Victoria Junior College
Biology Department
2023 H2 Biology Prelim Paper 4 Suggested Answer

Marking abbreviations:
A: Accept, R: Reject, BOD: benefit of doubt, AW: alternative wording, AVP: Any valid point, NAQ: not answering question, ECF: error carried forward

Question 1

(a) (i) State the volume of **W** that you added to the test-tube in step **16**. [1]

- volume recorded between 10.0 and 20.0 cm^3;

(ii) Record your results in an appropriate table. [4]

Example:

Sampling time / min	Colour of bromothymol blue indicator
0	blue
1	blue
2	blue-green
3	blue-green
4	green
5	green
6	green-yellow
7	green-yellow
8	yellow
9	yellow

1. Independent variable on leftmost column;
2. Correct headings and no units in body of table;
   Column 1 heading – Accept time;
   Column 2 heading – Accept colour of B/ (B and W) mixture/ sample; Reject colour (observed)
3. Record using only colours from Fig. 1.1, at least 4; Reject dark green, light green
4. Trend: Colour for each minute for 10 minutes or until end-point reached for **two** consecutive times from left to right of colours from Fig.1.1 and **time 0** is **blue**;

(iii) This investigation used colour to indicate the concentration of carbon dioxide in the sample which is subjective.

Describe **two** improvements to this investigation that would increase the accuracy of the results other than the use of colorimeter/ colour chart. [2]

Any **two** from:

- use smaller intervals of time e.g., 30 s to determine the end-point more accurately;
- use a pH meter to determine the pH of the solution due to release of carbon dioxide which dissolves in the surrounding water;
- use a carbon dioxide probe to determine the concentration of carbon dioxide released;
- use set volume e.g., 0.5 cm^3 of **B** and/ or **W** instead of using drops (with a 1 cm^3 micropipette or syringe);

(iv) A student hypothesised that glucose diffuses into the surrounding of the dialysis tube.

You are provided a vial labelled **R** which contains the remaining contents of the boiling tube, collected after 20 minutes of the investigation.

Describe and carry out an appropriate test to determine whether the student's hypothesis can be accepted. Suggest how this would impact your results. [4]

- Add 2 cm^3 of sample R and 2 cm^3/ equal volume of Benedict's solution into a boiling tube and mix well;
- Put the boiling tube into a boiling water-bath for 3 minutes;
- *Contents changed/ turned from a clear blue solution to a **cloudy, blue mixture with suspended reddish-brown precipitate**;
- showing the presence of (minute quantity of) reducing sugar, thus accept/ do not reject the student's hypothesis;

- Since glucose diffuses into the surrounding of the dialysis tube, with time, less glucose is available for yeast to respire to produce carbon dioxide;
- The results obtained is an underestimate of the actual carbon dioxide production from the mixture of yeast and glucose/ more time is required for end-point to be reached;

OR

- Since only minute quantity of glucose is present after 20 minutes, most of the glucose is available as a respiratory substrate for yeast during the duration of the experiment;
- there is not much impact on the results obtained;

*** Without this observation, maximum is 3 marks.**

(b) (i) State the independent variable in this investigation. [1]

- temperature;

The results from the investigation at **35 °C** are shown in Table 1.2.

(ii) Plot a graph of the data shown in Table 1.2 on the grid in Fig. 1.4. Draw a line of best-fit. [4]

1. x-axis: time / min and y-axis: carbon dioxide production/ arbitrary unit;
2. scale on x-axis: 10 min to 2 cm, labelled every 2 cm and scale on y-axis: 1.00 arbitrary unit to 2 cm, labelled every 2 cm;
3. correct plotting of all six points using small crosses or dots in circles;
4. best-fit line drawn with equal number of points on both sides of line;

(iii) Explain the trend shown by the graph in Fig. 1.4. [3]

