* 0000800000001 * DFD

Cambridge Assessment International Education

Cambridge IGCSE™

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CENTRE NUMBER

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* 1 6 5 3 6 0 8 7 6 7 *

CO-ORDINATED SCIENCES **0654/62**

Paper 6 Alternative to Practical **October/November 2025**

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 [ ].
- 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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DO NOT WRITE IN THIS MARGIN

1 A student investigates the movement of water into and out of plant cells by osmosis.

The student uses a potato and a salt solution.

(a) The student records the temperature of the salt solution used in the procedure in **(b)**.

Fig. 1.1 shows the reading on the thermometer.

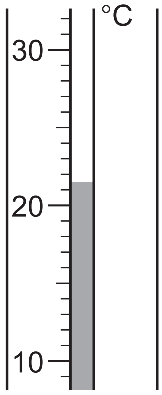


Fig. 1.1

Record this temperature to the nearest 0.5 °C.

temperature = ... °C [1]

(b) The student has three cylinders of potato with the same diameter.

Procedure

The student:

- labels 3 beakers **A**, **B** and **C**
- measures the initial mass of each cylinder of potato
- adds one cylinder of potato to each beaker
- pours a different concentration of salt solution into each beaker, as shown in Fig. 1.2

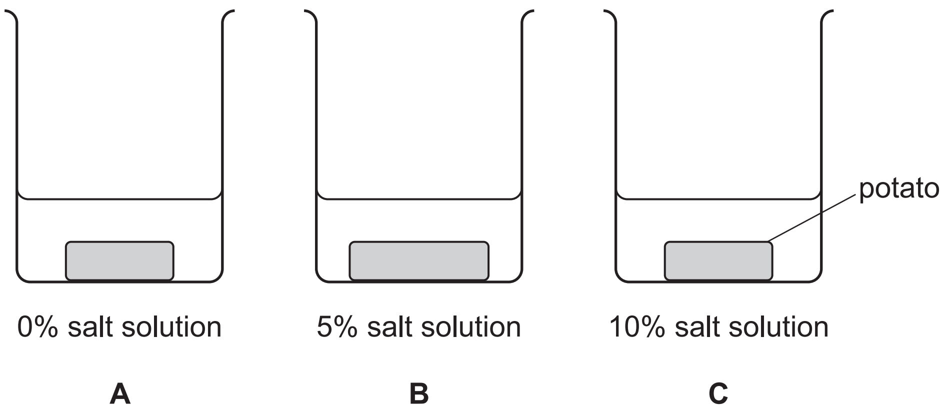


Fig. 1.2

- after 1 hour removes the cylinders of potato
- dries the outside of each cylinder of potato with a paper towel
- measures the final mass of each cylinder of potato
- calculates the change in mass for each cylinder of potato.

Some of the student's results are shown in Table 1.1.

Table 1.1

beaker	percentage concentration of salt solution	initial mass of potato / g	final mass of potato / g	change in mass of potato / g	percentage change in mass of potato
A	0	50.2	52.1	+1.9	+3.8
B	5	73.0			
C	10	50.3			

(i) Fig. 1.3 shows the balance readings for the potato cylinders from beakers **B** and **C** after 1 hour.

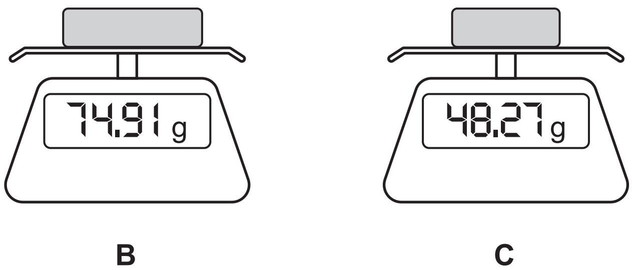


Fig. 1.3

Record in Table 1.1 these masses to the nearest 0.1 gram. [2]

(ii) Calculate the change in mass of the potato cylinders from beakers **B** and **C**.

Record these values in Table 1.1. [2]

(iii) Calculate the percentage change in mass of the potato cylinders from beakers **B** and **C**.

Use the equation shown.

$$\text{percentage change in mass} = \frac{\text{change in mass}}{\text{initial mass}} \times 100$$

Record these values in Table 1.1. [2]

(c) (i) Suggest why it is important in this investigation to compare the percentage change in mass instead of the change in mass.

