education

Department:
Education
PROVINCE OF KWAZULU-NATAL

PHOTOSYNTHESIS

SUPPORT DOCUMENT

PLUS

SOLUTIONS

TERM 2

GRADE 11

LIFE SCIENCES

APRIL 2020

Content **Page No.**

A. TOPIC PLAN

Lesson	Aspect	Classwork	Homework
1	Introduction • Overview of plant organs Structure of a leaf and chloroplast*	Activity 1.1 Teaching tool 1	Activity 1.2
2	Requirement and product Process: • Light phase • Dark phase	Activity 2.1 Teaching tool 3	Activity 2.2
3	Investigation if starch and light is produced for photosynthesis	Activity 8.3	Activity 5.2
4	Investigation if CO_2, oxygen and Chlorophyll is necessary for photosynthesis	Activity 5.1 Teaching tool 4	Activity 7.1
5	Factors affecting photosynthesis • Light • Carbon dioxide • Temperature Importance of photosynthesis	Activity 4.2	Activity 8.1
6	Greenhouse system & food production The role of ATP	Activity 6 Activity 9	Activity 3
7	Topic test		
8	Remedial		

Try to include as many of the following as possible as classwork/homework:

Extracts	Graph to interpret	Graph to draw	
Diagrams to label	Diagrams to draw	Paragraph questions	Tables
Calculations	Investigations	Extracts	

B. TERMINOLOGY

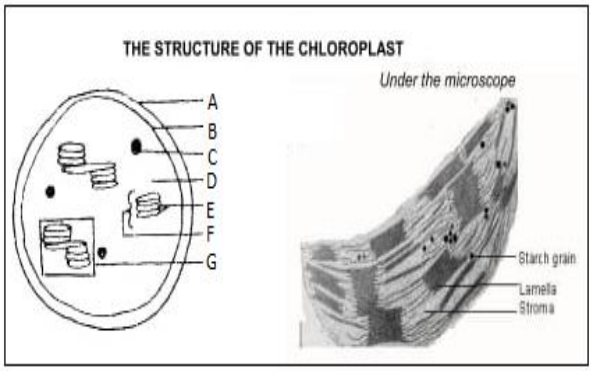
The following terms should be covered in this topic:

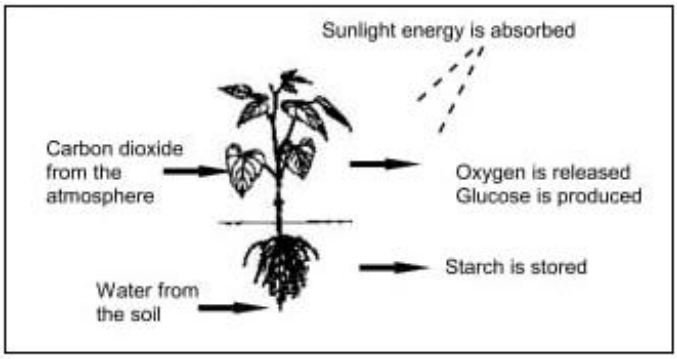
Photosynthesis	ATP	Variegated	Starch
Chloroplast	Iodine solution	Greenhouse	Limiting factor
Chlorophyll	Autotrophs	Destarch	Photolysis
Light phase	Experiment	Control	Anabolic
Dark phase	Glucose	Heterotrophs	Enzymes
Stroma	Thylakoids	Lamella	Xylem
Phloem	Cuticle	Spongy mesophyll	Stomata

Term	Description
Photosynthesis	A process whereby green plants manufacture their own food using radiant energy
Chloroplast	Organelle in a plant cell where photosynthesis occur
Chlorophyll	Green pigment that trap light for photosynthesis
Light phase	Occurs in the grana of the chloroplast
Dark phase	Occurs in the stroma of the chloroplast
ATP	Energy carrier in the living things used for various activities
Iodine solution	Used to test for the presence of starch
Autotrophs	Organisms that use light energy to manufacture its own food
Experiment	A scientific procedure undertaken to make a discovery, test a hypothesis or demonstrate a known fact.
Glucose	Sugar that is the product of photosynthesis
Variegated	Leaf that has more than one colour
Greenhouse	Special building that is used for growing plants in an area where they would not normally grow that well.
Destarch	Process of eliminating starch reserves in a plant for experiments concerning photosynthesis
Control	A variable that is not changed throughout an experiment
Heterotrophs	Organisms that are unable to manufacture their own food (consumers &decomposers)
Starch	A carbohydrate that store energy in plants
Limiting factor	Factor that limits the rate at which photosynthesis takes place

