



RIVER VALLEY HIGH SCHOOL

JC 2 PRELIMINARY EXAMINATION

CANDIDATE
NAME

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CENTRE
NUMBER

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CLASS

24J

INDEX
NUMBER

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H2 BIOLOGY

9744/04

Paper 4 Practical

28 Aug 2025

2 hours 30 minutes

Candidates answer on the Question Paper.

Additional Materials: As listed in the Confidential Instructions.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, index number, class and name on all the work you hand in.
Give details of the practical shift and laboratory, where appropriate, in the boxes provided.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO NOT WRITE ON ANY BARCODES.

Answer **all** questions in the spaces provided on the Question Paper.

The use of an approved scientific calculator is expected, where appropriate.
You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [] at the end of each question or part question.

Shift
Laboratory

For Examiner's Use	
1	
2	
Total	

Answer **all** questions.

- 1** A farmer claimed that the carrots he grew contained a high sugar concentration and that the sugars were more effectively taken up by the gut as compared to standard carrot breeds.

Carrots generally contain different types of sugars, with sucrose and simple sugars being the most abundant.

In this experiment, you will investigate the validity of his claims.

You are required to:

- perform serial dilution to obtain different concentrations of **S**
- estimate the sugar concentration in **X**
- determine if sugars in the farmer-grown carrots are more effectively taken up.

You are provided with:

- 100 cm³ of 1.0 mol dm⁻³ sugar solution obtained from standard carrot breeds, in a beaker labelled **S**
- 50 cm³ of farmer-grown carrot extract, in a beaker labelled **X**
- Visking tubing, in a beaker of distilled water labelled **D**
- distilled water, in a beaker labelled **W**.

Before starting the investigation, read through steps 1-24 and prepare a table in (c).

Proceed as follows.

- 1 You are required to make a proportional dilution of 1.0 mol dm^{-3} sugar solution **S**, to reduce its concentration by **five-fold** between each successive dilution.

After the serial dilution is completed, you will need to have at least 40 cm^3 of each concentration available for use.

- (a) Complete Fig. 1.1 to show how you will dilute **S**.

For each specimen tube:

- state, under the tube, the volume and concentration of the solution **S** in the tube that will be available for use in the investigation, after the serial dilution has been completed
- use one arrow, with a label above the tube, to show the volume and concentration of **S** added to prepare the solution in the tube
- use another arrow, with a label above the tube, to show the volume of distilled water, **W**, added to prepare the concentration of **S** in the tube. [3]

