

ST. JULIAN SCHOOLS

S.5

TERM ONE HOLIDAY PACKAGE

ALL SUBJECTS

INSTRUCTIONS:

- KEEP YOUR WORK CLEAN
- DRAW CLEAR DIAGRAMMS
- DO NOT COPY

NAME: mubire

STREAM: _____

P425/1 PURE MATHEMATICS HOLIDAY WORK

Answer all the questions in your books

- Given $\frac{2^5 + 4^{-x}}{\sqrt{8}} = \frac{1}{2}$, find the value of x
- Show that if x is small enough such that its cube and higher powers can be neglected then $\sqrt{\frac{1-x}{1+x}} = 1 - x + \frac{1}{2}x^2$ and hence using $x = \frac{1}{8}$, evaluate $\sqrt{7}$ correct to 3 sfs.
- Show that $\tan(A - B) = \frac{\tan A - \tan B}{1 + \tan A \tan B}$ and hence evaluate $\tan 15^\circ$
- Given that $x = 2t$ and $y = \frac{2t}{1-t}$, show that $y(2 - x) = 2x$
- Solve the equation $\tan^{-1}(2x + 1) + \tan^{-1}(2x - 1) = \tan^{-1} 2$
- The coefficient of x^3 in the expansion $(1 + x)^n$ is four times the coefficient of x^2 . Find the value of n .
- Show that $\cot(A + B) = \frac{\cot A \cot B - 1}{\cot A + \cot B}$
- Without using a table or a calculator, evaluate $\tan 105^\circ$ correct to 3 dps
- Find the term independent of x in the expansion of $\left(\frac{3x^2}{2} - \frac{1}{2x}\right)^9$
- (a.) Express the complex numbers $z_1 = 1 - 4i$ and $z_2 = 2 + i$ in the polar form. Hence find $z_1(z_2)^2$.
(b.) Find the values of x and y if, $\frac{x}{3-i} - \frac{y}{5+2i} = \frac{4+17i}{17+i}$.
- (a) The polynomial $f(x)$ leaves a remainder of 3 when divided by $x + 3$ and a remainder of 18 when divided by $x - 2$. Find the remainder when $f(x)$ is divided by $x^2 + x - 6$.
(b) The roots of the equation $25x^2 + x + 1 = 0$ are α^2 and β^2 . Find the equation with integral coefficients whose roots are $\frac{1}{\alpha}$ and $\frac{1}{\beta}$.
- Solve the simultaneous equations:
 $3y + x - 3z = -4$, $3x - y + 2z = 1$, $-2x + y + z = 7$
- Prove that $\tan^2\left(\frac{\pi}{4} + \theta\right) = \frac{1 + \sin 2\theta}{1 - \sin 2\theta}$.
- Find the point of intersection between the lines $\mathbf{r} = (-2\mathbf{i} + 5\mathbf{j} - 1\mathbf{k}) + \lambda(3\mathbf{i} + \mathbf{j} + 3\mathbf{k})$, and $\mathbf{r} = (8\mathbf{i} + 9\mathbf{j}) + t(4\mathbf{i} + 2\mathbf{j} + 5\mathbf{k})$.
- (a) Differentiate from first principles $y = \frac{1}{\sqrt{x}}$.
(b) Differentiate the following from first principles

- i. $y = \sin x$
- ii. $y = \cos x$
- iii. $y = \tan x$
- iv. $y = x^2$
- v. $y = x^3 - 3x + 5$

16 (a) Solve: $\cos x - \sin x + \cos 3x - \sin 3x = 0$ for $0^\circ \leq x \leq \pi$.

b) Prove that: $\tan^{-1} \frac{\sqrt{3}}{2} + \tan^{-1} \frac{\sqrt{3}}{5} = \frac{\pi}{3}$.

17. Show that: $\cot 2\theta = \frac{1 - (\tan \theta)^2}{2 \tan \theta}$

18. Express $f(x) = \frac{3x^2 - 4x + 5}{(x+1)(x-3)(2x-1)}$ into partial fraction

19. Solve: $\sqrt{4-p} - \sqrt{6+p} = \sqrt{14+2p}$

20. Find the square root of $23 - 4\sqrt{15}$

25. Find the expansion of $(4 - 3x^2)^{\frac{1}{2}}$ in ascending powers of x up to and including the term in x^4 .

26. Solve the simultaneous equations: $x + 2y = 7$, $x^2 - 4x + y^2 = 1$

27. Find the number of terms in the A.P: $\frac{9}{4} + \frac{57}{20} + \frac{69}{20} + \dots + \frac{81}{4} + \frac{417}{20}$

28. If the sum of two numbers is 4 and the sum of their squares minus three times their product is 76, find the numbers.

29. Solve the equation: $\sin 2x + \sin 3x + \sin x = 0$ for $0 \leq x \leq \pi$

30. Find the first three terms of the expansion $(2 - x)^6$ and hence evaluate $(1.998)^6$ correct to 3dps

31. How many terms of the series $11 + 16 + 21 + 26 + \dots$ are needed to exceed a sum of 450.

32. (a) Line 1 has vector equation $L_1: \begin{pmatrix} 5 \\ 4 \\ 4 \end{pmatrix} + t \begin{pmatrix} -2 \\ -3 \\ 4 \end{pmatrix}$ and line 2 $L_2: \begin{pmatrix} 1 \\ -4 \\ 14 \end{pmatrix} + \mu \begin{pmatrix} 0 \\ -2 \\ 2 \end{pmatrix}$.