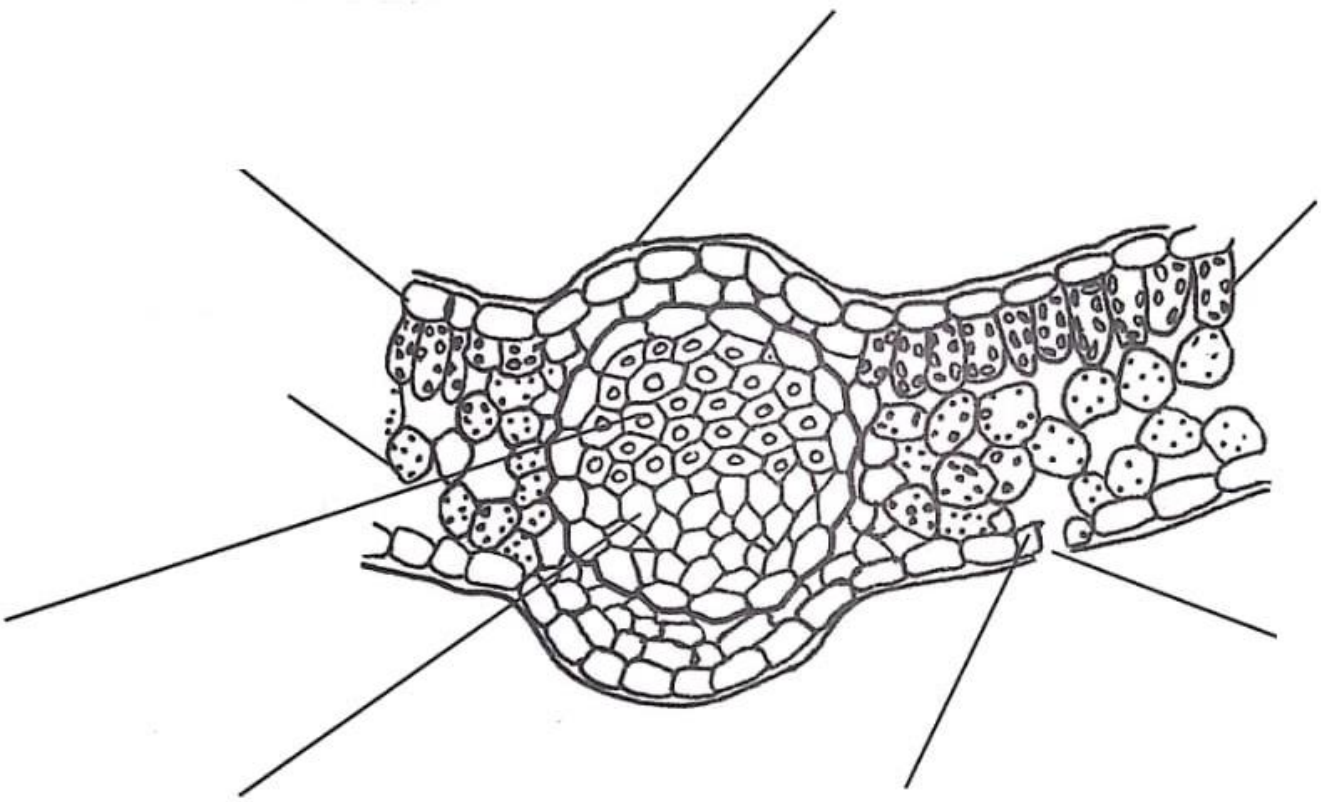
C. TEACHING TOOLS

Teaching Tool 1



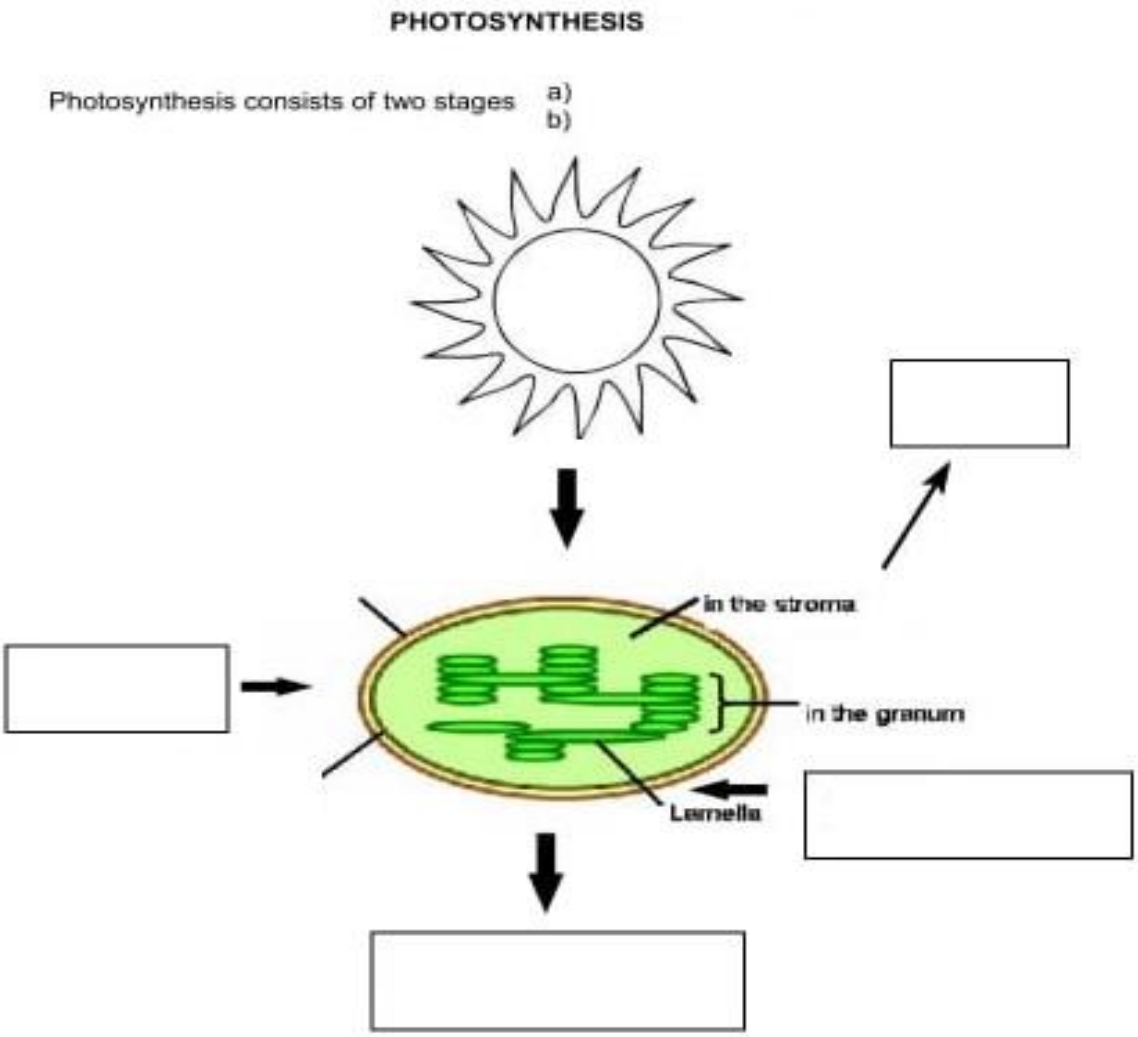


Teaching Tool 2

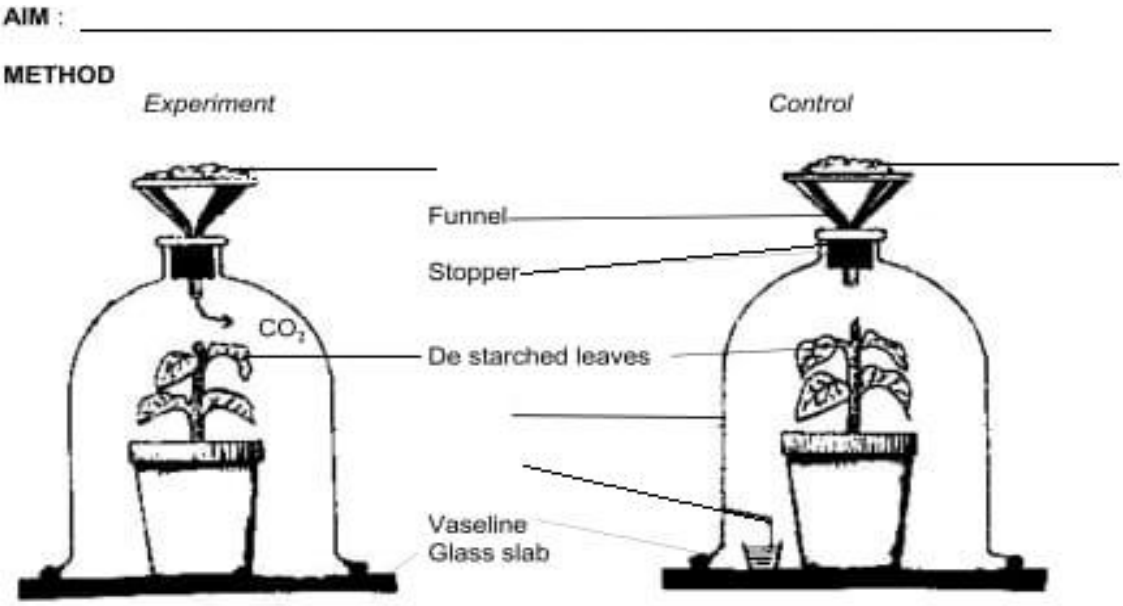


Transverse section through a leaf

Teaching Tool 3



Teaching Tool 4



Activity 1

1.1

1.1.1 The characteristics listed below are all applicable to chloroplasts.

(i) Contain a double membrane
(ii) Contain a fluid matrix with enzymes
(iii) Contain parallel sacs called lamellae
(iv) Contain a green pigment called chlorophyll
(v) Contain starch granules

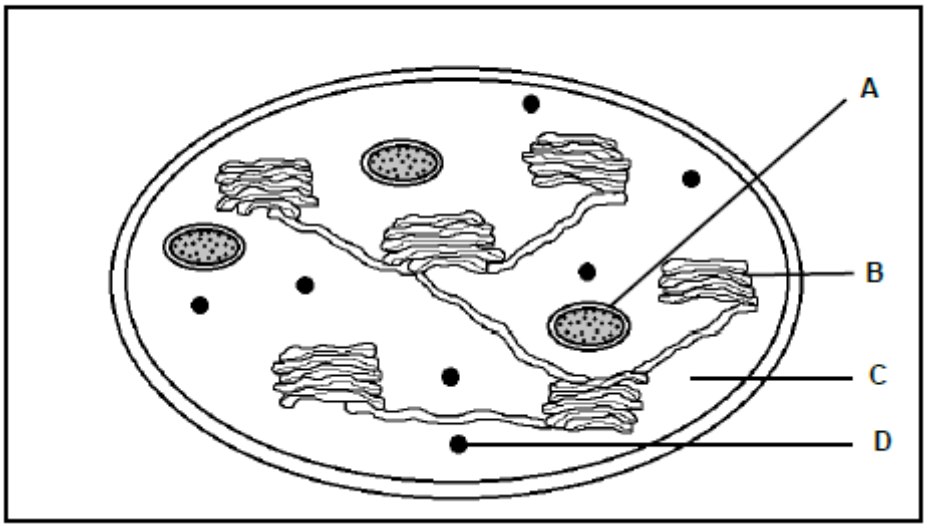
Which combination of characteristics make the chloroplast suitable to perform its function?

A (i), (ii), (iv) and (v)
B (ii), (iii) and (iv)
C (ii), (iii), (iv) and (v)
D (i), (ii), (iii) and (v)

1.1.2 Which ONE of the following characteristics make the leaf suitable for photosynthesis to take place?

A The spongy mesophyll is elongated
B The leaf has many stoma for gaseous exchange in the lower epidermis
C The upper epidermis has a white cuticle
D Xylem is present to the products of photosynthesis

1.2 The diagram below represents the structure of a chloroplast.