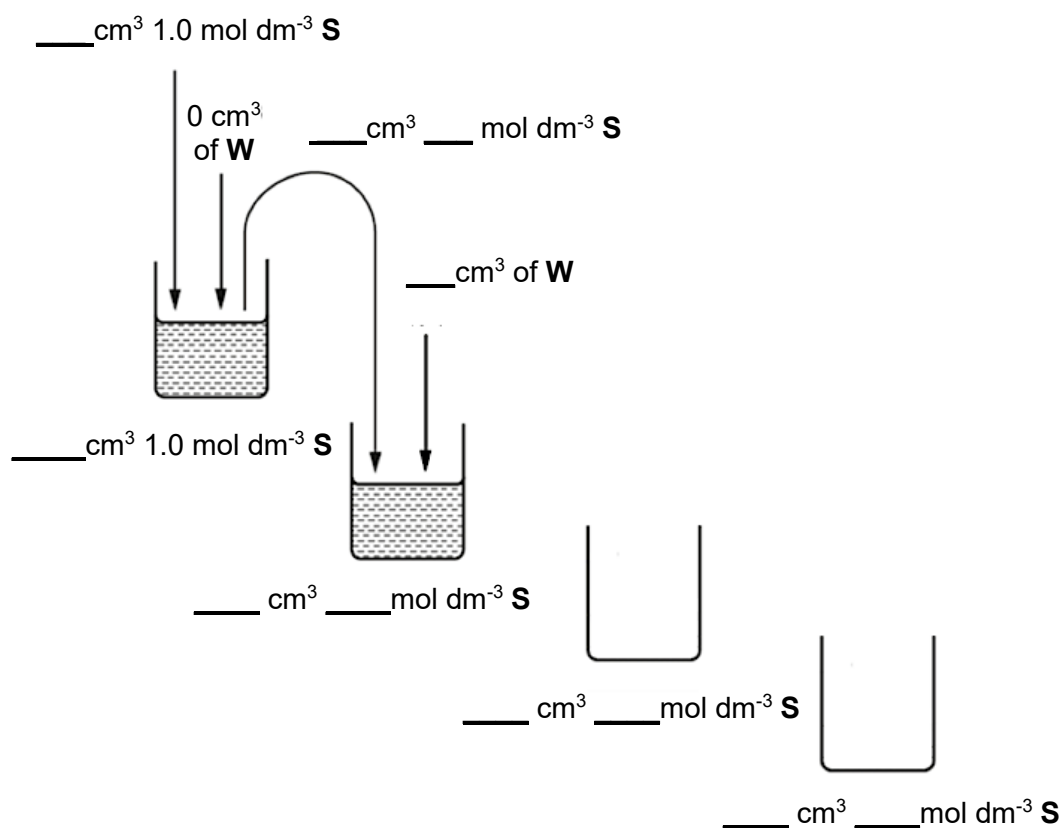


Fig. 1.1

- 2 Using **hot water** and **tap water**, adjust around 300 cm³ of water in the beaker labelled **water-bath** to 60 °C. You do **not** need to maintain this temperature.
- 3 Label five boiling tubes with the concentrations diluted in **(a)** and with **X**.
- 4 Put 12 cm³ of distilled water **W** into each boiling tube and place them in the water bath.
- 5 Remove a Visking tubing from beaker **D**.
- 6 Tie a knot in the Visking tubing as close as possible to one end, so that the end is sealed.
- 7 To open the other end, rub the tubing gently between your fingers and thumb.
- 8 Put 6 cm³ of 1.0 mol dm⁻³ **S** into the open end of the Visking tubing.
- 9 Rinse the outside of the Visking tubing with distilled water and wipe dry with a paper towel.
- 10 Repeat steps **5** to **9** for the other concentrations diluted in **(a)** and for **X**.
- 11 Put the filled Visking tubings into the respective labelled boiling tubes **at the same time**.
- 12 Ensure that the content in the Visking tubing is fully submerged in **W**. You may need to fold the tubing to do so.

Leave the apparatus for 10 minutes. Use this time to continue with **(b)** and step 13.

The sugar concentration in the carrot extract can be estimated using the semi-quantitative results of the Benedict's test. The amount of precipitate settled at the bottom of the test-tube may be used to estimate the sugar content.

- (b)** Describe how Benedict's test may be conducted to more **reliably** estimate the **total** sugar content in **X**. [4]

The results of Benedict's test on the concentrations diluted in **(a)** and on **X** are provided in the test-tube rack and labelled **B1**, **B2**, **B3**, **B4** and **BX**, where **B1** is the highest concentration and **B4** is the lowest.

- 13** Record the amount of precipitate in the table in **(c)**. You may use the terms 'large', 'moderate', 'small' and 'trace' to describe the amount of precipitate observed.
- 14** After 10 minutes, remove all Visking tubing from the boiling tubes **at the same time**. Place the Visking tubing in the beaker labelled "waste".
- 15** Label the test-tubes (marked 3 cm from the bottom) with the concentrations diluted in **(a)**.
- 16** Using the measuring cylinder, put 10 cm³ of the solution remaining in the boiling tube labelled "1.0 mol dm⁻³ **S**" into the appropriately labelled test-tube.
- 17** Repeat step 16 with each of the other diluted sugar concentrations.
- 18** Put 1 cm³ of the blue dye, **M**, into the boiling tube labelled **X**. Swirl the contents to mix **M** with the solution. The blue dye may not mix in completely. This will not affect the results.
- 19** Use a pipette to remove a sample of the blue solution in boiling tube **X**.

