1. *Answers should be written in continuous prose. Credit will be given for biological accuracy; the organisation and presentation of the information and the way in which the answer is expressed.*

Read the following passage.

Photosynthesis takes place in the chloroplasts. These are disc-shaped organelles surrounded by an outer envelope consisting of two layers of membrane. Inside, there are further membranes which are arranged in stacks called grana. Surrounding these is the stroma. Chlorophyll and other light- capturing pigments are found on the membranes of the grana and it is here that the light-dependent reaction takes place. This generates the ATP and reduced NADP which are used in the light-independent reaction in the stroma.

(a) (i) Describe the way in which ATP and reduced NADP are produced in the light-dependent reaction of photosynthesis.

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(5)

(ii) Explain how ATP and reduced NADP are used in the light-independent reaction of photosynthesis.

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(4)

(b) Using the information in the passage, describe how the structure of a chloroplast is adapted to its function in photosynthesis.

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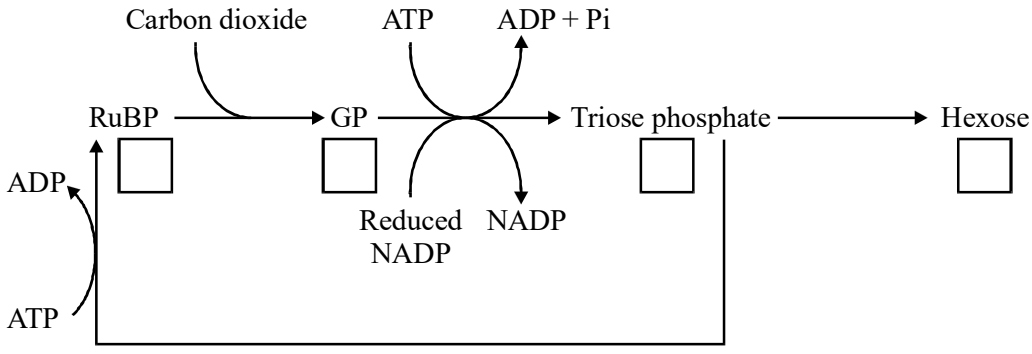
(3)
(Total 12 marks)

2. (a) The diagram summarises the light-independent reaction of photosynthesis.



(i) Complete the **four** boxes to show the number of carbon atoms in a molecule of each substance.

(1)

(ii) Where in the chloroplast does the light-independent reaction take place?

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(1)

(iii) Explain why the amount of GP increases after a photosynthesising plant has been in darkness for a short time.

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(2)

(b) Describe the role of water in the light-dependent reaction of photosynthesis.

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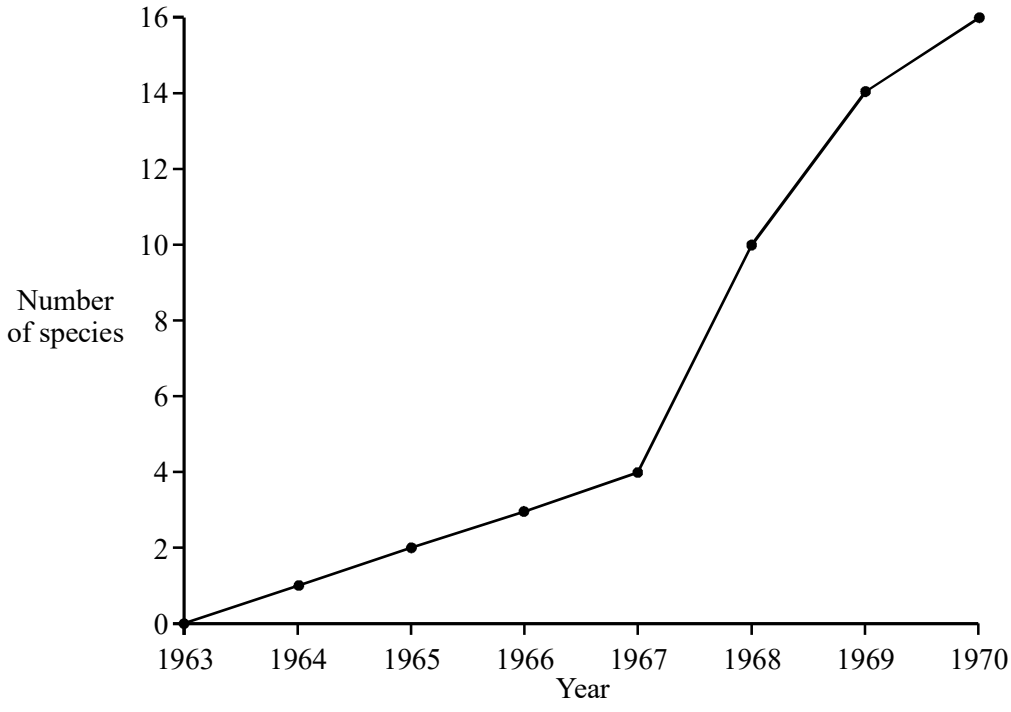
(2)