1.2.1 Identify:

(a) Part C (1)

(b) Structure D (1)

1.2.2 Give the function of the part labelled A. (1)

1.2.3 Name the part that will be active in light only. (1)

Activity 2

2.1

2.1.1 The simple sugar formed during photosynthesis in green plants

2.1.2 The type of plastid that absorbs radiant energy during photosynthesis

2.1.3 The splitting of water molecules into hydrogen and oxygen in the presence of light

2.1.4 Site of reactions of the dark phase in the chloroplast

2.1.5 The form in which excess glucose is stored in a plant

2.1.6 The green, light–trapping pigment in photosynthesis found in plant leaves

2.1.7 The type of energy absorbed by chlorophyll

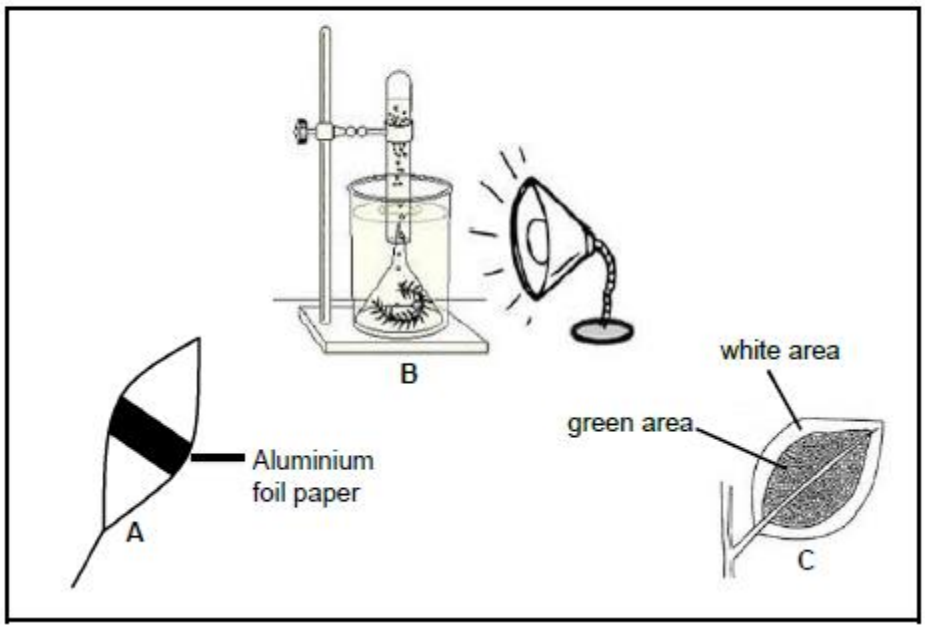
2.1.8

The type of energy stored in food molecules during photosynthesis	A: Chemical energy B: Potential energy

2.1.9

Raw material(s) essential for photosynthesis	A: Oxygen B: Carbon dioxide

2.2 The following diagrams represent investigations involved in a process which takes place in green plants. The plant/leaves represented as A and C were exposed to sunlight for 4–5 hours.



