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1 A student investigates the rate of diffusion in model cells.

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

- (a)
- Cubes of agar are stained with universal indicator.
 - The student records the colour of the agar cubes.

colour of agar cubes = blue-green

Fig. 1.1 shows the pH chart for the universal indicator used.

pH	1	2	3	4	5	6	7	8	9	10	11	12	13	14
colour	red	orange		green			blue				purple			

Fig. 1.1

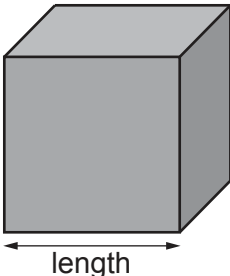
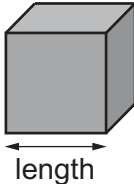
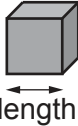
State the pH of the agar cubes.

.....

[1]

- (b) The student cuts three agar cubes so that they are different sizes. The sizes of the cubes are shown in Table 1.1.

Table 1.1

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

- (i) Calculate the surface area for cube **B** and for cube **C**.

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

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

[1]

- (ii) Calculate the volume for cube **B** and for cube **C**.

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

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

[1]

- (c) • Each cube is put into a separate beaker.
 • Sufficient dilute hydrochloric acid is added to cover each of the cubes.
 • The cubes gradually change colour from blue-green to red.
 • The time taken for the cubes to change to a red colour is measured.

The times displayed on the stop-clock for the three cubes are shown in Fig. 1.2.

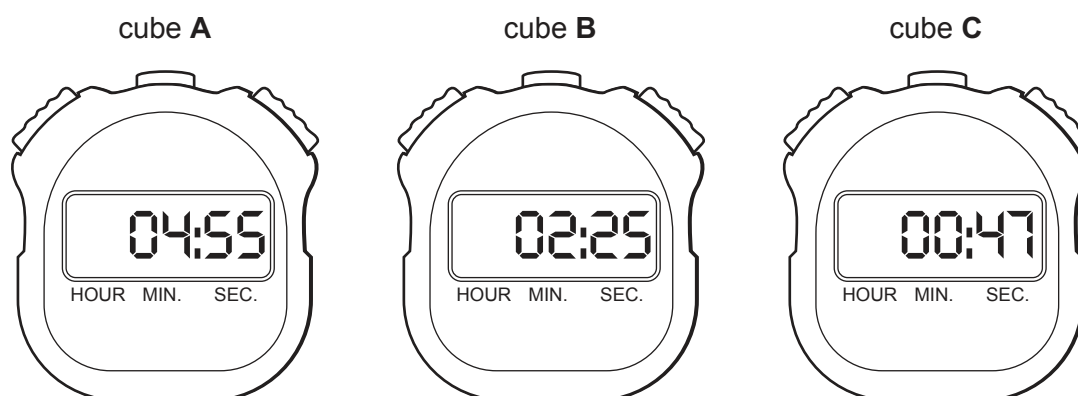


Fig. 1.2

- (i) Record in Table 1.2 these times in seconds.

[2]

- (ii) Complete the heading in Table 1.2.

Table 1.2

cube	$\frac{\text{surface area}}{\text{volume}} / \text{mm}^{-1}$	 /
A	0.3	295
B	0.6	
C	1.2	

[1]

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

.....
..... [1]

(iv) Explain why the cubes completely changed to a red colour.

.....
.....
..... [2]

(v) State **one** safety hazard in this 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 cube.