(Total 6 marks)

3. The island of Surtsey was formed in 1963 by a series of volcanic eruptions. Biologists have studied the colonisation of this new island by plants and animals.

(a) The graph shows the number of species of plants found on the island each year for the first seven years of its existence.



The development of the plant community on Surtsey illustrates the process of succession. Explain why:

(i) very few species could grow on the island in the first few years after it was formed;

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(1)

(ii) once some plants were growing, the rate at which new species could establish themselves increased rapidly.

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(2)

(b) Animals also colonised Surtsey. One conclusion drawn from studying them was that particular species of animals found here had broader ecological niches than they did on the nearby mainland. Suggest why.

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(1)
(Total 4 marks)

4. *Answers should be written in continuous prose. Credit will be given for biological accuracy, the organisation and presentation of the information and the way in which the answer is expressed.*

Read the following passage.

The living state requires a constant input of energy, and the most fundamental difference between animals and plants is the way they obtain their energy. Animals take in food - organic compounds - and release chemical energy during respiration; green plants absorb light energy from the sun, converting it to chemical energy in the process of photosynthesis.

Source. adapted from RIDGE.I.(ED), *Plant Physiology* (Hodder and Stoughton, 1991)

(a) Describe how plants absorb light energy from the sun and use this energy to produce useful substances in the light-dependent stage of photosynthesis.

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(5)

(b) Describe how the products of the light-dependent stage of photosynthesis are used in the Calvin cycle and how carbohydrate is synthesised as a result of the cycle.

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(6)

(c) Describe the similarities between photosynthesis and respiration.

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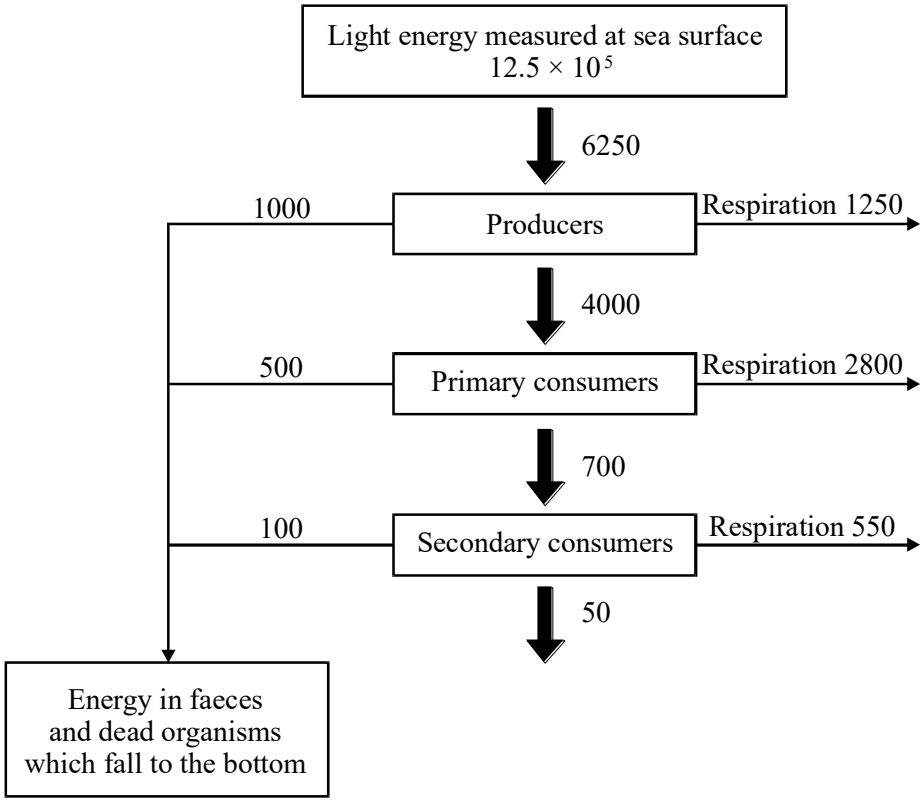
(6)