....

....

.... [1]

(ii) Suggest why it is important to dry the potato cylinders before the final mass is measured.

....

.... [1]

(iii) The student uses 25 cm^3 of salt solution in each beaker in the procedure.

Suggest a piece of apparatus suitable to measure this volume accurately. Include the size of the apparatus.

.... [1]

(iv) Explain why repeating the investigation gives the student more confidence in their results.

....

.... [1]

(d) Water molecules move into and out of potato cells by osmosis.

Salt particles do **not** move into and out of potato cells.

Use this information to explain the results in beaker **B** containing 5% salt solution.

....

....

.... [1]

(e) The particles in the salt solution move more slowly at lower temperatures.

The student repeats the procedure with salt solutions at a lower temperature of 10 °C.

Suggest how the results of the experiment change at a lower temperature.

Explain your answer.

change ....

explanation ....

....

[1]

[Total: 13]

2 Yeast is a unicellular organism that respires.

DCPIP is an indicator that turns from blue to colourless when respiration takes place.

When DCPIP is added to yeast cells the rate of colour change is an indication of the rate of respiration.

Plan an investigation to determine the effect of temperature on the rate of respiration in a suspension of yeast cells.

You are provided with:

- a suspension of yeast cells (yeast cells in water)
- DCPIP solution.

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 draw a conclusion.

You may include a labelled diagram if you wish.

You may include a results table if you wish. You do not need to enter any readings into the table.

[7]

Question 3 starts on page 9.

3 A student investigates the dyes contained in several food colourings using chromatography.

(a) Procedure

The student:

- draws a baseline in ink on a piece of chromatography paper
- puts a spot of each food colouring on the baseline
- dips the chromatography paper in water
- takes the paper out when the water is near the top of the chromatography paper
- marks the position moved by the water (the solvent front)
- allows the paper to dry.

Fig. 3.1 shows the student's assembled apparatus.

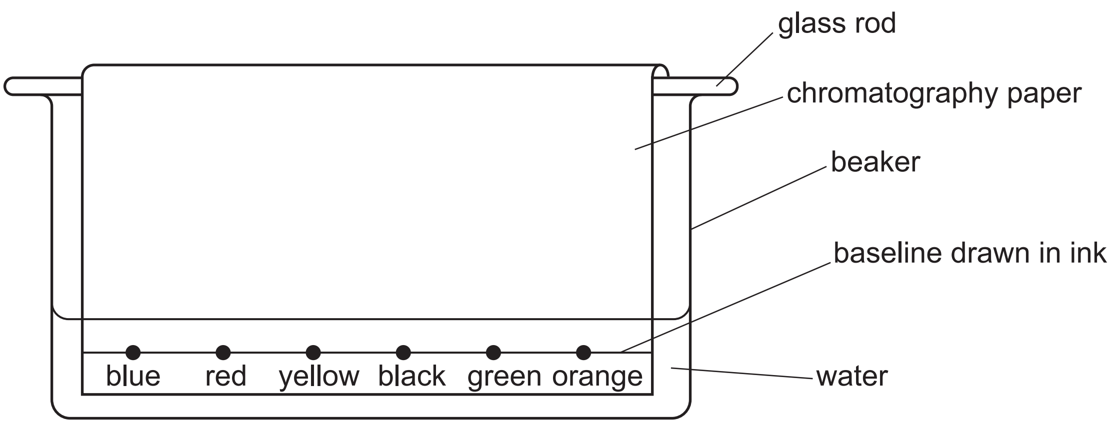


Fig. 3.1

Identify the **two** mistakes the student makes when they assemble the apparatus.

Explain why the mistakes do **not** allow the student to compare the dyes.

mistake 1 ....

....

explanation ....

....

mistake 2 ....

....

explanation ....

....

[4]

(b) A teacher corrects the mistakes in the apparatus.

The student repeats the procedure using the corrected assembled apparatus.

Fig. 3.2 shows the chromatogram the student obtains.

