Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME			
CENTRE NUMBER		CANDIDATE NUMBER	

7073381640

COMBINED SCIENCE **0653/51**

Paper 5 Practical Test **May/June 2020**

1 hour 15 minutes

You must answer on the question paper.

You will need: The materials and apparatus listed in the confidential instructions

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 [ ].
- Notes for use in qualitative analysis are provided in the question paper.

For Examiner's Use	
1	
2	
3	
4	
Total	

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DC (JC/CT) 188489/4

1 You are going to investigate the rate of diffusion in model cells.

Agar is a type of jelly that allows substances to diffuse (move) into it. Blocks of agar can be used to represent cells of different sizes.

(a) You are provided with one large block of agar stained with universal indicator.

Record the colour of the agar block and use the colour chart to determine its pH.

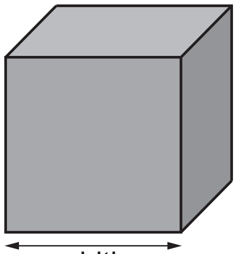
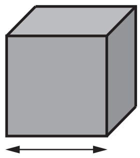
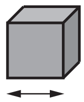
colour of agar block ....

pH of agar block ....

[1]

(b)
- Place the large agar block onto a white tile.
- Use the knife to cut the block into three smaller cubes. The sizes of these cubes are shown in Table 1.1. Cut cube **A** first, then cube **B** and then cube **C**.

Table 1.1

	cube **A**	cube **B**	cube **C**
description	 20 mm each side	 10 mm each side	 5 mm each side
surface area / mm^2	2400	....	....
volume / mm^3	8000	....	....
$\frac{\text{surface area}}{\text{volume}}$ / mm^{-1}	0.3	0.6	1.2

(i) Calculate the surface areas of cube **B** and cube **C**.

Use the equation shown and record your values in Table 1.1.

$$\text{surface area} = (\text{width})^2 \times 6$$

[1]

(ii) Calculate the volumes of cube **B** and cube **C**.

Use the equation shown and record your values in Table 1.1.

$$\text{volume} = (\text{width})^3$$

[1]

(c) (i) Read through the whole of **(c)(ii)** before answering this part.

Complete the heading in Table 1.2. [1]

(ii)
- Place each block into a separate beaker.
- Add sufficient dilute hydrochloric acid to cover each of the cubes.
- Start the stop-clock immediately.
- Measure to the nearest second the time taken for each agar block to completely change colour to red.
- If the time taken is greater than 300 seconds then stop timing and record this as **>300**.

Record your results in Table 1.2. [3]

Table 1.2

cube	$\frac{\text{surface area}}{\text{volume}}$ / mm^{-1}	.... / ....
A	0.3	
B	0.6	
C	1.2	

(iii) Describe the relationship between the value of the ratio $\frac{\text{surface area}}{\text{volume}}$ and the time taken for the agar to change colour to red.

....

.... [1]

(iv) Identify **one** source of error in your investigation.

....

.... [1]

(v) State **one** safety hazard in your investigation and explain how the risk from this hazard is reduced.

safety hazard ....

explanation ....
[1]

(d) The temperature of the acid affects its rate of diffusion through an agar block.

A student calculates the rate of diffusion of acid, through agar blocks of the same size, at different temperatures.

