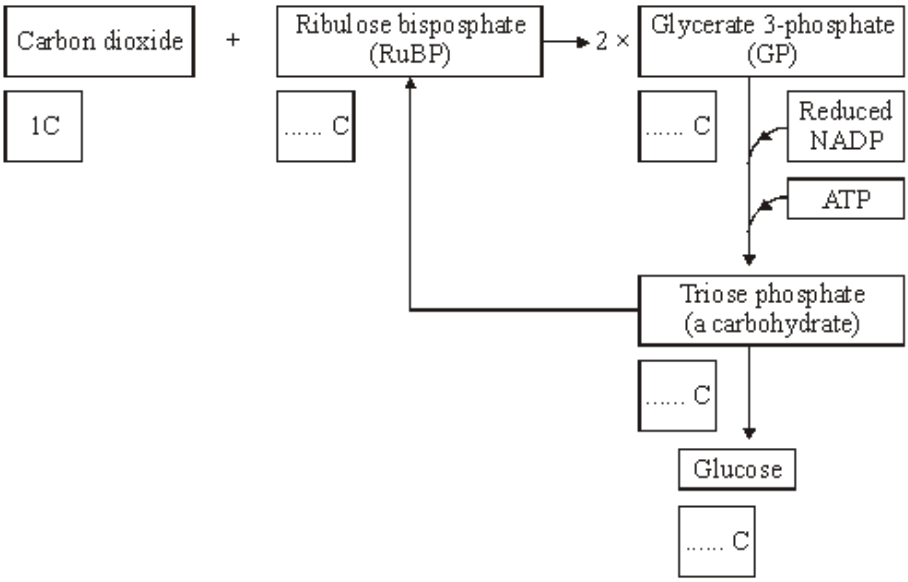
Q1. The diagram shows a summary of the light-independent reaction of photosynthesis.



(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?

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(1)

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

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(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.

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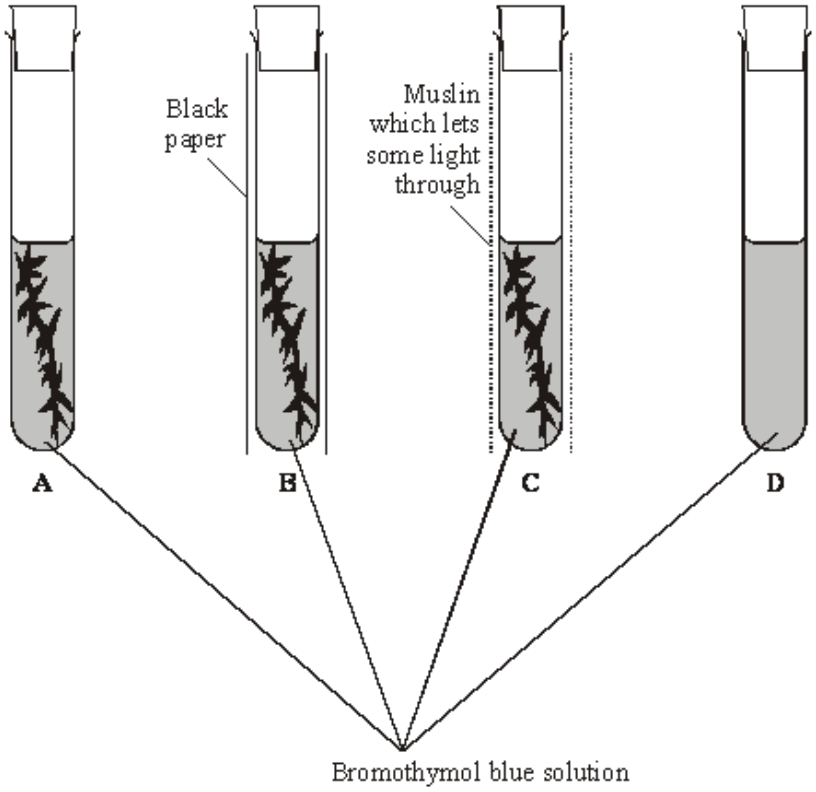
(2)

(Total 7 marks)

Q2. 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**;

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tube **B**;

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tube **C**.

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(4)

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

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(1)

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

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(1)

(Total 6 marks)

Q3. (a) Describe how NADP is reduced in the light-dependent reaction of photosynthesis.