Throughout steps **20** to **22**, the pipette must be held still so that its position does not change. Drops can then be released at the mark and observed without disturbing the solution as shown in Fig. 1.2.

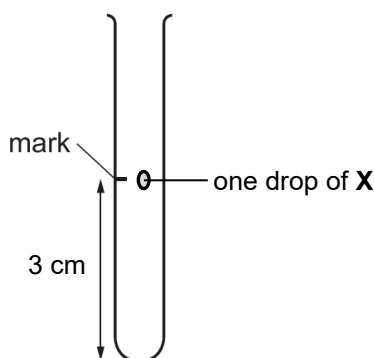


Fig. 1.2

- 20** Put the end of the pipette into the small test-tube labelled "1.0 mol dm⁻³ **S**". The end of the pipette should be level with the mark on the small test-tube
- 21** Keeping the end of the pipette as still as possible, release a drop of the blue solution from the pipette.
- 22** Observe the direction of movement of the drop of blue solution. You may use the terms 'move up', 'move down' and 'remains at the same level' to describe the movement.

This movement occurs when two solutions of **different densities** are added to one another without mixing, the denser solution will sink to the bottom and the less dense solution will rise to the top.
- 23** Record your observations in **(c)**.
- 24** Repeat steps **19** to **23** for the other concentrations of sugar.

- (c) Record your results in a suitable table in the space below. [3]

- (d) Using the data from your table in (c),

- (i) estimate the sugar concentration in **X**. [1]

- (ii) explain if the sugar in the farmer-grown carrot is absorbed more effectively than the standard carrot breed. [2]

- (e) Explain why the results on the effectiveness of sugar absorption in (c) may be different if the investigation was conducted using gut epithelial cells. [2]

(f) Complete Table 1.1 to:

- identify one significant source of error for each of your investigations.
- suggest how to make an improvement to increase the validity of your results in (c), excluding repeats.

[4]

Table 1.1

investigation on	significant source of error	how to make an improvement
the sugar concentration in X		
the effectiveness of sugar absorption		

- (g) In another investigation, a student wanted to find out if the farmer-grown carrot extract can be a replacement for sucrose solution used in isotonic buffers for research on isolated organelles. The farmer-grown carrots are best harvested around 50 days after seeds have germinated.

The investigation was carried out as follows:

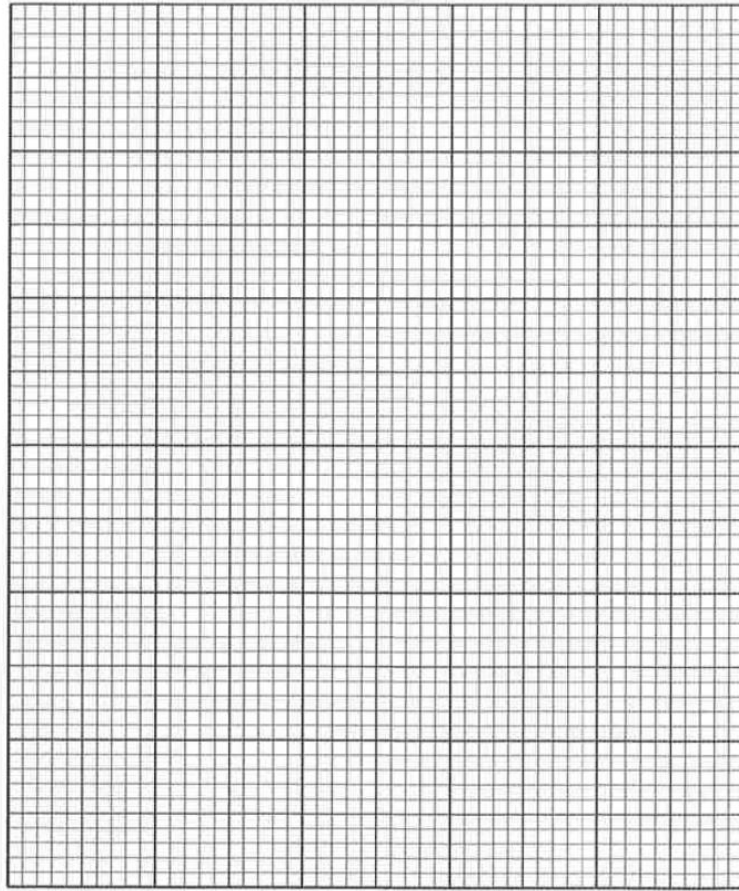
- intact chloroplasts were isolated from leaves of a terrestrial plant
- an extract was obtained from carrots which were harvested at different number of days after seed germination
- chloroplasts, carrot extract and DCPIP were added to a test-tube placed under a constant light source and temperature throughout the experiment
- DCPIP was then used to measure the activity of chloroplasts.