Show that these lines intersect and give the coordinates of the point of intersection.

(b) find the equation of the plane through $A(-1,2,0)$ $B(3,1,1)$ and $C(1,0,3)$ in Cartesian equation.

33. (a) Find t such that $a = \begin{pmatrix} -1 \\ 5 \end{pmatrix}$ and $b = \begin{pmatrix} 2 \\ t \end{pmatrix}$ are perpendicular.

(b)

if $a = \begin{pmatrix} 2 \\ 3 \\ -1 \end{pmatrix}$ and $b = \begin{pmatrix} -1 \\ 2 \\ 4 \end{pmatrix}$, find $a \times b$

(c) find t

given that $\begin{pmatrix} 2-t \\ 3 \\ t \end{pmatrix}$ and $\begin{pmatrix} t \\ 4 \\ t+1 \end{pmatrix}$ are perpendicular.

34. Expand $\frac{1}{\sqrt{1+x}}$ in ascending powers of x upto the term in x^2 and state its validity hence using $x = \frac{1}{4}$, Show that $\sqrt{5} = \frac{256}{115}$

36. Use first principles to differentiate $y = 5x^3 + 6x^2 - 3x + 2$.

37. Determine the values of θ between 0° and 360° which satisfy the equation $\sin 2\theta + \cos \theta - 2 \sin \theta - 1 = 0$.

38. The first three terms in the expansion of $(1 + kx)^n$ are $1 - 4x + \frac{15}{2}x^2$. Find k and n

39. Solve for x and y : $\log(x+y) = 1$
 $2 \log y - \log(30-x) = 0$

40. Express $1 - 5x - 2x^2$ in the form $a - b(x+c)^2$ and hence find the values of a , b and c

41. Show that if n is a positive integer, $3^{2n} + 7$ is divisible by 8.

b) Prove by induction that

$$1(2) + 2(3) + 3(4) + \dots + n(n+1) = \frac{1}{3}n(n+1)(n+2)$$

42. Without using a calculator, show that $\frac{\log \sqrt{27} + \log \sqrt{8} - \log \sqrt{125}}{\log 6 - \log 5} = \frac{3}{2}$

43. Prove by induction that $8^n + 6$ is divisible by 14.

44. The two lines $ax + by = 32$ and $2x - 3y = 4$ are perpendicular and intersect at $(8, 4)$. Find the values of a and b .

45. If $y = \sqrt{x}$, show from first principles that $\frac{\Delta y}{\Delta x} = \frac{1}{\sqrt{x+\Delta x} + \sqrt{x}}$. Hence find $\frac{dy}{dx}$.

46. If $y = \ln \left[e^x \left(\frac{x+1}{x-1} \right)^{\frac{1}{2}} \right]$, show that $\frac{dy}{dx} = \frac{x^2-2}{x^2-1}$.

47. Prove that: $\cot \theta - \tan \theta = 2 \cot 2\theta$ (05 mks)

48. The polynomial $Q(x)$ is defined by $Q(x) = x^4 + 4x^3 + ax^2 + bx + 5$. It is known that $Q(x)$ is divisible by $x^2 - 1$, the remainder $2x + 3$ is obtained. Find the values of a and b . (05 mks)

49. If $y = \sqrt{x}$, show from first principles that $\frac{\Delta y}{\Delta x} = \frac{1}{\sqrt{x+\Delta x} + \sqrt{x}}$. Hence find $\frac{dy}{dx}$. (05 mks)

50. The coefficient of x^3 in the expansion $(1+x)^n$ is four times the coefficient of x^2 . Find the value of n . (05 mks)

51. If the roots of the equation $x^2 - 92x + 16 = 0$ are α^2 and β^2 , find an equation whose roots are $\frac{2}{\alpha}$ and $\frac{2}{\beta}$.

52. Find the value of x if $\log_a x$, $\log_a(x+3)$ and $\log_a(x+12)$ are three consecutive terms of an AP.
(05 mks)
53. Find the angle between the lines $x+2y+5=0$ and $2x-3y-7=0$. (05 mks)
54. Show that the locus represented by the parametric equations: $x-1=\sin\theta$ and $y+2=\cos\theta$ is a circle. Hence state its radius and centre.
55. Given that the function $f(x) = ax^3 - bx^2 - x + 6$ is divisible by $x^2 - 1$, find the values of a and b hence solve $f(x) = 0$
58. Show that the locus of a point which moves so that the sum of squares of its distances from $(-2, 0)$ and $(2, 0)$ is 26 is a circle with the centre at the origin hence state its radius.
59. (a) In a triangle ABC, show that $\cos \frac{B}{2} = \sqrt{\frac{s(s-b)}{ac}}$.
(b) The angle α is obtuse and $\sin \alpha = \frac{3}{5}$. Find the values of $\sin 2\alpha$ and $\cos 2\alpha$
60. If α_1 and α_2 are gradients of the lines L_1 and L_2 respectively. Show that the angle between the lines L_1 and L_2 is given by $\tan^{-1} \left(\frac{\alpha_1 - \alpha_2}{1 + \alpha_1 \alpha_2} \right)$.