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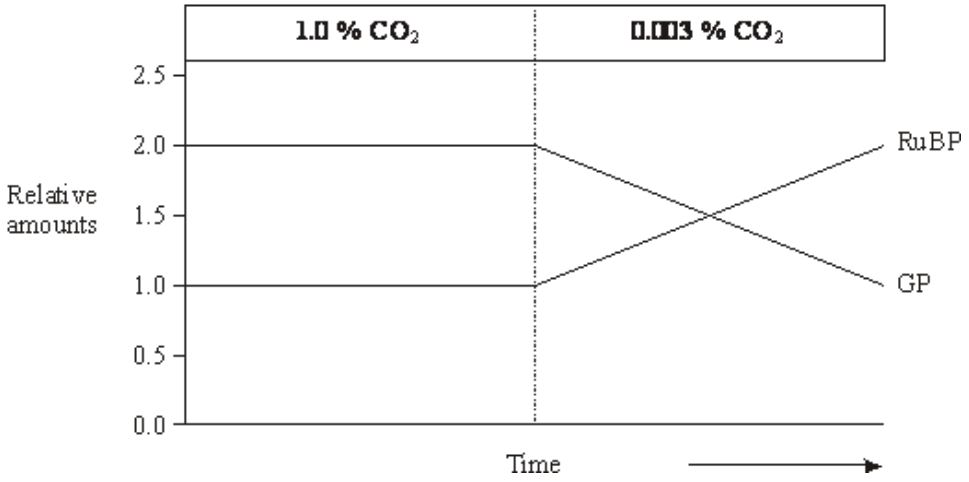
(2)

(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.

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(1)

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

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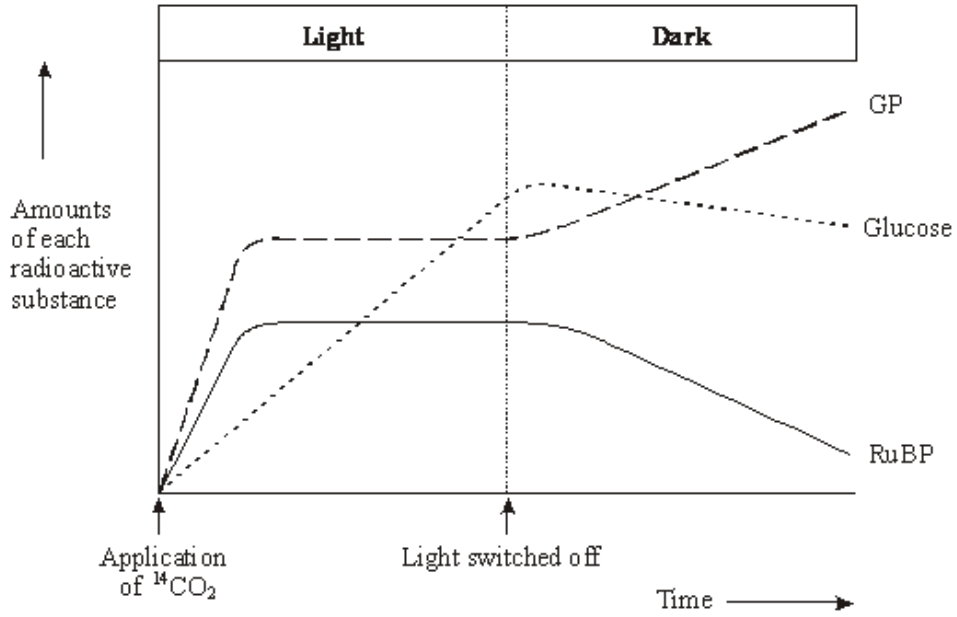
(1)

(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.