1. Carbon dioxide production increases at a decreasing rate from 0 arbitrary unit at 0 min, reaching 3.25 arbitrary unit at 66 min;
2. Initial increase of carbon dioxide with time is due to high concentration of substrates resulting in effective collision of enzymes with substrates, forming enzyme-substrate complexes and hence the by-product of respiration, carbon dioxide;
3. With increasing time, substrates are used up/ become limiting and carbon dioxide production plateaus off;

(iv) Use the graph in Fig. 1.4 to find the initial rate of carbon dioxide production when the yeast was incubated at 35°C. [1]

Initial rate of carbon dioxide production = gradient of line drawn
$= \frac{2.00}{15}$
= 0.133 arbitrary unit / min;

Question 2

(a) (i) Describe how you will make up the various chloroplast concentrations using the chloroplast suspension **C** and the sucrose solution **S**. [2]

Using the 5/ 10 cm^3 **syringes** provided, add the stated volume of chloroplast suspension and sucrose solution and mix well:

Concentration of chloroplast suspension/ %	Volume of stock chloroplast suspension to used/cm^3	Volume of sucrose used/ cm^3
100	10.0	0.0
80	8.0	2.0
60	6.0	4.0
40	4.0	6.0
20	2.0	8.0

1m – for correct concentration (in %) and use of syringes;
1m – for correct volume used;

(ii) Suggest why a dilute sucrose solution is used instead of distilled water in the above preparation? [1]

- To ensure that the chloroplast remain intact/ maintain the chloroplast integrity/ does not burst;

(iii) Tabulate your data in the space provided.

Process your data to obtain the rate of photosynthesis. Add your processed data to the table. [3]

Concentration of chloroplast suspension/ %	Time taken for the indicator to decolorised/ s	Rate of photosynthesis/ s^{-1}
100	10	10.0
80	25	4.0
60	43	2.3
40	166	0.6
20	More than 300	Less than 0.3/ -

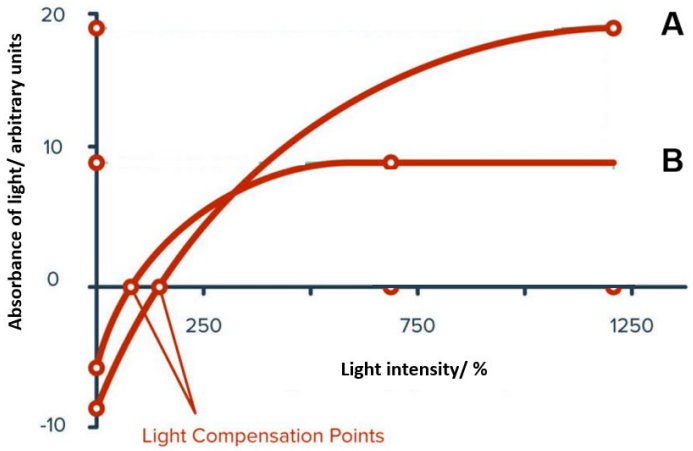
Rate = 100/t

1. [I] Independent variable at most left column, correct headings and units for the 3 columns
2. [T] Correct trend, raw data is to the nearest whole number in seconds
3. [R] Correct processed data, rate should be calculated using 100/t or 1000/t or presented in standard form in 1 decimal place/whole number

(iv) With reference to your results, explain the effect of increasing chloroplast suspension concentration on the rate of photosynthesis. [3]

1. When chloroplast suspension **increases**, the rate of photosynthesis **increases**. [QV from the results table];
2. In the presence of light**, light dependent reaction** can occur resulting in **electron transfer/electron transport/flow of electrons**;
3. With increasing chloroplast suspension concentration, there **is more electrons** flow and get **accepted by the indicator/reduced the indicator**, resulting in **faster decolorisation**;

(b) (i) In the space below, sketch the graphs to show how the light compensation point of species **A** and **B** can be determined.