The result of the investigation is shown in Table 1.2.

Table 1.2

number of days after seed germination	time taken for DCPIP to decolourise / s
10	15
15	25
30	220
45	285
50	290

- (i) On the grid provided, plot a graph of the data shown in Table 1.2. [4]



- (ii) Explain the relationship between the two variables in graph (g)(i). [5]

[Total: 28]

2 During this question you will require access to a microscope.

(a) **L1** is a slide of a stained transverse section through a plant leaf.

You are not expected to be familiar with this specimen.

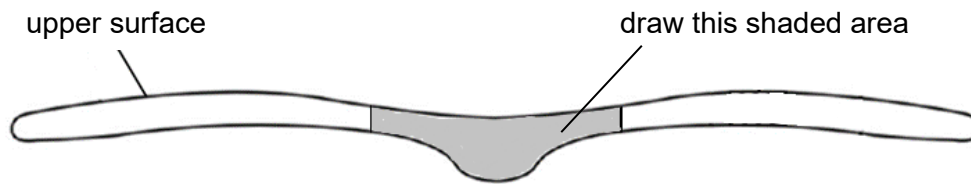


Fig 2.1

(i) Draw a large plan diagram of the area of the leaf on **L1** shown in Fig. 2.1.

A plan diagram shows the arrangement of different tissues. Your drawing should show the correct shape and proportions of the different tissues.

You should only draw the **largest** vascular bundle and **two** airspaces **adjacent** to both that vascular bundle and each other.

No cells should be drawn.

Labels are **not** required.

[4]

- (ii) Using a calibrated eyepiece graticule, measure the thickest part of the specimen on slide **L1**.

Measure the size of your drawing across the same point.

Draw a line on your drawing to show where you made this measurement.

Calculate the magnification of your drawing.

Show **all** working.

[4]

magnification

- (iii) Identify and explain **one** feature of the leaf on slide **L1** that is an adaptation to the plant's aquatic habitat.

Explain your answer.

[1]

- (b) Fig. 2.2 is a photomicrograph of a stained transverse section through a leaf from a different type of plant. A grid has been placed over the photomicrograph where each square is 1 cm^2 .

You are not expected to be familiar with this specimen.

