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CO-ORDINATED SCIENCES

0654/62

Paper 6 Alternative to Practical

May/June 2023

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 [].

This document has **24** pages. Any blank pages are indicated.

- 1 A student investigates the effect of plants and animals on their aqueous environment.

Organisms that photosynthesise or respire affect the concentration of carbon dioxide dissolved in their aqueous environment.

The student uses some water **W** to set up aqueous environments in three beakers **A**, **B** and **C**.

Fig. 1.1 shows the aqueous environments.

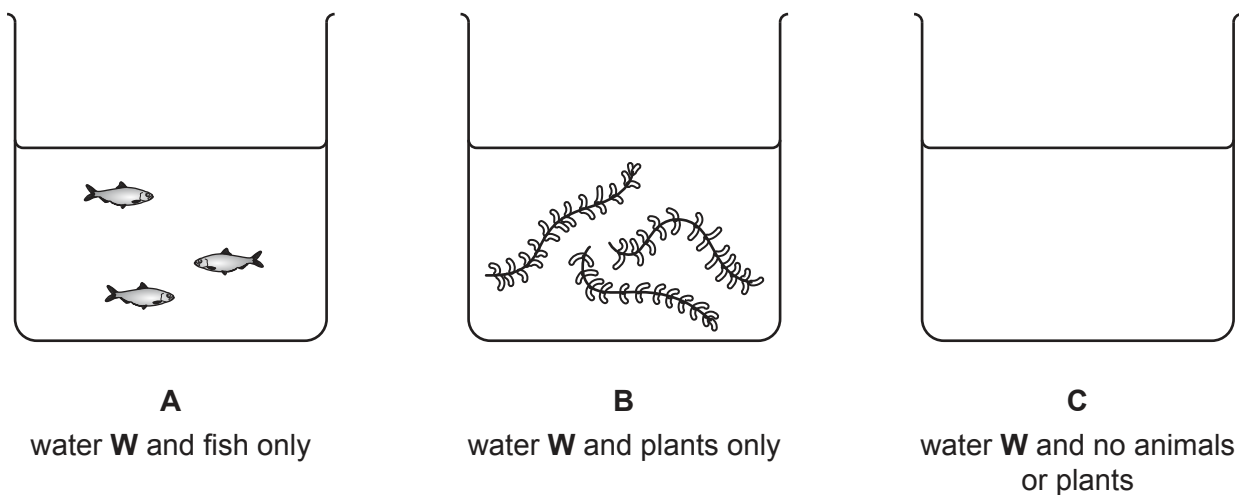


Fig. 1.1

(a) Procedure

The student:

- places beakers **A**, **B** and **C** at the same temperature and in the light for 1 hour
- takes a sample of water from each beaker after 1 hour
- adds a few drops of hydrogencarbonate indicator to each sample and swirls to mix
- records the final colours observed
- deduces the concentration of carbon dioxide for each sample.

Fig. 1.2 shows part of the student's notebook.

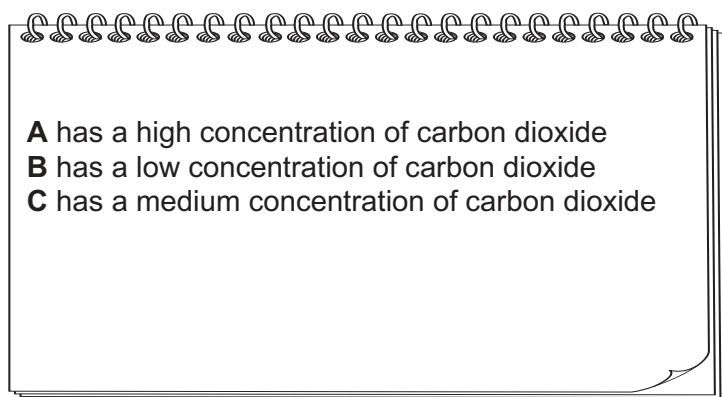


Fig. 1.2

Hydrogencarbonate indicator changes colour depending on the concentration of carbon dioxide dissolved in the water.