2.2.1 Which investigation (**A**, B or C) is designed to test for the following?

(a) Chlorophyll is necessary for photosynthesis (1)

(b) Light is required for photosynthesis (1)

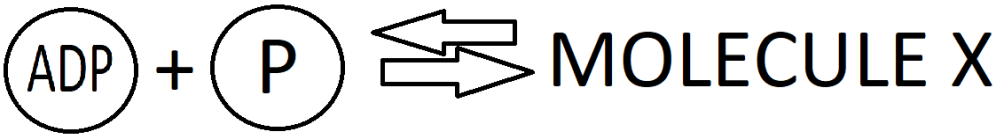
(c) Oxygen is produced during photosynthesis (1)

2.2.2 Give the LETTER of the investigation that does not show a control. (1)

2.2.3 Which investigation(s) need(s) a chemical to test for whether photosynthesis took place? (2)

Activity 3

3.1 Study the equation below showing the formation of the energy carrier molecule X



3.1.1 Give the full name of ADP (1)

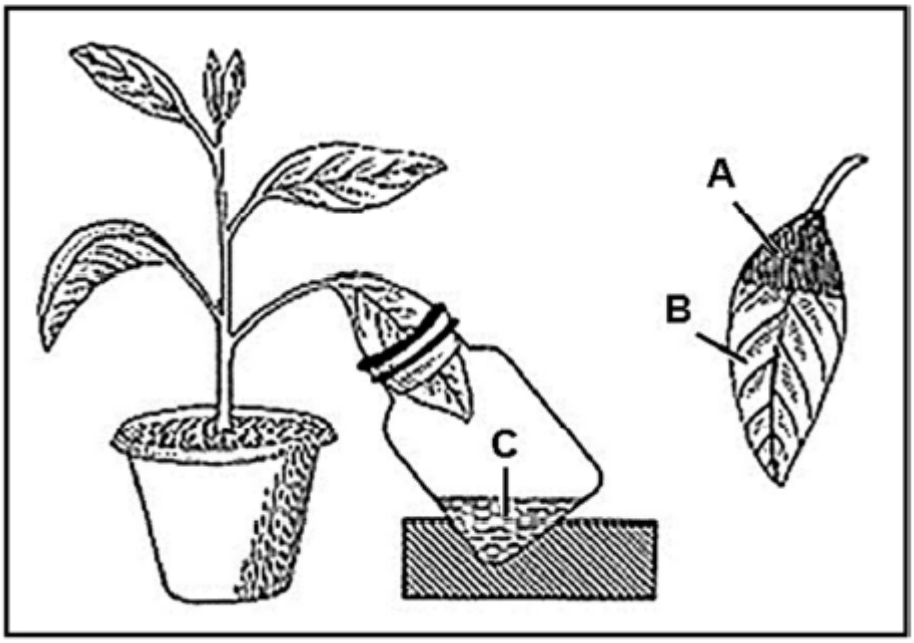
3.1.2 Name molecule X (1)

3.1.3 Give one reason why molecule is biologically important. (1)

Activity 4

4.1

4.1 The diagram below shows the set-up of an experiment to investigate whether carbon dioxide is necessary for photosynthesis to take place. The plant was destarched before the apparatus was set up as in the diagram and placed in a sunny room.



4.1.1 Name liquid C. (1)

4.1.2 Give the function of liquid C. (1)

4.1.3 What result can be seen at A? (1)

4.1.4 Explain ONE reason for the result at B. (2)

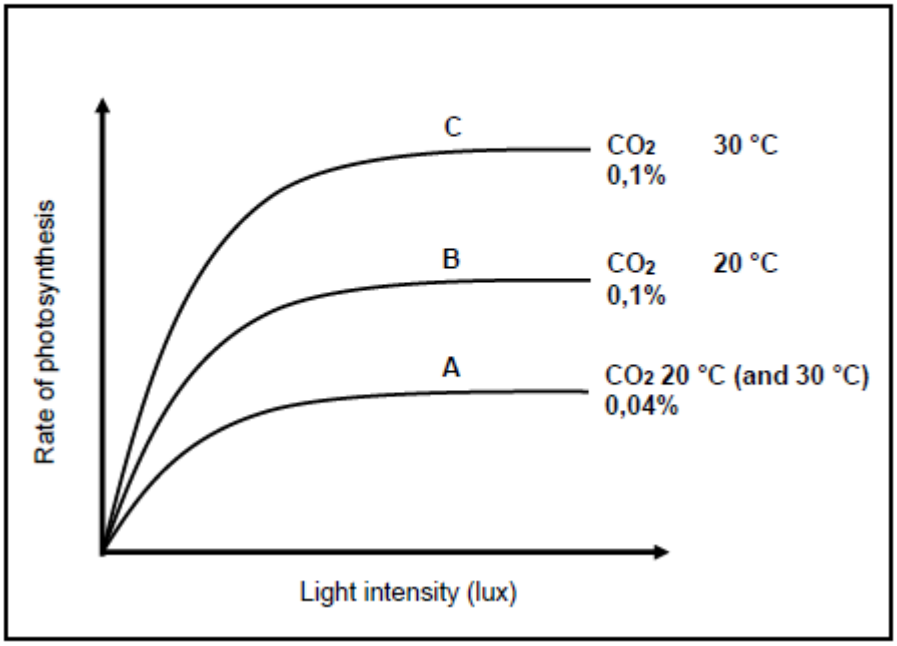
4.1.5 In which phase of photosynthesis will carbon dioxide be used? (1)

4.1.6 Where in the cell will the phase named in QUESTION 1.5.5 take place? (1)

4.1.7 Why was the plant destarched before the experiment was conducted? (1)

.

4.2 The graph below shows the rate of photosynthesis under different environmental conditions. Study the graphs and answer the questions that follow.



4.2.1 Which of the graphs shows the highest production of glucose? (1)

4.2.2 Why is the production of glucose in graph A, low? (1)

4.2.3 What factor in graph B and C limits the rate of photosynthesis? (1)

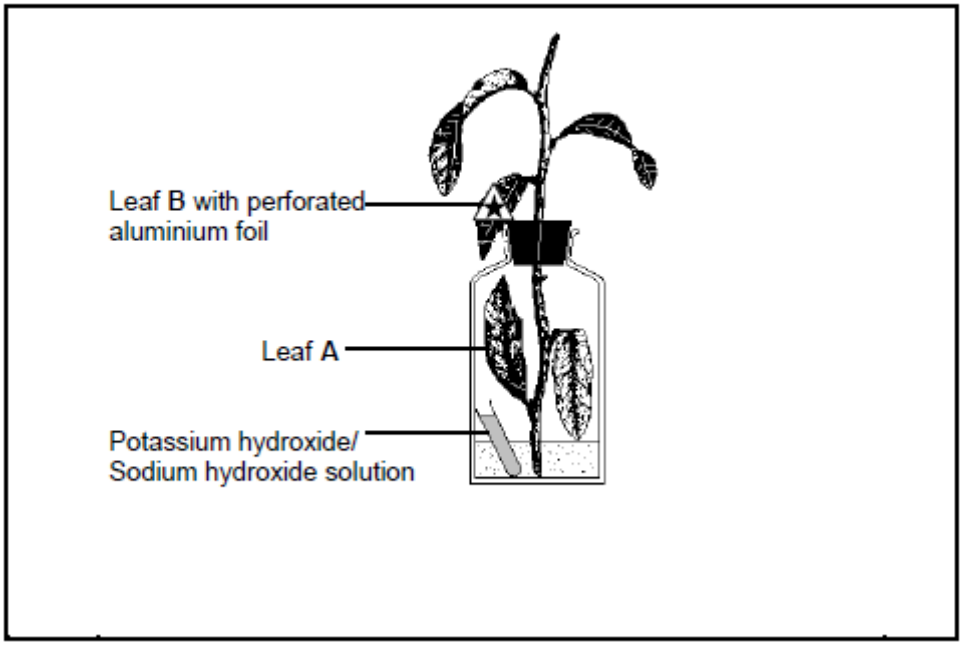
4.2.4 Predict what the graphs would look like if the temperature were increased first to 40 °C and then to 60 °C. (2)

