AQA A-LEVEL · 7402

BIOLOGY



EXAM QUESTION PACK

3.5.1 PHOTOSYNTHESIS

SCORE	PERCENTAGE
/ 419	%

STEMUP

These questions belong to AQA, not to us.

The examination questions, mark schemes and examiner reports in this pack were written and published by AQA. They are past assessment materials, reproduced here so that students can revise from them.

What we do not own

STEMUP is not affiliated with AQA and does not own, and makes no claim to own, any of the question, mark scheme or examiner report material in this pack. AQA has not endorsed, approved or been involved in the production of it. AQA and the qualification titles used here belong to their respective owners and appear for identification only.

Where to find the originals

AQA publishes its past papers, mark schemes and examiner reports free of charge. Always check the current specification at aqa.org.uk before you revise, because content and wording can change between series.

If you hold the rights to any material in this pack and would like it amended or removed, contact admin@stemup.co.uk and we will act on it.

Q1.

Heat stress is a condition that often occurs in plants exposed to high temperatures for a prolonged period of time. Heat stress is a major factor in limiting the rate of photosynthesis.

(a) Heat stress decreases the light-dependent reaction of photosynthesis.

Explain why this leads to a decrease in the **light-independent reaction**.

_____

_____

_____

_____

_____

_____

(2)

(b) Another effect of heat stress is a decrease in the activity of the enzyme rubisco. A decrease in the activity of an enzyme means that the rate of the reaction it catalyses becomes slower.

A decrease in the activity of the enzyme rubisco would limit the rate of photosynthesis.

Explain why.

_____

_____

_____

_____

_____

(2)

(c) Where precisely is rubisco found in a cell?

_____

_____

(1)

Scientists investigated the effect of temperature on the activity of two enzymes isolated from the leaf cells of cotton plants.

- Rubisco
- Rubisco activase – an enzyme that activates rubisco

Figure 1 and **Figure 2** show their results.

Figure 1

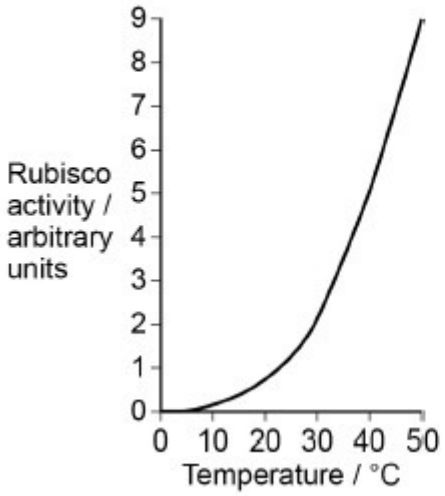
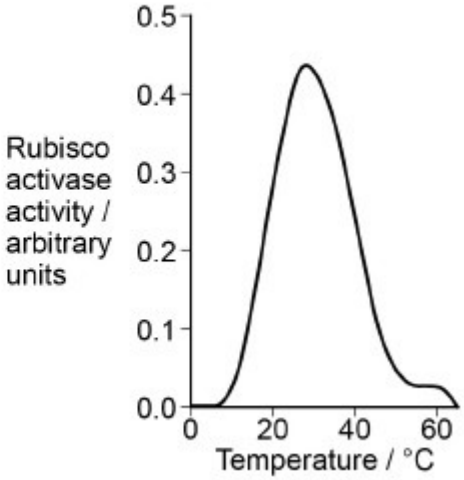


Figure 2



(d) The scientists concluded that heat stress reduces the activity of rubisco in plant leaves by affecting rubisco activase.

Use all the information to evaluate their conclusion.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(Total 9 marks)

Q2.

A student isolated chloroplasts from spinach leaves into a solution to form a chloroplast suspension. He used the chloroplast suspension and DCPIP solution to investigate the light-dependent reaction of photosynthesis. DCPIP solution is blue when oxidised and colourless when reduced.

The student set up three test tubes as follows:

- **Tube 1** – 1 cm^3 of solution without chloroplasts and 9 cm^3 of DCPIP solution in light.
- **Tube 2** – 1 cm^3 of chloroplast suspension and 9 cm^3 of DCPIP solution in darkness.
- **Tube 3** – 1 cm^3 of chloroplast suspension and 9 cm^3 of DCPIP solution in light.

The student recorded the colour of the DCPIP in each of the tubes at the start and after the tubes had been left at 20 °C for 30 minutes.

His results are shown in the table.

Tube	Colour of DCPIP in tube	
	At start	After 30 minutes
1	blue	blue
2	blue	blue
3	blue	colourless

(a) The solution that the student used to produce the chloroplast suspension had the same water potential as the chloroplasts.

Explain why it was important that these water potentials were the same.

_____

_____

_____

_____

_____

(2)

(b) Explain why the student set up **Tube 1**.

_____

_____

_____

_____

(2)

(c) Explain the results in **Tube 3**.

_____

_____

_____

_____

(2)

(d) The student evaluated the effectiveness of different chemicals as weed-killers by assessing their ability to prevent the decolourisation of DCPIP in chloroplast suspensions.

He added different concentrations of each chemical to illuminated chloroplast suspensions containing DCPIP. He then determined the IC_{50} for each chemical. The IC_{50} is the concentration of chemical which inhibits the decolourisation of DCPIP by 50%.

Explain the advantage of the student using the IC_{50} in this investigation.

_____

_____

_____

(1)

(e) Explain how chemicals which inhibit the decolourisation of DCPIP could slow the growth of weeds.

_____

_____

_____

_____

_____

(2)

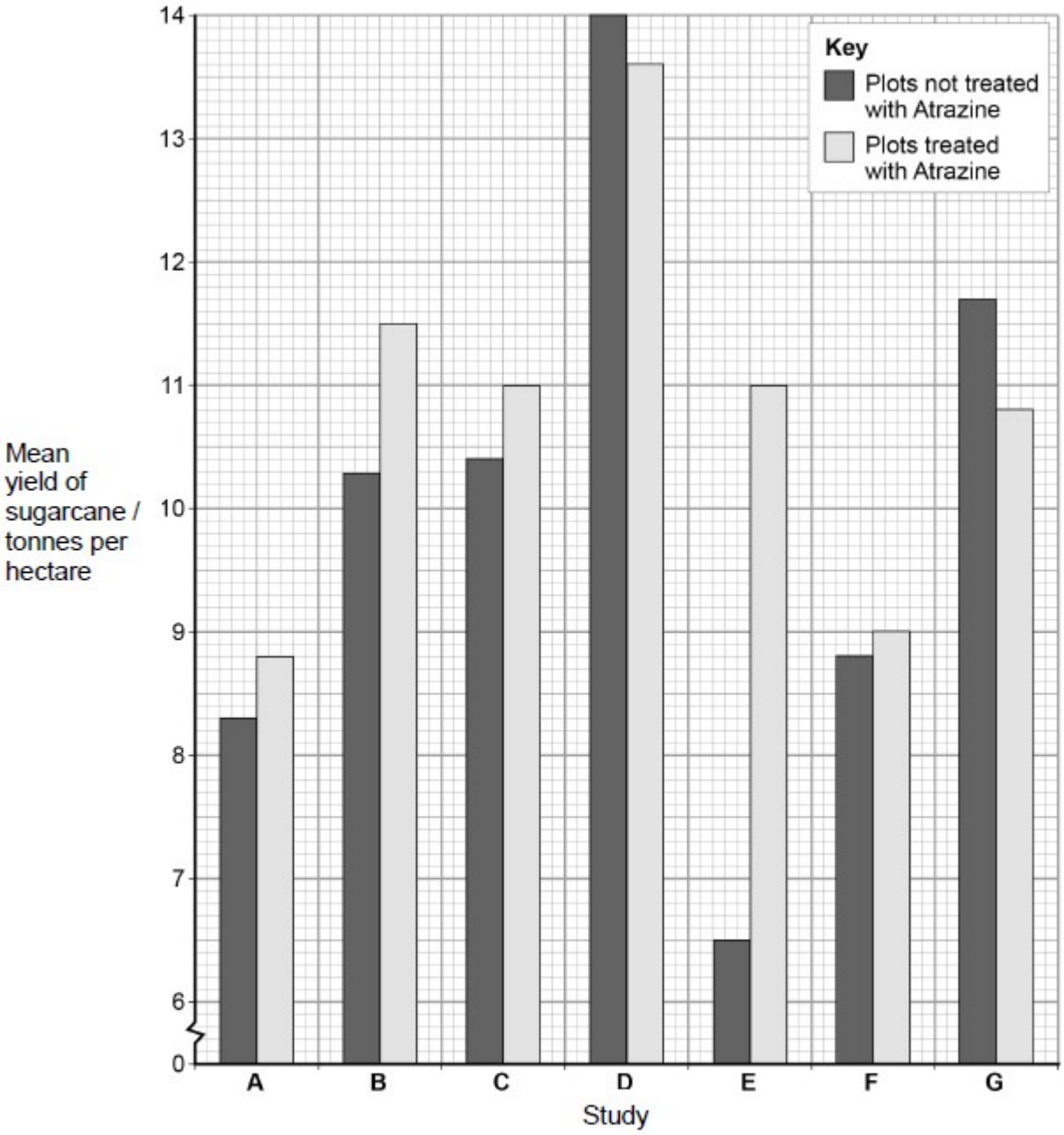
(Total 9 marks)

Q3.

Herbicides can be used to reduce the growth of weeds.

Scientists completed seven studies to determine how the use of the herbicide Atrazine affected the yield of sugarcane. In each study, some plots were treated with Atrazine and some plots were not treated with Atrazine.

The graph below shows the scientists' results. (1 hectare = 10 000 m^2)



(a) Calculate the percentage decrease in yield caused by the use of Atrazine in study **G**.

Answer = _____ %

(1)

(b) A teacher studying these data with her students told her class that no definite conclusions could be drawn when comparing the mean values in the graph.

Suggest why the teacher said this.

_____

_____

_____

_____

_____

(2)

(c) Atrazine binds to proteins in the electron transfer chain in chloroplasts of weeds, reducing the transfer of electrons down the chain.

Explain how this reduces the rate of photosynthesis in weeds.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(d) When treated with Atrazine, weeds have been shown to give off small amounts of heat.

Suggest an explanation for this observation.

_____

_____

_____

_____

(1)

(Total 8 marks)

Q4.

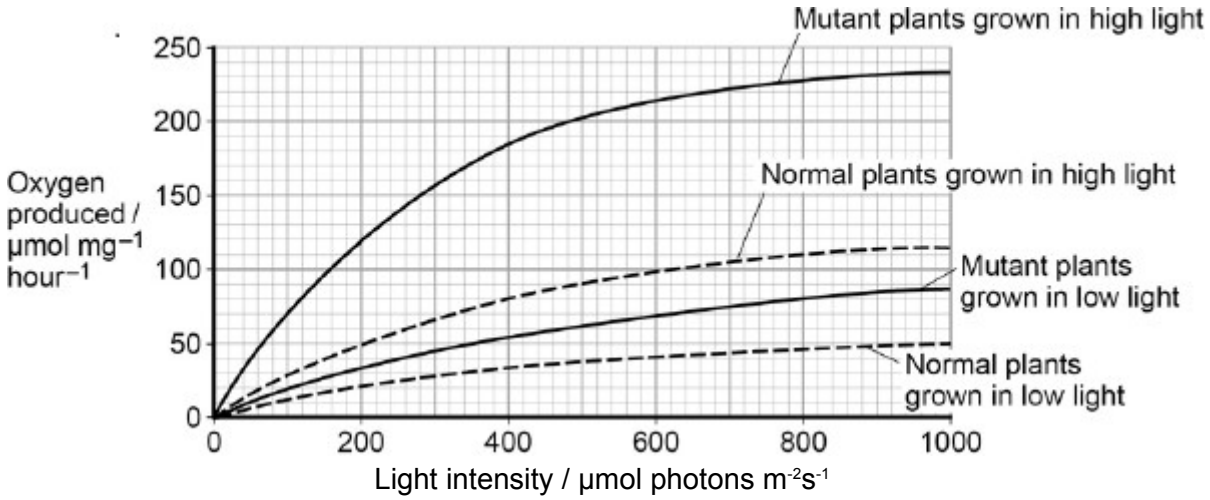
Chloroplasts contain chlorophyll a and chlorophyll b. Scientists found tobacco plants with a mutation that caused them to make more chlorophyll b than normal tobacco plants. They investigated the effect of this mutation on the rate of photosynthesis.

The scientists carried out the following investigation.

- They grew normal and mutant tobacco plants. They grew some of each in low light

intensity and grew others in high light intensity.
- They isolated samples of chloroplasts from mature plants of both types.
- Finally, they measured oxygen production by the chloroplasts they had isolated from the plants.

The figure below shows the scientists' results.



(a) Explain why the scientists measured the rate of production of oxygen in this investigation.

_____

_____

_____

_____

(2)

In each trial, the scientists collected oxygen for 15 minutes.

(b) Calculate the difference in the oxygen produced by the chloroplasts from mutant plants grown in low and high light intensities at a light intensity of 500 µmol photons m^{-2} s^{-1}.

Show your working.

Difference _____ µmol O_2 mg^{-1} $hour^{-1}$

(2)

(c) The scientists suggested that mutant plants producing more chlorophyll b would grow faster than normal plants in all light intensities.

Explain how these data support this suggestion.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(Total 8 marks)

Q5.

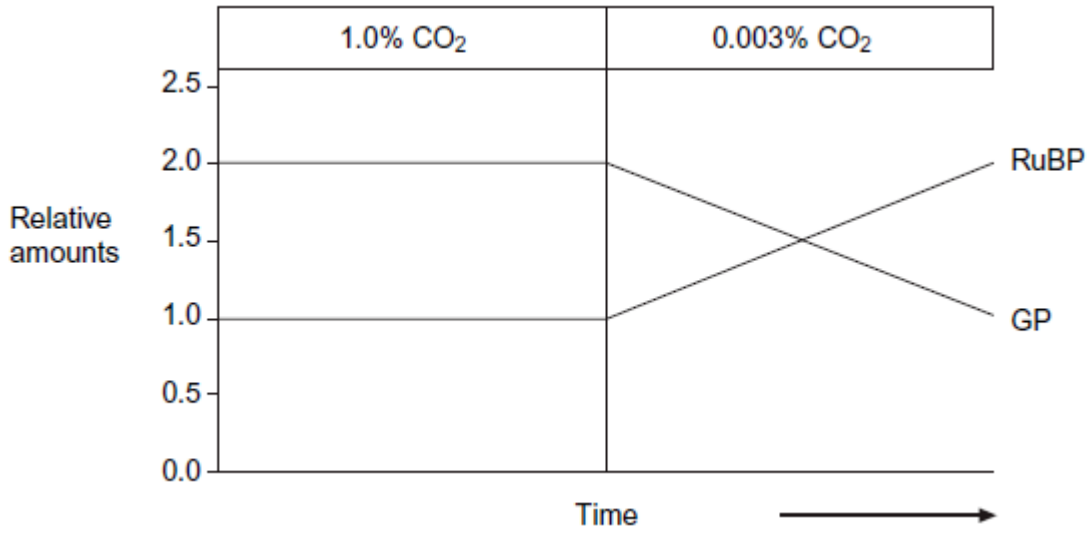
(a) Where precisely in a cell does the Calvin cycle take place?

_____

(1)

(b) A scientist investigated the effect of changing the carbon dioxide concentration on the amounts of glycerate-3-phosphate (GP) and ribulose bisphosphate (RuBP) in photosynthesising cells.