1. Correct axes of graph, showing both light absorbance as y axis and light intensity as x axis
2. Showing the correct light compensation point of both species A and B (B having a lower light compensation point)

(ii) Describe the method you will carry out to determine the light compensation point of the two species of phytoplankton **A** and **B**. You do not have to plan for repeats. [5]

1. Place 10cm^3 of hydrogen carbonate indicator in 0% ND filter specimen tube and place the tube 20cm from the bench lamp
2. Add 20 alginate beads of species A into the specimen tube and turn on the lamp
3. After incubating for 10min, switch off the bench lamp and decant the solution into a cuvette
4. Blank the colorimeter with hydrogen carbonate indicator (red in colour)/distilled water
5. Using the colorimeter, measure the absorbance value of the decanted solution
6. Repeat step 1-5 with 100% ND filter specimen tube and this serves as a control to show that the colour change is due to the presence of light.
7. Repeat step 1-6 with different ND filter specimen tubes of 20, 40, 60 and 80%
8. Repeat step 1-7 with Species B
9. Light compensation point is the light intensity (ND filter) that has an absorbance value of zero (if blank with hydrogen carbonate indicator)/ absorbance value that corresponds to red colour (if blank with distilled water)

Marking points:
1. Use at least 5 different ND filters specimen tubes with stated percentage
2. Keeping variables constant [Any 2]
    a. Fixed volume of hydrogen carbonate
    b. Fixed amount of alginate beads
    c. Fixed lamp distance
    d. Fixed time for incubation
3. Blanking of colorimeter with hydrogen carbonate
4. Use of colorimeter to measure the absorbance value of the solution decanted
5. Use of control – 100% ND filter or using of glass beads instead of alginate beads. Need to state the purpose of the control.
6. Repeat for species B and explain how to derive the light compensation point.

(iii) State one safety measure to minimise any risk associated with the proposed methodology. [1]

Any one:
- **Hydrogen carbonate indicator** can be a skin irritant, **wear gloves** to prevent direct contact;
- **Alginate** can be an eye irritant, wear **protective googles.**
- **Do not touch the bulb/head of the lamp with bare hands/Handle the lamp using the base** as the bulb is hot and can cause burns**.**

Question 3

(a) (i) Draw, in the space provided, **two** whole cells. These cells need not be adjacent to each other. For each cell, you only need to draw the three largest inclusions.

Annotate clearly in your drawing, your observations of the colour and identity of the inclusions stained by iodine.

No other labels are required. [4]

Drawing of banana cells

Most cells are generally oval, with a pointed end. Although there is variation in shapes none of the cells are rectangular. Size of cells also varies greatly.

Marking points

1. Only 2 cells drawn, each with 3 inclusions;
2. Correct cell shape & size with double line indicating presence of cell wall;
   Refer to the range of cell shape above. Most cells are oval/almond/ spindle in shape;
3. Neatness of drawing: cells drawn with firm outline and label line drawn with a ruler and cell must occupy half to two thirds of the space provided;
4. Annotations on inclusions being stained **blue-black** + identifying inclusions as **starch**;

(ii) The length of one smallest division on the stage micrometer is 0.05 mm.

Use the stage micrometer to calibrate the eyepiece shown in Fig. 3.2.

Show your working clearly. [2]

1. State clearly the number of divisions on the eyepiece graticule that corresponds to the stage micrometer eg.
   40 yepiece graticule units = 2 division on stage micrometer = 2 x 0.05 mm;

2. 1 Eyepiece graticule units = 0.05/20 = 0.0025 mm
   = 0.0025 x 10^3
   = 2.5 um; (1 dp) – correct calculation plus dp

(iii) Assuming that the eyepiece shown in Fig 3.2 is the same as the one fitted onto your microscope, show how you can determine the average length of the three inclusions in one of the cells that you have drawn.

