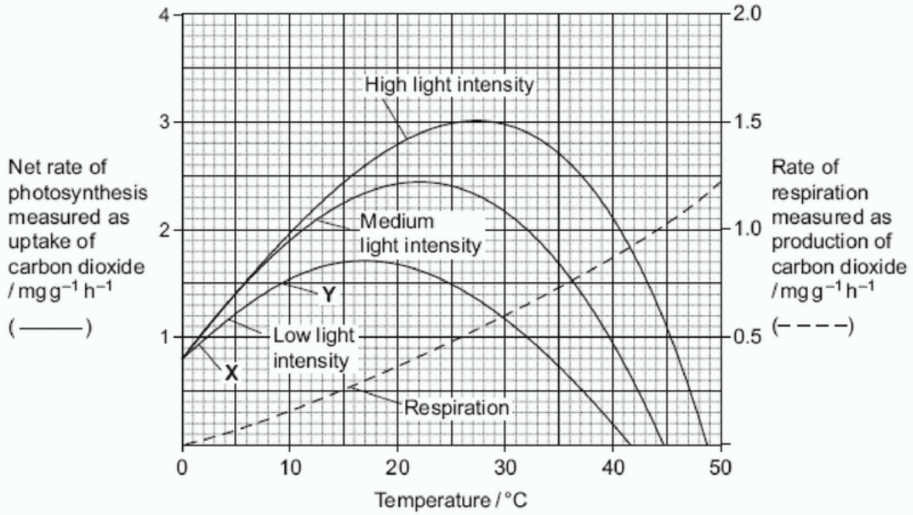
EXAM PAPERS PRACTICE

Photosynthesis Pack 2

Question paper

1 Scientists investigated the effects of temperature and light intensity on the rate of photosynthesis in creeping azalea. They investigated the effect of temperature on the net rate of photosynthesis at three different light intensities. They also investigated the effect of temperature on the rate of respiration. The graph shows the results.



(a) (i) Name the factors that limited the rate of photosynthesis between **X** and **Y**.

_____

(1)

(ii) Use information from the graph to explain your answer.

_____

_____

_____

_____

_____

(2)

(b) Use information from the graph to find the gross rate of photosynthesis at 20°C and medium light intensity.

Answer _____

(1)

(c) Creeping azalea is a plant which grows on mountains. Scientists predict that in the area where this plant grows the mean summer temperature is likely to rise from 20 °C to 23 °C. It is also likely to become much cloudier. Describe and explain how these changes are likely to affect the growth of creeping azalea.

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(3)

(Total 7 marks)

2 (a) The concentrations of carbon dioxide in the air at different heights above ground in a forest changes over a period of 24 hours. Use your knowledge of photosynthesis to describe these changes and explain why they occur.

(5)

(b) In the light-independent reaction of photosynthesis, the carbon in carbon dioxide becomes carbon in triose phosphate. Describe how.

(5)

(Total 10 marks)

3 Tomato plants were grown in two glasshouses, each with an area of 2000 m^2. The table shows the mean number of hours of sunshine per month during fruit production.

	1995 – 1997 (no extra carbon dioxide	**1998 – 2000 (extra carbon dioxide)**
Mean number of hours of sunshine per month	148.91	147.00

- The scientists used heating to maintain the tempera ture inside the glasshouses above 18 °C. They opened the windows to keep the tempera ture below 30 °C.
- From 1998 to 2000 they maintained the carbon dioxide concentration between 0.06 % and 0.08 % when the windows were closed and between 0.04 % and 0.05 % when the windows were open.
- The carbon dioxide concentra tion in the air outside the glasshouse was 0.04 %.

(a) The scientists monitored the number of hours of sunshine per month. Explain why they monitored the number of hours of sunshine.

_____

_____

_____

_____

_____

_____

(2)

(b) The temperature, the use of fertiliser and the number of insect pests were controlled during this investigation. Name one other factor which should have been controlled during the investigation. Explain why variation in this factor would affect yield.

Factor _____

Explanation _____

_____

(2)

(Total 4 marks)

4 **Introduction**

Resource A – D relate to a single investigation.

Scientists investigated the effect of supplying extra carbon dioxide on the yield of tomatoes growing in a glasshouse. They compared the mean yield of tomatoes from 1995 to 1997 when no extra carbon dioxide was supplied with the mean yield of tomatoes from 1998 to 2000 when extra carbon dioxide was supplied.

Resource A

Tomato plants were grown in two glasshouses, each with an area of 2000 m^2. Figure 1 shows the mean number of hours of sunshine per month during fruit production.

Figure 1

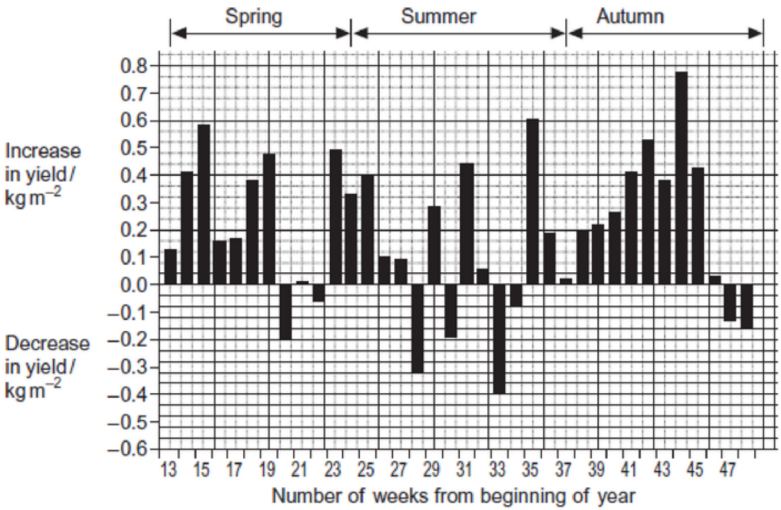
	1995 - 1997 (no extra carbon dioxide)	**1998 - 2000 (extra carbon dioxide)**
Mean number of hours of sunshine per month	148.91	147.00

- The scientists used heating to maintain the tempera ture inside the glasshouses above 18 °C. They opened the windows to keep the tempera ture below 30 °C.
- From 1998 to 2000 they maintained the carbon dioxide concentration between 0.06 % and 0.08 % when the windows were closed and between 0.04 % and 0.05 % when the windows were open.
- The carbon dioxide concentra tion in the air outside the glasshouse was 0.04 %.