4.2.5 Give a reason for your answer in QUESTION 2.1.4. (1)

Activity 5

5.1

5.1 Study the diagram and then answer the questions.



5.1.1 Why was the plant kept in a dark place for 48 hours before it was placed in sunlight? (1)

5.1.2 Looking at the diagrams given, which leaf (**A** or **B**) would be used:

(a) To show that CO_2 is necessary for photosynthesis? (1)

(b) To show that light is necessary for photosynthesis? (1)

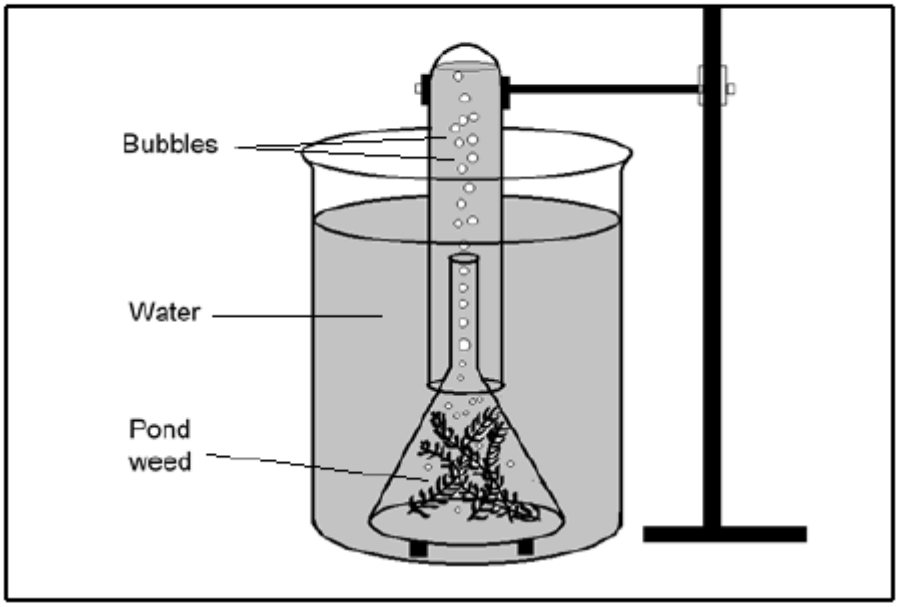
5.1.3 What is the role of the potassium hydroxide / sodium hydroxide in this experiment? (1)

5.1.4 With which chemical will you test to see if photosynthesis takes place? (1)

5.2 When light shines on pondweed, *Elodea* sp, bubbles of gas are released. The rate at which bubbles of gas are produced can be used to measure the rate of photosynthesis. An investigation was carried out to study the effect of different colours of light on the rate of photosynthesis in the pondweed.

The apparatus was set up as shown in the diagram below.

- The pondweed was exposed to one colour of light and left for 5 minutes before measurements were taken.
- The time taken for the release of 20 bubbles was recorded.
- The procedure was repeated using light of different colours but of equal intensity.
- The results are given in the table below.



Colour of light	Time (in seconds) for 20 bubbles to form
Violet	80
Green	40
Blue	160
Red	140
Yellow	70

5.2.1 Which colour light is the best for photosynthesis? (1)

5.2.2 Name the:

(a) Independent variable (1)

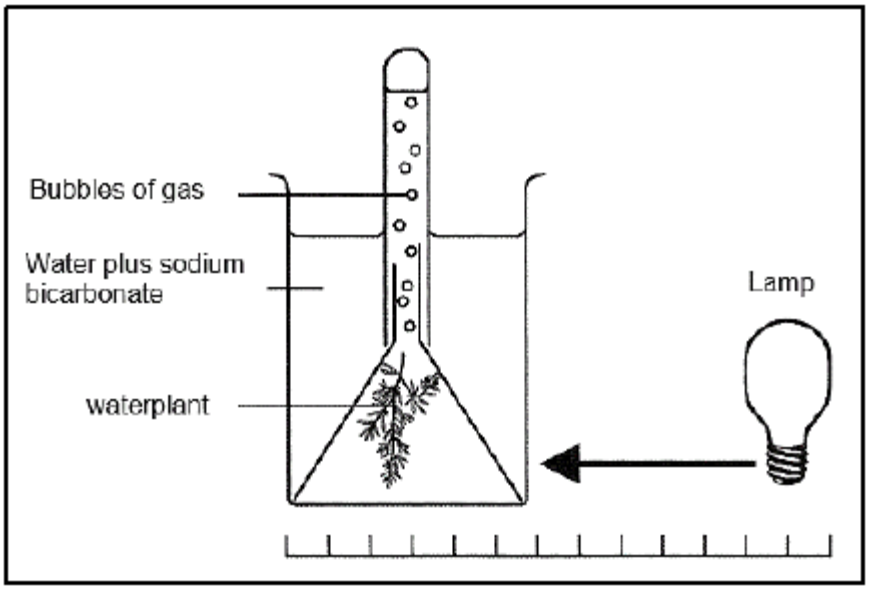
(b) Dependent variable (1)

(c) Two fixed variables (2)

5.2.3 Calculate the average time taken to release 20 bubbles for all the colours together. Show all your calculations. (2)

5.2.4 Draw a bar graph of the results shown in the table. (6)

5.3 An experiment was conducted to investigate the effect of light intensity and the rate of photosynthesis. The apparatus was set up as shown in the diagram below. Study the diagram and answer the questions.