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(1)

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

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(2)

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

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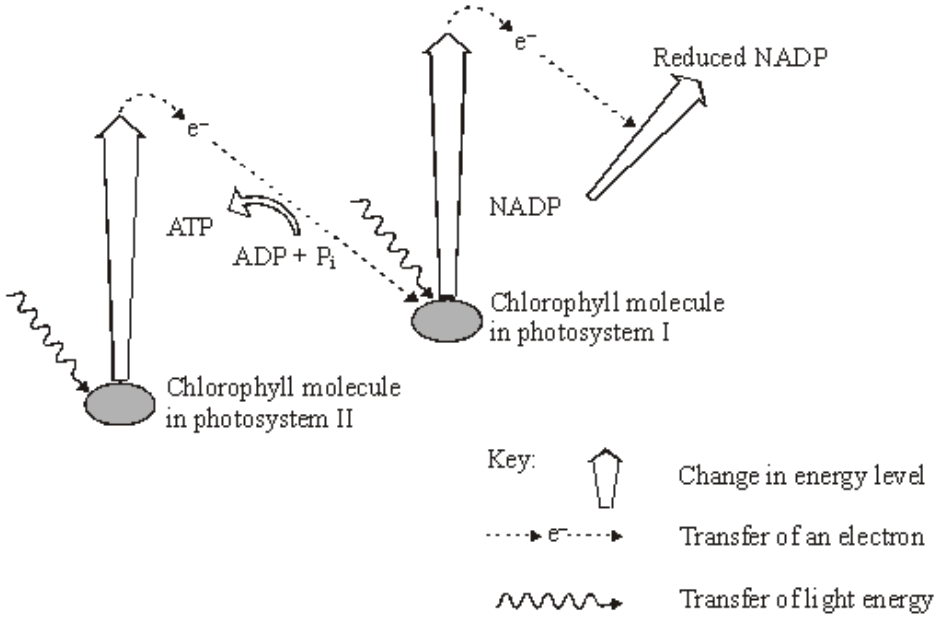
(1)

(Total 8 marks)

Q4. (a) The diagram summarises some of the light-dependent reactions of photosynthesis.



(i) Use the diagram to describe what happens to a molecule of chlorophyll in photosystem II when it absorbs a photon of light.

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(2)

(ii) Molecules of ATP are formed as electrons are transferred from photosystem II to photosystem I. Explain how this is possible.

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(1)

(b) Reduced NADP produced during the light-dependent reactions of photosynthesis is used in the light-independent reactions. Explain how.

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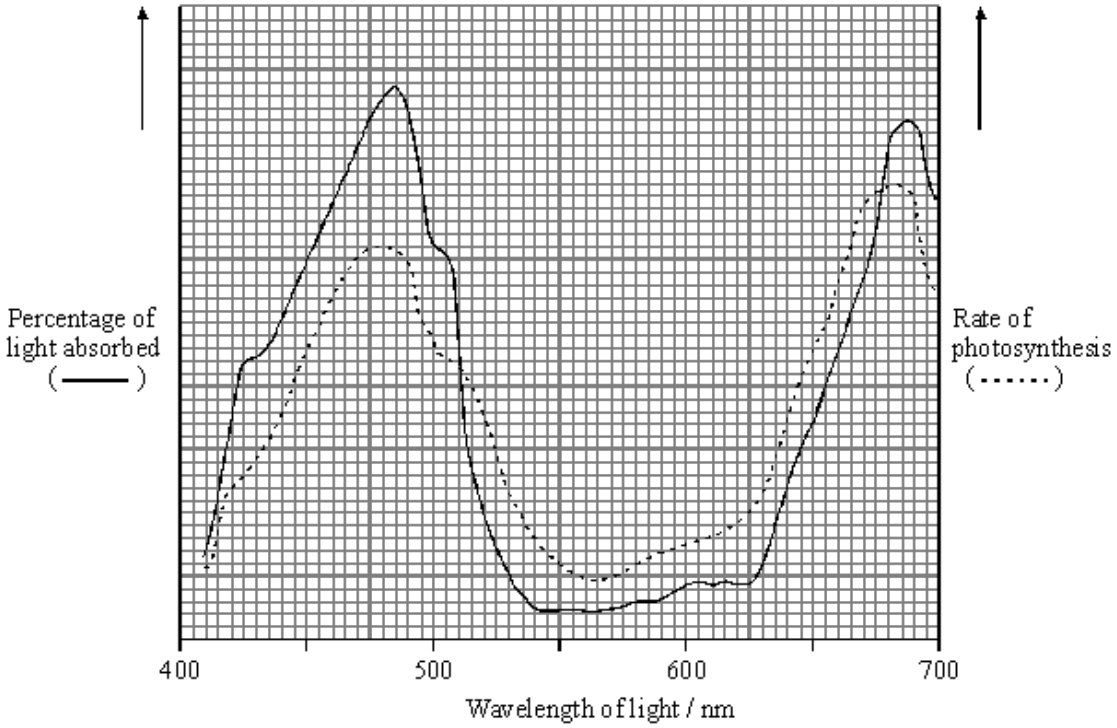
(2)
(Total 5 marks)

Q5. 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.

