochloric acid in **step 1** is 21.0 °C.

Calculate the temperature increase when 10.0 cm^3 and when 20.0 cm^3 of aqueous sodium hydroxide are added.

Record in Table 2.1 these values to the nearest 0.5 °C. [1]

(b) **(i)** On the grid, plot the temperature increase (vertical axis) against the volume of aqueous sodium hydroxide added.

[3]

(ii) One of the results is anomalous.

Circle on the grid this anomalous result. [1]

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

(iv) Explain what actions the student takes to confirm that the result in **2(b)(ii)** is anomalous.

....

.... [1]

(v) The student thinks the temperature increase is proportional to the volume of sodium hydroxide added.

Explain if the student is correct.

....

....

.... [1]

(c) Explain why the student needs at least two different sizes of measuring cylinder to measure the different volumes of aqueous sodium hydroxide.

....

.... [1]

(d) Suggest **two** changes to the investigation that improve confidence in the values of the temperature increase.

1 ....

....

2 ....

....

[2]

[Total: 13]

Turn over

3 A student investigates an electrical circuit.

The student is given the circuit shown in Figure 3.1.

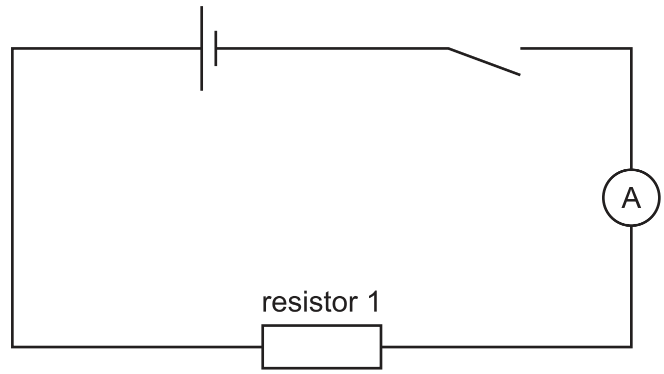

Figure 3.1

Procedure

The student:

- closes the switch
- records the ammeter reading
- opens the switch.

(a) Figure 3.2 shows the ammeter reading I_1.

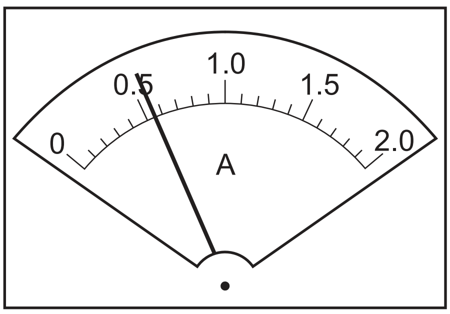

Figure 3.2

Record I_1 to the nearest 0.05A.

I_1 = ...A [1]

(b) The student connects an identical resistor in parallel with resistor 1.

Draw this resistor connected to the circuit on Figure 3.1.

Label this resistor as resistor 2. [1]

(c) Procedure

The student:

- closes the switch
- records the ammeter reading
- opens the switch.

Figure 3.3 shows the ammeter reading I_2.

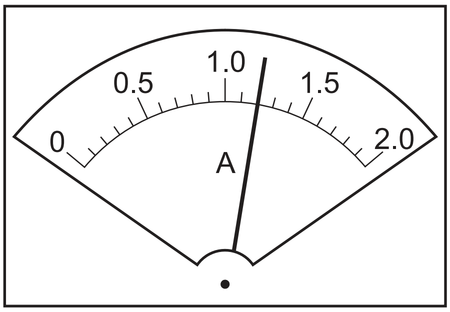

Figure 3.3

Record I_2 to the nearest 0.05A.

I_2 = ...A [1]

(d) A student suggests that if resistor 2 has the same resistance as resistor 1 then

$$I_2 = 2 \times I_1.$$

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

State if your values of I_1 and I_2 support the student's suggestion within the limits of experimental error.

Justify your answer with a calculation.

....

.... [2]

(e) The student suggests that if a third identical resistor, resistor 3, is connected in parallel with the other two resistors, the relationship between the resulting current I and I_1 is

$$I = 3 \times I_1$$

Suggest a value for I if resistor 3 is added to the circuit in Figure 3.1.

I = ... A [1]

(f) Another student repeats the investigation using the same circuit but makes a mistake.

The student finds it difficult to read the ammeter because the value keeps decreasing.

Suggest the error the student makes and explain why the value keeps decreasing.

error ....

explanation ....
[1]

[Total: 7]

Turn over

4 Figure 4.1 shows a flexible metre ruler resting on two supports.

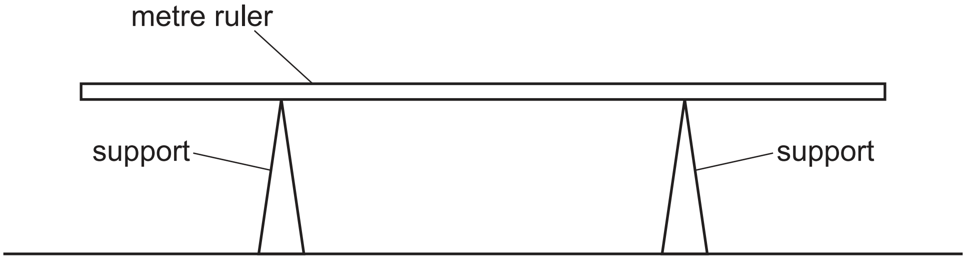

Figure 4.1

An identical mass is placed on each end of the metre ruler.

The centre of the metre ruler bends upwards through a distance *y* as shown in Figure 4.2.

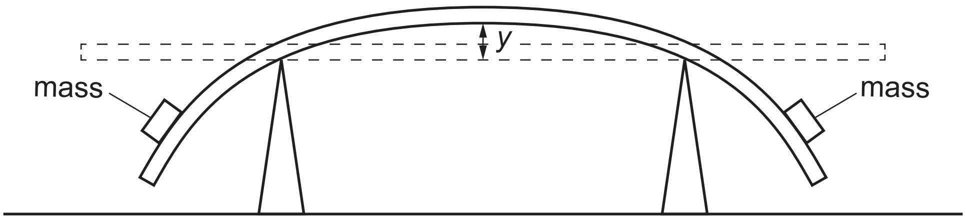

Figure 4.2

Plan an investigation to determine the relationship between distance *y* and the mass placed on each end of the metre ruler.

You are provided with a metre ruler and two supports.

You may use any common laboratory apparatus in your plan.

In your plan, include:

- any additional apparatus you will use
- a brief description of the method
- what you will measure
- which variables you will control
- how you will process your results to form a conclusion.

You may include a results table if you wish (you are **not** required to enter any readings into the table).

[7]

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
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