5.3.1 State a reason:

(a) for choosing a water plant instead of a terrestrial plant in this particular experiment. (1)

(b) for the addition of sodium bicarbonate (baking powder) to the water. (1)

5.3.2 How was the rate of photosynthesis measured using this experiment? (1)

5.3.3 The data in the table below was recorded during the experiment:

A	B	C
Distance between the water plant and light source (metres)	**100 W bulb** Light intensity = power/Area Light intensity = W/m^2	Number of bubbles given off in one minute.
1,0	7,96	8
0,5	31,85	28
0,25	127,39	105
0,125	510,20	105

5.3.4 With reference to the results given above, what deduction can be made with regard to the relationship between the intensity of light and rate of photosynthesis? (3)

Explain why there is no
when the light source is

Activity 6

6.1 Complete the missing words in the statements below:

6.1.1 As the light intensity increases, the rate of photosynthesis_____ (1)

6.1.2 Structures in which crops are grown in a protected and controlled environment are called_____ (1)

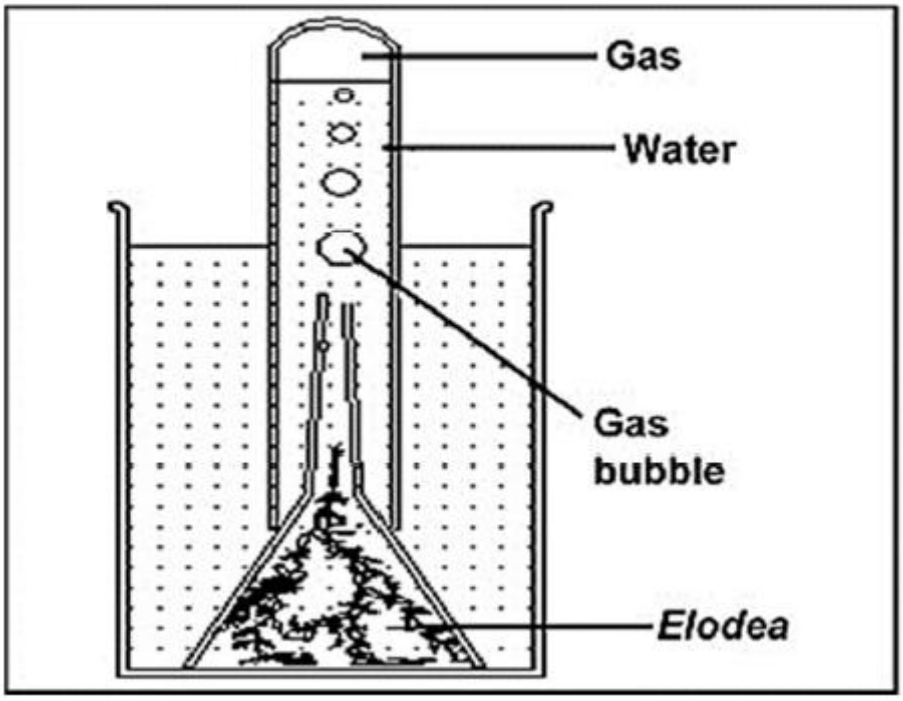
6.1.3 ATP stands for_____ (1)

6.1.4 _____ energy is found between phosphates. (1)

6.1.5 Photosynthesis helps maintain a healthy level of carbon dioxide in the _____ (1)

Activity 7

7.1 The diagram below shows a photosynthesis experiment done to investigate if a gas is produced during the process. A small amount of sodium carbonate was added to the water before the experiment was started.



7.1.1 Name the gas produced by the plant. (1)

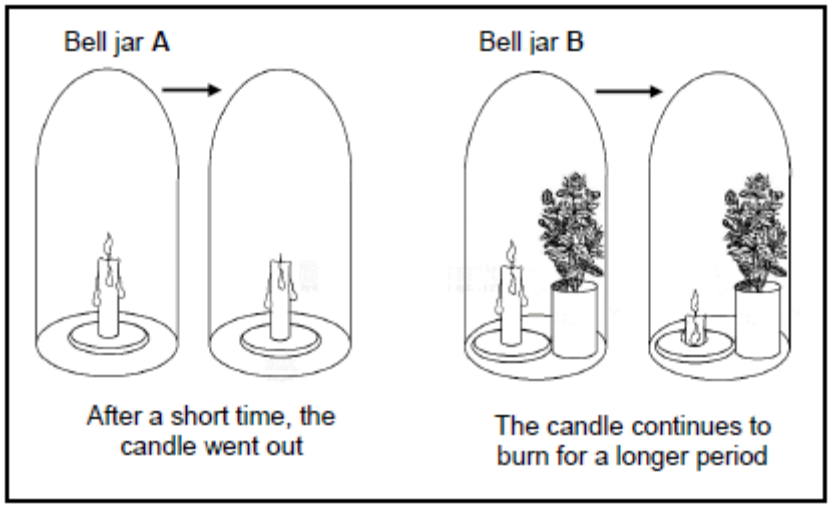
7.1.2 Describe a test for the gas mentioned in QUESTION 2.4.1. (2)

7.1.3 Explain why sodium carbonate was added to the water. (2)

7.1.4 Why was this experiment done under water? (1)

7.1.5 Explain TWO ways in which the rate of this experiment could be increased. (4)

7.2 An experiment was set up to investigate whether oxygen is released during photosynthesis. The result of the experiment is represented in the following diagram.



The following deductions were made before arriving at the final conclusion.

(i) Photosynthesis reduces the amount of CO_2 inside bell jar **B**
(ii) The oxygen in bell jar **A** was completely used up and the burning is not supported
(iii) The photosynthesis increases the amount of oxygen inside bell jar **B**
(iv) The vapour produced inside bell jar **A** due to combustion extinguished the burning candle

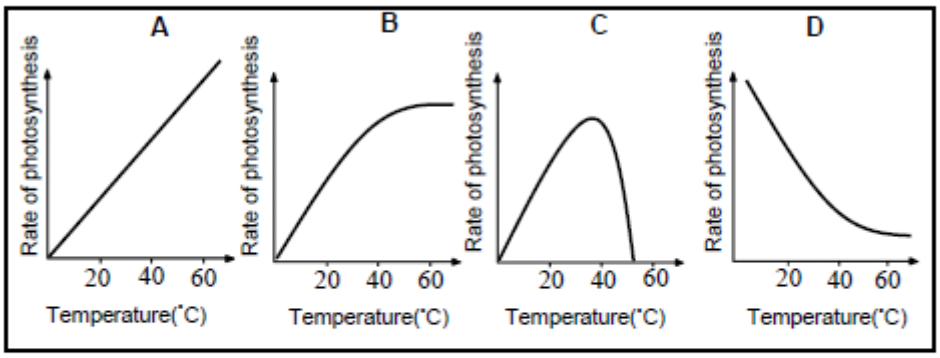
Which ONE of the following set of deductions is correct?