The graph shows the results obtained when the carbon dioxide concentration was reduced.



(i) Explain the decrease in the amount of GP after the carbon dioxide concentration was reduced.

_____

_____

(1)

(ii) The scientist carried out a similar experiment but increased the carbon dioxide concentration from 1% to 2%. The relative amounts of GP and RuBP remained the same.

Suggest **two** reasons why.

1. _____

_____

2. _____

_____

(2)

(c) Some bacteria use hydrogen sulfide, H_2S, to produce organic compounds. The hydrogen sulfide has a similar role to that of water in photosynthesis.

A simple equation for this process in bacteria is shown below:

hydrogen sulfide + carbon dioxide ⟶ glucose + sulfur + water

Suggest what the hydrogen sulfide is used for in these bacteria.

_____

_____

_____

_____

(2)

(Total 6 marks)

Q6.

(a) Crops use light energy to produce photosynthetic products.
Describe how crop plants use light energy during the light-dependent reaction.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(5)

(b) After harvesting, the remains of crop plants are often ploughed into the soil. Explain how microorganisms in the soil produce a source of nitrates from these remains.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(5)

(Total 10 marks)

Q7.

Scientists studied the rate of carbon dioxide uptake by grape plant leaves. Grape leaves have stomata on the lower surface but no stomata on the upper surface.

The scientists recorded the carbon dioxide uptake by grape leaves with three different treatments:

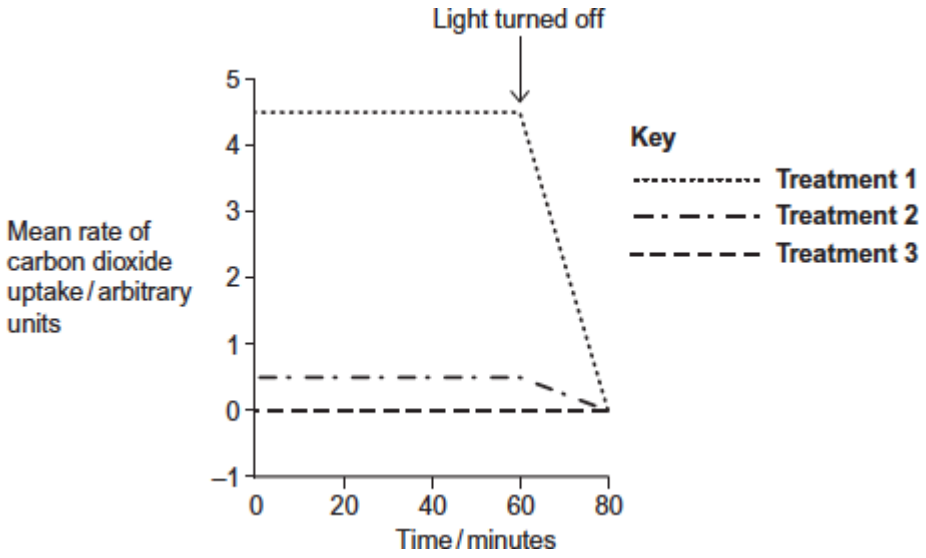
Treatment 1 − No air-sealing grease was applied to either surface of the leaf.

Treatment 2 − The lower surface of the leaf was covered in air-sealing grease that prevents gas exchange.

Treatment 3 − Both the lower surface and the upper surface of the leaf were covered in air–sealing grease that prevents gas exchange.

The scientists measured the rate of carbon dioxide uptake by each leaf for 60 minutes in light and then for 20 minutes in the dark.

The scientists' results are shown in the diagram below.



(a) Suggest the purpose of each of the three leaf treatments.

Treatment 1

_____

_____

_____

Treatment 2

_____

_____

_____

Treatment 3

_____

_____

_____

(3)

(b) (i) Describe the results shown for **Treatment 1**.

_____

_____

_____

_____

_____

(2)

(ii) The stomata close when the light is turned off.

Explain the advantage of this to the plant.

_____

_____

_____

_____

_____

(2)

(c) (i) **Treatment 2** shows that even when the lower surface of the leaf is sealed there is still some uptake of carbon dioxide.

Suggest how this uptake of carbon dioxide continues.

_____

_____

_____

(1)

(ii) In both **Treatment 1** and **Treatment 2**, the uptake of carbon dioxide falls to zero when the light is turned off.

Explain why.

_____

_____

_____

_____

_____

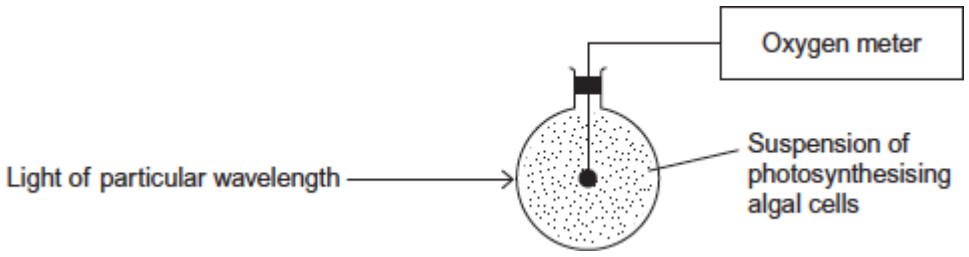
(2)

(Total 10 marks)

Q8.

A student investigated the effect of different wavelengths of light on the rate of photosynthesis. She used the apparatus shown in **Figure 1**.

Figure 1



(a) What measurements should the student have taken to determine the rate of photosynthesis?

_____

_____

(1)

(b) Other than temperature and pH, give **two** factors which should be kept constant during this investigation.

1. _____

2. _____

(2)

(c) The student did **not** use a buffer to maintain the pH of the solution.
Explain what would happen to the pH of the solution during this investigation.

_____

_____

_____

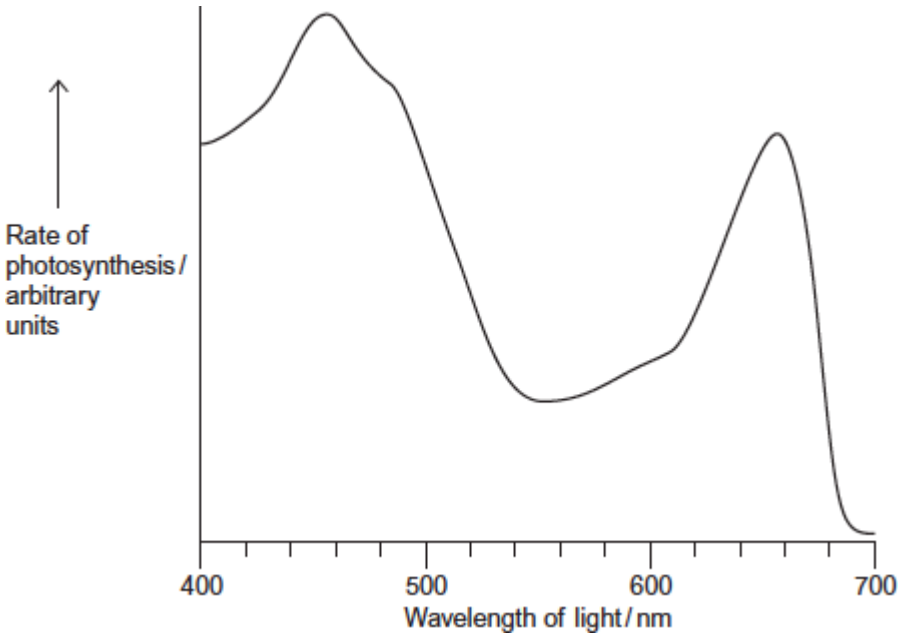
_____

_____

(2)

(d) **Figure 2** shows the student's results.

Figure 2



Suggest and explain why the rate of photosynthesis was low between 525 nm and 575 nm wavelengths of light.

_____

_____

_____

_____

_____

(2)

(Total 7 marks)

Q9.

(a) On islands in the Caribbean, there are almost 150 species of lizards belonging to the genus *Anolis*. Scientists believe that these species evolved from two species found on mainland USA. Explain how the Caribbean species could have evolved.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(6)

(b) *Anolis sagrei* is a species of lizard that is found on some of the smallest Caribbean islands. Describe how you could use the mark-release-recapture method to estimate the number of *Anolis sagrei* on one of these islands.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(c) Large areas of tropical forest are still found on some Caribbean islands. The concentration of carbon dioxide in the air of these forests changes over a period of 24 hours and at different heights above ground.

Use your knowledge of photosynthesis and respiration to describe and explain how the concentration of carbon dioxide in the air changes:

- over a period of 24 hours
- at different heights above ground.

(5)

(Total 15 marks)

Q10.

Farmland previously used for growing crops was left for 30 years and developed into woodland. During this period, ecologists recorded an increase in the diversity of birds in the area.

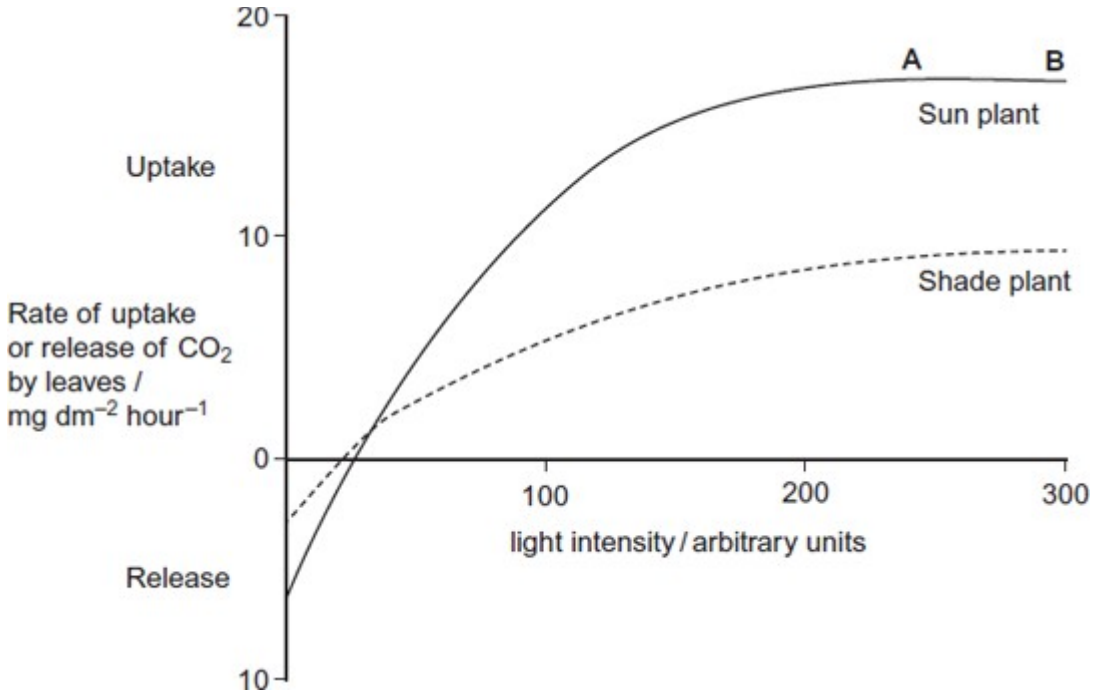
(a) Name the process that resulted in the development of woodland from farmland.

(1)

(b) Explain the increase in the diversity of birds as the woodland developed.

(3)

(c) The ecologists also investigated photosynthesis in two species of plant found in the woodland. One of the species was adapted to growing in bright sunlight (sun plant) and the other was adapted to growing in the shade (shade plant). The ecologists' results are shown in the figure below.



(i) Give **two** factors which could be limiting the rate of photosynthesis in the sun plant between points **A** and **B** on the figure.

1. _____

2. _____

(1)

(ii) Explain why CO_2 uptake is a measure of net productivity.

_____

_____

(1)

(iii) Use the information in the figure to explain how the shade plant is better adapted than the sun plant to growing at low light intensities.

_____

_____

_____

_____

(2)

(Total 8 marks)

Q11.

During the light-independent reaction of photosynthesis, carbon dioxide is converted into organic substances. Describe how.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(Total 6 marks)

Q12.

Scientists measured the rate of respiration in **three** parts of an ecosystem.

They did this by measuring carbon dioxide released into the air by:

- leaves of plants
- stems and roots of plants
- non-photosynthetic soil organisms.

The table below shows the scientists' results for these three parts of the ecosystem.

Part of ecosystem	**Mean rate of carbon dioxide production / $cm^3\ m^{-2}\ s^{-1}$**	**Percentage of total carbon dioxide production measured by the scientists**
Leaves of plants	0.032	25.0
Stems and roots of plants	0.051	
Non-	0.045	

photosynthetic soil organisms		

(a) Complete the table to show the percentage of total carbon dioxide production by each part of the ecosystem.

Show your working.

(2)

(b) A student who looked at the data in the table concluded that plants carry out more respiration than non-photosynthetic organisms in the ecosystem.

Use the information provided to suggest why these data may **not** support the student's conclusion.

_____

_____

_____

_____

(2)

(c) What measurements would the scientists have made in order to calculate the rate of carbon dioxide production?

_____

_____

_____

_____

(2)

(d) The scientists calculated the mean rate of carbon dioxide production of the leaves using measurements of carbon dioxide release in the dark.

Explain why they did **not** use measurements taken in the light.

_____

_____

_____

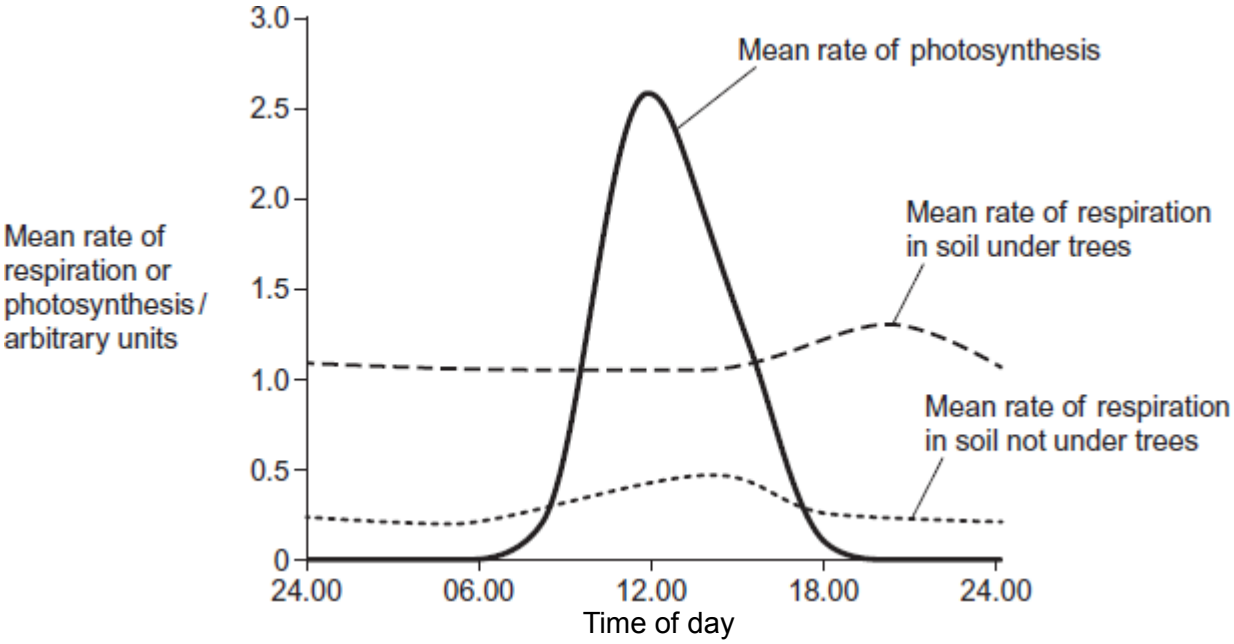
_____

(2)

Another group of scientists measured the mean rate of respiration in soil under trees and soil not under trees in the same wood. They also measured the mean rate of photosynthesis in the trees.