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(2)

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

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(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 .....

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(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.

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(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.

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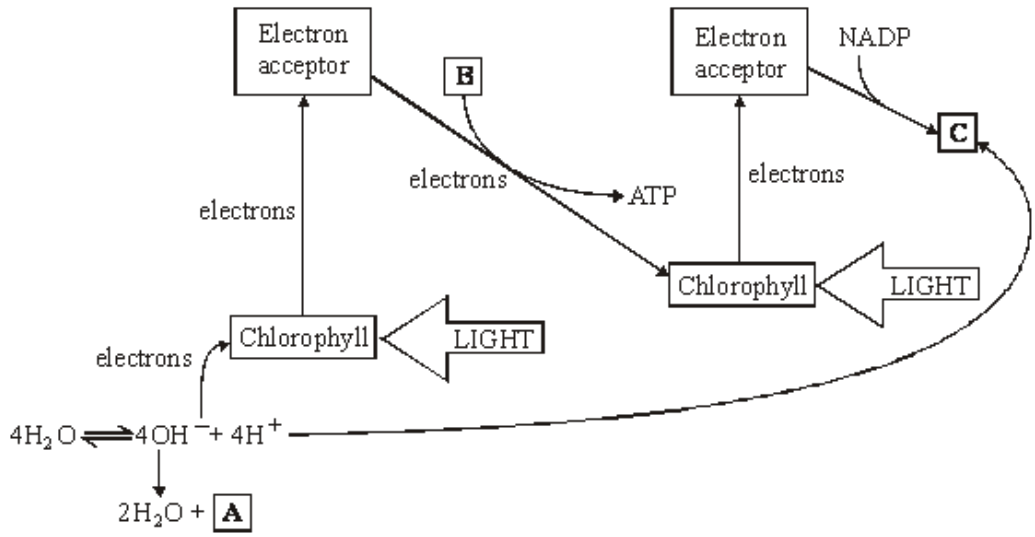
(2)
(Total 9 marks)

Q6. The diagram shows the light-dependent reactions of photosynthesis.



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

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(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;

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(3)

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

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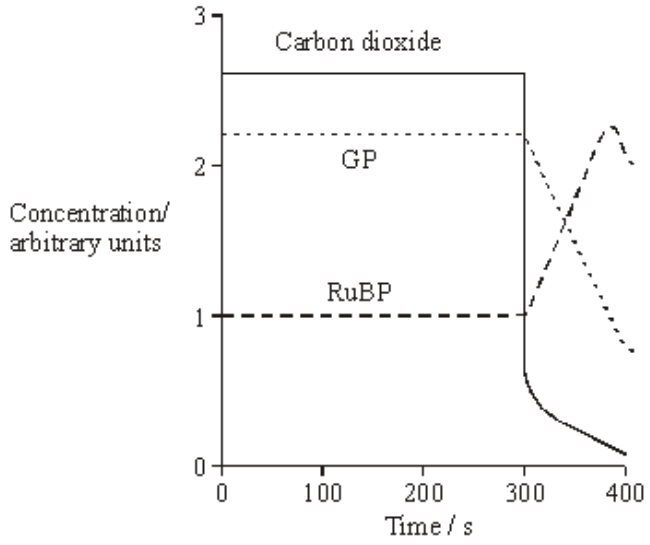
(3)

(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.

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(3)

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

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(2)

(Total 15 marks)

Q7. (a) The table contains statements about three biological processes.

Complete the table with a tick if the statement in the first column is true, for each process.

	Photosynthesis	**Anaerobic respiration**	**Aerobic respiration**
ATP produced			
Occurs in organelles			
Electron transport chain involved			

(3)

(b) Write a simple equation to show how ATP is synthesised from ADP.

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(1)

(c) Give **two** ways in which the properties of ATP make it a suitable source of energy in biological processes.

1 .....

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2 .....

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(2)

(d) Humans synthesise more than their body mass of ATP each day. Explain why it is necessary for them to synthesise such a large amount of ATP.