A (i) and (iv) only
B (i), (ii) and (iii) only
C (i), (iii) and (iv) only
D (iii) and (iv) only

Activity 8

8.1

8.1.1 1.1.3 The graphs below (**A, B, C** and **D**) represent the relationship between the rate of photosynthesis and temperature.



Which ONE of the graphs (**A, B, C** or **D**) represent the correct relationship between the temperature and the rate of photosynthesis?

A D
B A
C B
D C

8.2 An experiment was carried out to calculate the rate of photosynthesis in a group of plants at different concentrations of carbon dioxide. This was repeated at two different light intensities. The results are given below.

CO_2 concentration (%)	Rate of photosynthesis (Arbitrary units)	
	Low light intensity	High light intensity
0,00	0	0
0,02	20	20
0,04	29	35
0,06	35	47
0,08	39	68
0,10	42	84
0,12	45	89
0,14	46	90
0,16	46	90
0,18	46	90

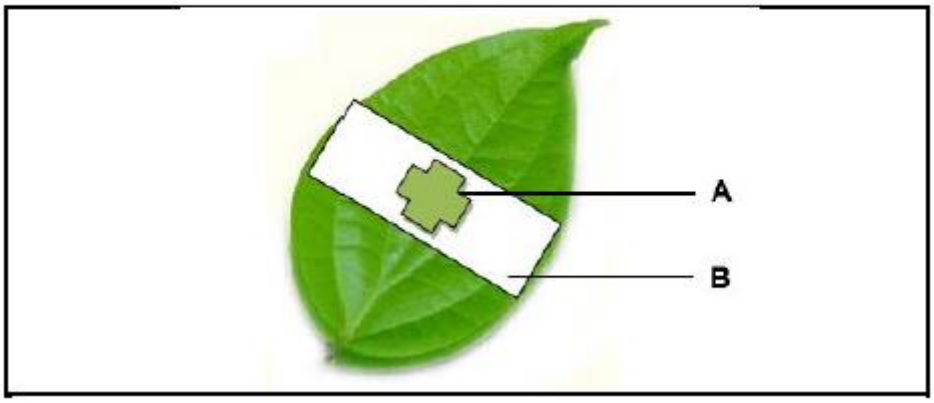
8.2.1 Identify the dependent factor in the above graph. (1)

8.2.2 Up to what values does CO_2 concentration act as a limiting factor at high light intensities? (1)

8.2.3 Name TWO limiting factors of photosynthesis other than the ones mentioned in QUESTION 3.4.2. (2)

8.2.4 Draw a line graph to represent the rate of photosynthesis under various concentrations of CO_2 at low light intensity. (7)

8.3 The diagram below shows how the leaf in a destarched plant was set up by a learner to perform an experiment on photosynthesis. Study the diagram and answer the questions below.



8.3.1 What was the aim of this experiment? (2)

8.3.2 What was the dependent variable in this experiment? (1)

8.3.3 What chemical was used to test for the presence of starch in the leaf? (1)

8.3.4 What was the colour change observed in areas of the leaf that were:

(a) Not exposed to sunlight (1)

(b) Exposed to sunlight (1)

8.3.5 State the:

(a) Human enzyme responsible for the digestion of the stored product of photosynthesis (1)

(b) Glands that secrete the enzyme mentioned in QUESTION 1.4.5(a) into the mouth cavity (1)

8.3.6 There are two gases involved in the process of photosynthesis.

(a) Which gas would not be produced, if the plant is placed in a dark box? (1)

(b) Which of the gases mentioned above is required by living organisms to generate energy for body processes? (1)

Activity 9

9.1.1 Which ONE of the following factors will cause optimal growth in greenhouses?

A Carbon dioxide enrichment
B Temperatures between 10 °C and 15 °C
C Dim lighting in the greenhouse
D Only irrigating once a week

A. MARKING GUIDELINES

PHOTOSYNTHESIS

Activity 1

1.1

1.1.1 C ✓✓ (2)

1.1.2 B ✓✓ (2)

1.2

1.2.1 (a) Stroma ✓ (1)

(b) Ribosome ✓ (1)

1.2.2 It stores the starch ✓ (1)

1.2.3 Granum / Grana / Thylakoid ✓ (1)

Activity 2

2.1

2.1.1 Glucose ✓ (1)

2.1.2 Chloroplast ✓ (1)

2.1.3 Photolysis ✓ (1)

2.1.4 Stroma ✓ (1)

2.1.5 Starch ✓ (1)

2.1.6 Chlorophyll ✓ (1)

2.1.7 Radiant energy ✓ (1)

2.1.8 A only ✓ ✓ (2)

2.1.9 B only ✓ ✓ (2)

2.2

2.2.1 (a) C ✓ (1)

(b) A ✓ (1)

(c) B ✓ (1)

2.2.2 -B ✓ (1)

2.2.3 -A and C ✓ ✓ (2)

Activity 3

3.1

3.1.1	Adenosine diphosphate✓	(1)
3.1.2	ATP or adenosine triphosphate✓	(1)
3.1.3	It is the energy carrier in living systems/cells✓	(1)
	Or it provides energy for all cellular activities✓ (ANY ONE)	(1)

Activity 4

4.1

4.1

4.1.1	Sodium hydroxide/Soda lime/Potassium hydroxide ✓	(1)
4.1.2	Removes carbon hydroxide from the air in the jar ✓	(1)
4.1.3	The leaf turns blue-black ✓	(1)
4.1.4	-as the leaf was outside the jar, it was exposed to carbon dioxide ✓	(1)
	-and could undergo photosynthesis/produce starch ✓	(1)
4.1.5	Dark phase /light independent phase ✓	(1)
4.1.6	Stroma ✓	(1)
4.1.7 .	To ensure that the starch at end of the investigation was produced ✓ during the experiment ✓	(2)

4.2

4.2.1	Graph C ✓	(1)
4.2.2	Due to carbon dioxide concentration ✓	(1)
4.2.3	Temperature ✓	(1)
4.2.4	The graph will show a steady increase in the rate up to 40°C and a further increase in temperature will let it fall dramatically ✓	(2)

4.2.5

	-At higher temperatures the enzymes become completely denatured/functionless ✓	(1)
	-When the temperature is incfeased to 40°C the temperature is optinum for maximun photosynthesis ✓	(1)

Activity 5

5.1

5.1.1 Destarch the plant ✓ (1)

5.1.2 (a) Leaf A ✓ (1)

(b)Leaf B ✓ (1)