They took measurements at different times of day during the summer.

The figure below shows the scientists' results.



(e) (i) Describe **two** ways in which the mean rate of respiration in soil under trees is different from soil not under trees.

1. _____

_____

2. _____

_____

(2)

(ii) Suggest **one** explanation for the differences in the mean rate of respiration in soil under trees and soil not under trees between 06.00 and 12.00.

_____

_____

_____

_____

(2)

(f) The scientists suggested that the rise in the mean rate of photosynthesis was the cause of the rise in the mean rate of respiration in soil under trees.

(i) Suggest how the rise in the mean rate of photosynthesis could lead to the rise in the mean rate of respiration in soil under trees.

_____

_____

_____

_____

(2)

(ii) Suggest why there is a delay between the rise in the mean rate of photosynthesis and the rise in the mean rate of respiration.

_____

_____

(1)

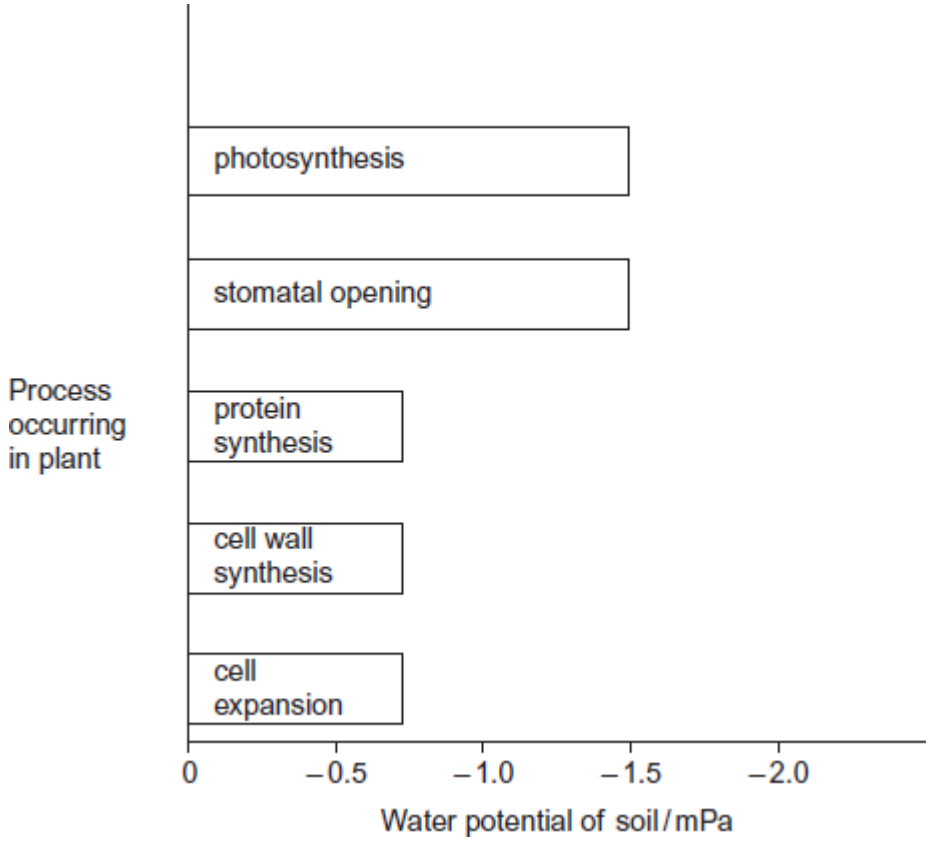
(Total 15 marks)

Q13.

Scientists investigated the effect of the water potential of soil water on plant growth. They investigated the effect of this water potential on several plant processes.

The figure below shows their results in the form they were presented. The bars show whether or not each process was occurring.

The plants stopped growing when the water potential of the soil water was below –0.7 mPa. All of the changes in the plants were related to the ability of the roots to take up water from the soil.



(a) Describe the results in the figure.

_____

_____

_____

_____

_____

(2)

(b) Explain the relationship between stomatal opening and photosynthesis.

_____

_____

_____

_____

_____

(2)

(c) Although photosynthesis is still occurring, plants stop growing when the soil water potential falls below –0.7 mPa.

Use information from the figure above to suggest two reasons why.

_____

_____

_____

_____

_____

_____

(3)

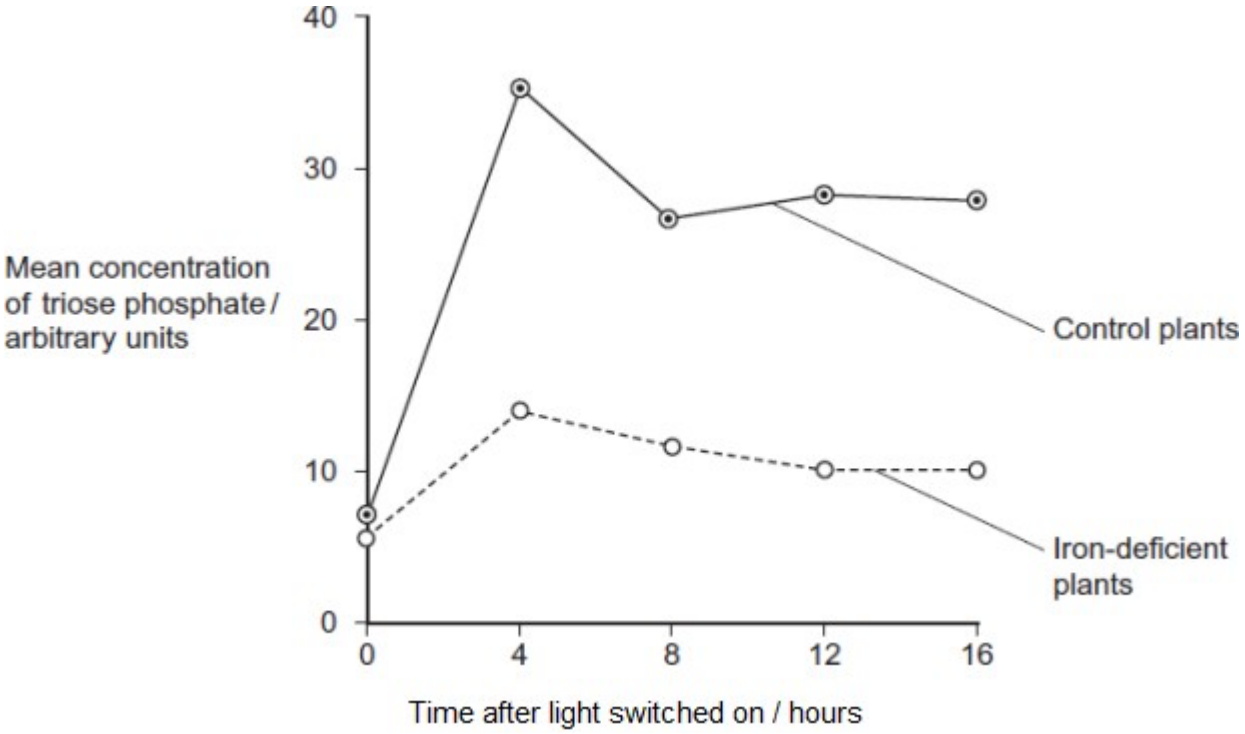
(Total 7 marks)

Q14.

Scientists investigated the effect of iron deficiency on the production of triose phosphate in sugar beet plants. They grew the plants under the same conditions with their roots in a liquid growth medium containing all the necessary nutrients. Ten days before the experiments, they transferred half the plants to a liquid growth medium containing no iron. The scientists measured the concentration of triose phosphate produced in these plants and in the control plants:

- at the end of 6 hours in the dark
- then for 16 hours in the light.

Their results are shown in the graph.



(a) (i) The experiments were carried out at a high carbon dioxide concentration. Explain why.

_____

_____

_____

(1)

(ii) Explain why it was important to grow the plants under the same conditions up to ten days before the experiment.

_____

_____

_____

(1)

(iii) The plants were left in the dark for 6 hours before the experiment. Explain why.

_____

_____

_____

(1)

(b) Iron deficiency reduces electron transport. Use this information and your knowledge of photosynthesis to explain the decrease in production of triose phosphate in the iron-deficient plants.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(c) Iron deficiency results in a decrease in the uptake of carbon dioxide. Explain why.

_____

_____

_____

_____

(2)

(Total 9 marks)

Q15.

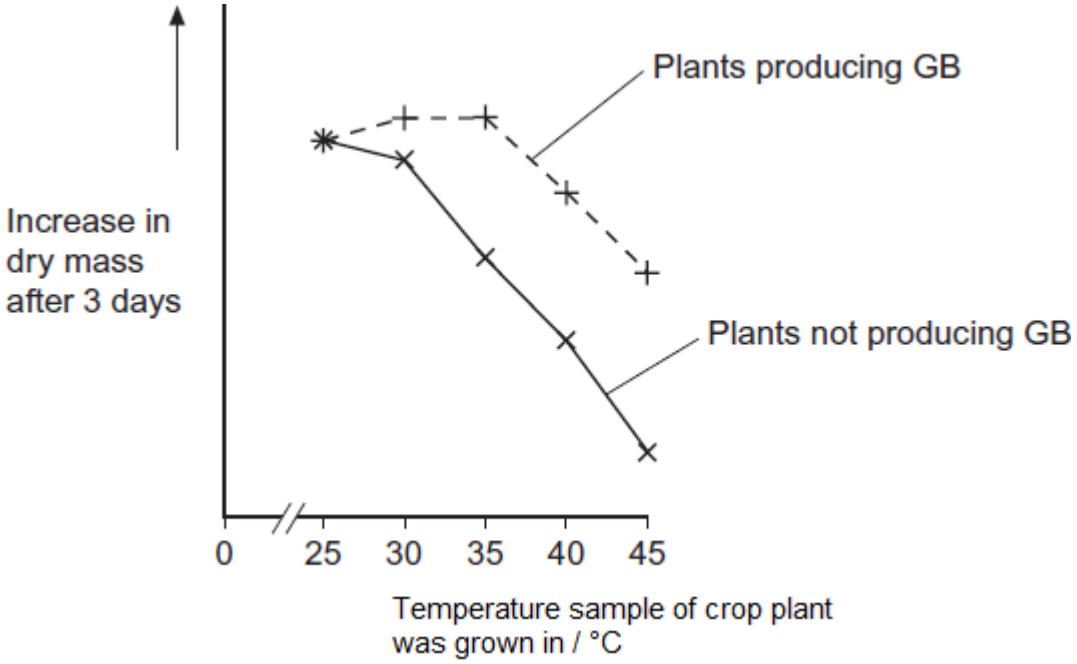
Some species of crop plant produce a substance called glycinebetaine (GB).

Scientists transferred the gene for GB into a species of crop plant that does not normally produce GB. These genetically modified plants then produced GB.

The scientists grew large numbers of the same crop plant with and without the gene at different temperatures. After 3 days, they found the increase in dry mass of the plants.

Figure 1 shows their results.

Figure 1



(a) Describe the effect on growth of transferring the gene for GB into this plant.

_____

_____

_____

_____

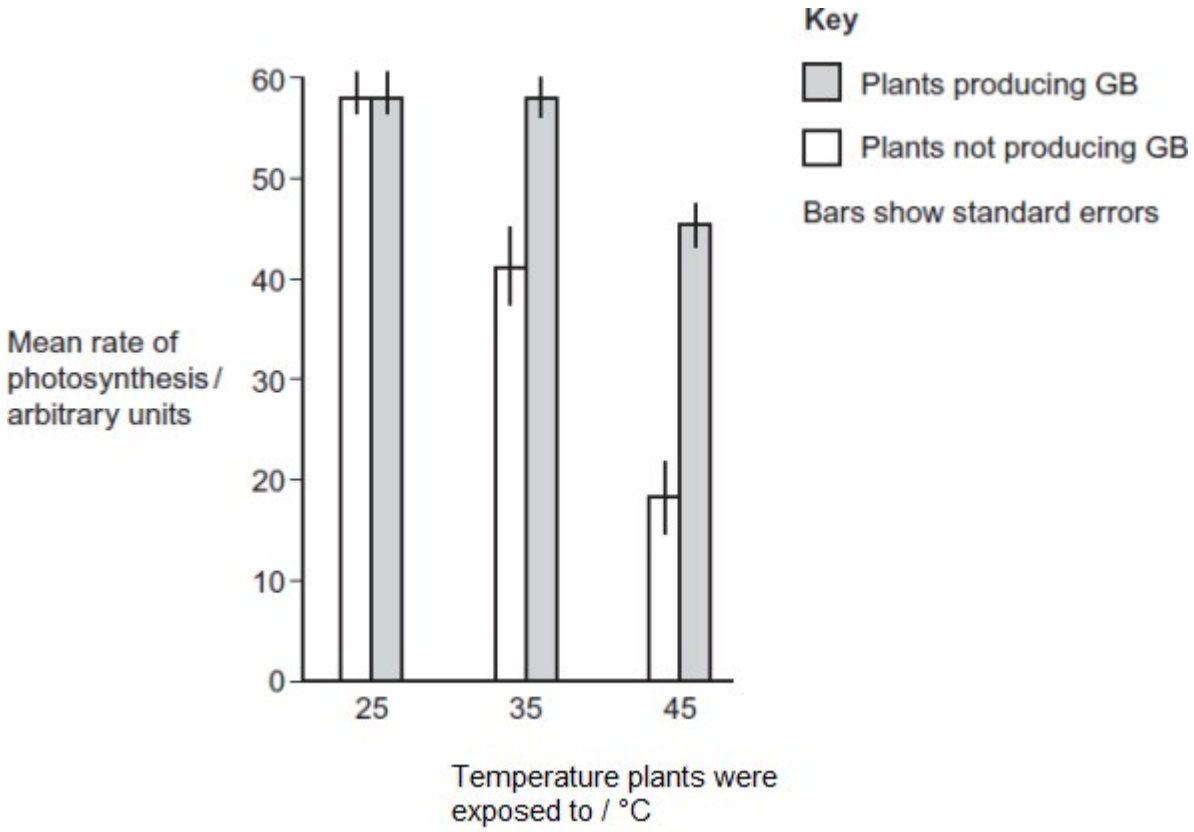
_____

(2)

(b) The scientists measured the rate of photosynthesis in plants that produce GB and plants that do not produce GB at 25°C, 35°C and 45°C.

Figure 2 shows their results.

Figure 2



(i) The scientists concluded that the production of GB protects photosynthesis from damage by high temperatures.

Use these data to support this conclusion.

_____

_____

_____

(1)

(ii) Use the data from **Figure 2** for plants that do not produce GB to explain the effect of temperature on changes in dry mass of the plants shown in **Figure 1.**

_____

_____

_____

_____

_____

_____

_____

_____

(4)

Rubisco activase is an enzyme found in chloroplasts. It activates the light-independent reaction of photosynthesis.