Fig. 1.3 shows the colour changes for the hydrogencarbonate indicator.

concentration of carbon dioxide	colour of hydrogencarbonate indicator
high	yellow
medium	red
low	purple

Fig. 1.3

At the start of the investigation, hydrogencarbonate indicator gives a red colour with water **W**.

Use the information in Fig. 1.2 and Fig. 1.3 to record in Table 1.1:

- the final colours the student observes for water samples **A**, **B** and **C**
- the changes in carbon dioxide concentration for the three aqueous environments **A**, **B** and **C**.

Table 1.1

water sample	colour with water W	final colour observed	change in carbon dioxide concentration (increase/decrease/no change)
A	red		
B			
C			

[5]

(b) Respiration releases carbon dioxide and photosynthesis uses carbon dioxide.

(i) Explain the observation for aqueous environment **A**.

.....
 [1]

(ii) Explain the observation for aqueous environment **B**.

.....
 [1]

(iii) Aqueous environment **C** is a control.

Explain why a control is used in this investigation.

.....
 [1]

(c) The student repeats the experiment using a beaker of water containing equal amounts of fish and plants.

Suggest the colour of the hydrogencarbonate indicator.

Explain your answer.

colour of hydrogencarbonate indicator

explanation

..... [1]

[Total: 9]

- 2 (a) A student investigates three nutrient solutions **D**, **E** and **F** for the presence of reducing sugar.

Procedure

The student:

- adds 2cm³ of Benedict's solution to each of three test-tubes labelled **D**, **E** and **F** containing the nutrient solutions
- places the test-tubes in a hot water-bath for 3 minutes.

The student observes the result for:

- a small amount of reducing sugar in **D**
- a large amount of reducing sugar in **E**
- no reducing sugar in **F**.

Complete Table 2.1 with the final colours the student observes.

Table 2.1

nutrient solution	final colour observed
D	
E	
F	

[3]

- (b) The student tests the nutrient solutions **D**, **E** and **F** for the presence of protein.

State the name of the solution used to test for protein.

Give the observation for a positive result.

name

observation

[1]

[Total: 4]

3 The seeds of a sycamore tree are shown in Fig. 3.1.

They have “wings” to help carry them in the wind.

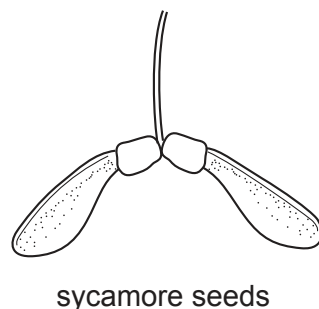


Fig. 3.1

Fig. 3.2 shows sycamore seeds fallen from the parent tree.

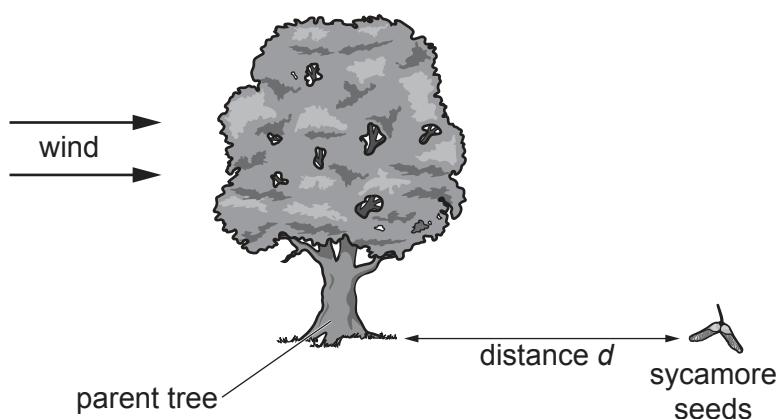


Fig. 3.2

Plan an investigation to determine the relationship between the vertical height the seeds fall from and the horizontal distance d the seeds travel from the height they were dropped.

You are provided with several sycamore seeds.

You may use any common laboratory apparatus.