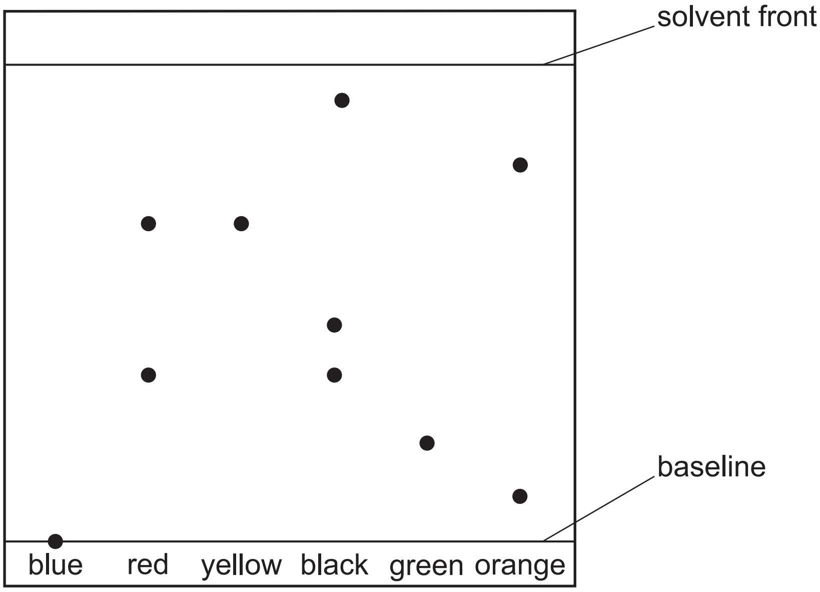


Fig. 3.2

(i) Dyes travel different distances up the paper depending on how soluble they are in the water.

State which food colouring contains the most soluble dye.

.... [1]

(ii) State which food colouring contains the largest number of soluble dyes.

.... [1]

(iii) The blue food colouring only contains dyes that are insoluble in water.

Suggest how the experiment is changed to separate the different dyes in the blue food colouring.

....

.... [1]

(c) To identify the dyes, R_f values are calculated.

The R_f value of a dye is calculated using the equation shown.

$$R_f = \frac{\text{distance from the baseline to the dye}}{\text{distance from the baseline to the solvent front}}$$

Calculate the R_f value of the yellow dye.

Show all of the distances measured and your working.

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

R_f = ... [3]

(d) Dye **J** has an R_f value of 0.21.

State the food colouring that contains dye **J**.

Show your working.

food colouring = ... [1]

[Total: 11]

4 A student investigates the reaction between copper carbonate and dilute sulfuric acid to prepare copper sulfate crystals.

copper carbonate + sulfuric acid → copper sulfate + carbon dioxide + water

(a) Procedure

The student:

step 1 puts 25 cm^3 of dilute sulfuric acid into a beaker
step 2 adds insoluble copper carbonate to the dilute sulfuric acid until the copper carbonate is in excess
step 3 filters the mixture to remove excess copper carbonate from aqueous copper sulfate
step 4 puts the aqueous copper sulfate into an evaporating basin
step 5 puts the evaporating basin on top of a tripod and gauze
step 6 heats the aqueous copper sulfate to evaporate all of the water
step 7 observes white anhydrous copper sulfate in the evaporating basin.

(i) Describe how the student knows in **step 2** when the copper carbonate is in excess.

....

.... [1]

(ii) Draw a labelled diagram of the assembled apparatus used for **step 3**.

Label the residue and the filtrate.

[2]

(iii) Draw a labelled diagram of the assembled apparatus used for **step 6**.

[3]

(b) The student wants to make blue copper sulfate crystals.

State the mistake in **step 6**.

Describe how **step 6** is changed to make blue copper sulfate crystals.

mistake ....

....

change ....

....

....
[2]

(c) State a chemical test for water. Include the observation for a positive result.

test ....

observation ....
[1]

[Total: 9]

5 A student investigates the percentage efficiency of the energy transfers for a ball bouncing on a hard surface.

Procedure

The student:

- drops a small ball from an initial height of 10.0 cm
- measures the maximum height the ball reaches after it bounces.

The student measures the heights from the hard surface to the bottom of the ball as shown in Fig. 5.1.