The scientists discovered that, as temperature increased from 25°C to 45°C, rubisco activase began attaching to thylakoid membranes in chloroplasts and this stopped it working.

(c) Rubisco activase stops working when it attaches to a thylakoid.

Use your knowledge of protein structure to explain why.

_____

_____

_____

_____

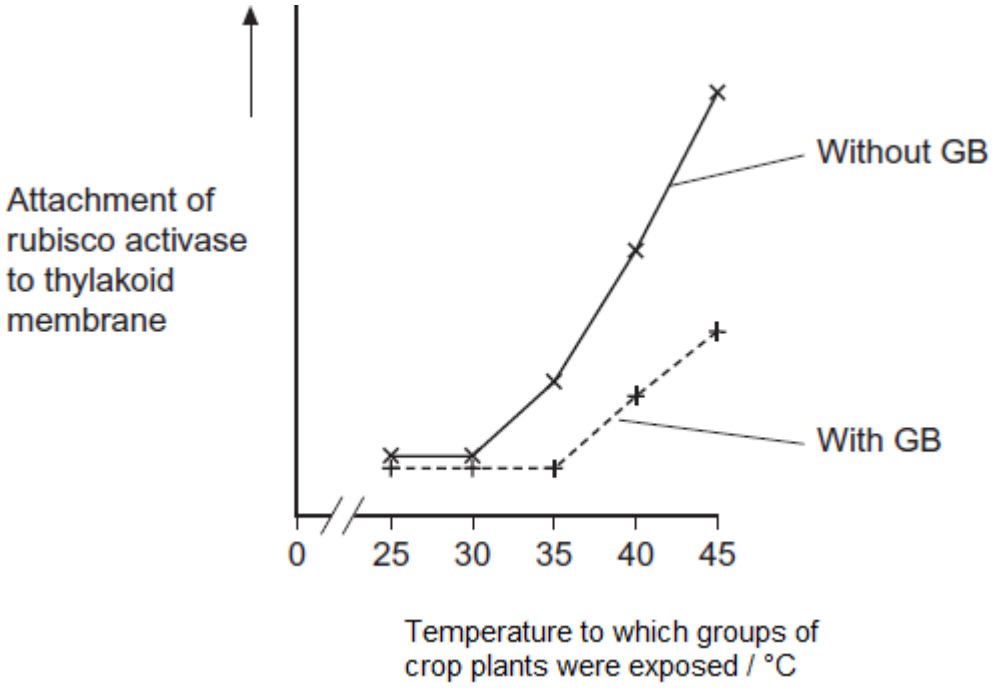
_____

(2)

(d) The scientists investigated the effect of GB on attachment of rubisco activase to thylakoid membranes at different temperatures.

Figure 3 shows their results.

Figure 3



Use information from **Figure 2** and **Figure 3** to suggest how GB protects the crop plant from high temperatures.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(e) The scientists' hypothesis at the start of the investigation was that crop plants genetically engineered to produce GB would become more resistant to high environmental temperatures.
The scientists developed this hypothesis on the basis of previous research on crops that are grown in hot climates.

Suggest how the scientists arrived at their hypothesis.

_____

_____

_____

_____

_____

(2)

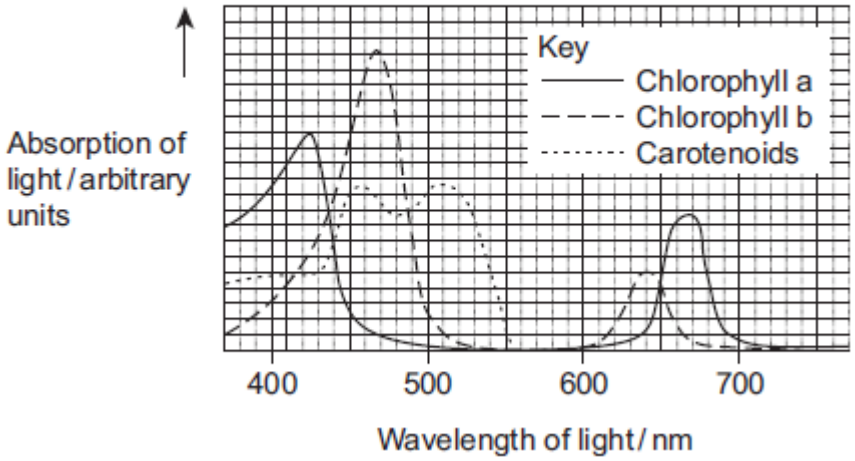
(Total 15 marks)

Q16.

Plants have pigments that absorb light energy for photosynthesis. These pigments include two types of chlorophyll and a group of pigments known as carotenoids. Different species of plant contain different amounts of these pigments. The pigments that each plant species has are adaptations to where and how they live; their ecological niche.

Figure 1 shows the absorption of light of different wavelengths by chlorophyll a, chlorophyll b and carotenoids.

Figure 1

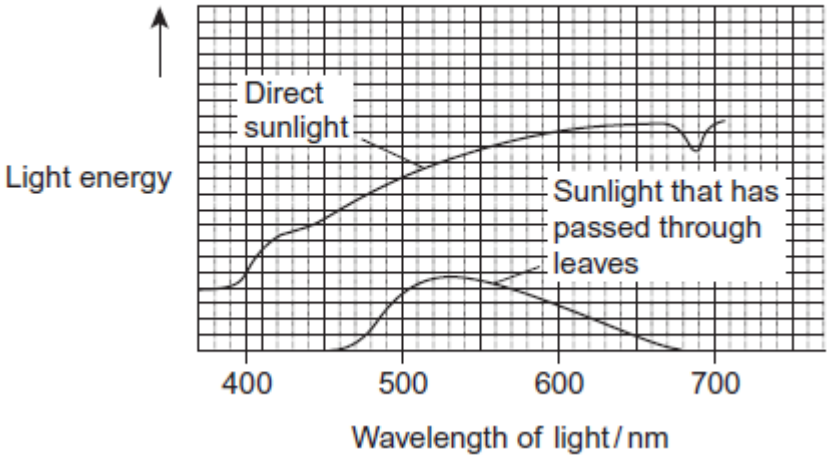


A scientist investigated the energy in light of different wavelengths reaching the ground in a forest. She measured the energy in

- direct sunlight
- sunlight that had passed through the leaves of trees.

Figure 2 shows her results.

Figure 2



(a) Use **Figure 1** to describe the absorption of light of different wavelengths by chlorophyll a.

_____

_____

_____

_____

_____

(2)

(b) Few species of plant can live below large trees in a forest.

Use the information in **Figure 1** and **Figure 2** to suggest why.

_____

_____

_____

_____

_____

_____

(3)

(c) In leaves at the top of trees in a forest, carbon dioxide is often the limiting factor for photosynthesis.
Use your knowledge of photosynthesis to suggest and explain **one** reason why.

_____

_____

_____

_____

_____

(2)

(Total 7 marks)

Q17.

Beech trees have two types of leaves called sun leaves and shade leaves. Sun leaves grow on branches exposed to direct sunlight, shade leaves grow on branches exposed to light that has passed through leaves. An ecologist collected sun leaves and shade leaves from beech trees and determined the mean mass of each photosynthetic pigment in both types of leaf. His results are shown the table below.

Photosynthetic pigment	**Mean mass of each pigment per m^2 of leaf area / µg (± standard deviation)**	
	Sun leaves	**Shade leaves**
Chlorophyll a	299.3 (± 2.1)	288.9 (± 0.1)
Chlorophyll b	290.7 (± 2.1)	111.1 (± 0.1)
Chlorophyll c	0.10 (± 0.01)	0.07 (± 0.01)

(a) Describe how you would present the data in the table as a graph.

_____

_____

_____

_____

_____

(2)

(b) The ecologist collected shade leaves at random from a branch.
Suggest a method he could have used to collect shade leaves at random from a branch.

_____

_____

_____

_____

_____

(2)

(c) The ecologist concluded that there is a significant difference between the amounts of chlorophyll b in sun leaves and shade leaves of beech trees.

Do you agree with this conclusion?

_____

_____

_____

_____

_____

(2)

(d) Each type of chlorophyll is produced by a specific enzyme-controlled pathway.
Use this information to suggest how the same beech tree can produce more chlorophyll b in some leaf cells than others.

_____

_____

_____

_____

_____

(2)

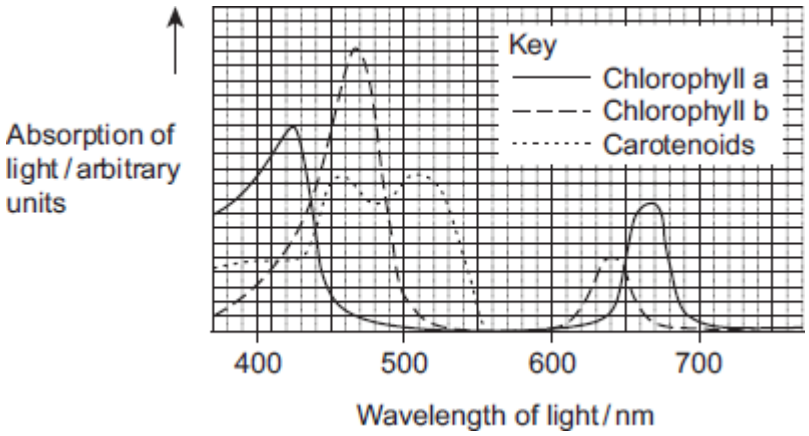
(Total 8 marks)

Q18.

Plants have pigments that absorb light energy for photosynthesis. These pigments include two types of chlorophyll and a group of pigments known as carotenoids. Different species of plant contain different amounts of these pigments. The pigments that each plant species has are adaptations to where and how they live; their ecological niche.

Figure 1 shows the absorption of light of different wavelengths by chlorophyll a, chlorophyll b and carotenoids.

Figure 1

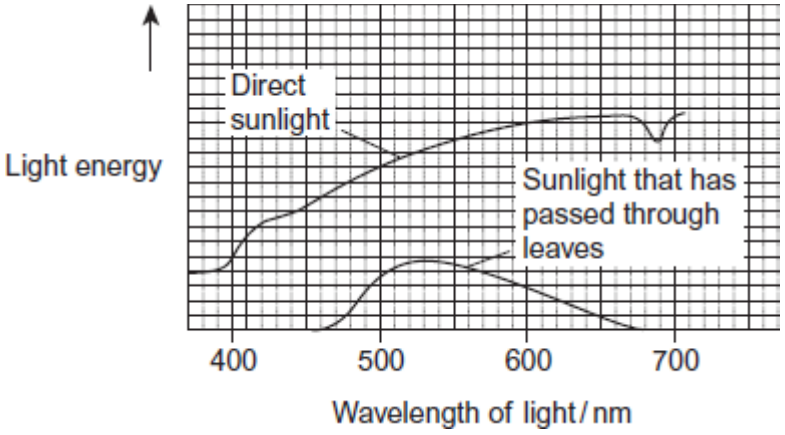


A scientist investigated the energy in light of different wavelengths reaching the ground in a forest. She measured the energy in

- direct sunlight
- sunlight that had passed through the leaves of trees.

Figure 2 shows her results.

Figure 2



Beech trees have two types of leaves called sun leaves and shade leaves. Sun leaves grow on branches exposed to direct sunlight, shade leaves grow on branches exposed to light that has passed through leaves. An ecologist collected sun leaves and shade leaves from beech trees and determined the mean mass of each photosynthetic pigment in both types of leaf. His results are shown in **Figure 3**.

Figure 3

Photosynthetic pigment	Mean mass of each pigment per m^2 of leaf area / µg (± standard deviation)	
	Sun leaves	Shade leaves
Chlorophyll a	299.3 (± 2.1)	288.9 (± 0.1)
Chlorophyll b	90.7 (± 2.1)	111.1 (± 0.1)
Carotenoids	0.10 (± 0.01)	0.07 (± 0.01)

(a) It is an advantage to beech trees to produce more chlorophyll b in the shade leaves.

Suggest and explain why.

_____

_____

_____

_____

_____

_____

(2)

(b) There are two hypotheses about the advantage to plants of producing carotenoids.

Hypothesis 1

Carotenoids help shade leaves to absorb more light of wavelengths 480 nm to 520nm for photosynthesis.

Hypothesis 2

Carotenoids prevent damage to chlorophyll from very bright light.

(i) Which hypothesis do the data provided on the resource sheet support?

Explain your answer.

Hypothesis _____

Explanation _____

_____

_____

_____

(2)

(ii) Suggest **one** other piece of experimental evidence you would need in order to be more confident about drawing your conclusion in (b)(i).

_____

_____

_____

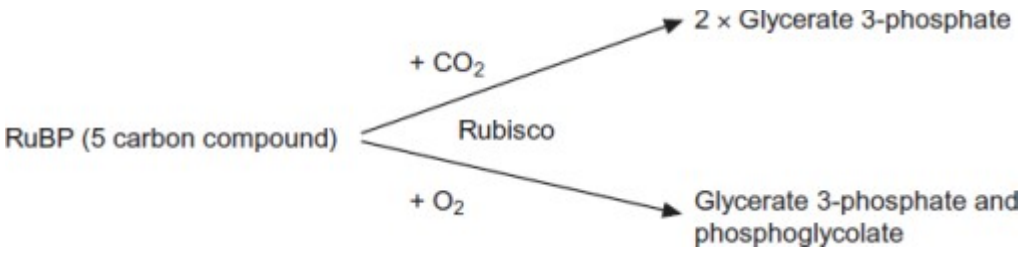
(1)

(Total 5 marks)

Q19.

During photosynthesis, carbon dioxide reacts with ribulose bisphosphate (RuBP) to form two molecules of glycerate 3-phosphate (GP). This reaction is catalysed by the enzyme Rubisco. Rubisco can also catalyse a reaction between RuBP and oxygen to form one molecule of GP and one molecule of phosphoglycolate. Both the reactions catalysed by Rubisco are shown in **Figure 1**.

Figure 1



(a) (i) Where exactly in a cell is the enzyme Rubisco found?

_____

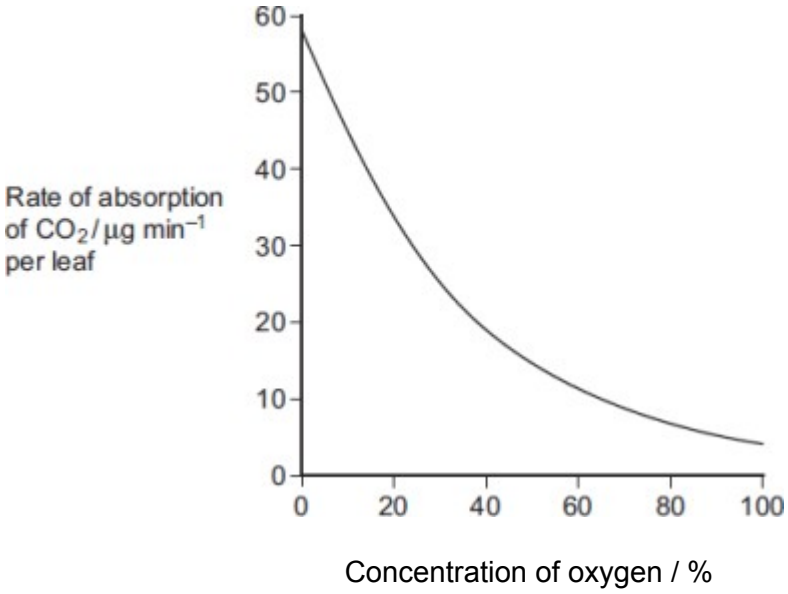
(1)

(ii) Use the information provided to give the number of carbon atoms in **one** molecule of phosphoglycolate.