Figure 2 shows the mean difference between the yield of tomatoes with extra carbon dioxide and the yield with no extra carbon dioxide for each week during the harvesting period.

If the yield is greater when extra carbon dioxide is supplied, the difference in yield is shown as an increase. If the yield is lower when extra carbon dioxide is supplied, the difference is shown as a decrease.

Figure 2



Resource C

Figure 3 shows the relationship between the time when the tomatoes were harvested and the yield.

Figure 3

Number of weeks from beginning of year	Mean yield per week with extra carbon dioxide / kg m^{-2}	Mean yield per week without extra carbon dioxide / kg m^{-2}
13 – 19	1.25	0.83
20 – 25	1.62	1.47
26 – 48	1.23	1.06

The commercial price for tomatoes varies with the time of year. The highest price is paid for tomatoes between weeks 13 and 19. The lowest price is paid between weeks 26 and 48.

Whiteflies are an important insect pest of tomatoes. The adults can fly from plant to plant. Their young do not have wings. The adults and young feed on the plant sap and introduce viruses into the tomato plants. Feeding and the introduction of viruses both reduce the yield of tomatoes. The scientists controlled the number of whitefly in the glasshouses by releasing parasitic wasps. The wasps lay their eggs in the young of the whitefly. The wasp eggs hatch and feed on the young whitefly, killing them.

(a) (i) An increase in carbon dioxide concentration affected the yield of tomatoes in week 35. Use **Figure 2** to describe how.

_____

_____

(1)

(ii) There was a decrease in yield when extra carbon dioxide was supplied during some weeks of the year. Use information from **Resource A** to suggest why.

_____

_____

(1)

(b) Using **Figure 3**, calculate the percentage increase in yield when extra carbon dioxide was added for weeks 13 to 19. Show your working.

Percentage increase _____

(2)

(c) Additional information is required for tomato growers to decide whether it is economically profitable to add extra carbon dioxide to produce very early tomatoes.

Give **two** pieces of information that the growers would require.

1. _____

_____

2. _____

_____

(2)

(d) Adding extra carbon dioxide during the summer (weeks 24 – 36) is unlikely to be profitable. Use data from the resource sheet explain why.

(2)

(e) The control experiment in this investigation was when data were collected with no extra carbon dioxide added. Some scientists said this control experiment was not satisfactory. Explain how you could improve the control experiment.

(2)

(Total 10 marks)

5 In the light-dependent reaction of photosynthesis, light energy generates ATP.

Describe how.

(Total 5 marks)

6 Transpiration in sorghum plants was measured under different conditions. The table shows the results

Growing conditions	Transpiration rate / mmol m^{-2} s^{-1}	
	Low carbon dioxide concentration	High carbon dioxide concentration
Dry soil	12.68 ± 1.64	11.07 ± 1.52
Watered soil	18.29 ± 1.51	15.08 ± 1.38

(a) Changing the carbon dioxide concentration had a greater effect on the rate of transpiration when the plants were watered than when they were kept in dry conditions. Explain why.

_____

_____

_____

_____

(2)

S (b) (i) Giving a reason for your choice, suggest **one** factor which should be kept constant during this investigation.

Factor _____

Reason _____

_____

(1)

(ii) The figures in the table are the mean values ± standard deviation. Suggest what the values of standard deviation given in the table indicate about the effects of carbon dioxide concentration and of watering on the variability of the results.

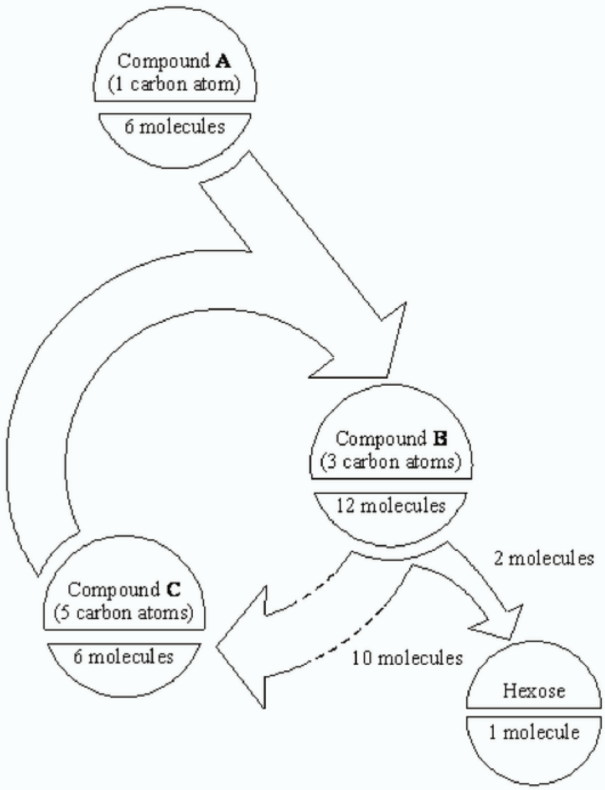
_____

_____

(1)

(Total 4 marks)

7 The diagram represents some of the light-independent reactions of photosynthesis.



(a) Describe the light-independent reactions of photosynthesis and explain how they allow the continued synthesis of hexose sugars.

(6)

(b) Describe the role of electron transport chains in the light-dependent reactions of photosynthesis.