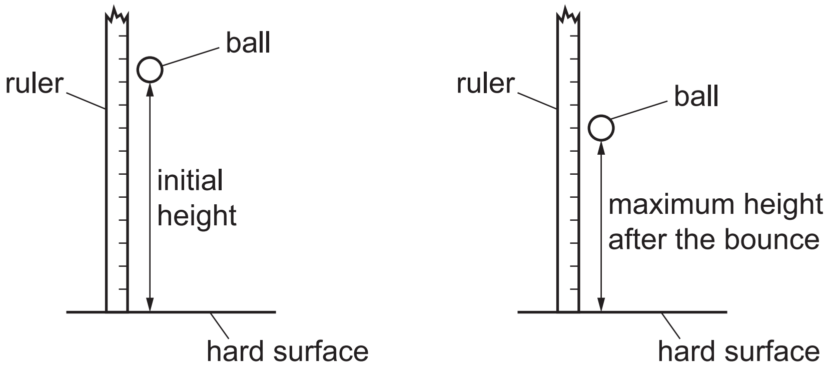


Fig. 5.1

The student repeats the procedure for the initial heights shown in Table 5.1.

Table 5.1

initial height / cm	maximum height after the bounce / cm	percentage efficiency
10.0	7.5	75
20.0	16.0	80
30.0		
40.0	36.5	91
50.0	47.0	94
60.0	57.0	95

(a) (i) Fig. 5.2 shows the maximum height after the bounce when the initial height is 30.0 cm.

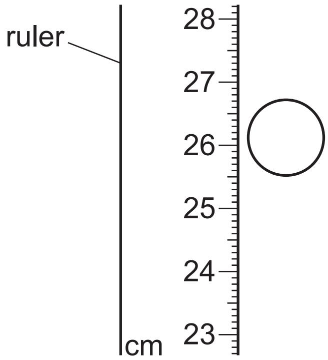


Fig. 5.2

Record in Table 5.1 the height of the bottom of the ball in cm to the nearest 0.5 cm. [1]

(ii) Calculate the percentage efficiency for the initial height of 30.0 cm.

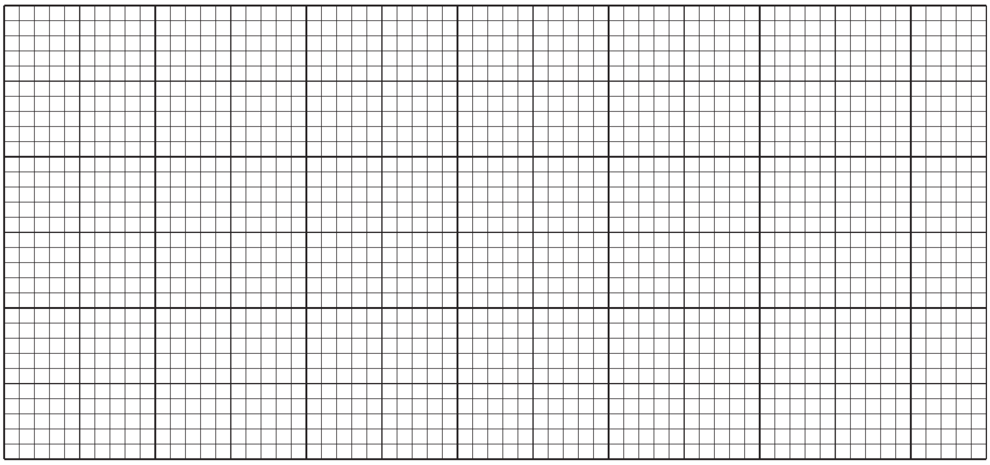
Use the equation shown.

$$\text{percentage efficiency} = \frac{\text{maximum height after the bounce}}{\text{initial height}} \times 100$$

Record this value in Table 5.1. [1]

(b) (i) On the grid, plot percentage efficiency (vertical axis) against **initial** height.

Do **not** start the vertical axis from zero.



[3]

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

(c) One source of error is that the ruler is not vertical.

(i) Describe how the student ensures the ruler is vertical.

You may draw a labelled diagram to illustrate your answer.

....

.... [1]

(ii) Describe **one other** source of error in this experiment.

Suggest what the student does to reduce this error.

source of error ....

....

suggestion ....

....
[2]

(d) The ball is dropped from an initial height of 20.0 cm and bounces to a height of 16.0 cm with an efficiency of 80%.