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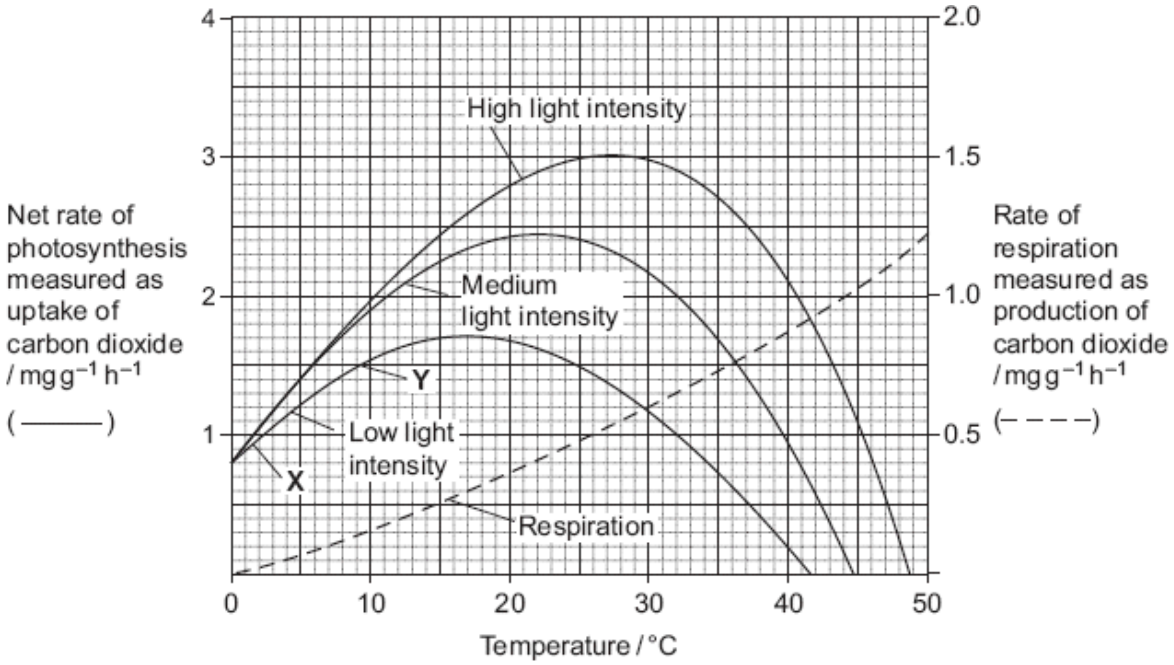
(2)
(Total 8 marks)

Q8. 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**.

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(1)

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

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(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)

Q9. The table shows the effect of carbon dioxide concentration on the rate of photosynthesis of wheat.

Carbon dioxide concentration/parts per million	**Rate of photosynthesis as net uptake of carbon dioxide per hour/mg dm^{-3}**
100	18
200	33
300	45
400	53
500	60
600	68
700	70
800	71

(a) (i) The rate of photosynthesis is given as the net uptake of carbon dioxide. The true rate of photosynthesis is greater than this. Explain why.

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(1)

(ii) Describe and explain the trend shown by the data in the table above a carbon dioxide concentration of 500 parts per million.