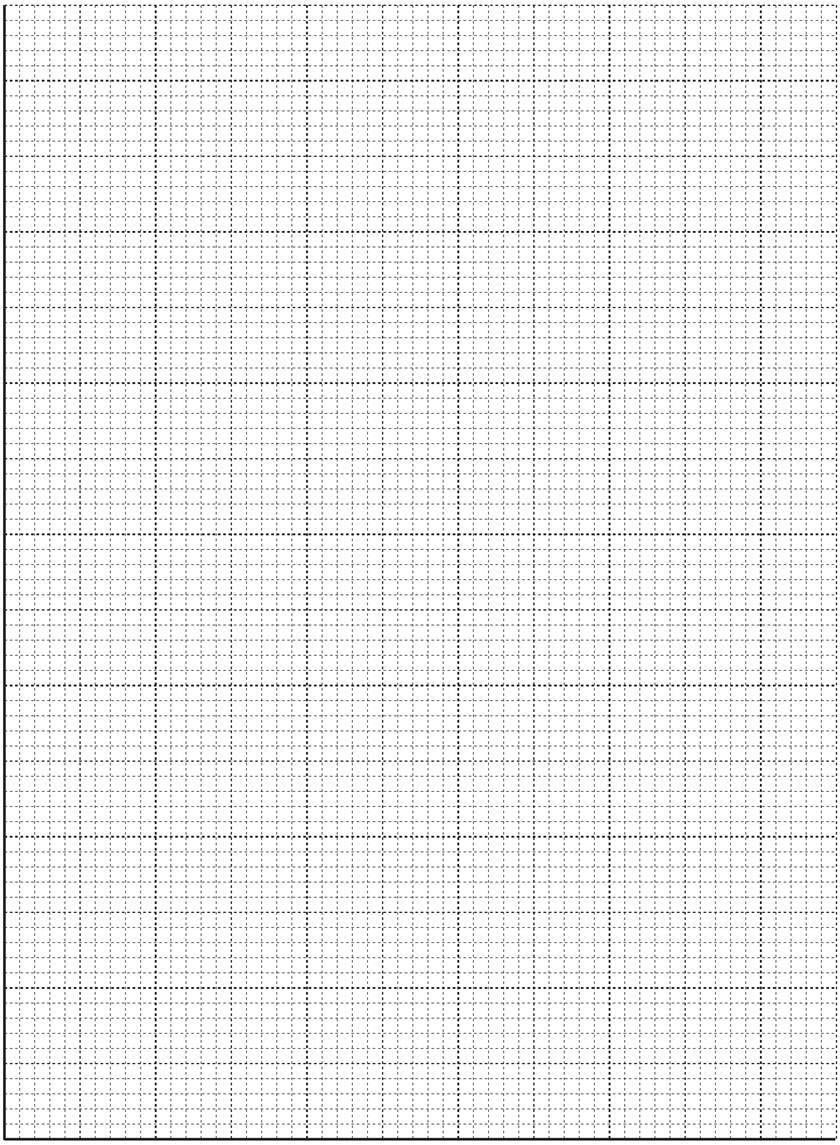
The results are shown in Table 1.3.

Table 1.3

temperature / °C	rate of diffusion / mm per hour
10	10
20	18
30	25
40	29
50	33

(i) On the grid provided, plot the rate of diffusion against temperature.

rate of diffusion
/ mm per hour



temperature / °C

[2]

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

[Total: 13]

2 You are going to investigate the reaction between aqueous sodium hydroxide and dilute hydrochloric acid.

The equation for this reaction is shown.

hydrochloric acid + sodium hydroxide $\longrightarrow$ sodium chloride + water

(a) **Procedure 1**

- Add 1 cm depth of dilute hydrochloric acid to a clean test-tube.
- Add a few drops of MO indicator.
- Record the colour in Table 2.1.

Repeat **procedure 1** with aqueous sodium hydroxide, instead of dilute hydrochloric acid.
Repeat **procedure 1** with solution **A** which is neutral, instead of dilute hydrochloric acid.

Table 2.1

solution	colour in MO indicator
hydrochloric acid	
sodium hydroxide	
A	

[1]

(b) (i) **Procedure 2**

- Measure 25 cm^3 of aqueous sodium hydroxide in a measuring cylinder and pour it into a conical flask.
- Add 5 drops of MO indicator to the aqueous sodium hydroxide.
- Fill the burette to **exactly** 0.0 cm^3 with dilute hydrochloric acid.
- Add the dilute hydrochloric acid from the burette into the flask slowly until the MO indicator turns orange. This is called the end-point.
- Record in Table 2.2 the colour of your solution at the end-point.
- Record in Table 2.2 the volume of dilute hydrochloric acid added to the nearest 0.1 cm^3.
  If you added too much acid the solution in the flask turns red but you should still record this volume in Table 2.2.
- Wash the conical flask.

Repeat **procedure 2 two** more times.

Table 2.2

experiment	final colour	volume of dilute hydrochloric acid added / cm^3
1		
2		
3		

[3]

(ii) Name **one** piece of apparatus for measuring the 25 cm^3 of aqueous sodium hydroxide more accurately.