The ball then falls and bounces again.

Suggest how the value of percentage efficiency for the second bounce compares to the first bounce.

Use Table 5.1 to explain your answer.

....

.... [1]

[Total: 10]

Question 6 starts on page 18.

6 A student determines the resistance of 1 metre of resistance wire.

(a) Fig. 6.1 shows the apparatus the student uses.

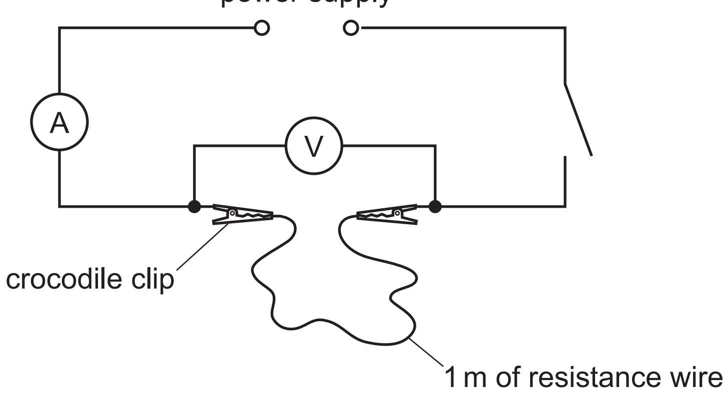


Fig. 6.1

(i) The student measures the voltage and the current in this circuit.

Fig. 6.2 shows the readings on the meters.

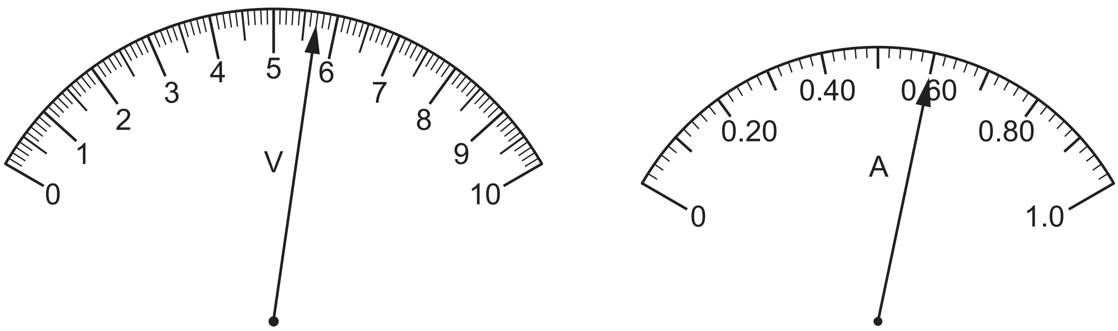


Fig. 6.2

Record the readings.

voltage = ... V

current = ... A
[2]

(ii) State the name of the apparatus used to measure current.

.... [1]

(iii) The student closes the switch and records the readings of voltage and current immediately.

Explain why the readings are taken immediately.

....

.... [1]

(iv) Calculate the resistance of the 1 m length of resistance wire.

Use your values from **(a)(i)** and the equation shown.

Include the unit in your answer.

$$\text{resistance} = \frac{\text{voltage}}{\text{current}}$$

resistance = ... unit .... [2]

(b) The student investigates if the length of the resistance wire affects the resistance.

The diameter of the resistance wire must be the same as in **(a)** to make it a fair test.

Explain why.

....

.... [1]

(c) Two values are considered to be equal within the limits of experimental error if the difference between them is less than 10%.

The diameter of the resistance wire is 0.250 mm.

The student measures the diameter of the resistance wire.

Calculate the smallest value of diameter the student measures that is within the limits of experimental error for a wire with a diameter of 0.250 mm.

diameter = ... mm [2]

(d) Two students do a similar experiment with a resistance wire of different length and a digital voltmeter.

The results for the students' voltage readings are shown in Table 6.1.

Table 6.1

	voltage / V			
	trial 1	trial 2	trial 3	trial 4
student **S**	4.81	4.83	4.81	4.83
student **T**	4.32	4.48	4.51	4.44

The readings of voltage from student **S** are more precise than the readings from student **T**.

Explain how the results show this.

....

.... [1]

[Total:10]

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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