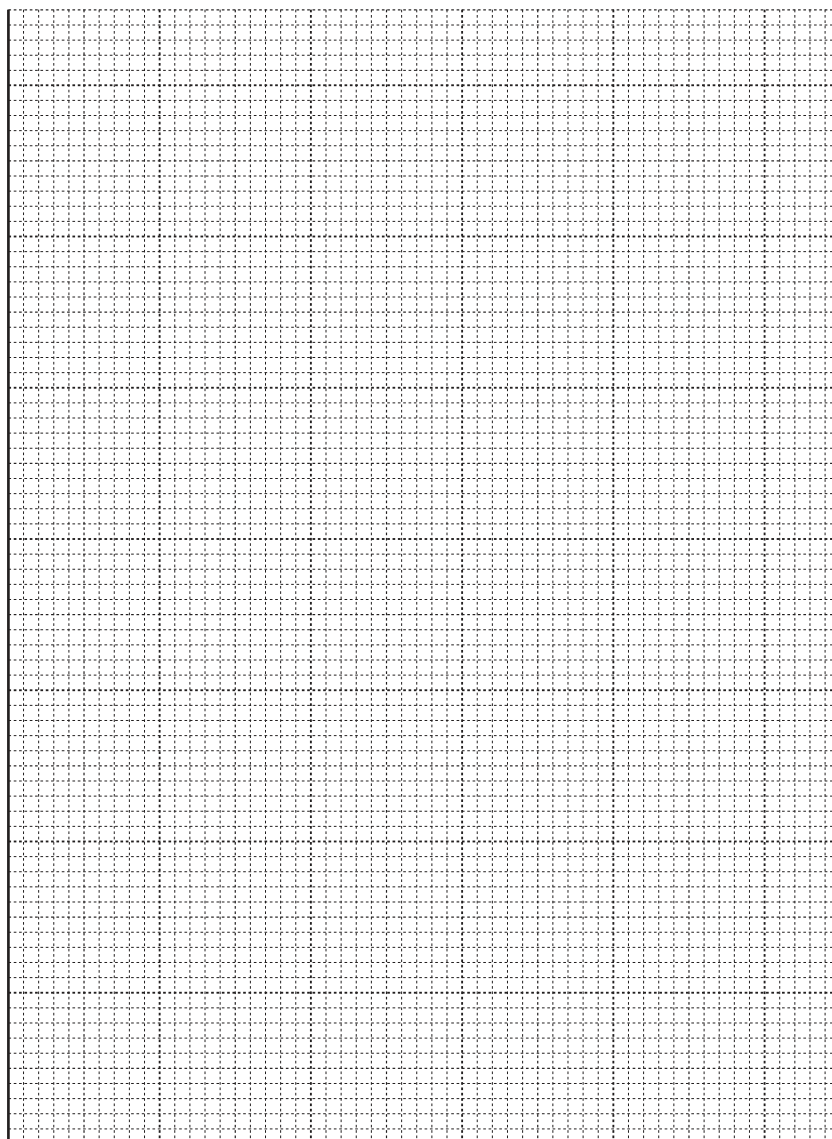
A student calculates the rate of diffusion of acid, through agar cubes of the same size, at different temperatures. The results are shown in Table 1.3.

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, 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 A student investigates the reaction between aqueous sodium hydroxide and dilute hydrochloric acid.

The equation for this reaction is shown.



The student uses methyl orange indicator.

This indicator is:

- red in dilute hydrochloric acid
- yellow in aqueous sodium hydroxide
- orange in a neutral solution.

(a) Procedure

The student:

- measures 25 cm^3 of aqueous sodium hydroxide in a measuring cylinder
- pours this into a conical flask and adds the indicator
- fills a burette with dilute hydrochloric acid
- adds the dilute hydrochloric acid to the flask slowly until the indicator turns orange. If too much acid is added the indicator turns red
- records in Table 2.1 the colour of the solution at the end of the experiment and the volume of dilute hydrochloric acid added
- repeats the experiment three more times.

- (i) Name a piece of apparatus for measuring the 25 cm^3 of aqueous sodium hydroxide more accurately.

..... [1]

- (ii) Fig. 2.1 shows the burette readings for experiments 2 and 3.

Record these volumes in Table 2.1.

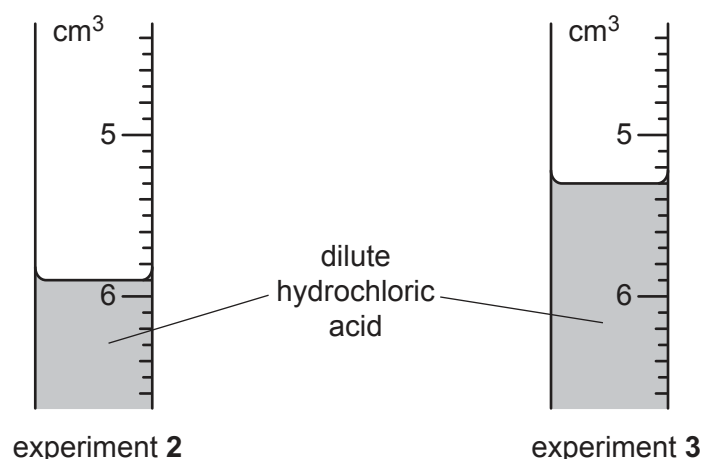


Fig. 2.1

Table 2.1

experiment	colour of indicator at end of experiment	volume of dilute hydrochloric acid added / cm ³
1	red	8.8
2	red	
3	orange	
4	orange	5.1

[2]

- (iii) The student wants to calculate the average volume of hydrochloric acid needed to just react completely with the aqueous sodium hydroxide.