(Total 17 marks)

5. The diagram shows the flow of energy through a marine ecosystem.
The units are kJ m^{-2} $year^{-1}$.



(a) (i) Calculate the percentage of the light energy at the sea surface which is converted into chemical energy in the producers. Show your working.

(2)

(ii) The percentage of the light energy at the sea surface which is converted into chemical energy in the producers is very small. Give **two** reasons for this.

(2)

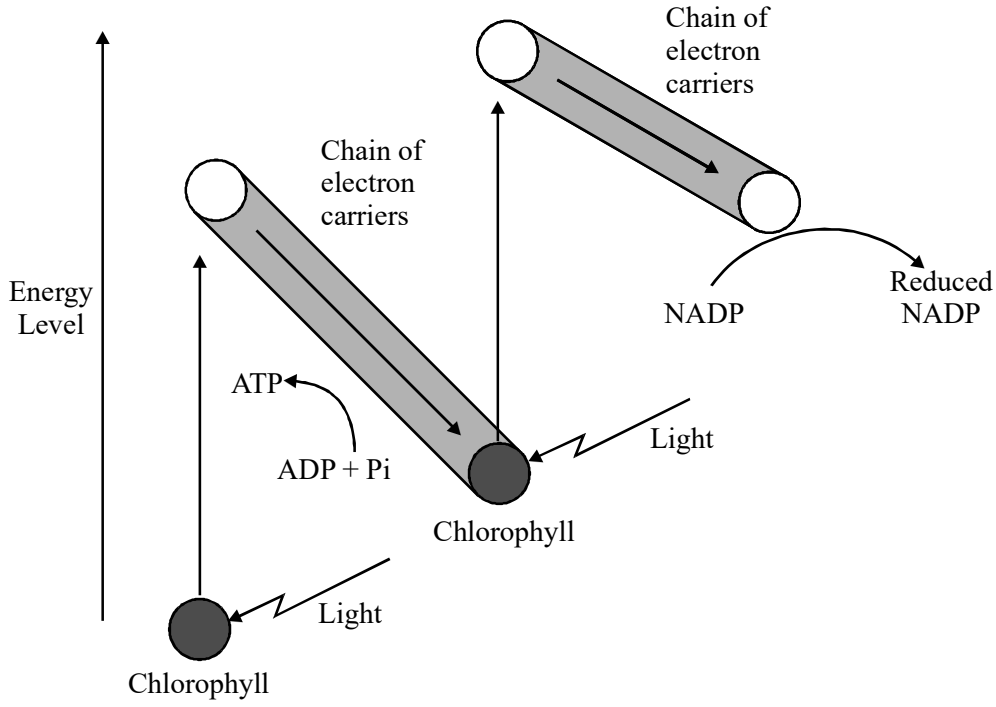
(b) Use the information in the diagram to explain why marine ecosystems such as this rarely have more than five trophic levels.