.... [1]

(iii) You are going to calculate the average volume of dilute hydrochloric acid needed to just react completely with the aqueous sodium hydroxide.

Identify from Table 2.2 the volumes you should use to calculate the average volume of dilute hydrochloric acid and explain your choice.

volumes ....

explanation ....
[1]

(iv) Use the volumes in **(b)(iii)** to calculate the average volume of dilute hydrochloric acid used.

average volume = ... cm^3 [1]

(v) Predict the volume of dilute hydrochloric acid needed to just react completely with 75 cm^3 of the same aqueous sodium hydroxide.

.... [1]

(c) Dilute hydrochloric acid and aqueous sodium hydroxide react in a 1:1 ratio.

(i) Suggest whether the dilute hydrochloric acid or the aqueous sodium hydroxide is more concentrated. Explain your answer.

more concentrated solution ....

explanation ....

....
[1]

(ii) Calculate how many times more concentrated the solution you chose in **(c)(i)** is than the other solution.

= .... times more concentrated [1]

(d) **Procedure 3**

- Measure 25 cm^3 of aqueous sodium hydroxide in a measuring cylinder and pour into a conical flask.
- Add the average volume of dilute hydrochloric acid calculated in **(b)(iv)** into the conical flask.
- Place 3 cm^3 of this solution into an evaporating basin.
  Keep the rest of the solution in the conical flask for use in **(d)(ii)**.
- Heat the solution in the evaporating basin until all the water has evaporated.

(i) Describe what is left in the evaporating basin.

.... [2]

(ii) **Procedure 4**

- Place about 1 cm depth of the solution from the conical flask in **(d)** into a test-tube.
- Add about 1 cm depth of dilute nitric acid to the test-tube.
- Add a few drops of aqueous silver nitrate into the test-tube.

Describe what you observe in the test-tube.

.... [1]

[Total: 13]

3 You are going to investigate a ray of light travelling from glass into air.

(a) Procedure

- Place the semi-circular glass block in the middle of the sheet of paper provided.
- Draw around the outline of the glass block with a pencil.
- Remove the glass block from the paper.
- Draw a line at 90° to the outline of the block at the middle of the straight edge, as shown in Fig. 3.1. This line is called the normal.

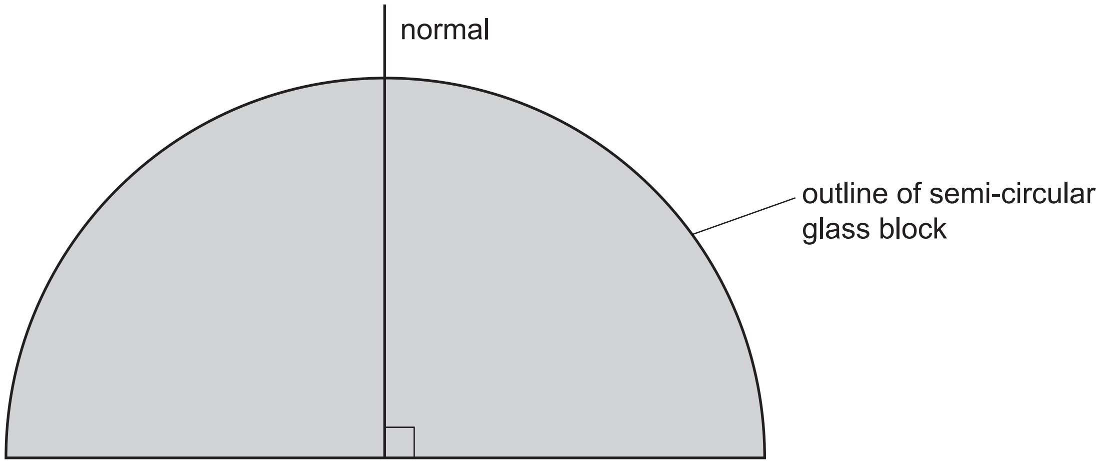


Fig. 3.1

- Replace the glass block in the same position on the paper.
- Switch on the ray box.
- Shine the ray of light through the glass block along the normal, as shown in Fig. 3.2.