Identify from Table 2.1 the volumes the student should use to calculate the average volume of dilute hydrochloric acid. Explain your choice.

volumes

explanation

[1]

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

average volume used = cm³ [1]

- (v) Predict the volume of dilute hydrochloric acid needed to just react completely with **75 cm³** of the same aqueous sodium hydroxide.

..... [1]

- (vi) State the type of reaction which occurs when dilute hydrochloric acid reacts with aqueous sodium hydroxide.

..... [1]

(b) 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

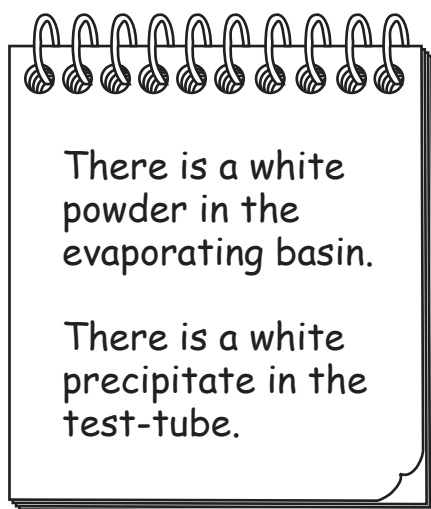
[1]

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

= times more concentrated [1]

(c) The student:

- adds some dilute hydrochloric acid to some aqueous sodium hydroxide
- places half of the mixture into a test-tube and the other half into an evaporating basin
- heats the mixture in the evaporating basin until all of the water has evaporated
- adds nitric acid and aqueous silver nitrate to the mixture in the test-tube
- records her observations.



- (i) Identify the anion that causes the white precipitate with aqueous silver nitrate.

..... [1]

- (ii) Identify the white powder in the evaporating basin.

..... [1]

- (iii) Draw the assembled apparatus used to evaporate the mixture.
Label your diagram.

[2]

[Total: 13]

3 A student investigates a ray of light travelling from glass into air.

- (a)
- She sets up the apparatus as shown in Fig. 3.1.
 - She shines the ray of light through the glass block along the normal (a line at 90° to the block at the middle of the straight edge).
 - The light emerges at 90° to the straight edge of the block.