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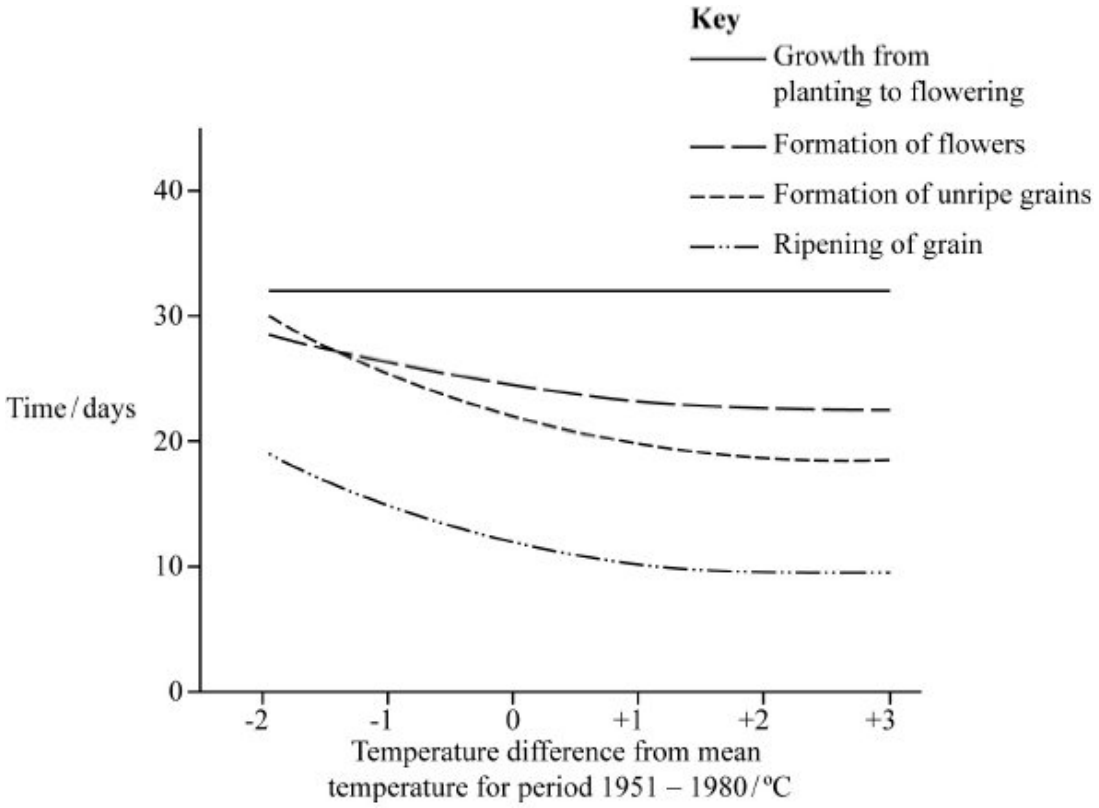
(2)

(b) Scientists investigated the effect of temperature on the development of wheat plants. They calculated the mean temperature for the period 1951 – 1980 and grew wheat plants over a range of 5°C around this temperature. The results of the investigation are shown in the graph.



A rise in carbon dioxide concentration in the atmosphere could influence the yield and timing of the wheat harvest. Use the information from both the table and the graph to explain how.

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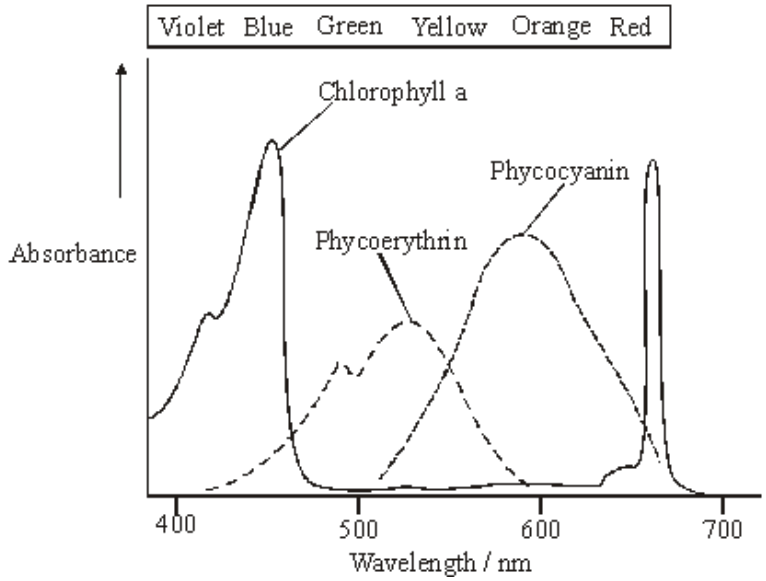
(4)
(Total 7 marks)

Q10. 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.

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(1)

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

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(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.

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(2)
(Total 6 marks)

Q11. Each of the following statements refers to a process that occurs either during photosynthesis or during respiration. A 6C compound refers to a compound whose molecules contain six carbon atoms, 5C refers to a compound with five carbon atoms, and so on.

For each statement, give as precisely as possible the stage of photosynthesis or respiration and the names of the compounds.

(a) A 6C compound is broken down into two 3C compounds.

Stage .....

6C compound .....

3C compound .....