Show your working clearly. [3]

1. Number of eyepiece divisions reported for 3 inclusions;
   Acceptable range based on observations under 400x magnification
   Range of acceptable values: 10 eyepiece divisions – 25 eyepiece divisions,
   At least 2 of the 3 readings must be within the acceptable range.
2. Converting the average eyepiece divisions to µm by multiplying with the value obtained in (ii);
3. Correct average value of inclusion in µm and right decimal place;

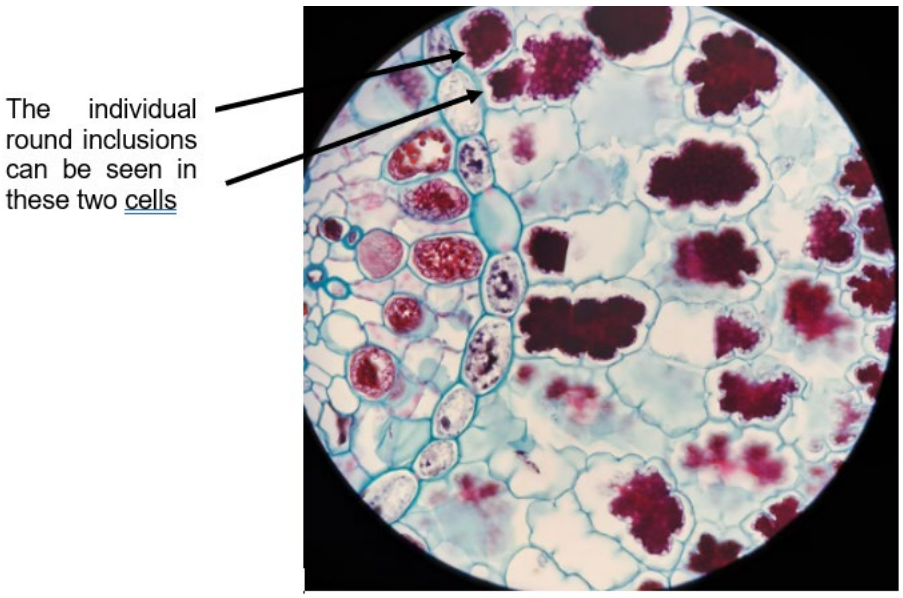
(b) Complete the table to show two **observable differences**, other than colour, **between these cells** and the banana cells that you have drawn in **(a)(i).** [2]

Any 2 below:

Features	**Banana cells**	**Cells above the ring of cells in slide K1**
Cell shape	Shows a range of cell shape varying from oval, almond, spindle in shape;	Cells are more uniform in shape – most are rectangular;
Cell wall (point to point comparison)	1. Outline of cell wall is smooth; 2. Thicker and in some unevenly thickened;	1. Outline of cell wall show infoldings; 2. Thinner and evenly thickened;
Inclusions (point to point comparison)	1. All cells have inclusions 2. Shape: oval/almond 3. Size: Larger (students may give number of eyepiece divisions) 4. Number per cell: Fewer (students may give an average or a range of number) 5. Arrangement within each cell: randomly distributed	1. Not all cells have inclusions 2. Shape of individual inclusion: round 3. Size: smaller if referring to individual / larger if referring to the large central stained region; 4. Number per cell: A lot more if looking at the individual inclusions; 5. Arrangement within each cell: All over due to the large number of inclusions/ center of the cell;

R: Arrangement of cells in banana sample and K1 as the banana cells were scraped from the banana sample and the arrangement would have been disrupted.
R: Any reference to **stained regions** without reference to inclusions as the entire slide K1 is stained.

For reference:



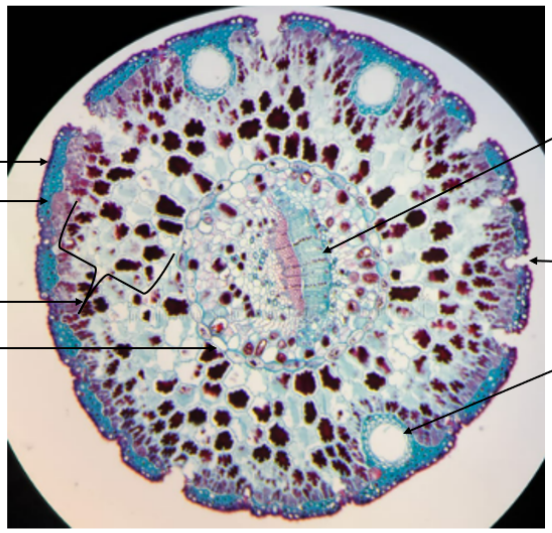
(c) Use the microscope to observe the distribution and proportion of the different tissues in the leaf on **K1**.