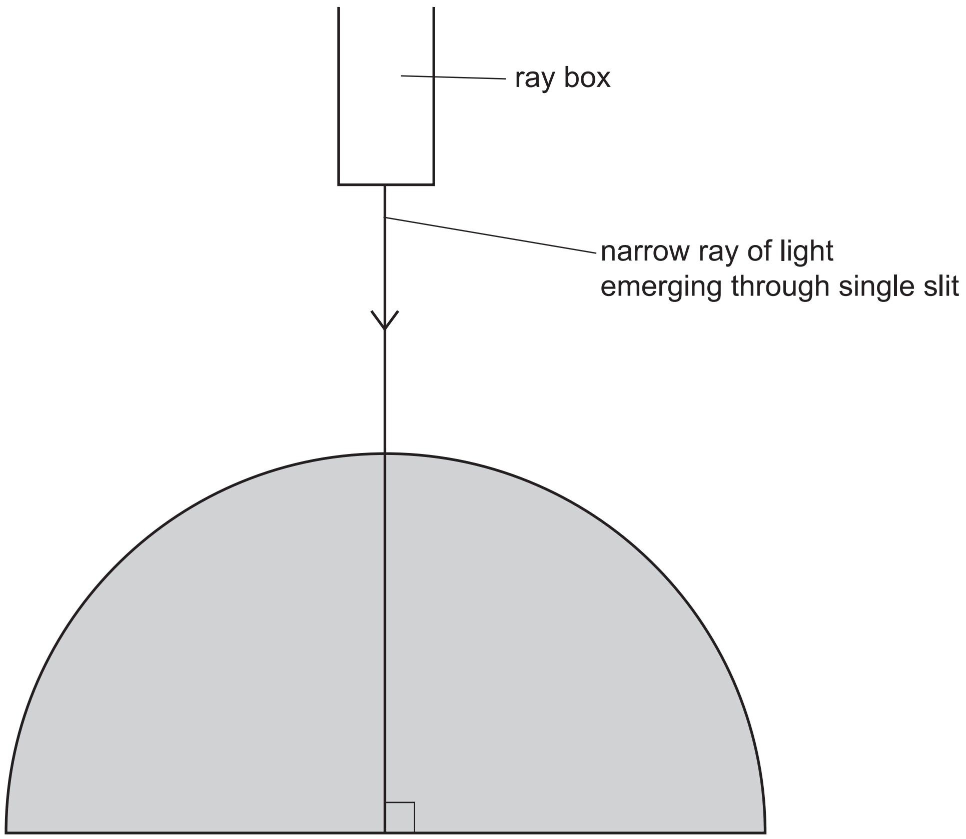


Fig. 3.2

- On the sheet of paper, draw and label with the letter **X** the ray of light as it emerges from the glass block.

[1]

(b) • Place a protractor on top of the glass block.
• Move the ray box around the curved surface of the glass block until the ray of light makes an angle of incidence *i* = 10° to the normal, as shown in Fig. 3.3.