(1)

(b) Scientists investigated the effect of different concentrations of oxygen on the rate of absorption of carbon dioxide by leaves of soya bean plants. Their results are shown in **Figure 2**.

Figure 2



Use **Figure 1** to explain the results obtained in **Figure 2**.

_____

_____

_____

_____

_____

(2)

(c) Use the information provided and your knowledge of the light-independent reaction to explain why the yield from soya bean plants is decreased at higher concentrations of oxygen. Phosphoglycolate is not used in the light-independent reaction.

_____

_____

_____

_____

_____

(3)

(Total 7 marks)

Q20.

(a) Energy enters most ecosystems through the light-dependent reaction of photosynthesis. Describe what happens during the light-dependent reaction.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(5)

(b) Changes in ecosystems can lead to speciation. A high concentration of copper in soil is toxic to most plants. In some areas where the soil is polluted with copper, populations of grasses are found to be growing. These populations of grass belong to a species also found growing on unpolluted soils.

It has been suggested that a new species of grass may evolve on soil that has been polluted with copper. Explain how this new species might evolve.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(5)

(Total 10 marks)

Q21.

A scientist investigated the uptake of radioactively labelled carbon dioxide in chloroplasts. She used three tubes, each containing different components of chloroplasts. She measured the uptake of carbon dioxide in each of these tubes.
Her results are shown in the table.

Tube	Contents of tube	Uptake of radioactively labelled CO_2 / counts per minute

A	Stroma and grana	96 000
B	Stroma, ATP and reduced NADP	97 000
C	Stroma	4 000

(a) Name the substance which combines with carbon dioxide in a chloroplast.

_____

(1)

(b) Explain why the results in tube **B** are similar to those in tube **A**.

_____

_____

_____

(1)

(c) Use the information in the table to predict the uptake of radioactively labelled carbon dioxide if tube **A** was placed in the dark. Explain your answer.

_____

_____

_____

_____

_____

(2)

(d) Use your knowledge of the light-independent reaction to explain why the uptake of carbon dioxide in tube **C** was less than the uptake in tube **B**.

_____

_____

_____

_____

_____

(2)

(e) DCMU is used as a weed killer. It inhibits electron transfer during photosynthesis. The addition of DCMU to tube **A** decreased the uptake of carbon dioxide. Explain why.

_____

_____

_____

_____

_____

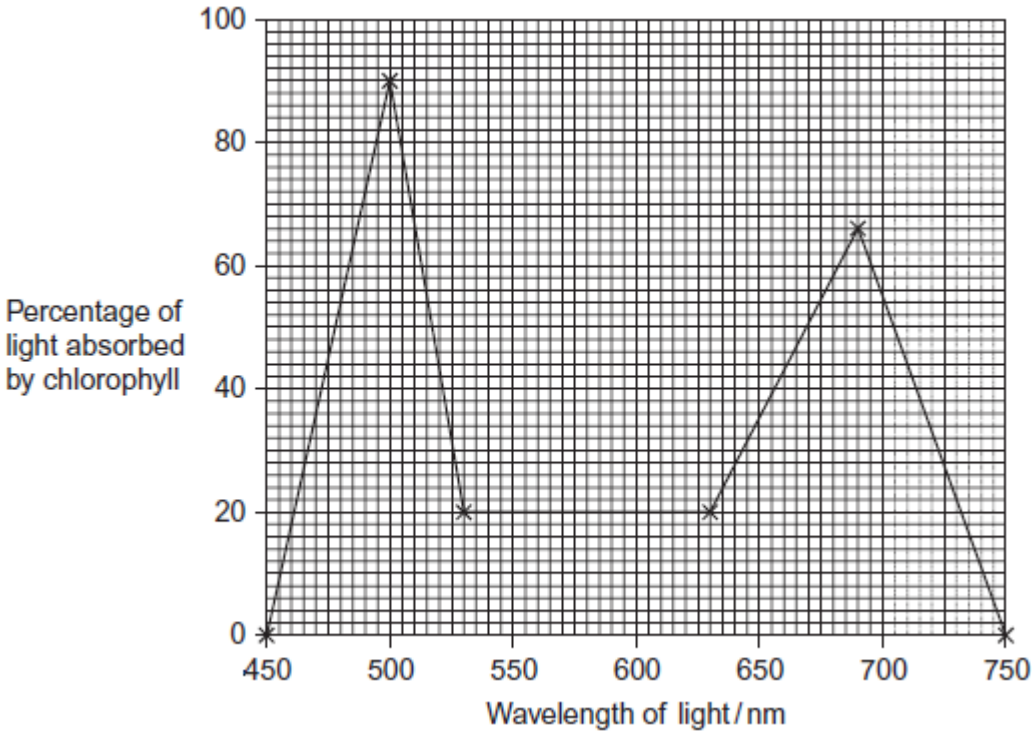
(2)

(Total 8 marks)

Q22.

Figure 1 shows the effect of wavelength on the percentage of light absorbed by the chlorophyll from these seaweeds.

Figure 1



Some scientists investigated the growth of these seaweeds in artificial conditions. They investigated the effect of different lamps on the rate of photosynthesis of the seaweeds.

- Lamp **P** produced light containing all wavelengths of visible light. (450 to 750 nm)
- Lamp **Q** only produced light of wavelength 460 nm.

The scientists measured photosynthesis by recording the rate of oxygen production. Their results are shown in **Figure 2**.

Figure 2

	Mean rate of photosynthesis/arbitrary units (± standard deviation)	
Species	Lamp **P**	Lamp **Q**

	Light of all wavelengths of visible light	Light of wavelength 460nm
Ulva pertusa	1300.9 (± 125.4)	776.6 (± 105.6)
Mastocarpus yendoi	318.9 (± 69.5)	299.6 (± 83.2)

(a) Between 500 and 700 nm, what range of wavelengths of light is absorbed least by chlorophyll?

_____

(1)

(b) The scientists measured the oxygen produced by the light-dependent reaction of photosynthesis. Name **two** other substances produced by the light-dependent reaction.

1. _____

2. _____

(2)

(c) (i) The scientists measured the rate of photosynthesis of the seaweeds in this investigation in terms of oxygen produced.
Suggest the units they should use.

_____

(2)

(ii) This investigation was carried out in bright light. Explain why reducing the light intensity would affect the amount of oxygen released by the seaweeds.

_____

_____

_____

_____

_____

_____

(3)

(d) In this investigation, the scientists kept the temperature at 15 °C. A student suggested that repeating the investigation at 20 °C would not affect the amount of oxygen released by the seaweed. Evaluate this suggestion.

_____

_____

_____

_____

_____

_____

(3)

(e) (i) Did the type of lamp used affect the rate of photosynthesis in *M. yendoi*? Explain the evidence for your answer.

_____

_____

_____

_____

_____

(2)

(ii) The different lamps resulted in different rates of photosynthesis by *U. pertusa*. Explain why there was a higher rate of photosynthesis when the seaweed was illuminated with lamp **P**.

_____

_____

_____

_____

_____

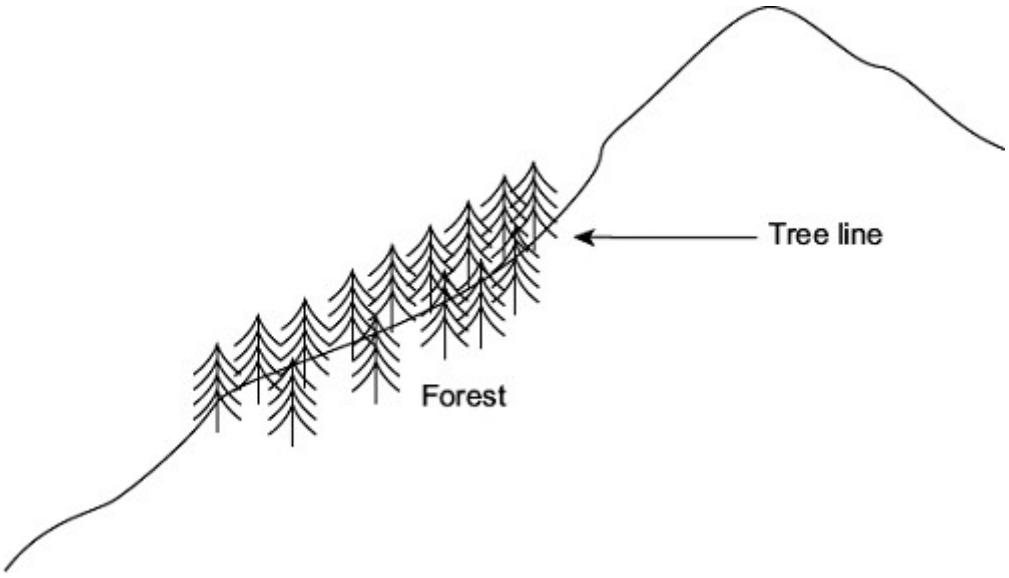
_____

(3)

(Total 16 marks)

Q23.

Mountains are harsh environments. The higher up the mountain, the lower the temperature becomes. The diagram shows a forest growing on the side of a mountain. The upper boundary of the forest is called the tree line. Trees do not grow above the tree line.



(a) (i) The position of the tree line is determined by abiotic factors.
What is meant by an abiotic factor?

_____

_____

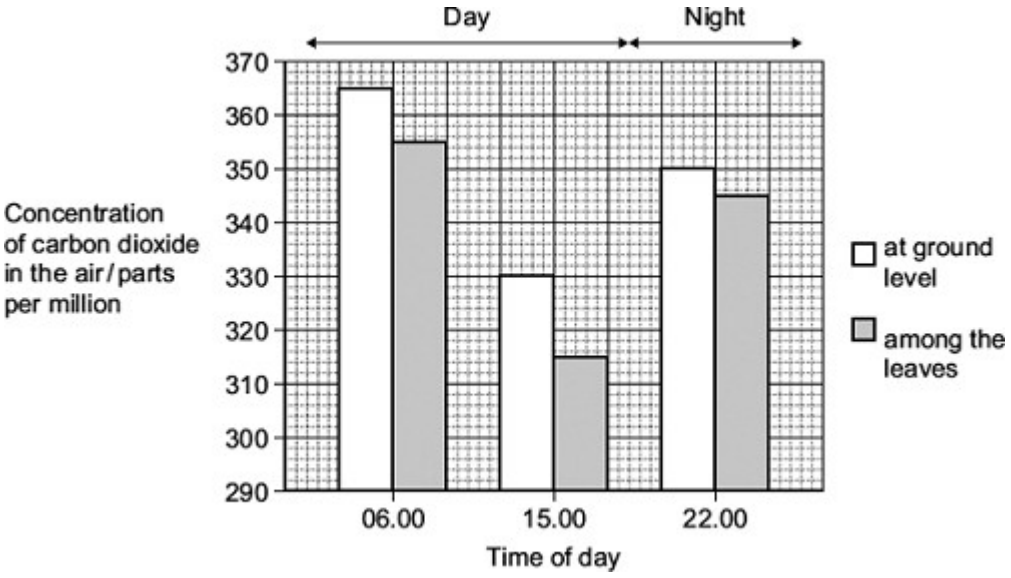
(1)

(ii) Other than temperature, suggest **one** abiotic factor that is likely to affect the position of the tree line on the mountain.

_____

(1)

(b) Scientists measured the concentration of carbon dioxide in the air in one part of the forest. They took measurements at different times of day and at two different heights above the ground. Their results are shown in the bar chart.



Use your knowledge of photosynthesis and respiration to explain the data in the bar chart.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(c) The population of trees in the forest evolved adaptations to the mountain environment.
Use your knowledge of selection to explain how.

_____

_____

_____

_____

_____

_____

(3)

(Total 9 marks)

Q24.

(a) ATP is useful in many biological processes. Explain why.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(b) Describe how ATP is made in mitochondria.

(6)

(c) Plants produce ATP in their chloroplasts during photosynthesis. They also produce ATP during respiration. Explain why it is important for plants to produce ATP during respiration in addition to during photosynthesis.

(5)

(Total 15 marks)

Q25.

(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.

_____

(1)

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

1. _____

_____

2. _____

_____

(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.

_____

_____

_____

_____

_____

(2)

(Total 8 marks)

Q26.

Much of Indonesia is covered with forest. Large areas of forest have been cleared and planted with oil-palm trees to be used in the production of fuel.

(a) In these forests, nitrogen in dead leaves is made available to growing plants by the action of bacteria. Describe the role of bacteria in making the nitrogen in dead leaves available to growing plants.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(5)

(b) During photosynthesis, oil-palm trees convert carbon dioxide into organic substances. Describe how.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

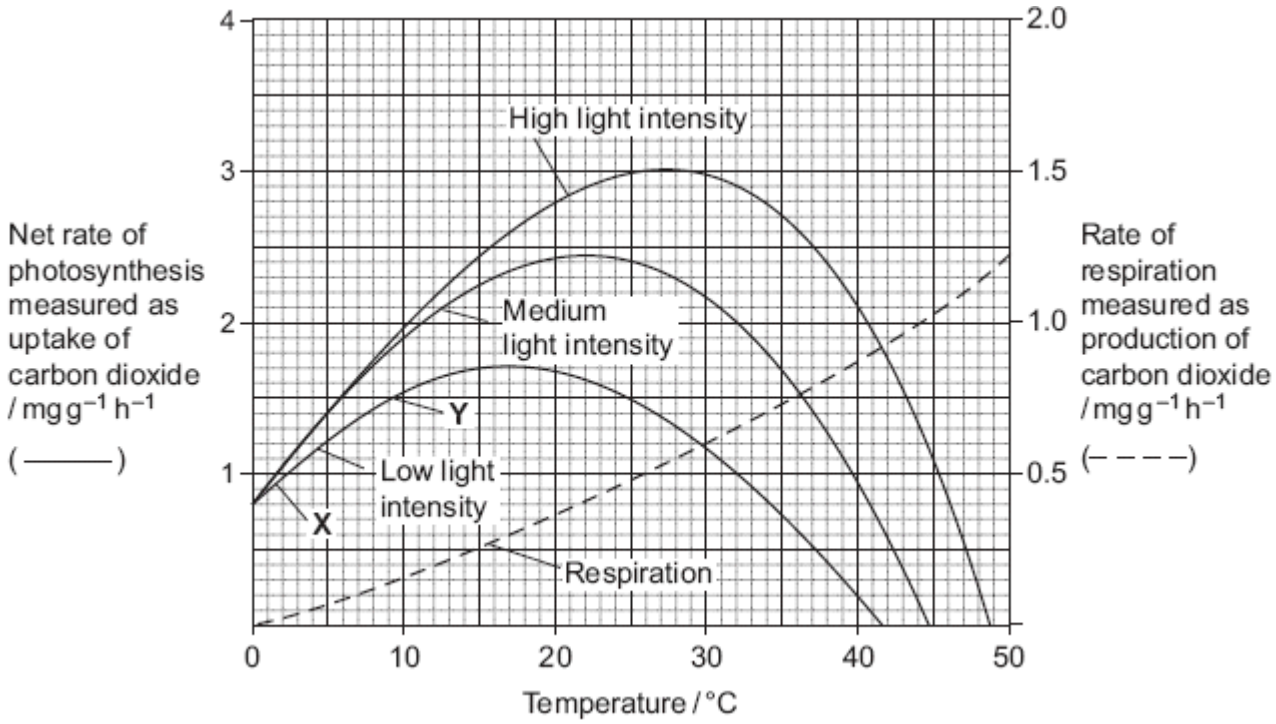
_____

(6)

(Total 11 marks)

Q27.