(2)

(c) What happens to the energy in faeces and dead organisms which fall to the bottom of the sea?

(2)

(d) Light energy is important in the light-dependent reaction of photosynthesis. The energy changes which take place in the light-dependent reaction are shown in the diagram.



(i) Describe what happens to the chlorophyll when it is struck by light.

(2)

(ii) The weedkiller DCMU blocks the flow of electrons along the chains of electron carriers. Describe and explain the effect this will have on the production of triose phosphate in the light-independent reaction.

(3)

(e) Living organisms release energy from organic molecules such as glucose during respiration.
Much of this energy is used to produce ATP.
Explain why ATP is better than glucose as an immediate energy source for cell metabolism.

(2)

(f) The production of ATP is said to be coupled to the transport of electrons along the carrier chain. Normally, electrons are only passed along the carrier chain if ADP is being converted to ATP at the same time. When the amount of ADP in a cell is low, electrons do not flow from reduced coenzyme to oxygen.

(i) Suggest how the rate of respiration is linked to the needs of the cell.

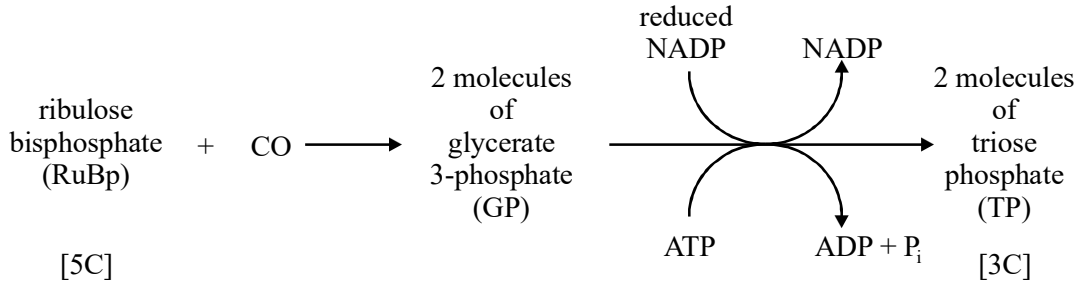
(3)

(ii) DNP is a substance which allows electron transport to take place without the production of ATP. When DNP is given to rats, their body temperatures rise. Explain why.

(2)

(Total 20 marks)

6. (a) The diagram shows part of the light-independent reaction of photosynthesis.



(i) How many carbon atoms are there in one molecule of glycerate 3-phosphate?

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(1)

(ii) What is the function of each of the following in the reactions shown in the diagram?

Reduced NADP .....

.....

ATP .....

.....

(2)

(b) Radioactive carbon dioxide was supplied to a culture of photosynthesising single-celled algae. At 5-second intervals, samples of the culture were dropped into boiling alcohol to stop all chemical reactions. The radioactive substances identified in these samples are given in the table.

Time / s	Radioactive substances identified
0	carbon dioxide
5	GP
10	GP, TP
15	GP, TP, ribulose phosphate, glucose
20	GP, TP, ribulose phosphate, glucose, RuBP

Explain how information in the table provides evidence for the following.

(i) Glycerate 3-phosphate is converted into triose phosphate.

.....

(1)

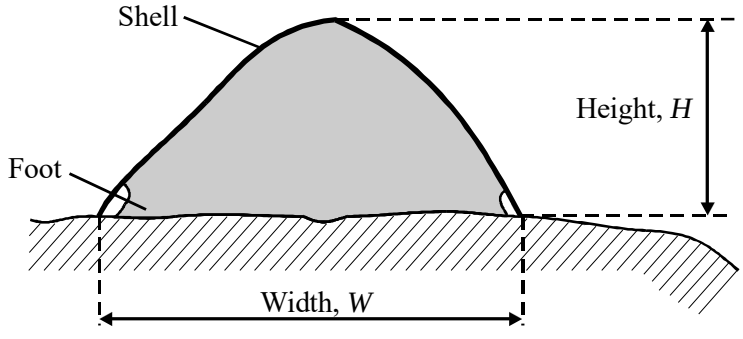
(ii) The reactions given in part (a) form part of a *cycle* of reactions.