END

APPLIED MATHEMATICS PAPER 2 S.5
STATISTICS

UGROUPED DATA

1. Given the following sets of values
2, 10, 1, 3, 4, 7, 5, 6, 7, 8, 9, 10, 3, 4, 6, 8, 9, 3, 2
- (a) Form a frequency table of ungrouped data.
(b) Use the table to find;
- (i) Mean.
 - (ii) Variance.
 - (iii) Standard deviation.
 - (iv) Mode.
 - (v) Median.
 - (vi) Range
 - (vii) Lower quartile
 - (viii) Upper quartile
 - (ix) 90th percentile
 - (x) 9th decile
2. The table below shows the marks scored by 40 students in a mathematics examination.
- | | | | | | | | | |
|-----------|----|----|----|----|----|----|----|----|
| Marks | 30 | 35 | 40 | 50 | 60 | 70 | 80 | 90 |
| frequency | 2 | 8 | x | 1 | 4 | 6 | y | 2 |
- If the mean mark is 57.75, find the values of frequencies x and y.
3. The ages of eight students in a class are; 12, 13, 14, 15, 12, 17, 12, 13, 16, 12. Find the;
- a. Form a frequency table of ungrouped data.
 - b. Use the table to find;
- (i) Mean
 - (ii) Variance
 - (iii) Standard deviation
 - (iv) Mode
 - (v) Median
 - (vi) Range
 - (vii) Interquartile range
 - (viii) 86th percentile

GROUPED DATA

1. The table below shows motorcycle casualties by age in 2011

Age (years)	16-19	20-24	25-29	30-39	40-80
Percentage casualties	36	26	15	11	12

Calculate the;

- a. Mean b. Standard deviation c. Median d.
 Mode
 e. interquartile range f. 58th percentile

2. The length in cm of 40 metal rods were as follows

Length (cm)	Frequency
≥ 30	8
≥ 35	5
≥ 40	12
≥ 55	9
≥ 60	6
≥ 65	0

- a. Calculate the mean length and upper quartile
 b. Display the data on a histogram and use it to estimate the mode.
3. The table below is the distribution of the distance run during training by members of an athletics club in a particular week.

Distance (km)	Frequency
31-40	10
41-45	15
46-50	20
51-55	70
56-57	64
58-60	24
61-70	20
71-90	10

- a. Draw a histogram and hence use it to find mode
 b. Calculate; i. Median mark ii. 90th percentile
4. The table below shows the time recorded in minutes when aero planes pass through a point of observation at a certain city.

Time	50-	60-	70-	80-	90-	100-	110-120
frequency	5	3	8	7	10	8	9

Calculate the;

- i. Median
 ii. Number of aero planes whose time exceed the median value.

5. The table below shows the ages of people who attended a certain function.

Age (years)	Frequency
10 – 19	6
20 – 34	16
35 – 44	27
45 – 64	39
65 – 79	18
80 – 89	8

- (a) Draw a cumulative frequency curve and use it to estimate the semi-interquartile range.

- (b) Calculate the; i. mean mark ii. standard deviation

6. The table below shows the time intervals between successive arrivals of telephone calls at an office.

Time (Minutes)	Frequency
$0 < x \leq 0.5$	23
$0.5 < x \leq 1.0$	39
$1.0 < x \leq 2.0$	23
$2.0 < x \leq 3.0$	9
$3.0 < x \leq 6.0$	6

- a. Calculate the;

- i. Mean
ii. Standard deviation

- b. Draw a histogram to illustrate the above information and use it to estimate the modal time interval.

7. The table shows the marks scored by a group of candidates in a mathematics exam.

Marks (%)	10-19	20-29	30-34	35-44	45-54	55-64	65-69
Frequency density	0.7	2.6	4.2	3.8	4.6	2.8	2.6

- a. Draw a histogram and use it to estimate the modal mark.

- b. Calculate the;

- i. mean mark
ii. Median mark
iii. Standard deviation

8. A school entered 90 candidates for an examination. The results of an examination are as shown in the table below.

Marks (%)	Frequency
$0 < x \leq 10$	8
$10 < x \leq 20$	7
$20 < x \leq 30$	9
$30 < x \leq 40$	10
$40 < x \leq 50$	12
$50 < x \leq 60$	18
$60 < x \leq 70$	15
$70 < x \leq 80$	16

- a) Determine the mean mark and standard deviation.
- b) Construct an Ogive and use it to estimate the probability of a candidate to score a distinction, if the distinction was at 75%
9. The table below shows the distribution of marks of students in a test.

Score	Frequency
$20 \leq x < 30$	4
$x < 45$	3
$x < 50$	9
$x < 65$	21
$x < 75$	3
$x < 80$	5
$x < 100$	14

Draw a histogram and use it to estimate the modal mark.