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.

(3)

(Total 7 marks)

Q28.

(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)

Q29.

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 temperature inside the glasshouses above 18 °C. They opened the windows to keep the temperature 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 concentration 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)

Q30.

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

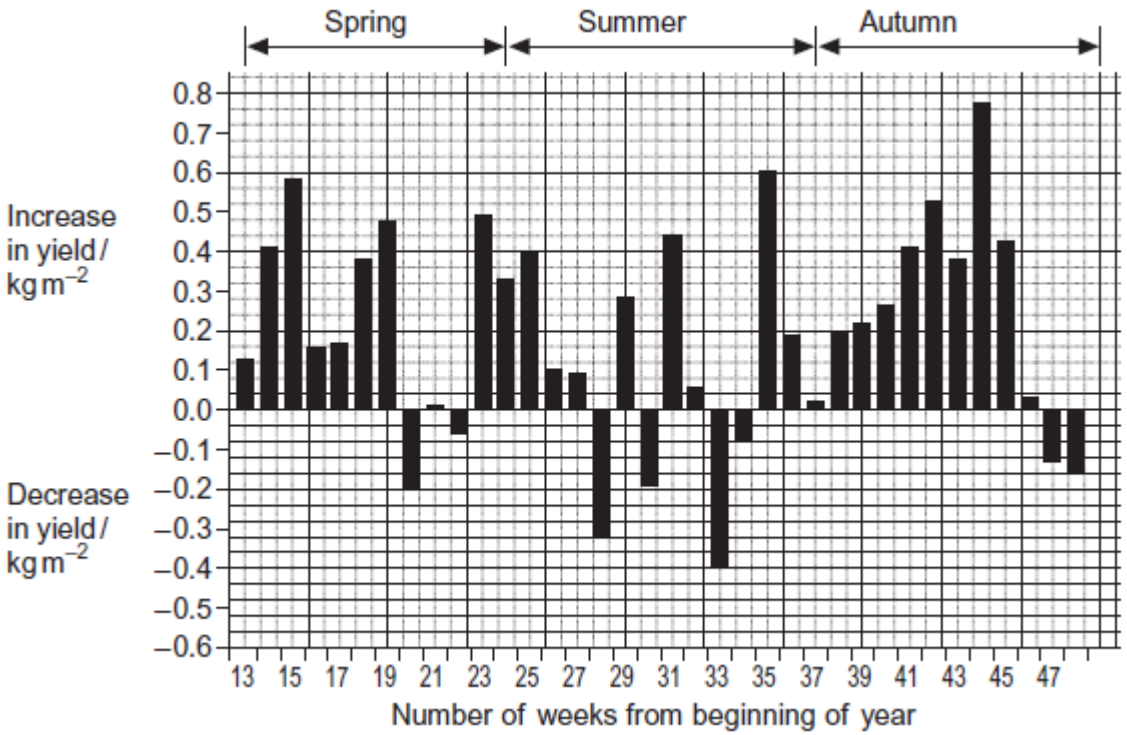
- The scientists used heating to maintain the tempera ture inside the glasshouses above 18 °C. They opened the windows to keep the tempera ture below 30 °C.
- From 1998 to 2000 they maintained the carbon dioxide concentration between 0.06 % and 0.08 % when the windows were closed and between 0.04 % and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

Resource B

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.

Resource D

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)

Q31.

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

Describe how.

_____

_____

_____

_____

_____

_____

_____

_____

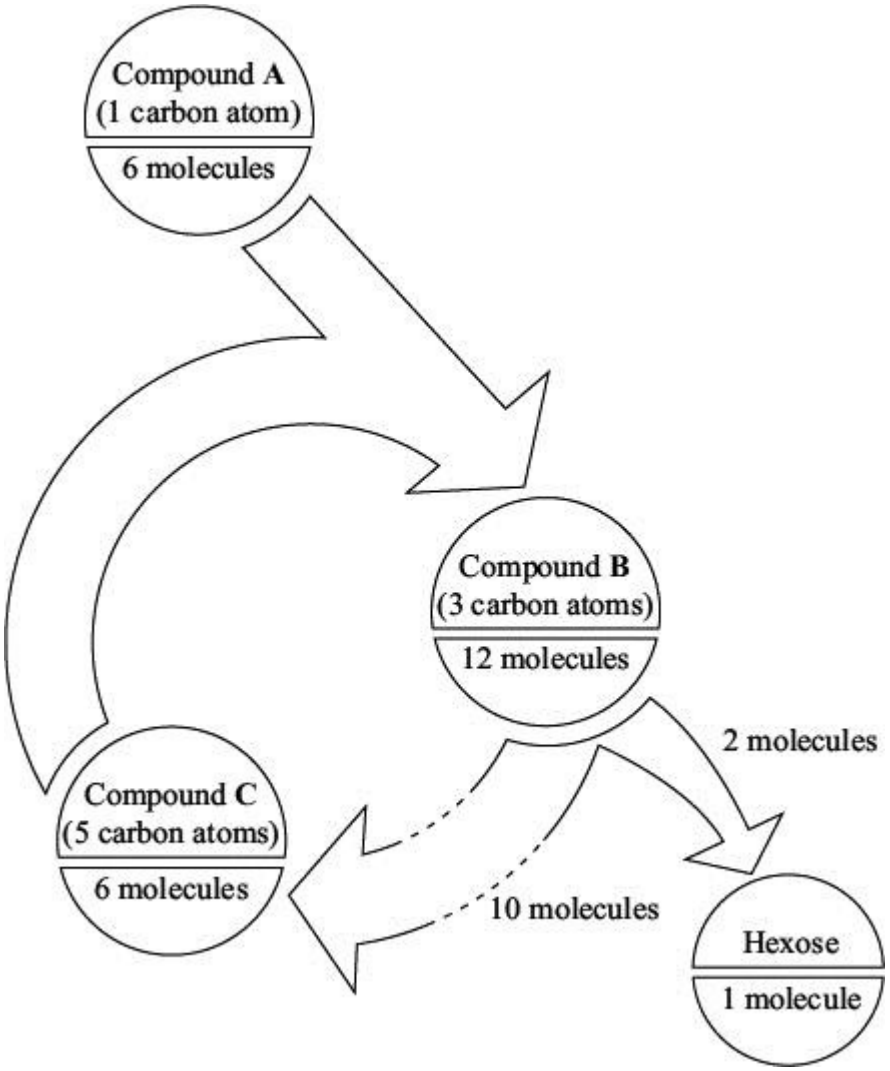
_____

_____

(Total 5 marks)

Q32.

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)

Q33.

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)

(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)

Q34.

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.

_____

_____

_____

_____

_____

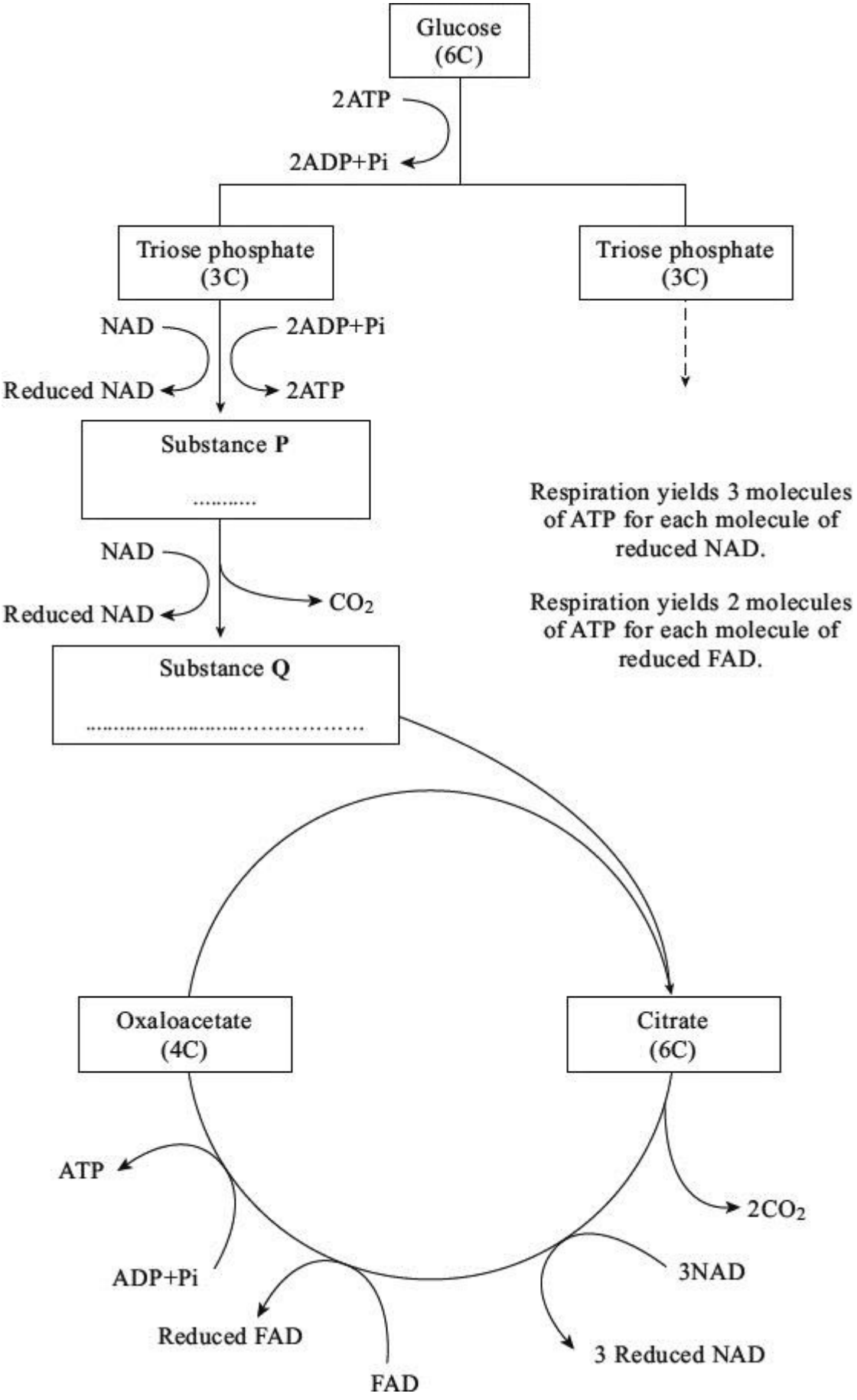
_____

(3)

(Total 5 marks)

Q35.

(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.

_____

_____

_____

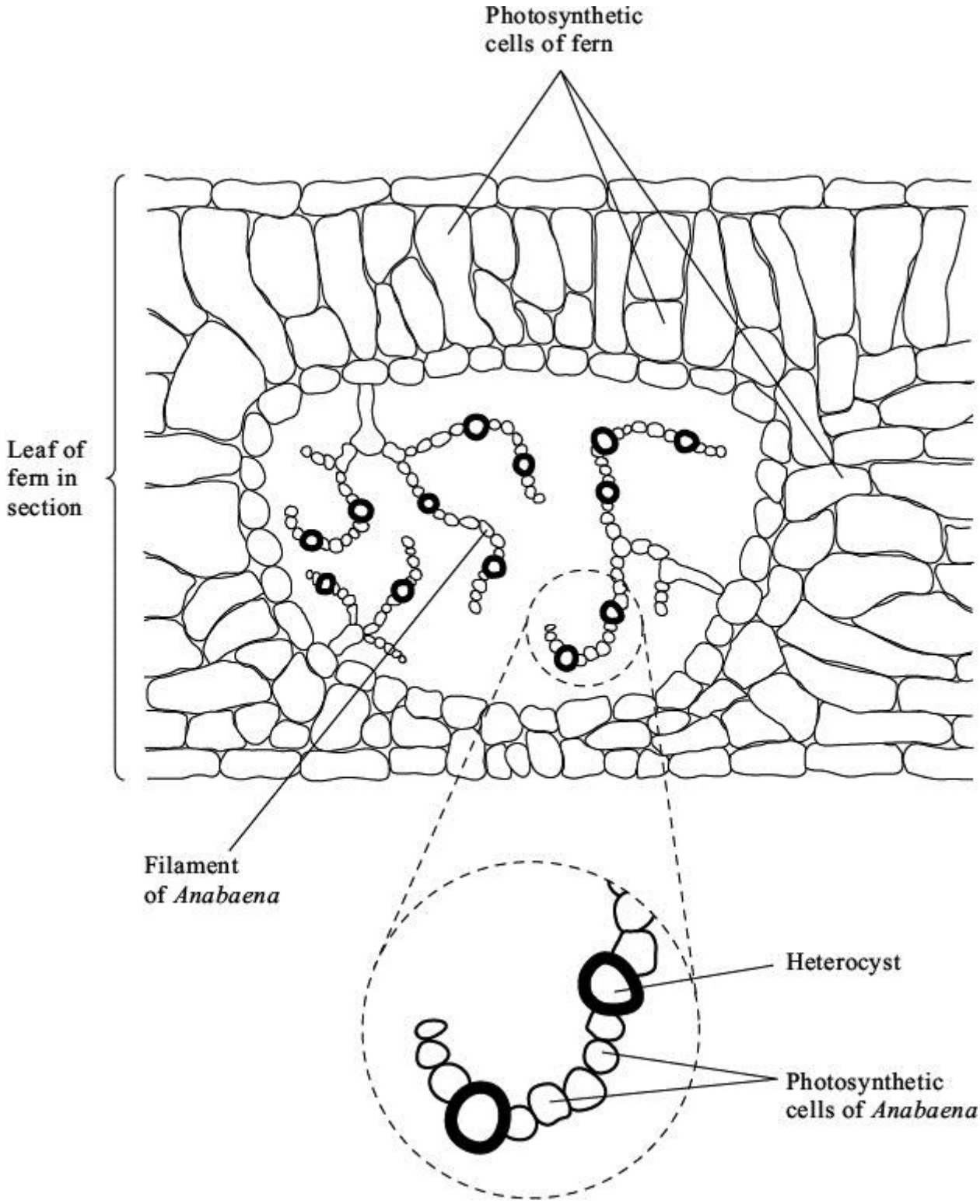
_____

_____

_____

(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)

Q36.