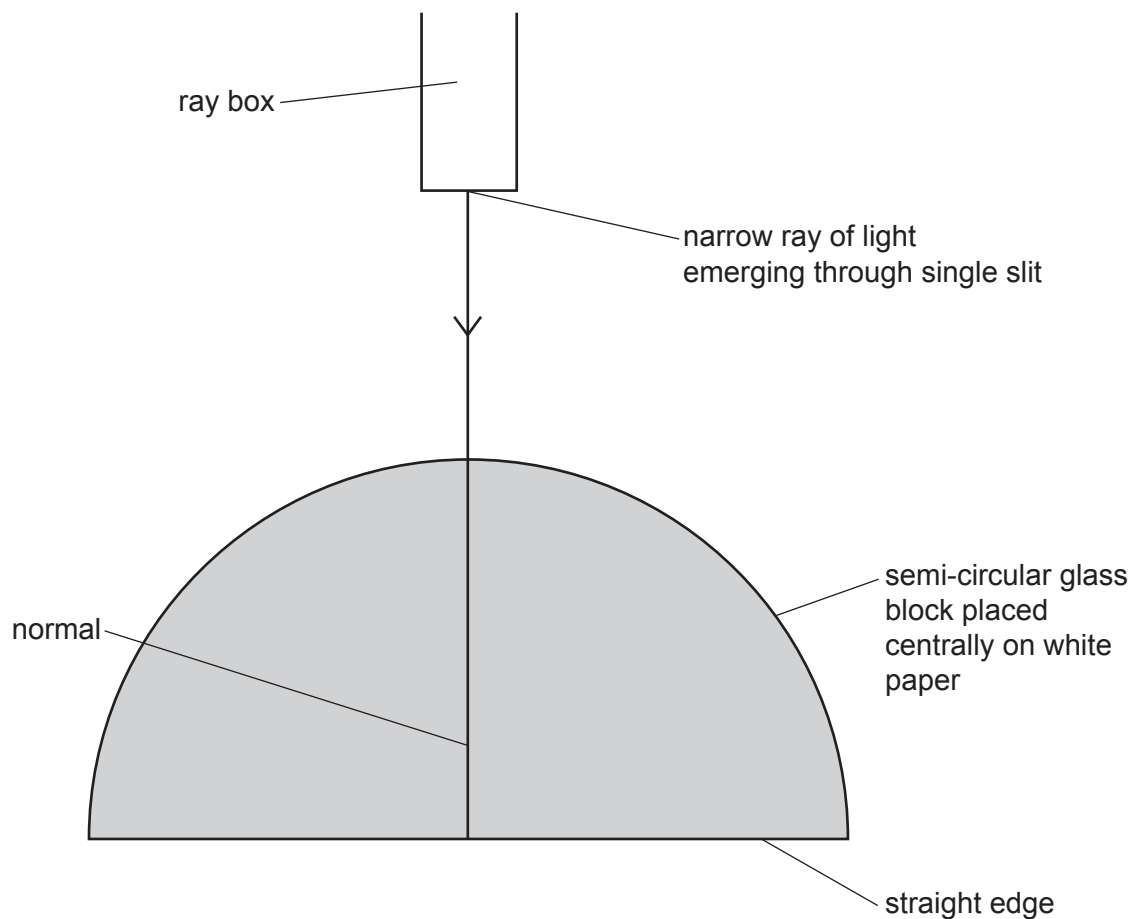


Fig. 3.1

- (i) Draw on Fig. 3.1 the ray of light as it emerges from the glass block. Label the line **X**. [1]

- (ii) • She varies the angle of incidence i of the light entering the glass block as shown in Fig. 3.2.