(2)

(b) A 5C compound is combined with a 1C compound.

Stage .....

5C compound .....

1C compound .....

(2)

(c) 3C compounds are combined to form a 6C compound.

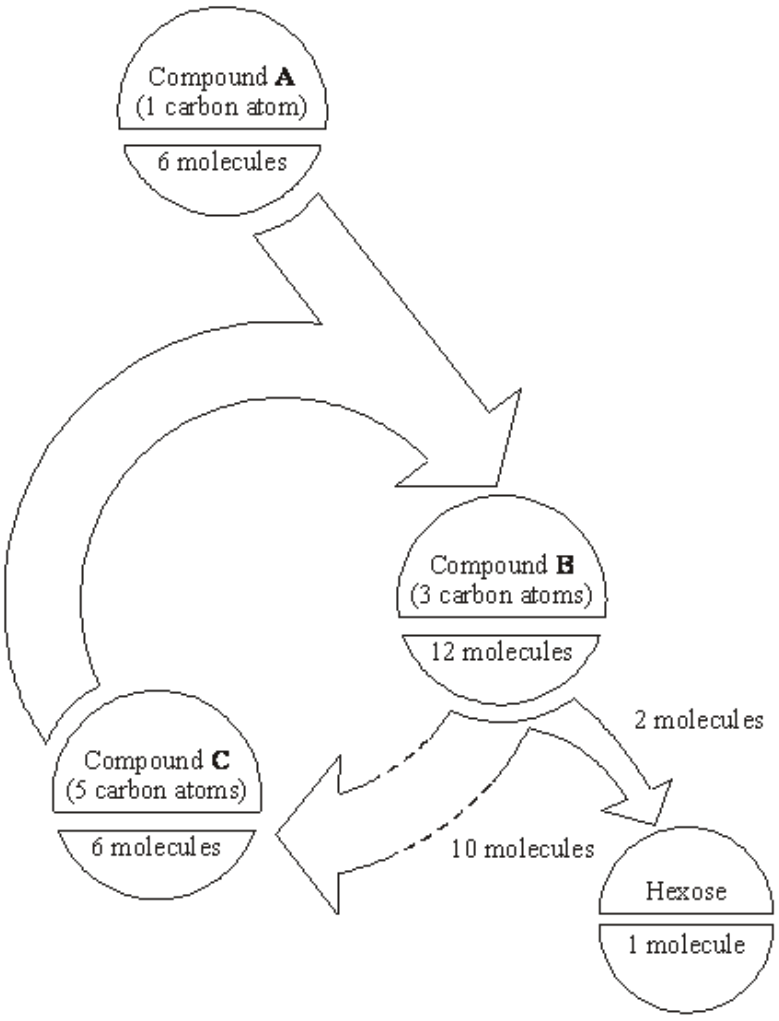
Stage .....

3C compound .....

6C compound .....

(2)
(Total 6 marks)

Q12. 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.

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(6)

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

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(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.

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(3)
(Total 15 marks)