(6)

(c) Explain why the increase in the dry mass of a plant over twelve months is less than the mass of hexose produced over the same period.

(3)

(Total 15 marks)

8 An investigation was carried out into the effect of carbon dioxide concentration and light intensity on the rate of photosynthesis in a species of plant.

(a) The temperature was kept constant during this investigation. Explain why.

_____

_____

(2)

(b) The table shows the effect of increasing carbon dioxide concentration on the rate of photosynthesis in maize.

Carbon dioxide concentration / arbitrary units	Rate of photosynthesis / arbitrary units
30	10
60	20
100	30
150	40
230	50
300	60
400	60

Describe and explain the effect of increasing carbon dioxide concentration on the rate of photosynthesis.

_____

_____

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_____

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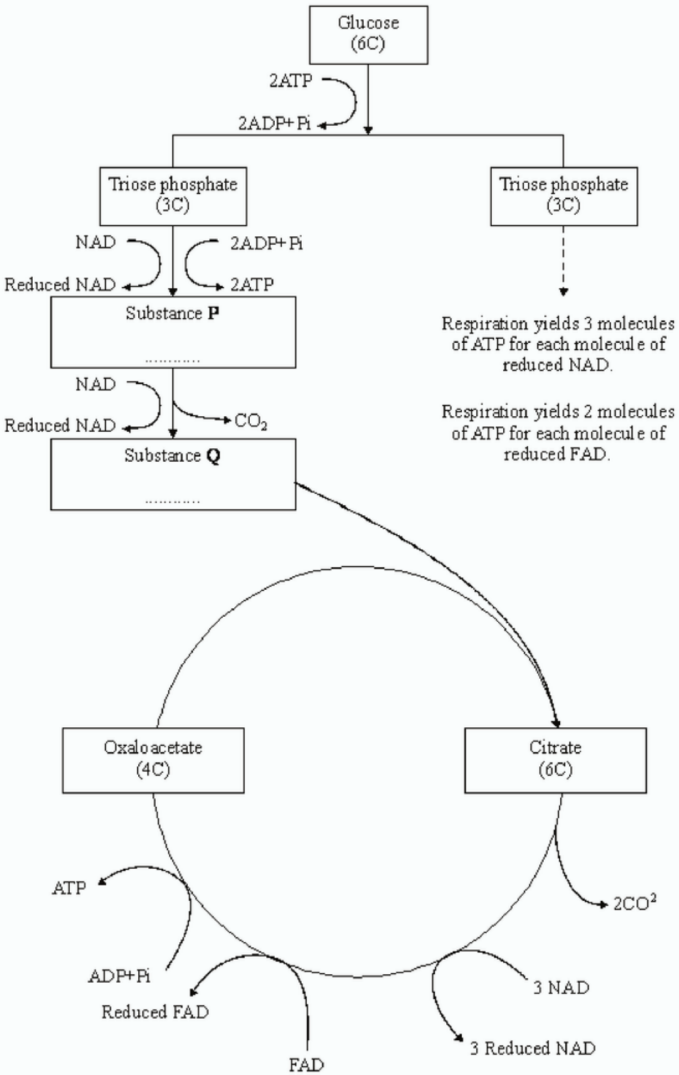
(3)

(Total 5 marks)

9 (a) The flow chart shows the main stages in aerobic respiration.



(i) Complete the flow chart by writing, in the appropriate boxes, the number of carbon atoms in substance **P** and the name of substance **Q**.

(2)

(ii) Some ATP is formed in the cytoplasm and some in the mitochondria. Use the information given to calculate the number of molecules of ATP formed in a mitochondrion from one molecule of glucose in aerobic respiration. Show how you arrived at your answer.

Answer_____

(2)

(iii) In the presence of oxygen, respiration yields more ATP per molecule of glucose than it does in the absence of oxygen. Explain why.