10. The heights of a sample of tea trees in a tea estate were recorded (in cm) as follows:

110	112	105	102	129	112	103	128	121	126
109	107	109	131	124	116	119	127	120	106
120	118	111	126	107	123	102	122	113	129
125	120	113	119	123	130	123	103	109	111
130	124	121	118	119	125	133	115	117	113

- (a) Construct a frequency table with classes having an interval of 5.0cm and use it to estimate the average height of the tea trees.

- (b) Construct a cumulative frequency curve and use it to estimate the median height of the tea trees.
- (C) What is the probability of finding a tree with a height between 118cm and 124cm

11. The following table summarizes the distance to the nearest mile, travelled to work by a random sample of commuters

Distance (miles)	0-9	10-19	20-29	30-39	40-49	50-59
No. of commuters	15	38	22	15	8	2

- a. Calculate the: i. Mean deviation ii. Median iii. Standard deviation
- b. Draw a histogram to represent the data and use it to estimate the mode.

12. The table below shows the distribution of students' heights in a certain school.

Heights (cm)	frequency
120-<130	7
130-<135	8
135-<145	36
145-<155	39
155-<170	17
170-<175	3
175-<190	5

- a. Draw a histogram and use it to find the mode
- b. Draw an ogive and use it to find
- i. Median
- ii. The middle 70% range
- iii. Number of students whose height is less than 150cm

13. Given the table below

Marks (%)	No. of students
20 -	5
≥ 40	15
≥ 50	10
≥ 55	10
≥ 60	30
≥ 70	25
≥ 90	5
≥ 100	0

- a. Draw a histogram and use it to estimate the modal mark.
- i. Calculate the; i. 78th percentile ii. Interquartile range

14.

The marks of 100 students were as shown in the table below:

Marks	Frequency
Below 10	6
10 and under 25	11
25 and under 35	17
35 and under 45	28
45 and under 50	20
50 and under 65	15
65 and under 80	3

- Calculate the mean
- Draw a histogram to represent the distribution and use it to estimate the mode.

NUMERICAL /ITERATIVE METHODS

SECTION A

- Given the equation $x^3 - 6x^2 + 9x + 2 = 0$;
 - Show that the equation has a root between -1 and 0
 - Use linear interpolation thrice to find the root correct to 2 decimal places.
- Show graphically that $f(x) = xe^x + 5x - 10$ has a root between 1 and 2 and hence find the initial approximation x_0 correct to 1 decimal place.
- By plotting graphs $y = xe^x$ and $y = 10 - 5x$ on the same axis, show that there's a root between 1 and 2, hence the initial approximation x_0 correct to 1 decimal place.
- The table below gives values of x and the corresponding values of $f(x)$.

x	0.1	0.2	0.3	0.4	0.5	
$f(x)$	4.21	3.83	3.25	2.85	2.25	

Use linear interpolation/extrapolation to find;

- $f(x)$ when $x = 0.6$
- x when $f(x) = 0.75$.

SECTIONB: SCENARIO QUESTIONS

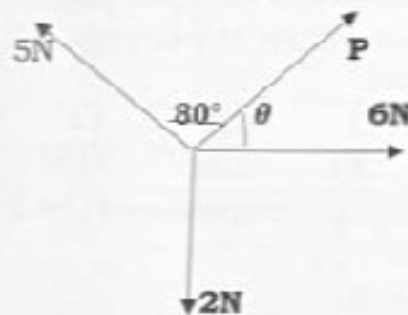
- Sarah had to call home for transport money from school located in jolwe village to the new home located in kasangati town since the term was ending.
She had the following information about the journey
 -the total distance between jolwe and kasangati is 5km
 -from jolwe to manyangwa its 3km and costs 3000/-
 -from manyangwa to Gayaza its 1.5km and costs 1000/=
 - As a friend to sarah, help her to calculate the transport money she should call for from home.

- b) If Sarah is to branch at the Kyetume market which is at 1km from Manyangwa to Gayaza, find how much she is going to pay the bodaboda rider.
2. A butcher had a corrupt weighing scale and customers used to complain about it, he realised it after the loss of some customers. He discovered the following information about a corrupt weighing scale;
- without any weight on the weighing scale, the scale shows 0.5kg
 - with 10kg on the weighing scale, the scale shows 12kg
- a. As a caring customer to the butcher, help him to estimate the weight is supposed to put on the weighing scale if it is to measure 1kg of meat for the customer.

MECHANICS

1. The resultant of forces $F_1 = 3i + (a - c)j$, $F_2 = (2a + 3c)i + 5j$, $F_3 = 4i + 6j$ acting on a particle is $10i + 12j$. Find the;
- Values of a and c
 - Magnitude of force F_2
2. Two forces 4N and 3N are acting away at an angle 60° between them. Find the magnitude and direction of their resultant force.

3. If the system in the diagram below is in equilibrium.



Find the value of P and θ

4. Forces of the magnitude 2N, 2N, 3N, 4N, $2\sqrt{2}N$ and $\sqrt{2}N$ are acting along sides AB, BC, AD, AC and DB respectively. Where ABCD is a square of side 2m. Find the magnitude and direction of the resultant force acting on the square.