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

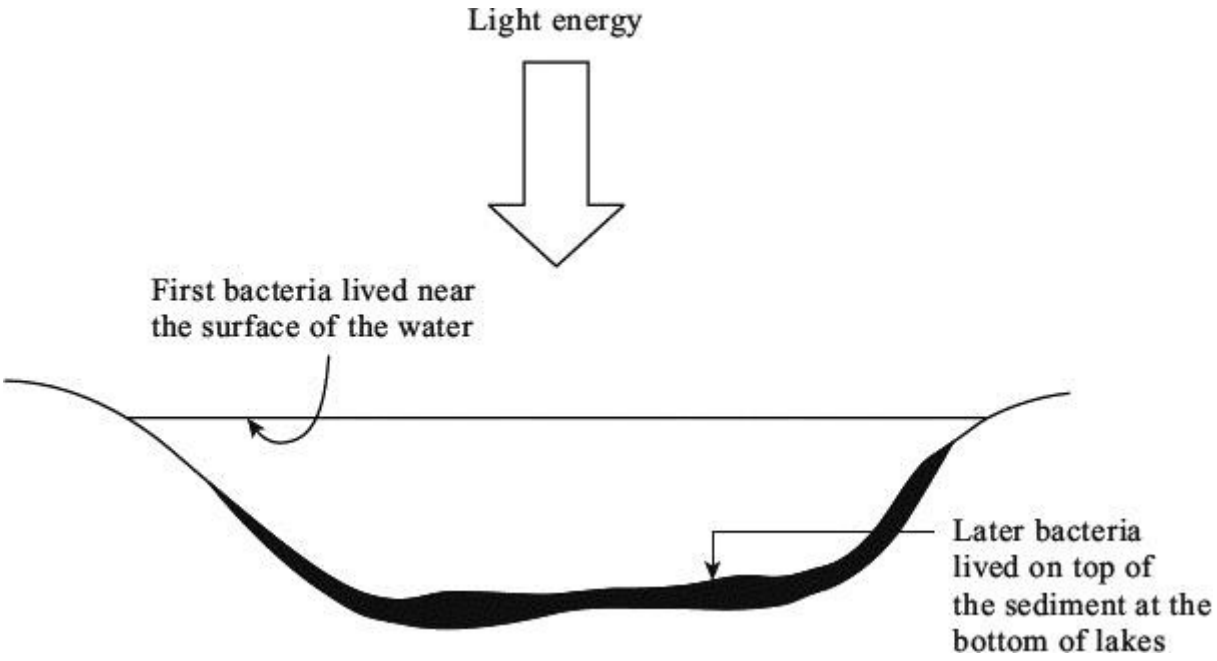
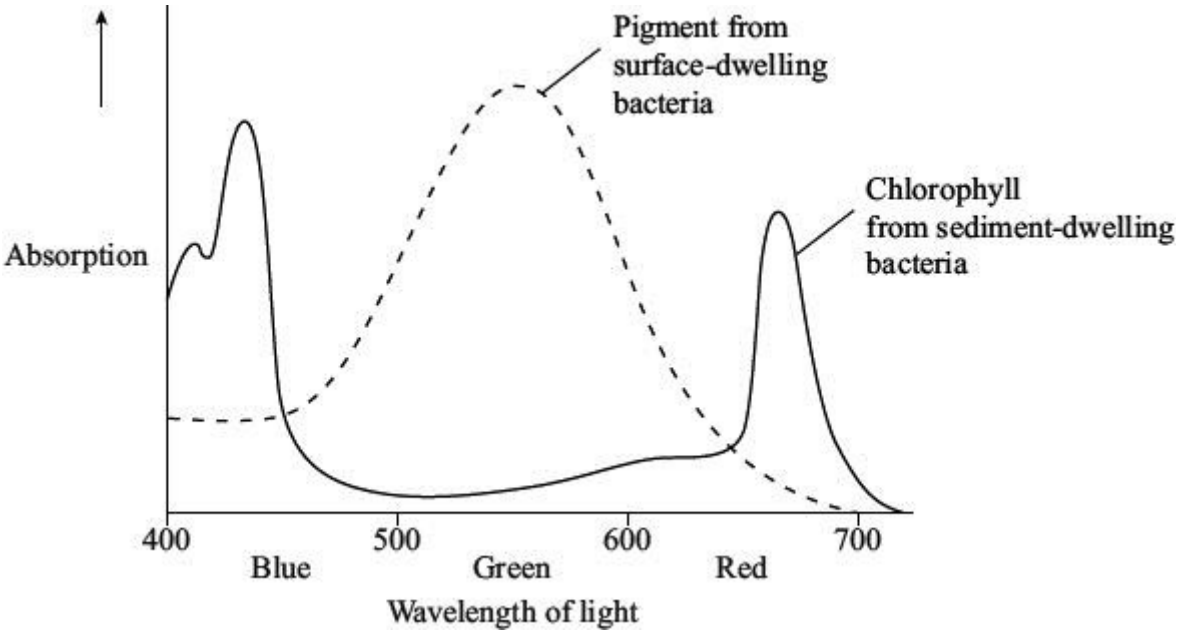


Figure 2



(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.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

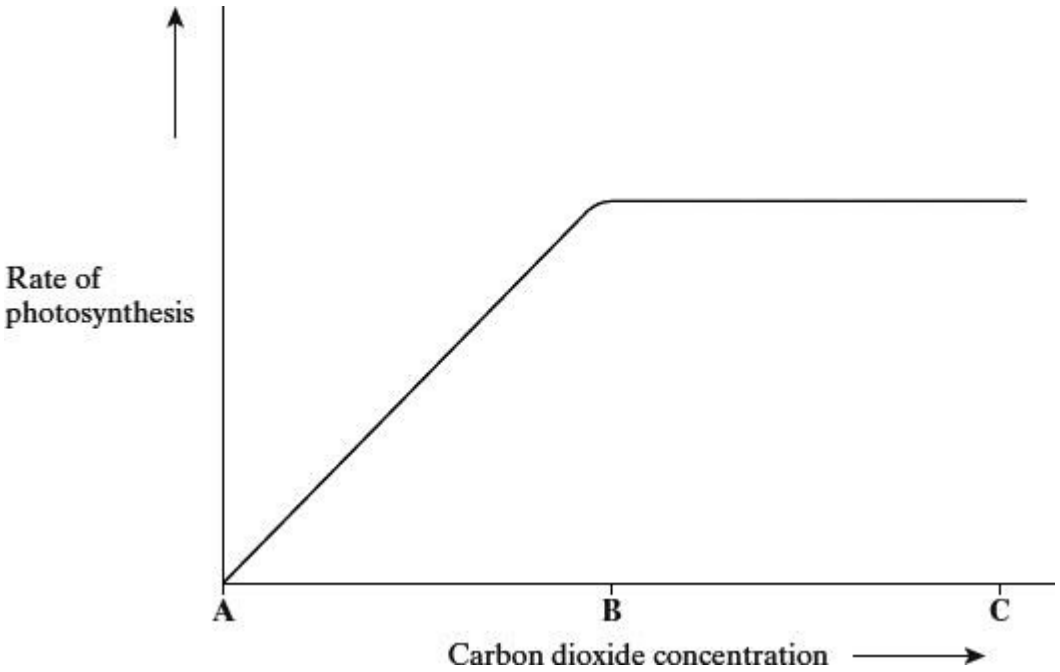
_____

(6)

(Total 11 marks)

Q37.

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**.

_____

_____

_____

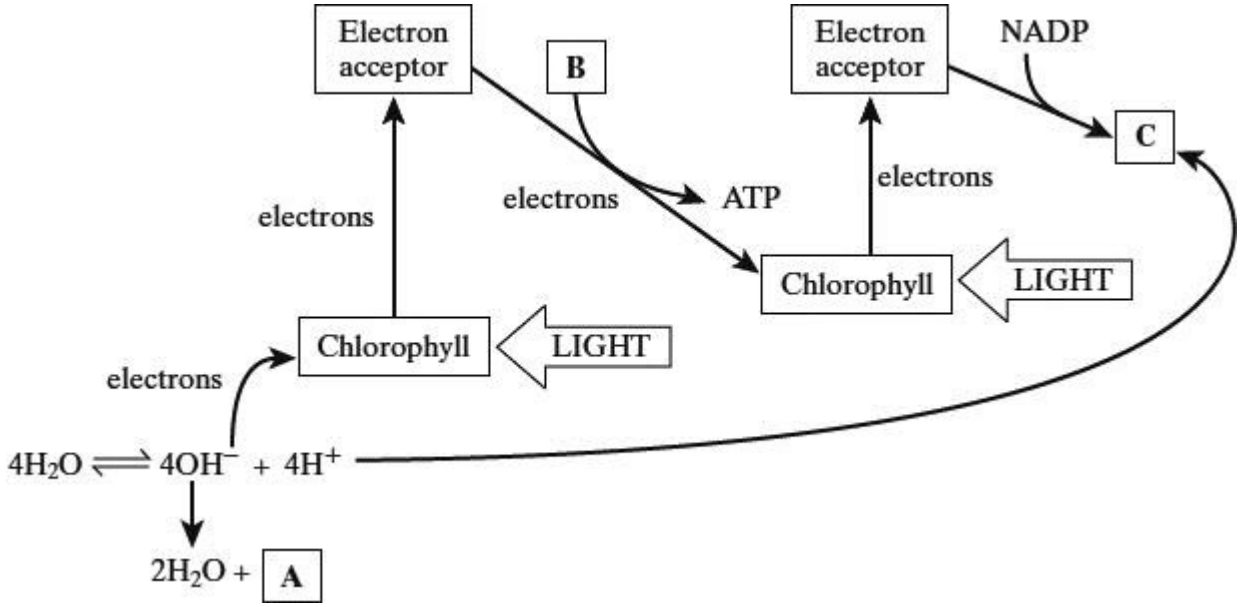
_____

(2)

(Total 6 marks)

Q38.

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.

_____

_____

_____

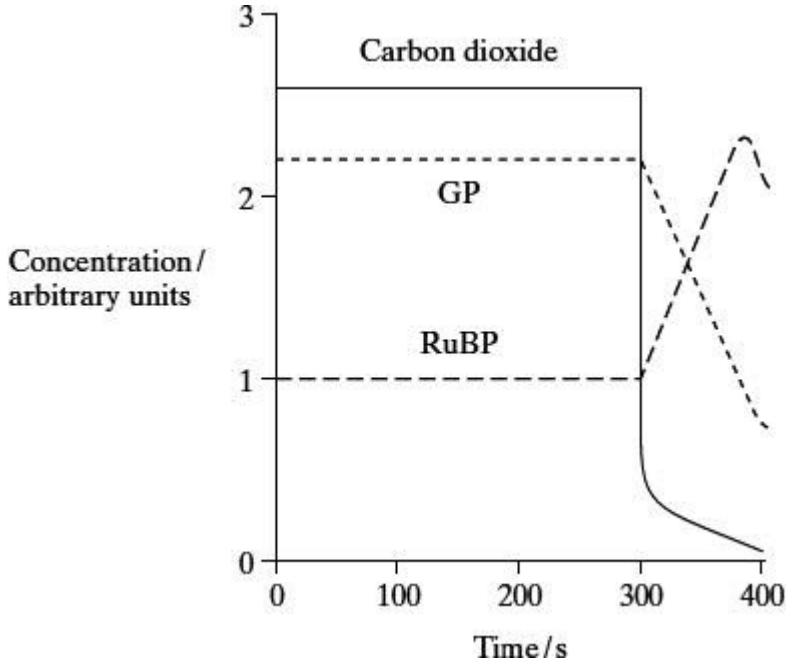
_____

_____

_____

(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.

_____

_____

_____

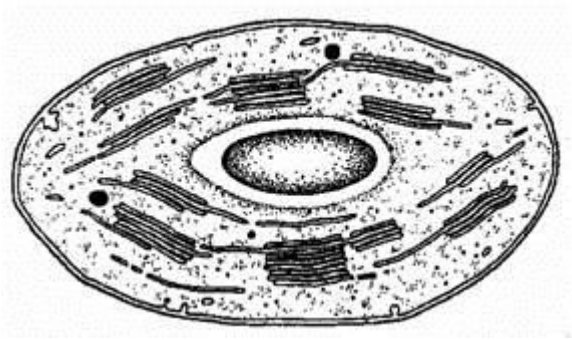
_____

(2)

(Total 15 marks)

Q39.

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)

Q40.

(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)

(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)

Q41.

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

_____

_____

_____

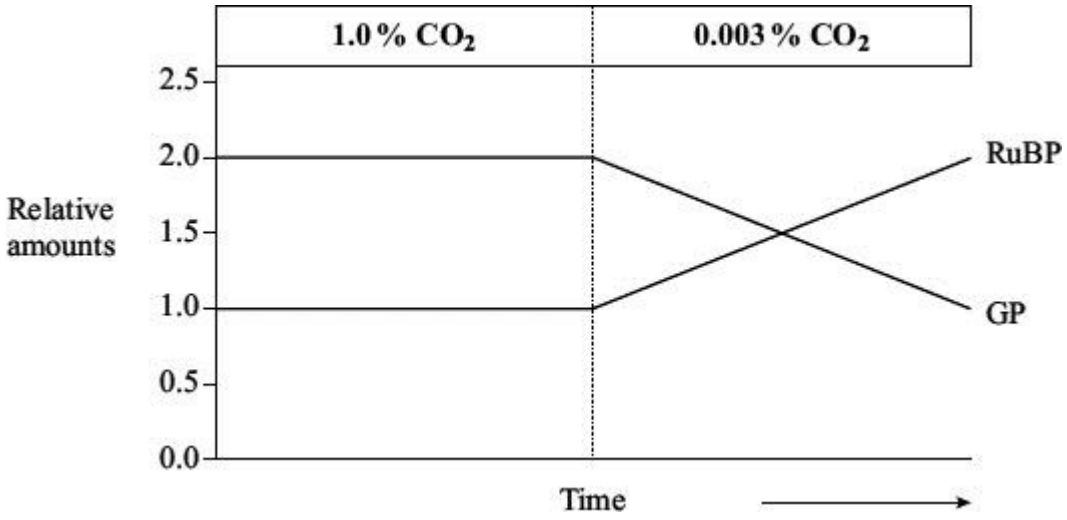
_____

(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.

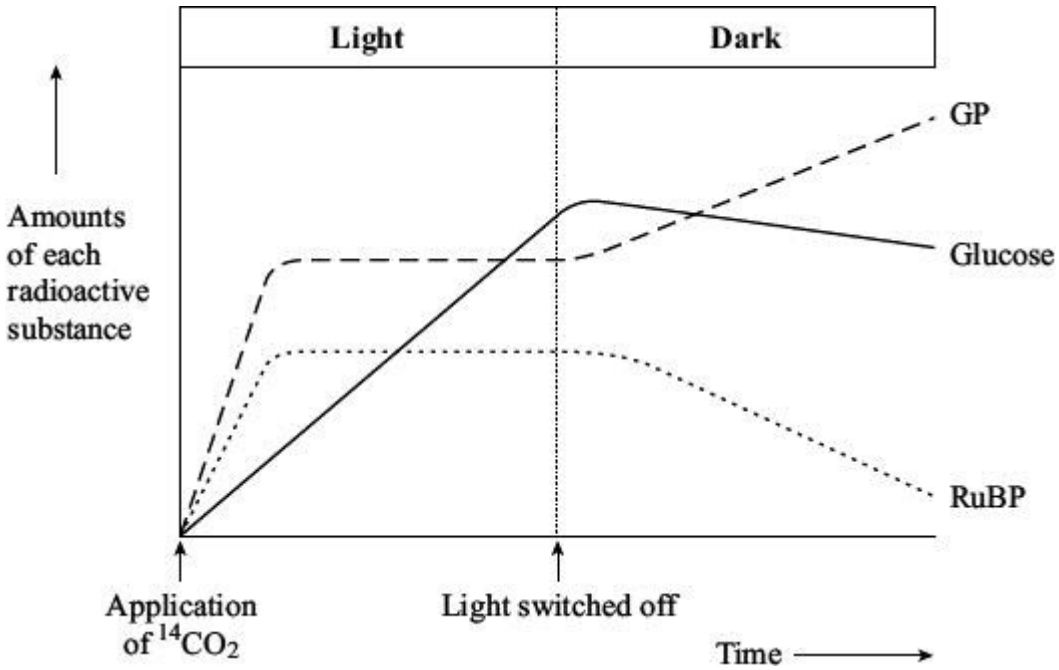
_____

_____

(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.