_____

_____

_____

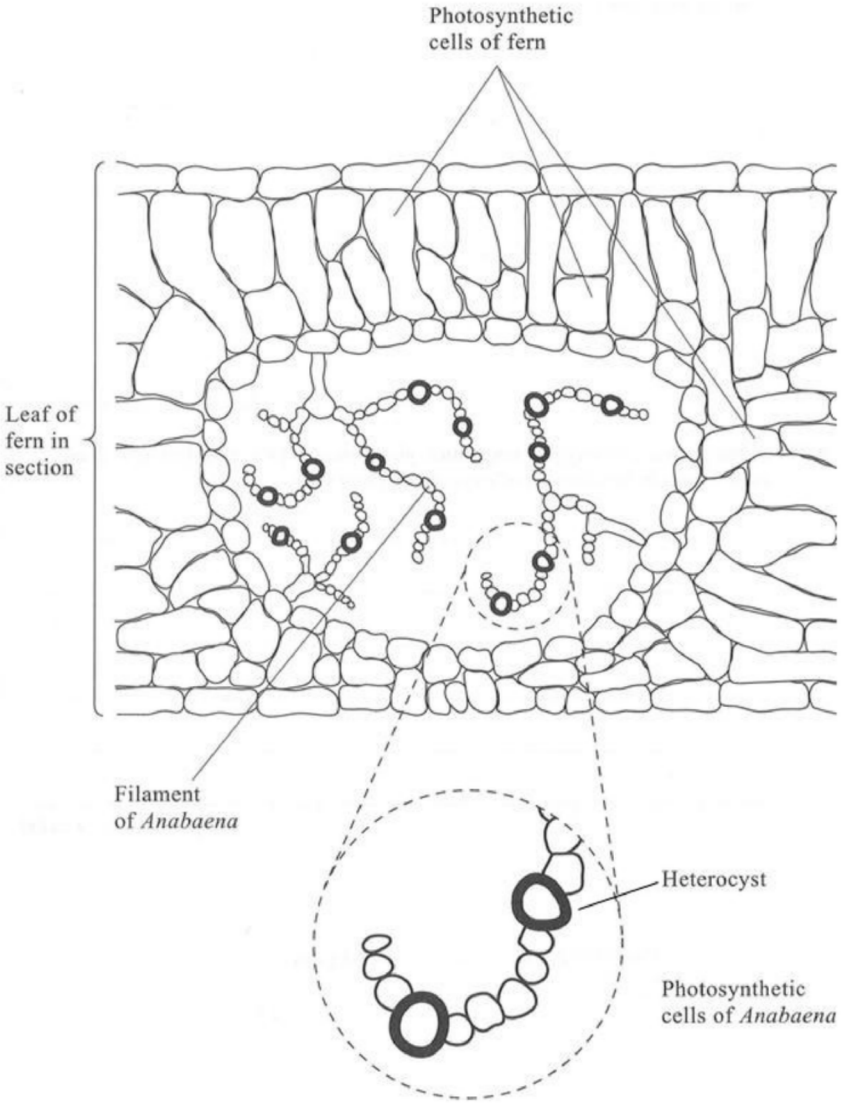
_____

_____

_____

(3)

(b) Anabaena is a prokaryote found inside the leaves of a small fern. Anabaena can produce ammonia from nitrogen (nitrogen fixation). This reaction only takes place in the anaerobic conditions found in cells called heterocysts. Heterocysts are thick-walled cells that do not contain chlorophyll. The drawing shows the relationship between *Anabaena* and the fern.



(i) Suggest how the features of the heterocysts improve the efficiency of the process of nitrogen fixation.

(3)

(ii) In China, the fern is cultivated and ploughed into fields to act as an organic fertiliser. Explain how ploughing the fern plants into the soil results in an improvement in the growth of the rice crop grown in these fields.

(5)

(Total 15 marks)

10 There is evidence that the first photosynthetic organisms were primitive water-dwelling bacteria. The very first of these lived near the surface of the water in lakes and contained a purple pigment that absorbed light most strongly in the green region of the spectrum. Later, other bacteria evolved that lived on the top of sediment at the bottom of the lakes (**Figure 1**). Gene mutations had enabled these bacteria to synthesise chlorophyll instead of the purple pigment present in the bacteria living near to the surface. Chlorophyll absorbs light most strongly in the blue and red regions of the spectrum (**Figure 2**).

Figure 1

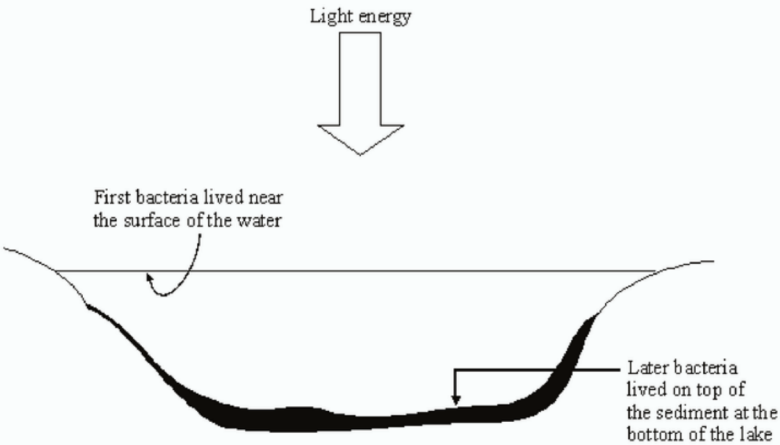
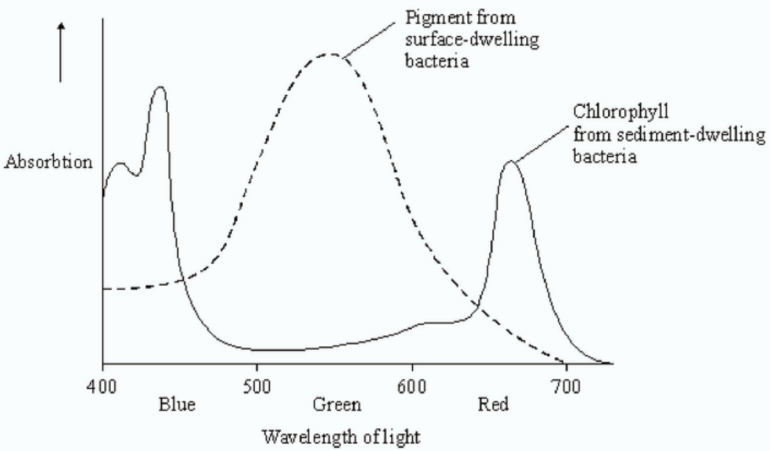


Figure 2



(a) Describe how light energy absorbed by chlorophyll molecules is used to synthesise ATP.

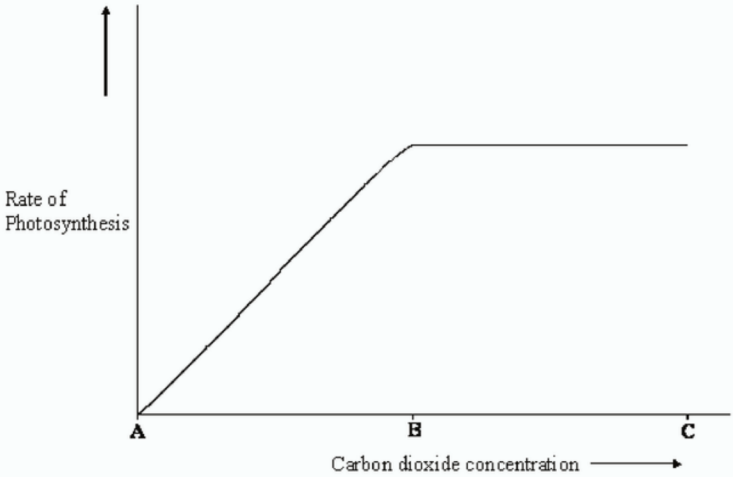
(5)

(b) Use **Figure 2** to explain how natural selection would favour the evolution of sediment-dwelling bacteria containing a different photosynthetic pigment from those living near the surface of the water.