Q13. 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

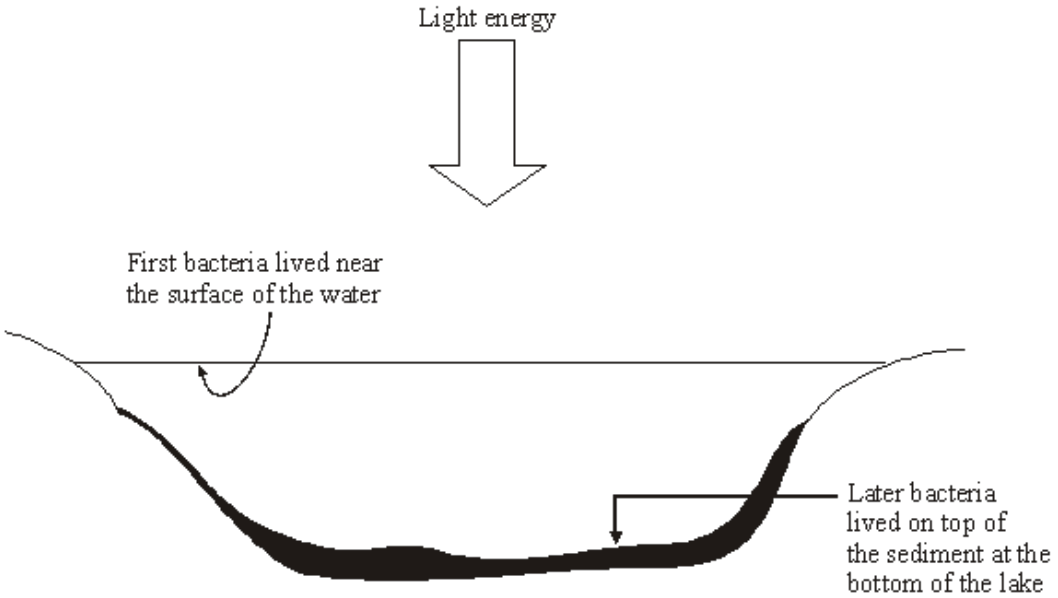
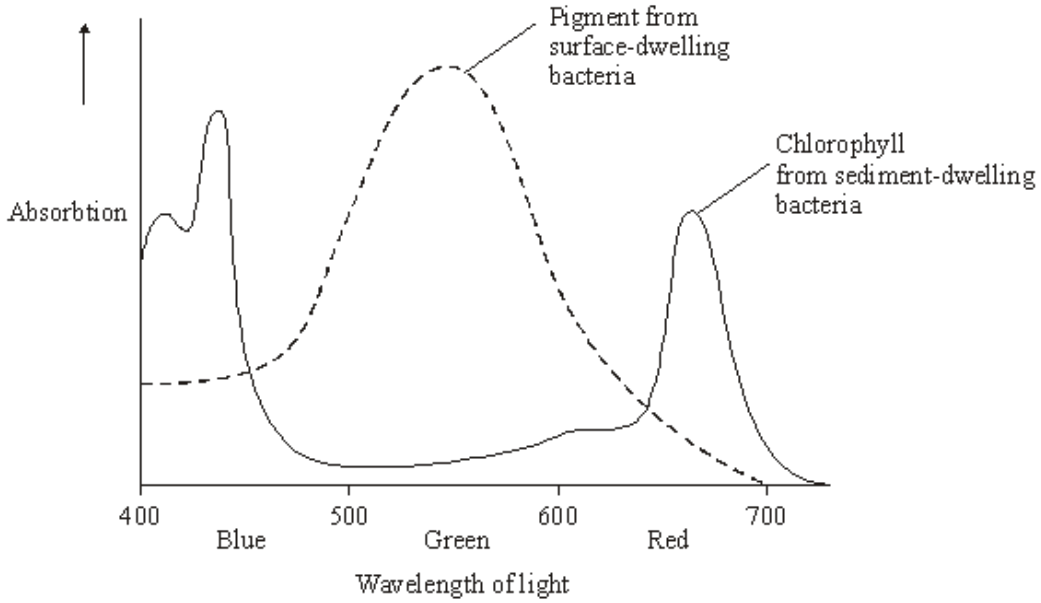


Figure 2



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

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(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.

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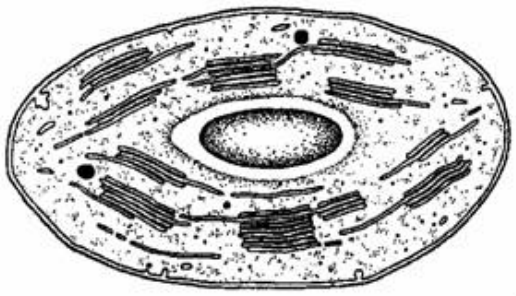
(6)
(Total 11 marks)

Q14. 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.

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(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 .....

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Reduced NADP .....

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(2)
(Total 5 marks)

Q15. (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.

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(1)

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

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(2)

(iii) A further investigation was carried out into the effect of three inhibitors, **A**, **B** and **C**, on the electron transport chain in these mitochondria. In each of three experiments, a different inhibitor was added. The table shows the state of the electron carriers, **W–Z**, after the addition of inhibitor.

Inhibitor added	**Electron carrier**			
	W	**X**	**Y**	**Z**
A	oxidised	reduced	reduced	oxidised
B	oxidised	oxidised	reduced	oxidised
C	reduced	reduced	reduced	oxidised

Give the order of the electron carriers in this electron transport chain. Explain your answer.

Order ....

Explanation .....

.....

.....

(2)
(Total 9 marks)