In the space below, draw a large plan drawing of **half** of the pine leaf. Your drawing must show the distribution and proportion of all tissues of the leaf.

Do not draw any cells.

Labels are not required. [4]

Marking points
1. At least 4 different tissues shown in correct proportion – see below.
Students are not expected to know the names of the tissues. It is labelled here to distinguish the 4 layers that must be represented in their drawing.



Marking points
2. Vascular bundle
- Correct shape – not round or oval, it is more like lip shape
- At least 2 layers (max of 3) – xylem and phloem

Vascular bundle

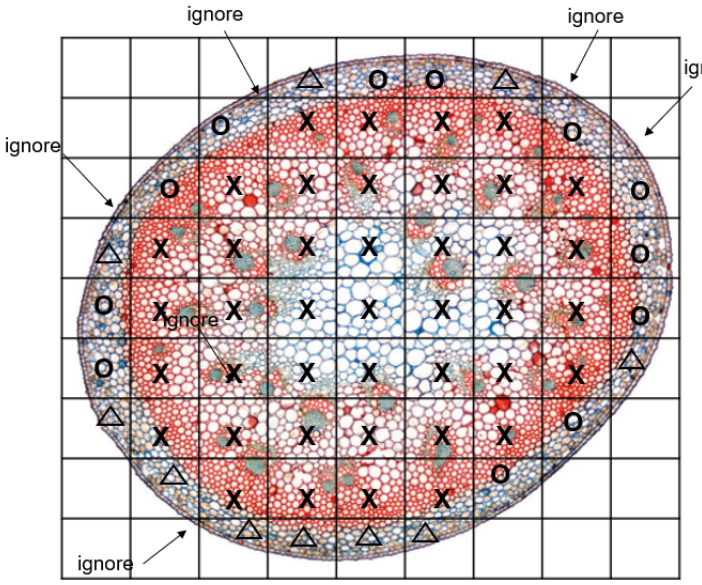
Marking points
3. Outline
- Presence of sunken areas in the leaf (sunken stomata) &parts of hypodermis in a pendulum shape must be shown in the outline
- and proportion of endodermis to entire leaf – size of center cylinder marked by endodermis must be 40-60% of the entire leaf

R: If there are breaks in the epidermis that results in air spaces within the leaf.

Marking points
4. Neatness & size of drawing
- Clear, firm lines;
- Drawing must occupy min of half to two-thirds of the space

Marking points – see diagram above

(d) (i) Using the grid provided, determine the total area occupied by the stem.
Each square on the grid is 1mm^2.



X Fully covered by stem = 41

O more than 50% covered by stem =12

△ about 50% or less covered = 10

Estimated total area covered
= 41 +12 + ½(10)
= 58 mm^2

If we choose to include the square marked (**) above, the answer will be 58.5 mm^2
So the reporting of the answer based on this method should be **whole number** as the error is large.
A: up to one decimal place but it can only be a 0.5 as in half a square.

Note:
Students may decide on a different way of counting and since deciding whether a square is 50% or less than 50% filled is subjective, a wide range of possible answers has been accepted.
Acceptable range: 53 min – 69 max

(ii) Identify a source of error in your determination of the total area and suggest an improvement to reduce this source of error. [2]

- Source of error: some parts of the stem do not cover the entire 1mm^2, so an estimation has to be made with regard to the percentage coverage, and this can lead to an overestimation or underestimation of the total area/ deciding which 2 squares can be combined to form a completely covered square is subjective;
- Improvement: use a grid with a smaller square eg. 0.5mm^2 so that a greater area of the stem can be determined more accurately and the error of estimation is reduced/ to reduce the uncertainty of estimating the area in partially filled squares;
  R: using a smaller grid