Include in your plan:

- the apparatus needed
- 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 are **not** required to include any results.

4 A student investigates the rate of reaction between solutions **H** and **K**.

When solutions of **H**, **K** and starch are mixed together, a blue-black colour is seen after a period of time.

When the volume of solution **H** is changed, the time taken for the blue-black colour to appear changes.

(a) Procedure

The student:

- adds 4 cm³ of solution **H** into a conical flask
- adds 5 drops of starch solution into the conical flask
- adds 10 cm³ of solution **K** into the conical flask, swirls the flask and immediately starts a stop-watch
- stops the stop-watch when the solution turns blue-black
- records in Table 4.1 the time taken t in seconds to the nearest 0.1 second.

The student repeats the procedure using the other volumes shown in Table 4.1.

Table 4.1

volume of solution H / cm ³	drops of starch solution	volume of solution K / cm ³	time taken t / s	rate of reaction per 100 s
4.0	5	10.0	82.3	1.22
7.0	5	10.0		
10.0	5	10.0		

- (i)** Suggest why the conical flask is swirled.

.....
 [1]

- (ii)** State the name of a piece of apparatus suitable for measuring the volume of solution **H**.

..... [1]

- (iii)** The substance made when solution **H** and solution **K** react together turns the starch solution blue-black.

Identify the substance made.

..... [1]

- (iv) Explain why the results are more reliable if the experiment is repeated and averages calculated.

.....
 [1]

- (b) (i) The stop-watch readings for 7.0 cm^3 and 10.0 cm^3 of solution **H** are shown in Fig. 4.1.

Record in Table 4.1 these values in seconds to the nearest 0.1 second.



7.0 cm^3 of solution **H**



10.0 cm^3 of solution **H**

Fig. 4.1

[2]

- (ii) Calculate the rate of reaction per 100 s for the experiments with 7.0 cm^3 and 10.0 cm^3 of solution **H**.

Use the equation shown.

$$\text{rate of reaction per 100 s} = \frac{100}{t}$$

Record in Table 4.1 the values of rate to **three** significant figures. [2]

- (iii) State the relationship between volume of solution **H** added and rate of reaction.

.....
 [1]

- (iv) Look at Table 4.1 at the volumes of solutions added to each conical flask.

To be able to compare the rates of reaction fairly, distilled water needs to be added to some of the experiments.

Complete Table 4.2 to show the volumes of distilled water that need to be added so that a fair comparison can be made.

Table 4.2

volume of solution H /cm ³	volume of distilled water that needs to be added /cm ³
4.0	
7.0	
10.0	

[1]

- (c) Solution **K** is unstable.

When heated, it breaks down and gives off oxygen gas.

State the test for oxygen gas and give the observation for a positive result.

test

observation

[2]

[Total: 12]

5 A student identifies the ions present in solution **L** and in solution **M**.

(a) Table 5.1 shows the tests the student does on separate samples of solution **L** and solution **M** to identify the cations present.

Table 5.1

test	observation	
	solution L	solution M
add a few drops of aqueous sodium hydroxide	no ppt.	no ppt.
add excess aqueous sodium hydroxide	no ppt.	no ppt.
flame test	red	lilac

(i) Identify the cation in solution **L**.

Circle the correct answer.

Ca²⁺ Cu²⁺ Fe²⁺ Fe³⁺ K⁺ Li⁺ NH₄⁺ Zn²⁺ [1]

(ii) Identify the cation in solution **M**.

Circle the correct answer.

Ca²⁺ Cu²⁺ Fe²⁺ Fe³⁺ K⁺ Li⁺ NH₄⁺ Zn²⁺ [1]

(iii) Describe how the student does the flame test.

.....

 [2]

- (b) Table 5.2 shows the tests the student does on separate samples of solution **L** and solution **M** to identify the anions present.

Table 5.2

test	observation	
	solution L	solution M
add dilute nitric acid	no reaction	no reaction
add dilute nitric acid and aqueous silver nitrate	white ppt.	colourless solution
add dilute nitric acid and aqueous barium nitrate	colourless solution	white ppt.