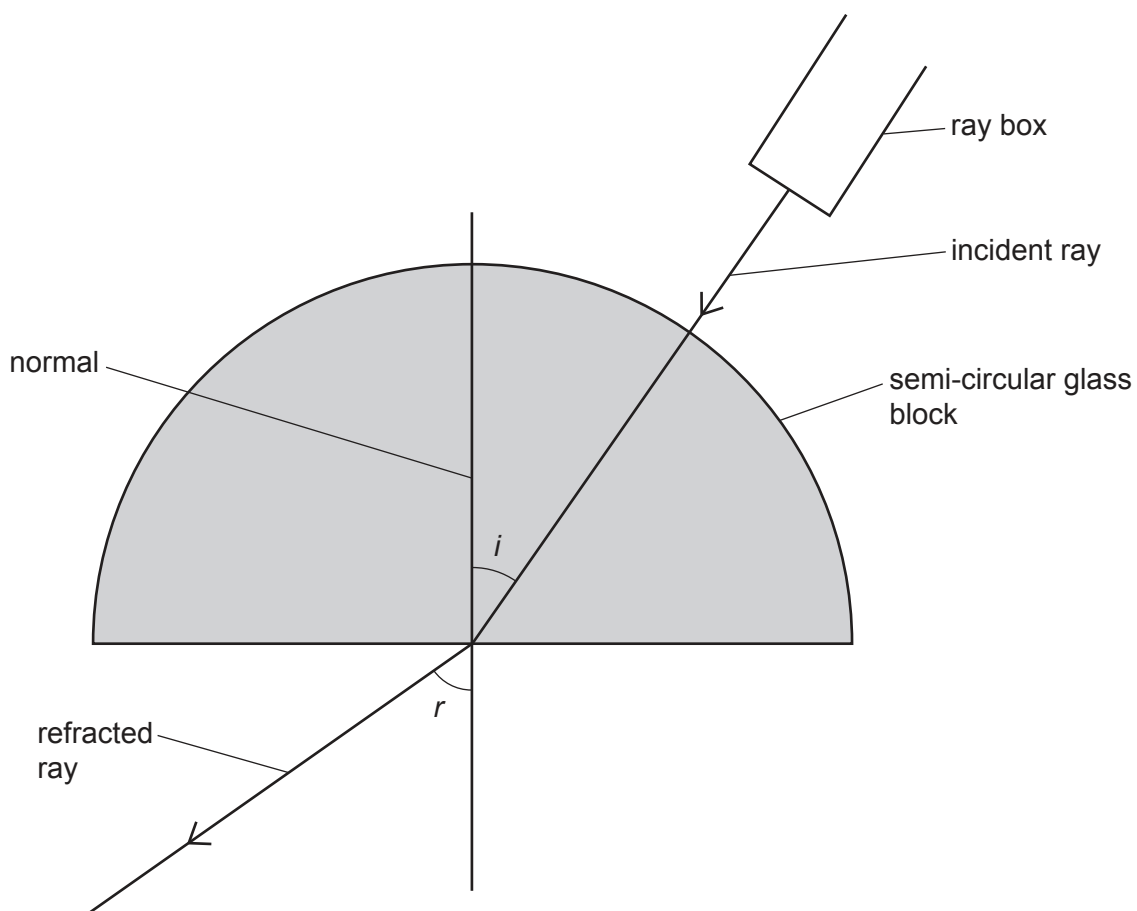


Fig. 3.2

- She measures and records the angle of refraction r for each angle of incidence i shown in Table 3.1.
- If no refracted ray emerges from the block she records this as **no refraction**.

Table 3.1

angle of incidence $i/^\circ$	angle of refraction $r/^\circ$
10	14
20	30
30	
40	74
50	no refraction
60	no refraction

Fig. 3.3 shows the refracted ray for the light with an angle of incidence $i = 30^\circ$.

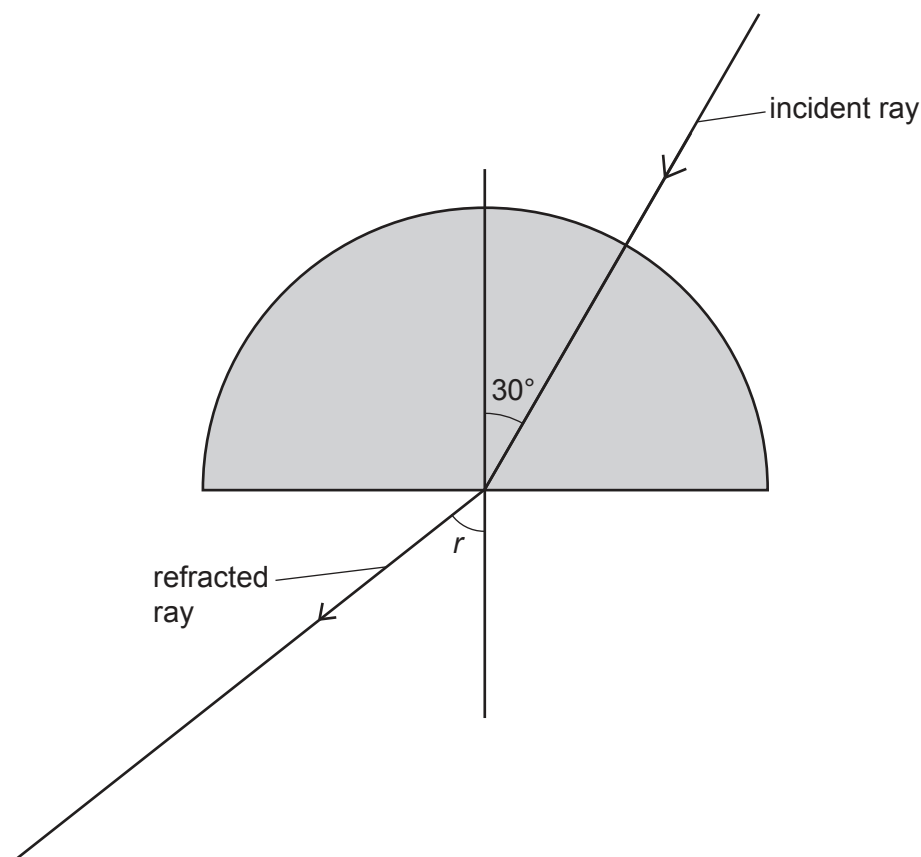


Fig. 3.3

Measure the angle of refraction r and record this value in Table 3.1.

[2]

- (b) Suggest **one** improvement that gives the student more confidence in her results.

.....
 [1]

- (c) A student predicts that doubling the angle of incidence i will always double the angle of refraction r .

Suggest whether the results in Table 3.1 support this prediction. Justify your answer with reference to the results in Table 3.1.

.....
 [1]

- (d) 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]

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

.....

..... [1]

[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.

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.

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.....

[7]

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