(6)

(Total 11 marks)

11 An investigation was carried out to find the effect of increasing carbon dioxide concentration on the rate of photosynthesis in a particular type of plant. The graph shows the results.



(a) (i) In this investigation, temperature was kept constant. Explain why.

_____

_____

(1)

(ii) Suggest suitable units for measuring the rate of photosynthesis in this investigation.

_____

(2)

(b) (i) Give the evidence from the graph that carbon dioxide is limiting the rate of photosynthesis between **A** and **B**.

_____

_____

(1)

(ii) Explain the shape of the curve between **B** and **C**.

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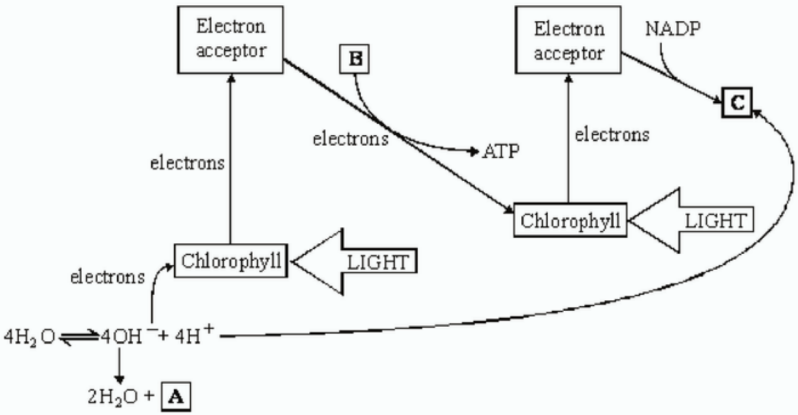
(2)

(Total 6 marks)

12 The diagram shows the light-dependent reactions of photosynthesis.



(a) In which part of a chloroplast do the light-dependent reactions occur?

_____

(1)

(b) Name the substances in boxes **A**, **B** and **C**.

A _____

B _____ + _____

C _____

(3)

(c) Use information in the diagram to explain

(i) the role of chlorophyll in photolysis;

_____

_____

_____

_____

_____

_____

(3)

(ii) how the energy of light is converted into chemical energy in the light-dependent reactions.

_____

_____

_____

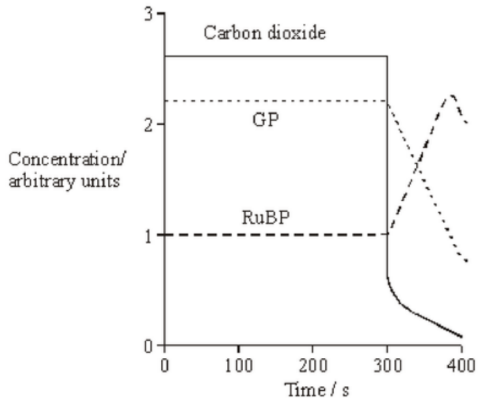
_____

_____

_____

(3)

(d) In an investigation, single-celled algae were kept in bright light and were supplied with carbon dioxide containing radioactive carbon atoms. After 300 seconds, the carbon dioxide supply was turned off. The graph shows how the concentrations of carbon dioxide, glycerate 3-phosphate (GP) and ribulose bisphosphate (RuBP) changed.



(i) Explain why, between 0 seconds and 300 seconds, the concentration of radioactive GP remained constant.

_____

_____

_____

_____

_____

_____

(3)

(ii) Explain why, between 300 seconds and 380 seconds, the concentration of radioactive RuBP increased.

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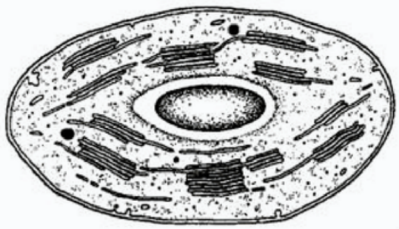
_____

_____

(2)

(Total 15 marks)

13 The diagram shows the structure of a chloroplast.



(a) Label the diagram with an **X** to show where the light-dependent reactions take place and with a **Y** to show where the light-independent reactions take place.

(1)

(b) The photolysis of water is an important part of the process of photosynthesis. Describe what happens in the photolysis of water.

_____

_____

_____

_____

(2)

(c) ATP and reduced NADP are two products of the light-dependent reactions. Describe **one** function of **each** of these substances in the light-independent reactions.

ATP _____

_____

Reduced NADP _____

_____

(2)

(Total 5 marks)

14 (a) The table contains some statements relating to biochemical processes in a plant cell. Complete the table with a tick if the statement is true or a cross if it is not true for each biochemical process.

Statement	Glycolysis	Krebs cycle	Light-dependent reaction of photosynthesis
NAD is reduced			
NADP is reduced			
ATP is produced			
ATP is required			

(4)

(b) An investigation was carried out into the production of ATP by mitochondria. ADP, phosphate, excess substrate and oxygen were added to a suspension of isolated mitochondria.

(i) Suggest the substrate used for this investigation.

_____

(1)

(ii) Explain why the concentration of oxygen and amount of ADP fell during the investigation.

_____

_____

_____

_____

(2)

14 (a) The table contains some statements relating to biochemical processes in a plant cell. Complete the table with a tick if the statement is true or a cross if it is not true for each biochemical process.

Statement	Glycolysis	Krebs cycle	Light-dependent reaction of photosynthesis
NAD is reduced			
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(4)

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(i) Suggest the substrate used for this investigation.

_____

(1)

(ii) Explain why the concentration of oxygen and amount of ADP fell during the investigation.