- (i) Identify the anion in solution **L**.

Circle the correct answer.

Br^- Cl^- CO_3^{2-} NO_3^- SO_4^{2-} [1]

- (ii) Identify the anion in solution **M**.

Circle the correct answer.

Br^- Cl^- CO_3^{2-} NO_3^- SO_4^{2-} [1]

- (c) The pH of a solution can be measured using a pH meter.

Describe **one** other way the student can determine the pH of solution **L**.

.....

 [2]

[Total: 8]

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6 A student measures the mass M of an object using a balancing method.

(a) **Procedure**

The student:

- fixes the object securely to a metre rule with the centre of the object directly over the 15.0 cm mark
- places a pivot directly under the 50.0 cm mark
- places a mass $m = 80\text{ g}$ on the rule
- adjusts the position of the mass until the rule is as close as possible to balance, as shown in Fig. 6.1.

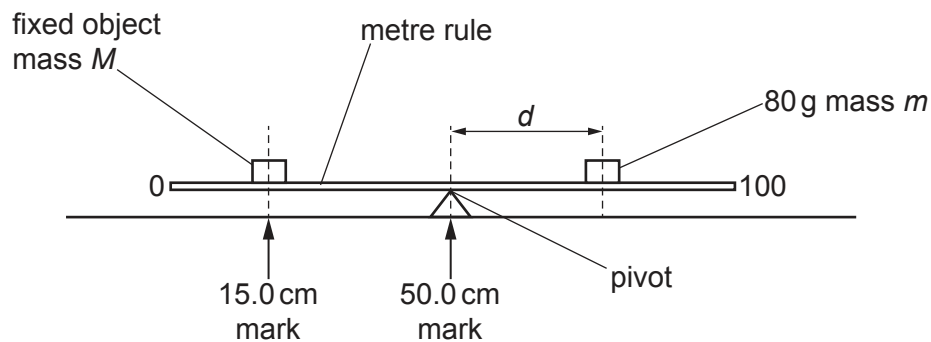


Fig. 6.1

Fig. 6.2 shows the position of the 80 g mass on the rule at balance.

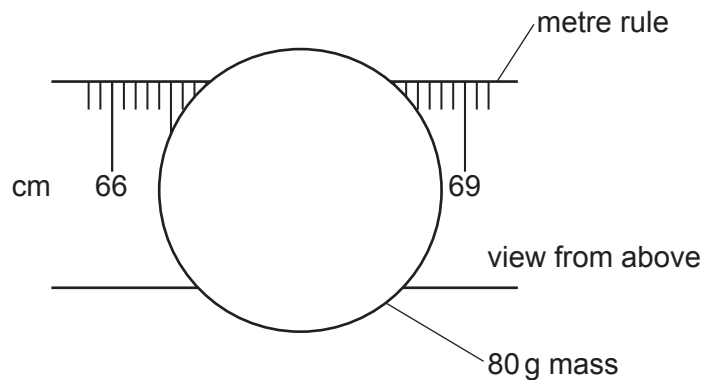


Fig. 6.2

- (i) Take readings from the metre rule to determine the position p of the centre of the 80 g mass on the rule to the nearest 0.1 cm.

Show your working.

$p = \dots\dots\dots \text{ cm [2]}$

- (ii) Calculate the distance d from the centre of the 80g mass to the 50.0cm mark on the rule.

Use the equation shown.

$$d = p - 50$$

Record this distance in Table 6.1.

Table 6.1

mass m /g	distance d /cm	$(m \times d)$ /g cm
80		
60	23.2	1392
40	35.0	1400

[1]

- (b) The student repeats the procedure in (a) using masses of 60g and 40g.

The results are shown in Table 6.1.

- (i) Calculate the product $(m \times d)$ for the 80g mass.

Record your answer in Table 6.1.

[1]

- (ii) State the relationship between distance d and mass m .

.....
 [1]

- (c) The teacher says that the product $(m \times d)$ for each mass is constant.