5.1.3 Absorbs carbon dioxide ✓ (1)

5.1.4 Iodine solution ✓ (1)

5.2

5.2.1 Blue-black ✓ (1)

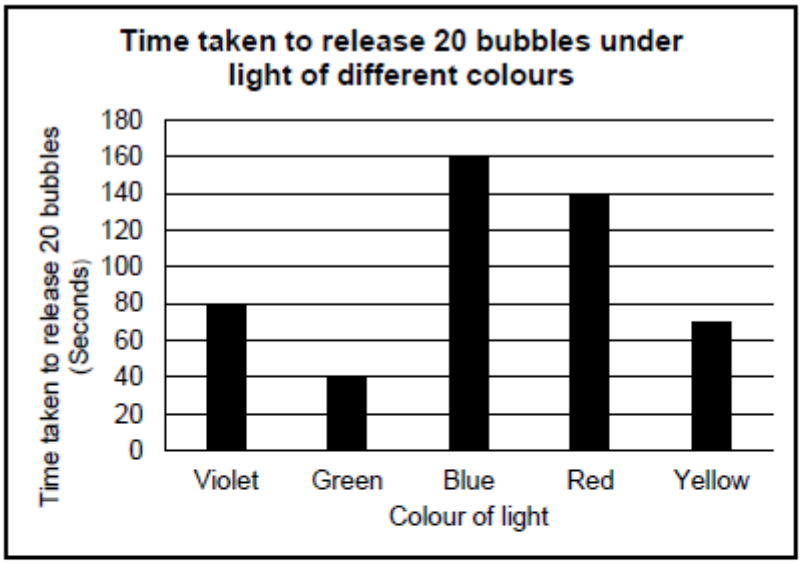
5.2.2 (a) colour of light ✓ (1)

(b) rate of photosynthesis ✓ (1)

5.2.3 (c) the light intensity/the pondweed/the time exposed ✓ (1)

490/5 ✓ = 98s ✓ (1)

5.2.4



Mark allocation for the graph

Bar graph drawn (T)	1
Title of graph (both variables included)	1
Correct scale for X-axis (equal width and spacing of the bars) and Y-axis (S)	1
Correct label and unit for X-axis and Y-axis (L)	1
Plotting of bars (P)	0: No bars plotted correctly 1: 1 to 4 bars plotted correctly 2: all 5 bars plotted correctly

NOTE: If a line graph is drawn – marks will be lost for the 'type and scale'.
If a histogram is drawn – marks will be lost for 'type of graph and correct scale'. (6)

5.3

5.3.1 (a) Waterplants are structurally adapted to perform photosynthesis under water. ✓ (1)

(b) Addition of small amounts of sodium bicarbonate increases the concentration CO_2 ✓to bring about a steady rate of photosynthesis. (1)

5.3.2 By counting the number of bubbles released in a minute (unit time) ✓ (1)

5.3.3
- As the intensity of light increases ✓
- the rate of photosynthesis increases proportionately up to a certain point. ✓
- A further increase in light intensity ✓
- will cause no further increase in the rate of photosynthesis. ✓

(Any 3 x 1) (3)

5.3.4
- When the light intensity increases ✓
- the temperature increases proportionately ✓ which
- limits the performance of various enzymes ✓ and
- hence limit the rate of photosynthesis. ✓ (4)

Activity 6

6.1

6.1.1 Increases ✓ (1)

6.1.2 Greenhouse✓ (1)

6.1.3 Adenosine Triphosphate ✓ (1)

6.1.4 Chemical ✓ (1)

6.1.5 Atmosphere ✓ (1)

Activity 7

7.1

7.1.1 Oxygen ✓ (1)

7.1.2
- Take a glowing wooden splint ✓ and insert it in the mouth of the test tube
- If it ignites, ✓ the gas is oxygen (2)

7.1.3
- To release carbon dioxide ✓ into the water
- for photosynthesis to take place. ✓ (2)

7.1.4
- To see the oxygen which is a colourless gas ✓ (1)

7.1.5
- Increase the light intensity ✓
- so that the plant absorbs more light energy ✓ to increase the rate of photosynthesis
- Increase the temperature to optimum ✓
- will increase the rate of photosynthesis ✓ and therefore the rate of this experiment (4)

(10)

7.2 B ✓ ✓ (2)

Activity 8

8.1

8.1.1 D ✓ ✓ (2)

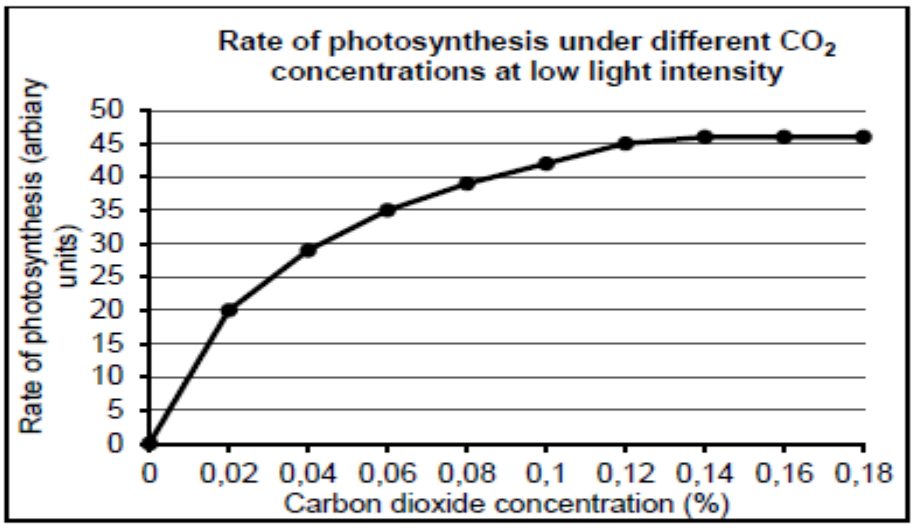
8.2

8.2.1 Rate of photosynthesis ✓ (1)

8.2.2 0,14% ✓ (1)

8.2.3
- Amount of water ✓
- Temperature ✓
- Light ✓

8.2.4 **(Mark the first TWO only)** (Any 2) (2)



Mark allocation for the graph:		
Line graph is drawn		1
Title of the graph (includes both variables)		1
Correct scale for x-axis and y-axis		1
Correct labels and units for the x-axis and the y-axis		1
Plotting of the points	0 points correct	0
	1–5 points correct	1
	All points correct	2
Only low light intensity graph is drawn		1

(7)

8.3

8.3.1		To demonstrate that light energy ✓ is necessary for photosynthesis. ✓	(2)
8.3.2		The presence/absence of starch ✓	(1)
8.3.3		(Dilute) iodine solution ✓	(1)
8.3.4	(a)	No colour change / remain reddish brown ✓	(1)
	(b)	Turns blue-black ✓	(1)
8.3.5	(a)	Carbohydrases ✓	(1)
	(b)	Salivary glands ✓	(1)
8.3.6	(a)	Oxygen ✓/ O_2	(1)
	(b)	Oxygen ✓ / O_2	(1)

Activity 9

9.1

9.1.1 A ✓ ✓ (2)