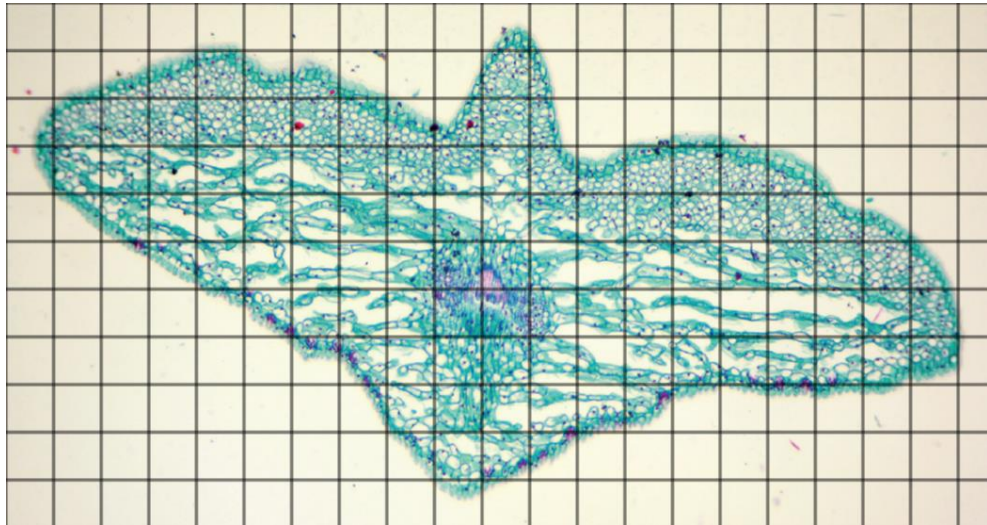


Fig 2.2

- (i) Use Fig. 2.2 to measure the total area of the air spaces and the total area of the leaf.

Outline the method you will use to measure the areas and state the two areas in the space given below. [2]

total area of air spaces: _____

total area of leaf: _____

- (ii) Calculate the total area of the air spaces as a percentage of the total area of the stem.

Show your working. [1]

- (c) Specimen **E** is a segment from another plant found in a similar environment. Use a pair of forceps to remove a leaf from specimen E.

Place the leaf facing upwards in a two drops of water on a microscope slide.

Cover it with a cover slip.

- (i) Observe under the high-power objective lens of your microscope.

Make a large **labelled** drawing of two cells adjacent to one another.

You should draw **only three** of the structures present within.

[4]

- (d) As global warming raises water temperatures, it is critical to determine the highest temperature at which aquatic plants can still photosynthesise effectively.

Preliminary research was first conducted to find the optimum conditions for determining the photosynthetic rate of different aquatic plants.

There are different methods of preparing the plant material. One method would be to mix the leaf extract with alginate to create leaf extract alginate beads whereas another would be to have leaf discs formed by cutting the leaf with a cork borer.

- (i) Suggest a disadvantage of using leaf discs as compared to using leaf extract alginate beads to determine the photosynthetic rate of different aquatic plants.

[1]

Preliminary research also revealed that:

- the best volumes of leaf extract and alginate to use were those that gave a mixture in which leaf extract accounted for 60% of the total mixture.
- optimum rate of photosynthesis for most aquatic plants occurred around 10% sodium hydrogen carbonate.

Under these conditions, optimum time for this experiment ranged from 10 minutes to 30 minutes – below which photosynthesis produced insufficient oxygen for alginate beads to float, and after which beads that did not float remained at the bottom of the tube.

Using the information, design an experiment to determine the highest temperature at which photosynthesis of plant specimen **E** can occur using leaf extract alginate beads.

In your plan, you must use:

- 20 cm³ of leaf extract from specimen **E**
- 20 cm³ of sodium alginate mixture
- 20 cm³ of calcium carbonate
- 10% sodium hydrogen carbonate solution

You may also select from the following apparatus and use appropriate additional apparatus:

- any normal laboratory glassware e.g. test tubes, beakers, measuring cylinders, graduated pipettes, glass rods, etc.
- syringes
- ruler
- timer, e.g. stopwatch
- thermostatically controlled water bath
- 60W bench lamp

Your plan should:

- have a clear and helpful structure such that the method you use is able to be repeated by anyone reading it
- identify the independent variable, dependent variable and the variables that you will need to control
- include details to ensure that results are as accurate and reliable as possible
- explain the use of a suitable control in this investigation
- use the correct technical and scientific terms

[9]

River Valley High School
2025 JC2 Preliminary Examination

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