_____

_____

_____

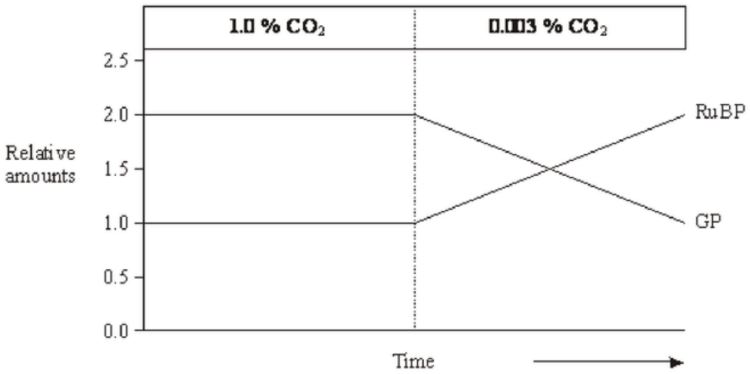
_____

(2)

(b) In an investigation of the light-independent reaction, the amounts of glycerate 3-phosphate (GP) and ribulose bisphosphate (RuBP) in photosynthesising cells were measured under different environmental conditions.

Figure 1 shows the effect of reducing the carbon dioxide concentration on the amounts of glycerate 3-phosphate and ribulose bisphosphate in photosynthesising cells.

Figure 1



(i) Explain why there is twice the amount of glycerate 3-phosphate as ribulose bisphosphate when the carbon dioxide concentration is high.

_____

_____

(1)

(ii) Explain the rise in the amount of ribulose bisphosphate after the carbon dioxide concentration is reduced.

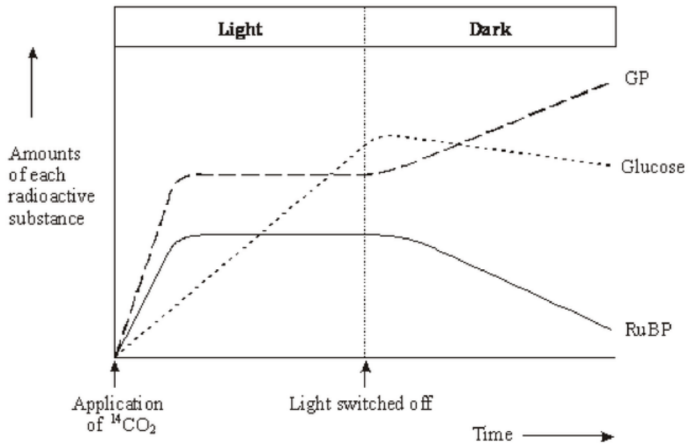
_____

_____

(1)

(c) **Figure 2** shows the results of an experiment in which photosynthesising cells were kept in the light and then in darkness.

Figure 2



(i) In the experiment the cells were supplied with radioactively labelled $^{14}CO_2$. Explain why the carbon dioxide used was radioactively labelled.

_____

_____

(1)

(ii) Explain how lack of light caused the amount of radioactively labelled glycerate 3-phosphate to rise.

_____

_____

_____

_____

(2)

(iii) Explain what caused the amount of radioactively labelled glucose to decrease after the light was switched off.

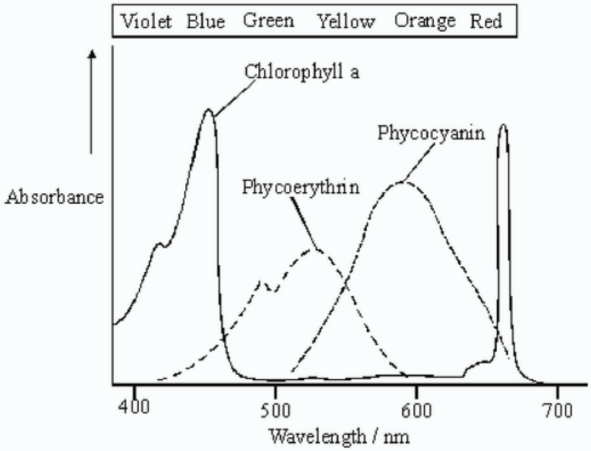
_____

_____

(1)

(Total 8 marks)

16 The graph shows the absorption of different wavelengths of light by three photosynthetic pigments in a red seaweed.



(a) (i) Describe what the graph shows about the properties of chlorophyll a.

_____

_____

(1)

(ii) Describe the part played by chlorophyll in photosynthesis.

_____

_____

_____

_____

_____

_____

(3)

(b) The red seaweed lives under water at a depth of 2 metres. Suggest an advantage to the red seaweed of having other pigments in addition to chlorophyll a.

_____

_____

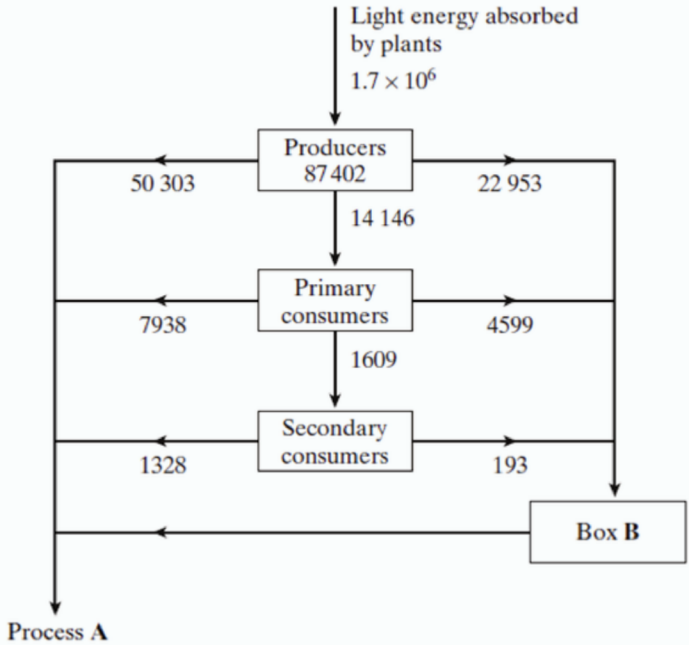
_____

_____

(2)

(Total 6 marks)

17 The diagram shows the energy flow through a freshwater ecosystem.
All units are kJ $m^{-2}year^{-1}$.



(a) Name

(i) process **A**;

_____

(1)

(ii) the group of organisms represented by box **B**.