Quantities can be considered to be equal, within the limits of experimental error, if their values are within 10% of each other.

Compare your values of $(m \times d)$ for each mass in Table 6.1.

State, giving a reason, if you agree with the teacher.

statement

reason

..... [1]

- (d) (i) Use the values of the product ($m \times d$) from Table 6.1 to calculate the average value of ($m \times d$).

$$(m \times d)_{AV} = \dots\dots\dots \text{ g cm [1]}$$

- (ii) The mass M of the fixed object is calculated using the equation shown.

$$M = \frac{(m \times d)_{AV}}{35}$$

Use your result from (d)(i) to calculate M .

$$M = \dots\dots\dots \text{ g [1]}$$

- (e) State **one** practical problem that makes it difficult to get accurate measurements when doing this experiment.

.....
 [1]

- (f) Another student repeats the procedure with a 20g mass instead of the 80g mass.

Suggest the problem the student encounters when doing this experiment with the 20g mass.

.....
 [1]

[Total: 10]

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7 A student investigates the image formed by a convex lens.

The apparatus is assembled as shown in Fig. 7.1.

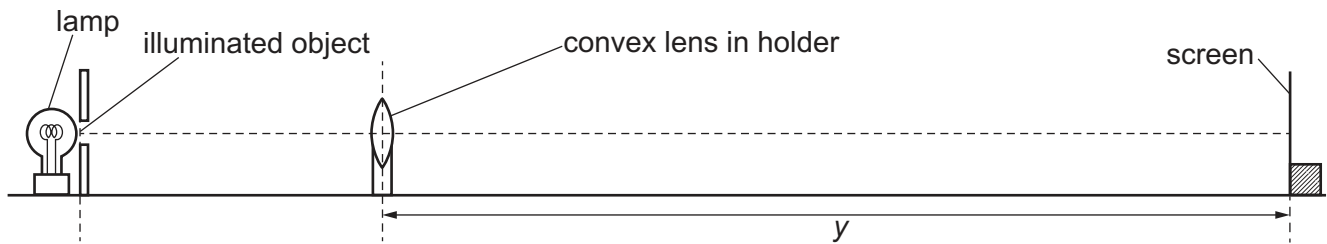


Fig. 7.1

(a) Procedure

The student:

- switches on the lamp
- places the lens a distance $u = 20.0$ cm in front of the illuminated object (a triangular hole in a card)
- adjusts the position of the screen by moving it backwards and forwards along the bench, until a sharp image of the illuminated object is formed on the screen.

On Fig. 7.1, measure the image distance y from the screen to the lens in centimetres to the nearest 0.1 cm.

$y = \dots\dots\dots$ cm [1]

(b) Fig. 7.1 is drawn to a scale of one-fifth full size.

Calculate the actual image distance v from the lens.

Record your answer in Table 7.1.

Table 7.1

object distance u / cm	image distance v / cm
20.0	
25.0	37.5
35.0	26.3
40.0	24.0
50.0	21.5
60.0	20.0

[1]

- (c) The diagram in Fig. 7.2 shows the illuminated object and its image.

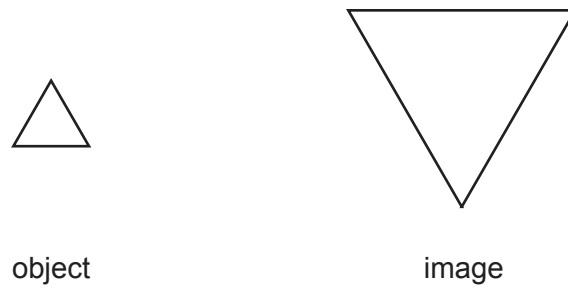


Fig. 7.2

- (i) State two differences between the object and its image.

difference 1

difference 2

[2]

- (ii) The magnification m of the image is calculated using the equation shown.