.....

(1)

(Total 5 marks)

7. Limpets are animals which live on rocky sea shores. When the tide is out, a limpet is firmly attached to the rock by a muscular „foot". Taller limpets are more likely to be dislodged by wave action. Variation in the size of limpets was investigated on two shores, **A** and **B**. The height and width of each limpet was measured as shown in the diagram.



The results of the investigation are given in the table.

	Shore A	Shore B
Mean $\frac{H}{W}$	0.33	0.47
Standard deviation	0.08	0.12
Sample size	28	33

(a) (i) On which shore did the limpets have a greater variation in values of $\frac{H}{W}$?

Give evidence from the table for your answer.

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(1)

(ii) Which shore had limpets that were better adapted to withstand wave action? Use evidence from the table to explain your answer.

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(3)

(b) (i) In investigations like this, why is it necessary to collect data from a large number of specimens which are selected at random?

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(2)

(ii) Describe how you would select limpets at random.

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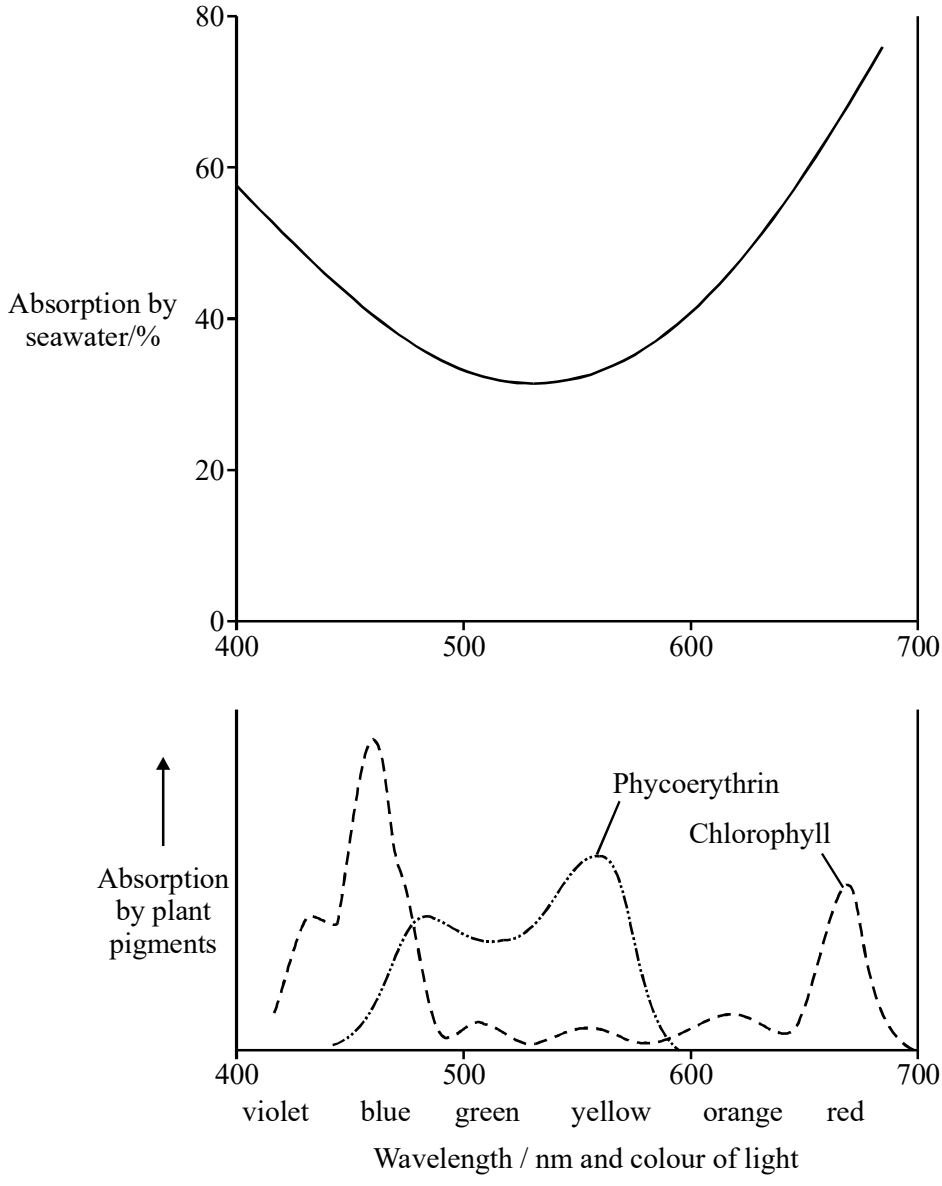
(3)