END

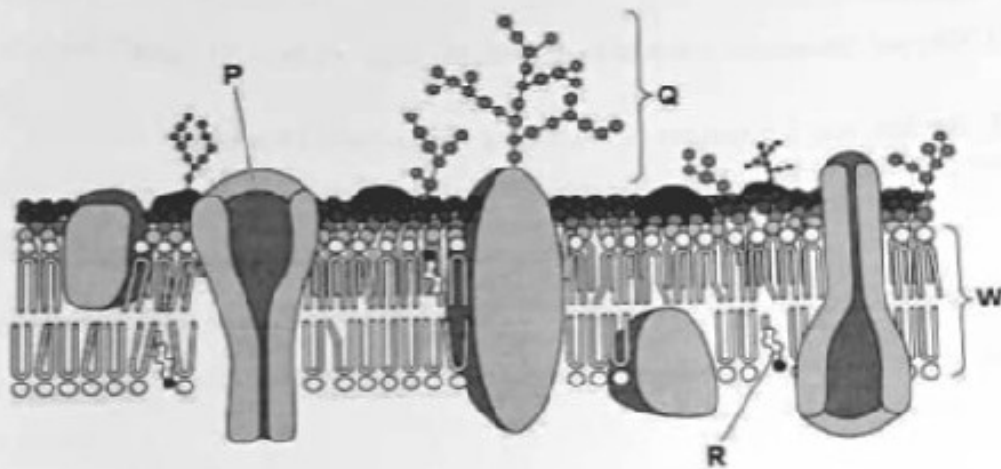
BIOLOGY

Item 1

Membranes such as the cell surface membrane are described as having a fluid mosaic structure.

Task

- a) Explain why the plasma membrane is referred to as being;
- i) Fluidy (2 marks)
 - ii) Mosaic (2 marks)
- b) The figure below shows a section of a cell surface membrane.



- i) Identify the structures P, Q, R and W. (2 Marks)
- ii) State the functions of the following structures. (2 marks)
- c) How is membrane fluidity essential to cell functioning? (2 marks)

Item 2

a) State the functions of each of the following organelles (add an adaptation for each organelle).

i) Chloroplast (2 marks)

Function.....

Adaptation.....

ii) Rough endoplasmic reticulum (2 marks)

Function.....

Adaptation.....

iii) Nucleus (2 marks)

Function.....

Adaptations.....

b) Why are lysosomes referred to as "suicide bags" of cells?(1 mark)

c) Explain any 3 functions of lysosomes within cells. (9 marks)

Item 3

There are membrane-bounded channels which form a network and almost fill the cytoplasm of most cells and are only recognizable under the electron microscope.

Task

a) What are the small granules "associated with the channels mentioned above, and state their function. (02 marks)

b) Give one way by which you would recognize the "colloidal state" of protoplasm.

c) Which constituent of the protoplasm are responsible for its colloidal state?

d) Viewed under the electron microscope, the cell membrane has a three layered structure. What is the chemical nature of each of these layers?

Item 4

The cell membrane is supported by intracellular filaments at the inner surface which act as cytoskeleton. Make a report on the different types of the cytoskeleton and their functions in the cell.

Task

- (a) Describe the functioning of Golgi apparatus in animal cells.
- (b) Explain the role of lysosomes in animal cells.

Item 5

By stating differences in structure and function, distinguish between

- (a) Rough endoplasmic reticulum and Golgi apparatus
- (b) Cell wall and cell membrane
- (c) Cilia and flagella

Item 6

(a) Describe the structure and function of TWO eukaryotic membrane-bound organelles other than the nucleus.

(b) Prokaryotic and eukaryotic cells have some non-membrane bound components in common. Describe the function of TWO of the following and discuss how each differs in prokaryotes and eukaryotes:

- (i) DNA
- (ii) Cell wall
- (iii) Ribosomes.

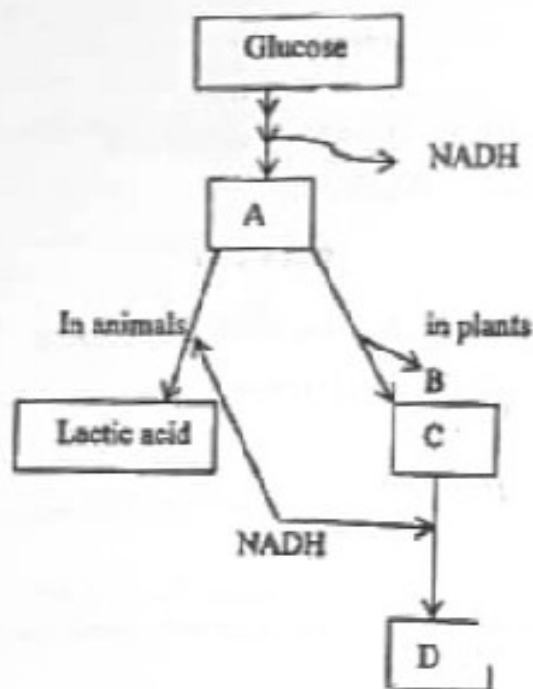
Item 7

Three processes are involved in respiration of sugars in a cell; glycolysis, Krebs cycle and electron transport system. Briefly describe each of the above processes involved in respiration.