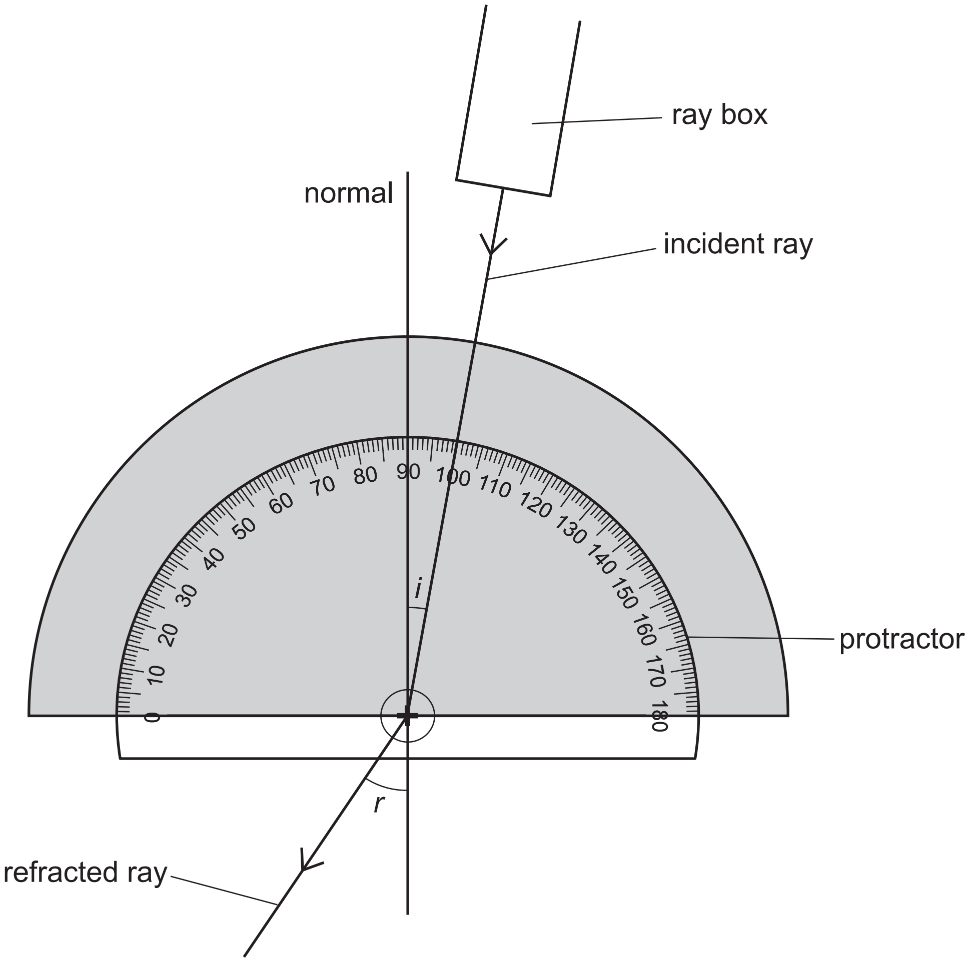


Fig. 3.3

• On the sheet of paper, draw the ray of light that emerges from the glass block.
• Remove the glass block from the paper.
• On the sheet of paper, use the protractor to measure the angle of refraction *r* of the ray which emerges from the straight edge of the glass block.

(i) Record in Table 3.1 the value *r*.

Table 3.1

angle of incidence *i* / °	angle of refraction *r* / °
10	
20	
30	
40	
50	

[1]

(ii) Repeat **(b)** for angles of incidence of 20°, 30°, 40° and 50°.

Record the values of *r* in Table 3.1. When no ray emerges from the straight edge of the glass block record this as **no refraction** in Table 3.1. [3]

(c) When no light emerges from the straight edge of the glass block, all the light has been reflected back inside the block.

The smallest angle of incidence at which all the light is reflected back inside the glass is called the critical angle.

Use your results in Table 3.1 to estimate a value for the critical angle.

estimate for critical angle = ... ° [1]

(d) Suggest how this experiment could be improved to find a more accurate value for the critical angle.

....

.... [1]

Write your name, centre number and candidate number on the sheet of paper used in this experiment.

Attach the sheet of paper to this exam paper using the string provided.

[Total: 7]

4 A student suggests that water waves will travel at different speeds in different depths of water.

Plan an investigation to find out how the speed of water waves varies with the depth of water they are travelling in.

You are provided with:

- a tank of length 50 cm × width 20 cm × depth 20 cm
- a supply of water
- a piece of wood that fits the width of the tank and can be dipped into the water to make water waves
- any other common laboratory apparatus that you need for the investigation.

You are not required to carry out this investigation.

In your plan, include:

- any additional apparatus
- a brief description of the method (you may include a labelled diagram if you wish)
- the values for any variables you will change
- the variables you will control
- the measurements you will make
- how you will process your results to draw a conclusion.

....

....

....

....

....

....

....

....

....

....

....

....

.... [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	effervescence, carbon dioxide produced
chloride (Cl^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	white ppt.
nitrate (NO_3^-) [in solution]	add aqueous sodium hydroxide then aluminium foil; warm carefully	ammonia produced
sulfate (SO_4^{2-}) [in solution]	acidify, 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 (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	green ppt., insoluble in excess
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 results
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