(c) Red seaweeds are algae which contain, in addition to chlorophyll, a red pigment called phycoerythrin. Green seaweeds do not contain phycoerythrin. Both phycoerythrin and chlorophyll absorb light energy which can be used in photosynthesis. The graphs show the percentage of light of different wavelengths absorbed by sea water, by chlorophyll and by phycoerythrin.



Use information from the graphs to explain why red seaweeds are usually found in deeper water (further down the shore) than green seaweeds.

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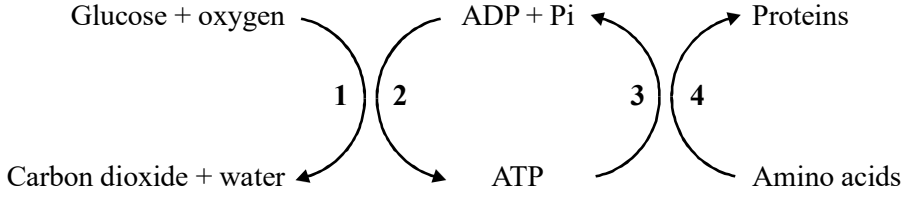
(6)
(Total 15 marks)

8. ATP links energy-releasing (exergonic) reactions with energy-requiring (endergonic) reactions. The diagram shows some of these reactions.



(a) Give the numbers in the diagram that correspond to *exergonic* reactions.

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(1)

(b) Explain why the total energy released from an exergonic reaction is not all available for the linked endergonic reaction.

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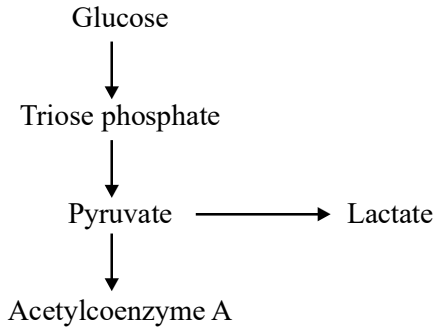
(1)

(c) The diagram shows some of the reactions of respiration.



On the diagram, draw and label **one** arrow to show a reaction that

(i) requires ATP (label this arrow **ATP in**);

(ii) produces ATP (label this arrow **ATP out**).

(2)

(d) The table shows the maximum number of ATP molecules that can be produced from a single molecule of glucose during the stages of respiration.

Stage	Maximum number of molecules of ATP produced during stage
Glycolysis	4
Krebs cycle	2
Oxidative phosphorylation	34

How many of these molecules of ATP are produced in the cytoplasm?

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(1)

(e) In a photosynthesising leaf, reduced NADP is produced during the light-dependent reactions.

(i) Where in chloroplasts do the light-dependent reactions take place?

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(1)

(ii) Describe how reduced NADP is involved in the light-independent reactions of photosynthesis.

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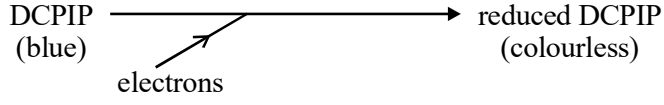
(2)

DCPIP is a blue dye that can be converted to colourless reduced DCPIP by gaining electrons. This is summarised below.