$$m = \frac{v}{u}$$

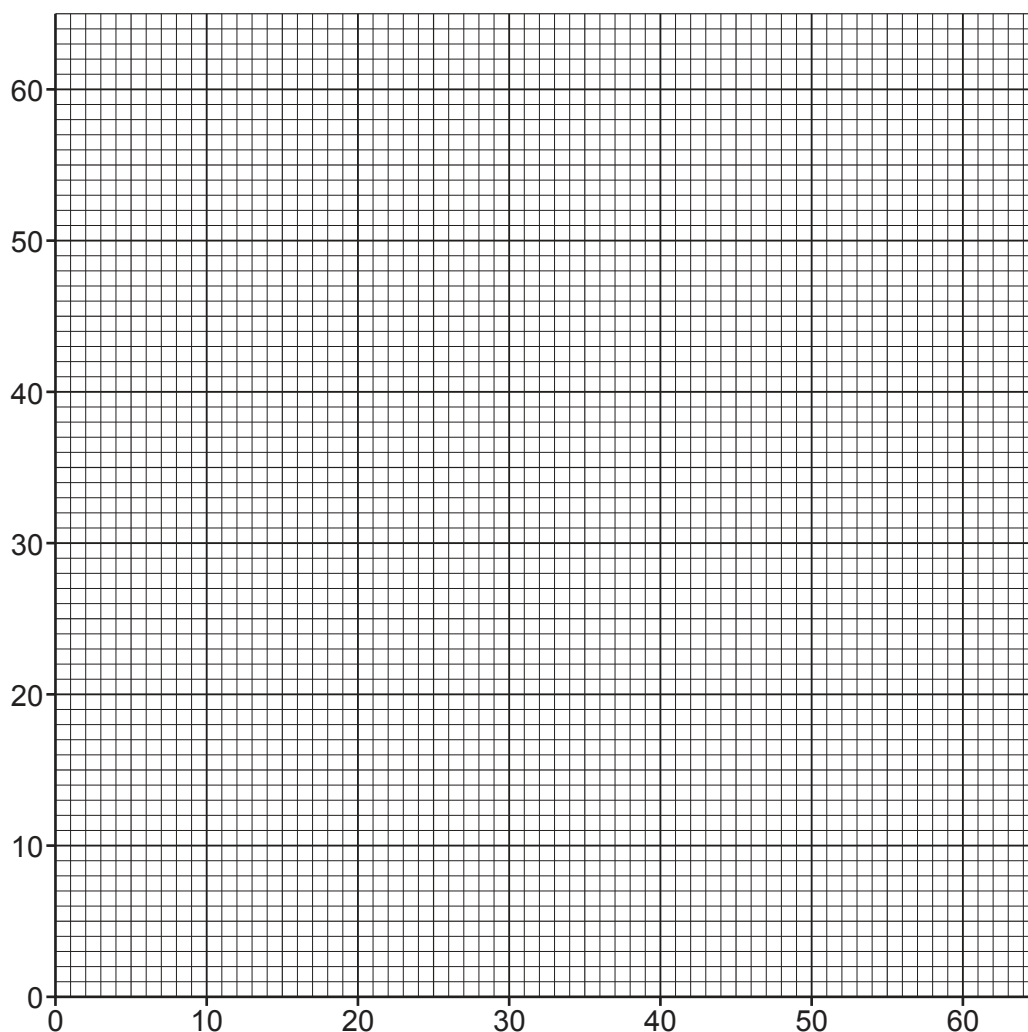
Use your answer to (b) to calculate the magnification of the image.

$m =$ [1]

- (d) The student repeats the procedure in (a) for values of $u = 25.0\text{ cm}$, 35.0 cm , 40.0 cm , 50.0 cm , and 60.0 cm .

The student's results are shown in Table 7.1.

- (i) On the grid, plot a graph of v (vertical axis) against u .



[2]

- (ii) Draw the best-fit curve.

[1]

- (e) Use your graph to find the value of v when $u = 30.0\text{ cm}$.

$v = \dots\dots\dots\text{ cm}$ [1]

- (f) When measuring the object and image distances with the metre rule, it is important to avoid line-of-sight (parallax) errors.

State how the student avoids such errors.

.....

..... [1]

[Total: 10]

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