- | | |
|------------------------------|-----------|
| a) Glycolysis | (8 marks) |
| b) Krebs cycle | (6 marks) |
| c) Electron Transport system | (6 marks) |

Item 8

Anaerobic respiration can occur in both plants and animals under conditions of oxygen deprivation. The scheme below shows different anaerobic pathways in different organisms.



Task

- a) (i) Name the substances labelled B and C.
B.....
C.....
- b) State the role of NAD^+ in respiration
- c) Describe the fate of
 - (i) Compound A in plant roots living in water logged soils
 - (ii) Lactic acid from anaerobic respiration
 - (iii) Explain why many plants or parts of plants indulge in anaerobiosis for a short period of time.

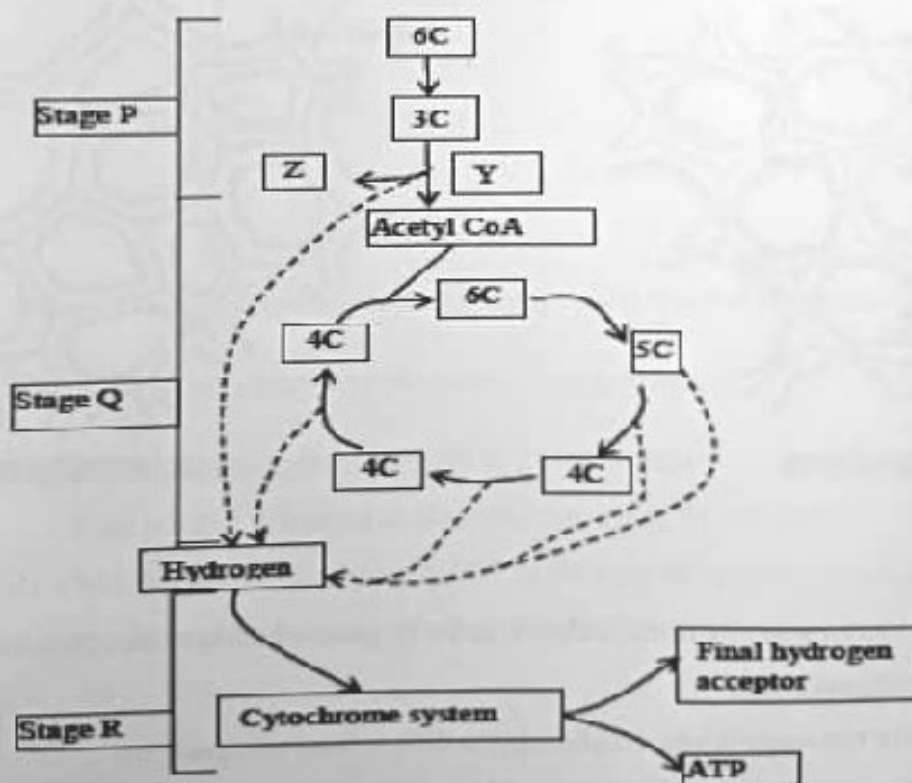
Item 9

Fill in the missing gaps using appropriate word (s) so as to complete the account of cellular respiration 'the initials stage in cellular respiration is glycolysis which occurs in the of the cell. A monosaccharide such as And is first Then converted into a 3-carbon intermediate product called

In the absence of oxygen this product may enter another metabolic pathway giving rise to in animals and in plants. The end product of glycolysis is Which is decarboxylated and enter the Cycle. This cycle links other pathways which enables organism acid such as and To be regarded and small organic molecules in the cycle provides uses into the reduction of during cycle a total of molecules are formed from complete oxidation per molecule of a 6-carbon sugar

Item 10

The scheme below shows the different stages of anaerobic respiration occurring in a eukaryotic cell.



Task

(a) Where exactly do reactions P, Q and R occur?

P

Q

R

(b) What is substance Z?

.....

(c) What is the 6C intermediate compound from the reaction between acetyl CoA and the 4C compound

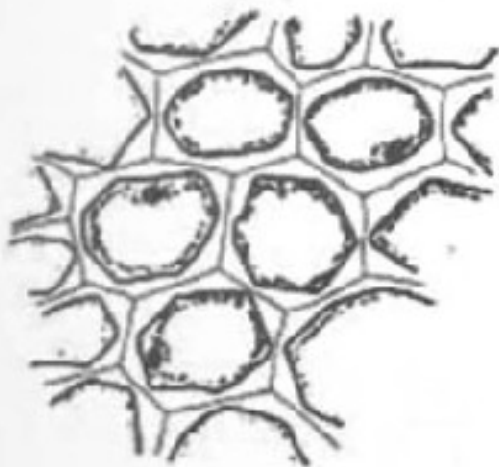
(d) Name the enzyme controlling reaction Y

.....