A chloroplast suspension was made by grinding fresh leaves in buffer solution and centrifuging the mixture. Tubes were prepared and treated in different ways. The colour of the tube contents was recorded at the start and after 15 minutes. This information is summarised in the table.

Tube	Contents	Treatment	Colour	
			at start	after 15 minutes
A	2 cm^3 chloroplast suspension 6 cm^3 DCPIP	tube kept in bright light	blue / green	green
B	2 cm^3 chloroplast suspension 6 cm^3 DCPIP	tube kept in dark	blue / green	blue / green
C	2 cm^3 buffer solution 6 cm^3 DCPIP	tube kept in bright light	blue	blue

(f) (i) Tube **C** was included as a control. Explain why this control was necessary in the investigation.

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(1)

(ii) Explain the colour of tube **A** after 15 minutes.

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(3)

(g) (i) The chloroplast suspension produced by centrifugation may also contain mitochondria. Explain the evidence from tube **B** that mitochondria are not responsible for reducing the DCPIR.

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(2)

(ii) Suggest why conclusions made only on the basis of the data in the table may not be reliable.

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(1)

(Total 15 marks)

9. (a) ATP is sometimes described as an *immediate* source of energy. Explain why.

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(1)

(b) Plants produce ATP in the light-dependent reaction of photosynthesis. Explain why plants cannot use this as their only source of ATP.

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(2)

(c) Red blood cells do not contain mitochondria but they use ATP. By what process do red blood cells produce ATP? Suggest a reason for your answer.

Process .....

Reason .....

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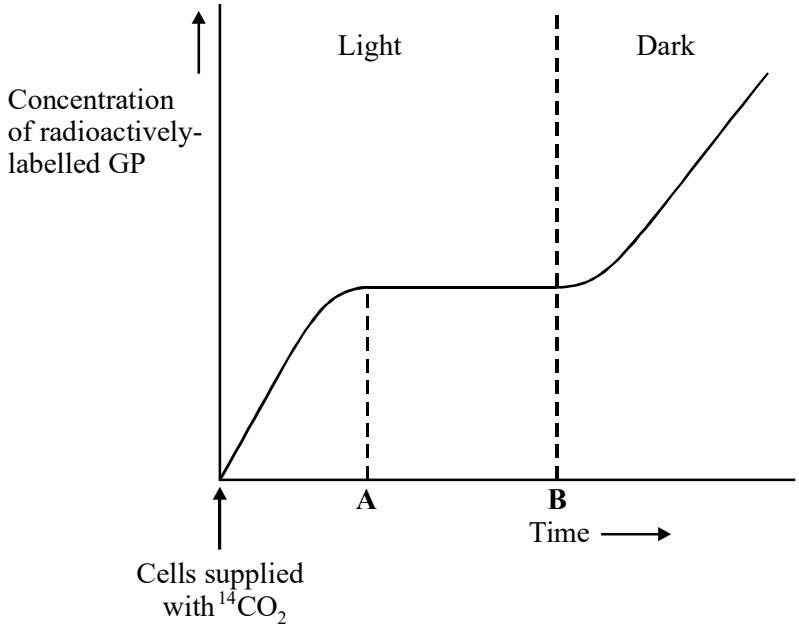
(2)

(Total 5 marks)

10. In an investigation, leaf cells were supplied with $^{14}CO_2$, carbon dioxide labelled with a radioactive isotope of carbon. These cells were kept in the light and allowed to photosynthesise. After a period of time, the light was switched off and the cells were left in the dark. The graph shows the concentration of radioactively-labelled glycerate 3-phosphate (GP) over the course of the investigation.



(a) (i) Describe how GP is formed from carbon dioxide in photosynthesis.

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(2)

(ii) In this investigation, the $^{14}CO_2$ was supplied in excess. Explain why the concentration of radioactively-labelled GP remained the same between times **A** and **B** on the graph.