_____

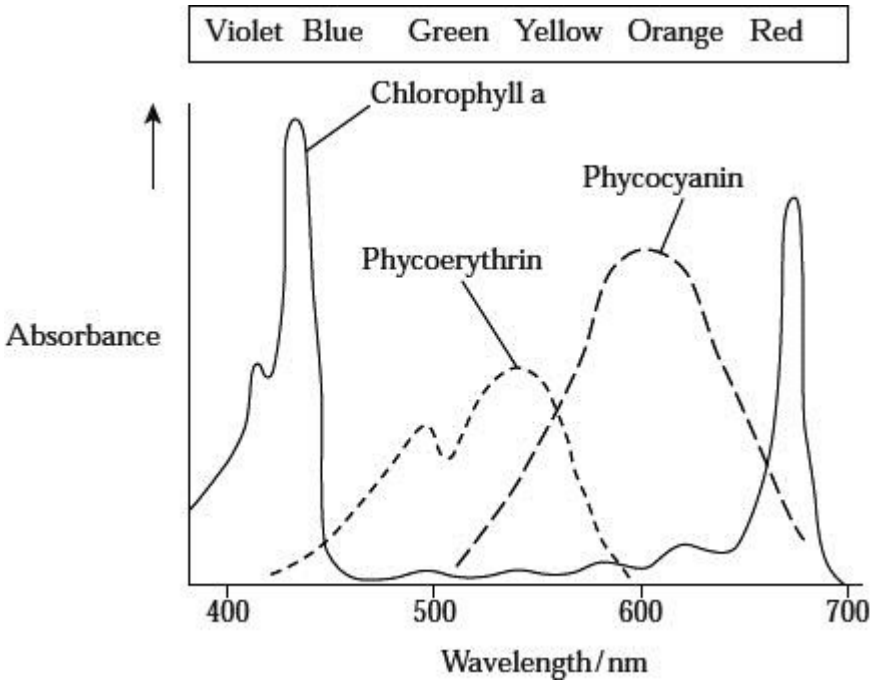
_____

(1)

(Total 8 marks)

Q42.

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.

_____

_____

_____

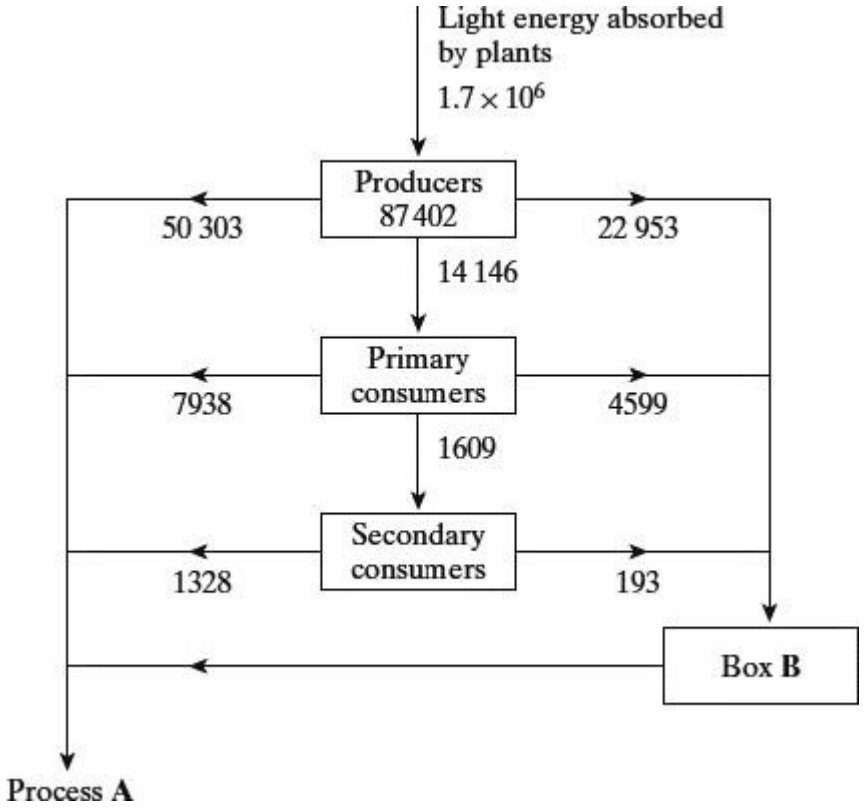
_____

(2)

(Total 6 marks)

Q43.

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)

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

_____

_____

_____

_____

(2)

(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 _____

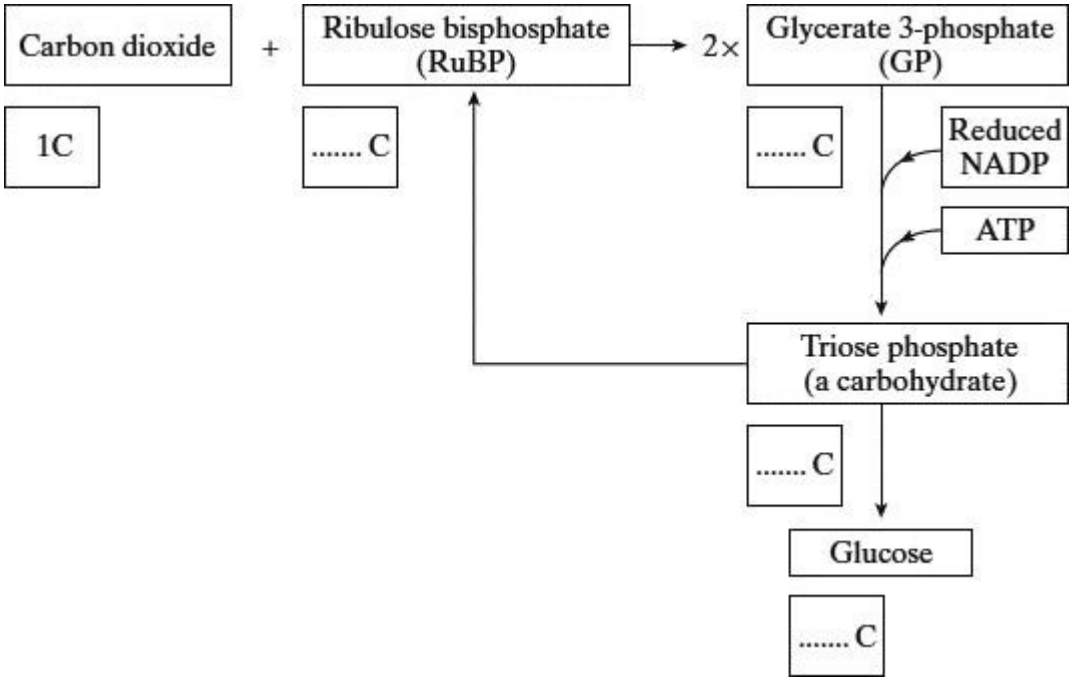
_____

(4)

(Total 10 marks)

Q44.

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.

_____

_____

_____

_____

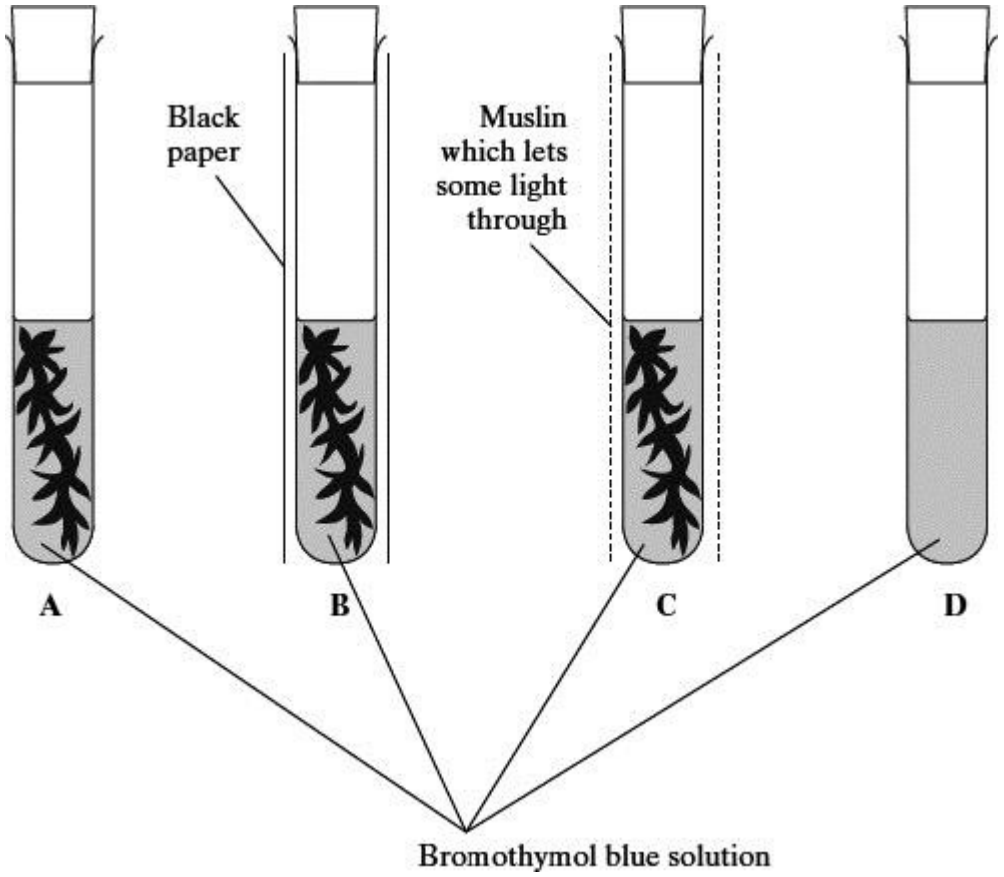
(2)

(Total 7 marks)

Q45.

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.

_____

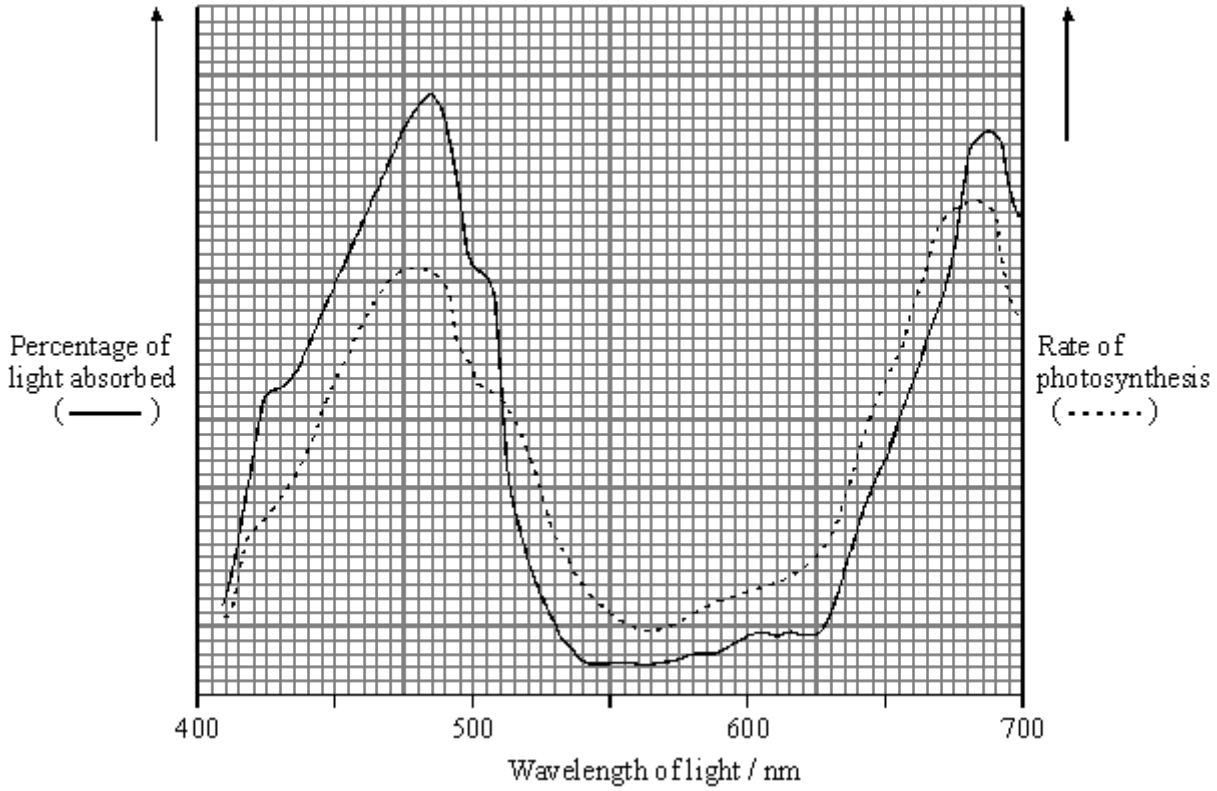
_____

(1)

(Total 6 marks)

Q46.

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.

_____

_____

_____

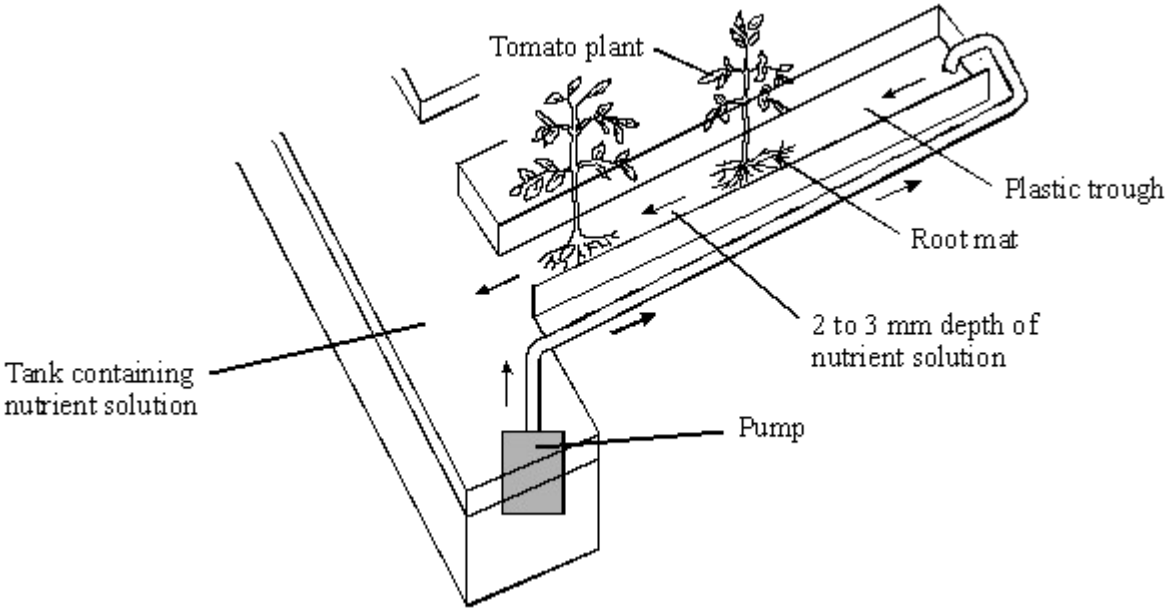
_____

(2)

(Total 9 marks)

Q47.

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)

(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)