(e) Name the final hydrogen acceptor in the cytochromes system indicated in the diagram

Item 11

The diagram below shows two supporting tissues in flowering plants.



collenchyma



sclerenchyma

Task

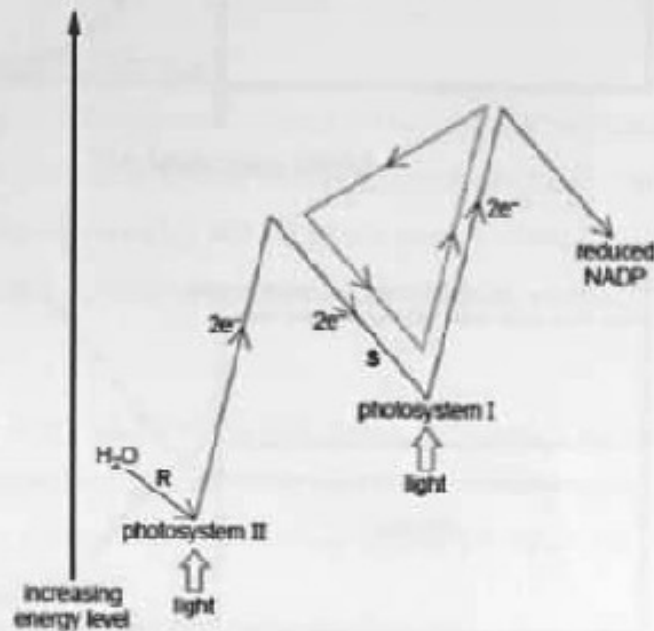
a) Give two structural features shown in the diagram which are characteristics of collenchyma tissue.

b) (i) Give two ways in which collenchyma differs from sclerenchyma

- (ii) Collenchyma tissue is often present in the petiole and midrib of leaves. Suggest two reasons why collenchyma is more suitable than sclerenchyma for support in these regions.
- c) Both tissues are shown in transverse section. Make a drawing of a sclerenchyma cell as it would appear in transverse section.

Item 12

Figure below shows the main reactions in the light-dependent stage of photosynthesis.



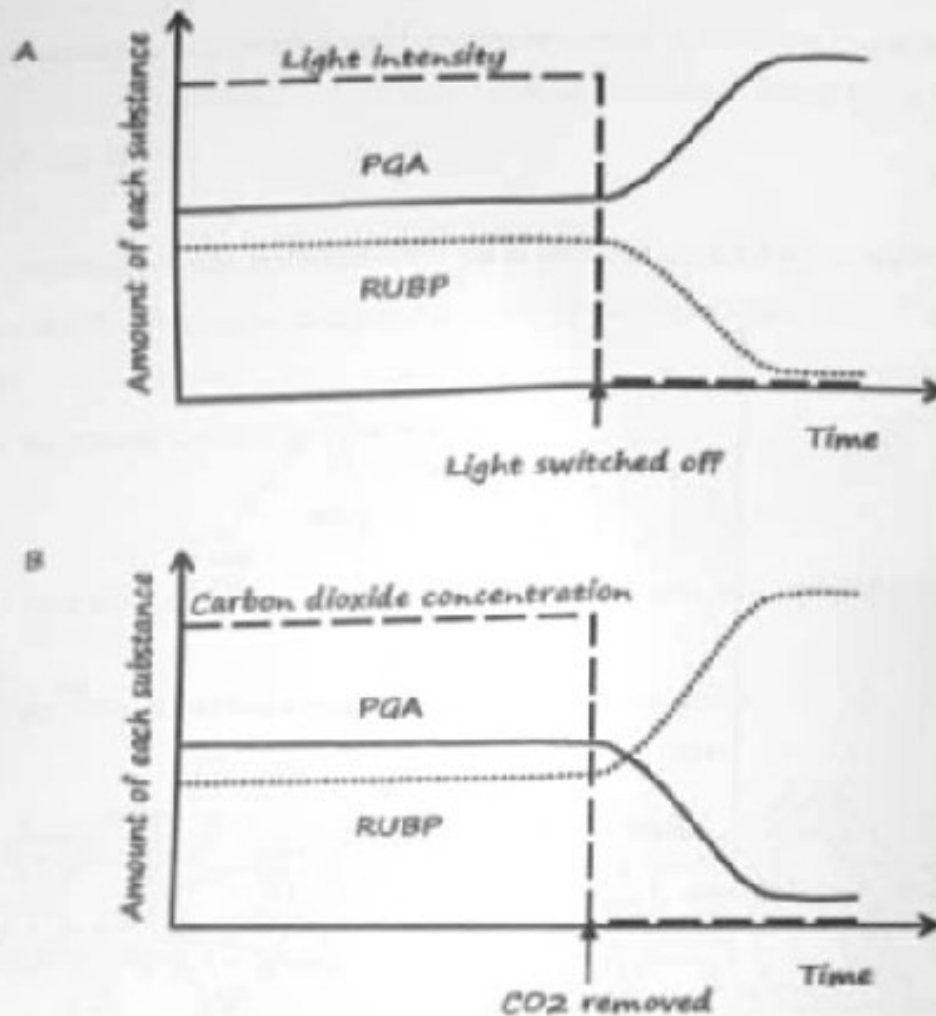
Task

- Where in the chloroplast does the light dependent reaction take place? (01 mark)
 - Name the process shown by the dotted arrows. (01 mark)
 - Describe what happens to water at R? (02 marks)
 - What product is formed as electrons flow along S? (01 mark)
- Explain briefly the role of reduced NADP in the light-independent stage. (02 marks)
- How is the chloroplast suited for photosynthesis? (03 marks)

Item 13

Experiments were carried out on cultures of a unicellular green protest to investigate the effect in the formation of phosphoglyceric acid (PGA) and ribulose biphosphate (RUBP)

of (A) switching the light off, i.e. suddenly putting the organisms in darkness, and (B) depriving the organisms of carbon dioxide. The results are summarized in the figures below.