_____

(1)

(b) Calculate the percentage efficiency with which light energy is transferred to energy in producers. Show your working.

Answer _____

(2)

S (c) Describe the effect of light energy in the light-dependent reaction of photosynthesis.

_____

_____

_____

_____

(2)

S (d) If a plant is kept in the dark it is still able to produce carbohydrates, as long as it is provided with two products of the light-dependent reaction of photosynthesis. Give the name of these products and explain their function in the light-independent reaction of photosynthesis.

Name _____

Function _____

_____

Name _____

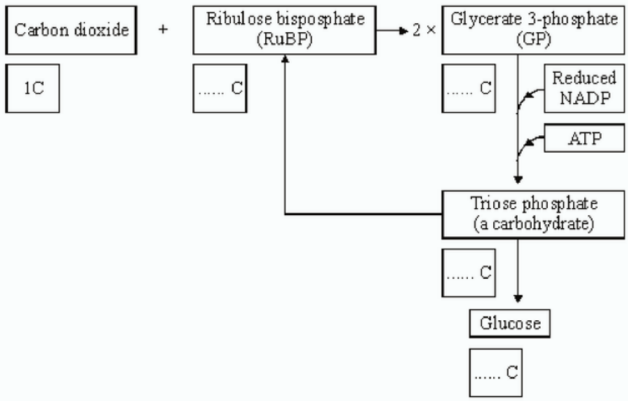
Function _____

_____

(4)

(Total 10 marks)

18 The diagram shows a summary of the light-independent reaction of photosynthesis.



(a) (i) Complete the boxes to show the number of carbon atoms in the molecules.

(2)

(ii) In which part of a chloroplast does the light-independent reaction occur?

_____

(1)

(iii) Which process is the source of the ATP used in the conversion of glycerate 3-phosphate (GP) to triose phosphate?

_____

(1)

(iv) What proportion of triose phosphate molecules is converted to ribulose bisphosphate (RuBP)?

_____

(1)

(b) Lowering the temperature has very little effect on the light-dependent reaction, but it slows down the light-independent reaction. Explain why the light-independent reaction slows down at low temperatures.

_____

_____

_____

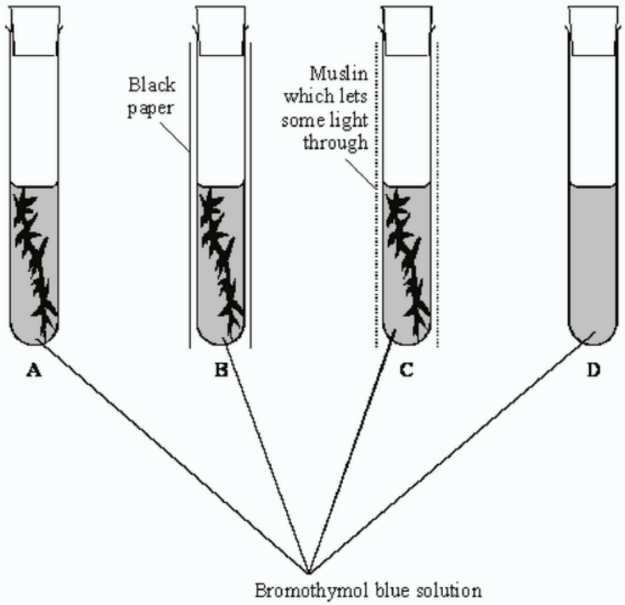
_____

(2)

(Total 7 marks)

19 Gas exchange in an aquatic plant was investigated by placing shoots in tubes containing bromothymol blue indicator solution. Bromothymol blue indicator is yellow below pH 6, green between pH 6.1 and 7.5, and blue at pH 7.6 and above. Into each of four tubes, **A**, **B**, **C** and **D**, 10 cm^3 of bromothymol blue solution were placed. Each tube was closed with a bung and left for 10 minutes. Similar-sized shoots of an aquatic plant were then placed into each of tubes **A**, **B** and **C**. The tubes were treated as shown in the diagram.

They were then placed at equal distances from a 60 watt lamp and left for one hour.



The table shows the initial and final colours of the indicator in the four tubes.

Tube	Treatment	Initial colour of indicator	Colour of indicator after one hour
A	Uncovered	Green	Blue
B	Covered with black paper	Green	Yellow
C	Covered with muslin	Green	Green
D	Uncovered	Green	Green

(a) Explain the results for

tube **A**;

_____

_____

_____

_____

tube **B**;

_____

_____

_____

_____

tube **C**.

_____

_____

_____

_____

(4)

(b) (i) Explain how the results from tube **D** help to confirm that the explanations for the other tubes are valid.

_____

_____

(1)

(ii) Explain why all the tubes were placed the same distance from the lamp.