- Describe the effect of switching off light and removing carbon dioxide on the quantity of substances formed with time in Graph A and B respectively. (06marks)
- Suggest explanations for the variation in the amount of PGA and RUBP in;
 - Graph A. (09marks)
 - Graph B. (05marks)
- Sucrose is one of the substances observed to be formed during the investigation.
 - Sketch a graph to show the effect of switching off light on the amount of sucrose formed. (03marks)
 - Account for the shape of the graph in (i) above. (06marks)
- Predict the levels of PGA and RUBP if experiments were continued for longer. (03marks)

c) Explain the following observations.

- (i) Although photosynthesis generates ATP, plants also generate ATP by respiration. (02 marks)
- (ii) At high temperatures, the photosynthetic rate is higher in C4 plants than in C3 plants. (03 marks)
- (iii) Photosynthetic rate in C4 is not enhanced by atmospheric carbon dioxide, yet in C3 plants it is. (03 marks)

Item 14

- a) What is photorespiration? (1 mark)
- b) State two differences between photorespiration and cellular respiration. (2 marks)
- c) Explain why photorespiration lowers photosynthetic activity. (2 marks)
- d) How would the abundance of C3 and C4 plants species change in a region whose climate becomes hotter and drier. Explain your answer. (3 marks)

Item 15

- (a) You are part of a group of scientists that wants to design a self-sustaining biodome that mimics the earth's natural ecosystem. Water recycling is crucial for the success of this habitat. As the lead scientist, you are tasked with ensuring that all organisms within the biodome can survive and function optimally.

Task

Using your understanding of water's physical properties, explain how they contribute to maintaining biological functions within the biodome. (12 marks)

- (b) A desert-dwelling animal, the camel, must survive in environments where food is scarce and movement through hot, dry terrain demands energy efficiency. This animal stores large amounts of energy in the form of lipids. Task As a student of biology, analyse and explain why lipids are particularly well suited for long-term energy storage in this animal. (08 marks)

- Answer all items

1. A newly discovered element X has an atomic number of 120 and an atomic mass of 300. Scientists are studying its electronic configuration, reactivity and nuclear stability.

Task:

- Write the expected electronic configuration of X . ($Z=120$)
- Predict whether X would be highly reactive or relatively inert based on its position in the periodic table.
- Considering the atomic mass of X , do you expect it to be radioactive? Why or why not?
- How does the neutron-proton ratio influence stability of X ?
- What type of radiation/particles would it most likely emit? Explain your reason.

2. You are a junior chemist analyzing simple molecules to understand their shapes and bonding.

You are provided with three compounds; Methane (CH_4) a key component of natural gas, water a unique solvent and essential molecule of life and Boron trifluoride used as an industrial catalyst.

Task:

- Draw the **Lewis dot structures** for each showing all the valence electrons and use them to explain the type of bonding exhibited.
- Using the VSEPR theory, predict, draw and name the molecular shape of each molecule.
- Explain the shape attained by water and Boron trifluoride.

d) Which of the molecules is/are polar or non-polar? Justify your answer.

e) Methane (CH_4) and water (H_2O) have almost similar molecular masses but the boiling point of water is higher than that of methane. Explain.

3. A scientist analyzed a sample of naturally occurring element, chlorine using a mass spectrometer so as to determine its relative atomic mass.

The sample contained two isotopes; chlorine-35 and chlorine-37 but the mass spectrum obtained showed three peaks corresponding to the different mass to charge ratios of 70, 72 and 74 with different heights in the ratio of 9:6:1 respectively.

Task:

a) Define the meaning of the following terms;

- i. Isotopes
- ii. Relative atomic mass as used as above.

b) Briefly describe how the mass spectrometer was used to obtain the mass spectrum and hence determine the relative atomic mass of chlorine.

c) Explain why the mass spectrum of chlorine consists of three peaks.

d) Determine the relative abundance of chlorine-37 isotope in the chlorine sample.

4. A compound has the molecular formula C_6H_{14} . The student is tasked with identifying possible structural isomers of this compound, considering it is part of the alkane series

Task:

- Draw the structural isomers of the above compound, and name them using IUPAC nomenclature.
 - Explain the types of isomerism shown by this compound
 - Evaluate how the unique bonding properties of carbon contribute to formation the formation of isomers in organic compounds.
5. A material scientist wanted to design a new alloy for aerospace applications. Among the factors to be considered is screening effect, atomic radius, ionic radius and ionization energy. An element with a higher ionization energy is the best choice to consider. The following elements sodium, magnesium and aluminium are under investigation.

Task:

- What is meant by the terms screening effect, atomic radius, and ionization energy.
- Explain the variations of atomic radius and ionization energy from sodium through magnesium to aluminium.
- Identify the element which could be the best choice for the intended purpose. Give a justification for your choice.

END

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