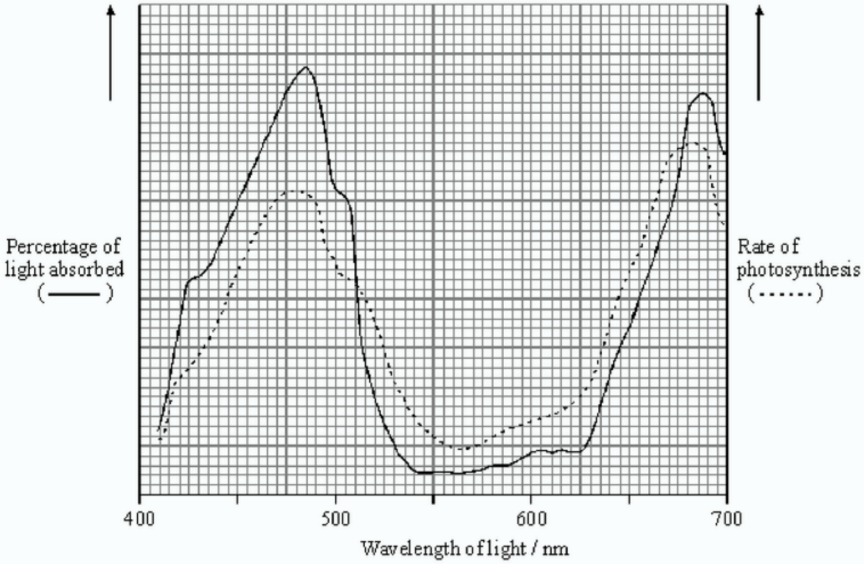
_____

_____

(1)

(Total 6 marks)

20 The percentage of light absorbed by an aquatic plant was measured when it was exposed to different wavelengths. The rate of photosynthesis was also measured at each wavelength of light. The results are shown in the graph.



(a) Describe and explain the relationship between light absorption and the rate of photosynthesis for the wavelengths of light between 410 nm and 500 nm.

_____

_____

_____

_____

(2)

(b) Give **one** dependent variable you could measure in order to determine the rate of photosynthesis in an aquatic plant.

_____

(1)

(c) Use the graph to identify the range of wavelengths of light that would be green in colour.

Give a reason for your answer.

Wavelengths _____ to _____ nm

Reason _____

_____

(2)

(d) A suspension of chloroplasts was isolated from an aquatic plant and a reagent was added. The reagent is blue when oxidised and is colourless when reduced.

(i) The suspension of chloroplasts in blue reagent was exposed to sunlight. The blue colour disappeared. Use your knowledge of the light-dependent reactions of photosynthesis to explain why.

_____

_____

_____

_____

(2)

(ii) Another suspension of chloroplasts was set up as before. Small quantities of ADP and phosphate ions were added and then the tube was exposed to light. The blue colour disappeared more quickly. Explain why.

_____

_____

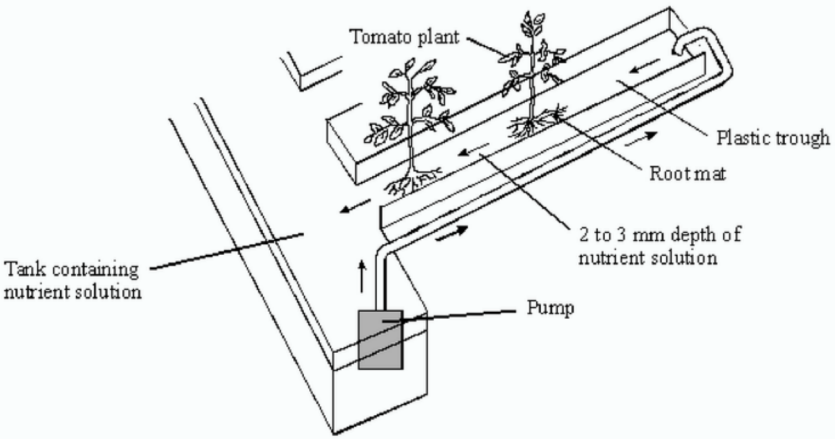
_____

_____

(2)

(Total 9 marks)

21 Tomato growers have increased the yield of fruit from 100 to 400 tonnes per hectare by growing the tomato plants in automatically heated glasshouses and enhancing the carbon dioxide concentration. To control the nutrient supply to the roots, the plants are grown without soil in plastic troughs, as shown in the diagram.



(a) Explain how enhancing the carbon dioxide concentration helps to increase the yield.

_____

_____

_____

_____

(2)

(b) Maintaining a high temperature in a glasshouse in winter, when the light intensity is low, may reduce the yield. Explain how.

_____

_____

_____

_____

(2)

S (c) Tomato fruits have a high percentage of water. When making tomato ketchup, it is more economical to use fruits which have a low percentage of water. Growers can reduce the water content of the fruit by adding sodium chloride to the nutrient solution in the plastic trough.

Explain how adding sodium chloride can reduce the water content of the fruit.

_____

_____

_____

_____

(2)

(Total 6 marks)

22 (a) (i) Give **two** products of the light-dependent stage of photosynthesis.

1. _____

2. _____

(2)

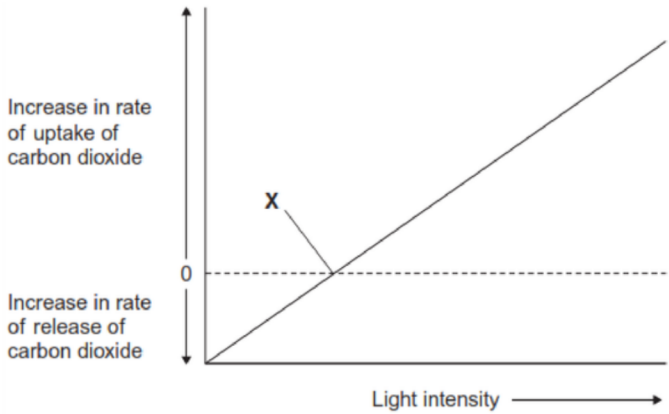
(ii) The products of the light-dependent stage are used in the light-independent stage of photosynthesis. What are these products used for?

_____

_____

(1)

(b) The graph shows the rate of uptake or release of carbon dioxide by a plant at different light intensities.



Explain the rate of carbon dioxide exchange at point **X**.

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_____

_____

_____

(2)

(Total 5 marks)