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(1)

(b) Explain the change in the concentration of radioactive GP after the light was switched off.

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(3)

The table shows some results from an investigation of the concentration of carbon dioxide in samples of air taken from among the leaves in a potato crop.

Date	**Mean carbon dioxide concentration in parts per million between**	
	8 pm and 4 am	**8am and 4 pm**
10 July	328	309
20 July	328	299
30 July	326	284
10 Aug	322	282

(c) (i) The figures in columns 2 and 3 of the table were calculated from readings obtained at different times of the day. Explain why the figures in column 3 are lower than those in column 2.

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(2)

(ii) How would you expect the mean carbon dioxide concentration between 8 am and 4 pm to have differed if the air samples had been collected at soil level? Give a reason for your answer.

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(2)

(d) Suggest why, in this investigation, the investigators recorded the wind speed.

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(2)

(e) Some of the leaves from this crop die and fall to the ground. Describe how the carbon contained in the dead leaves becomes available and can be taken up by plants.

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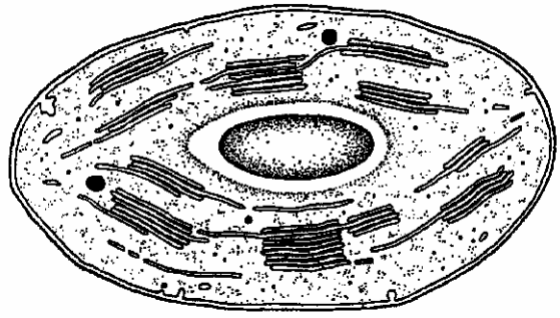
(3)

(Total 15 marks)

11. 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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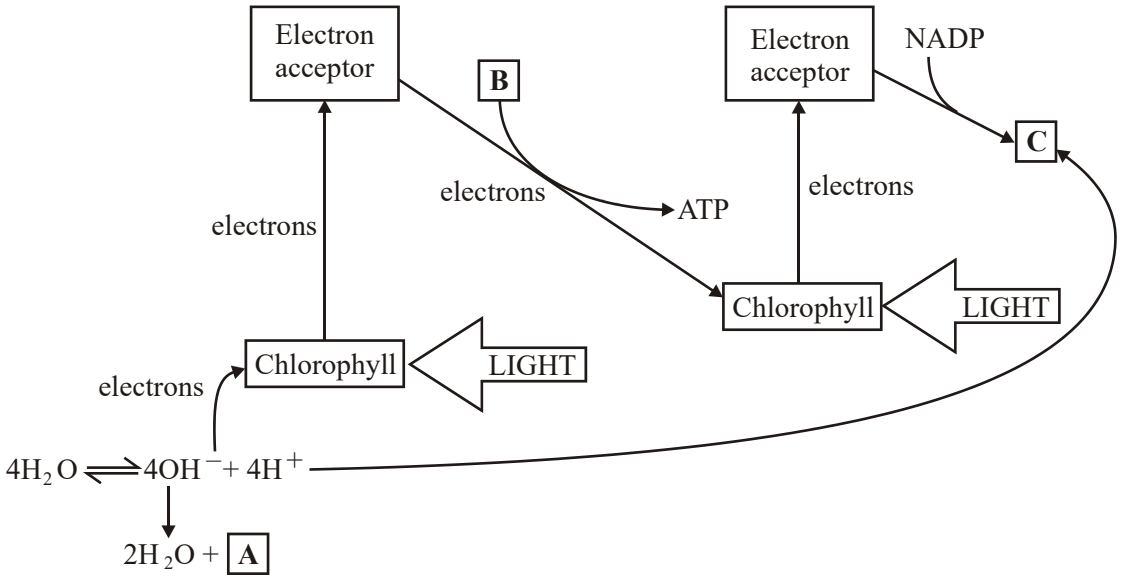
(2)

(Total 5 marks)

12. 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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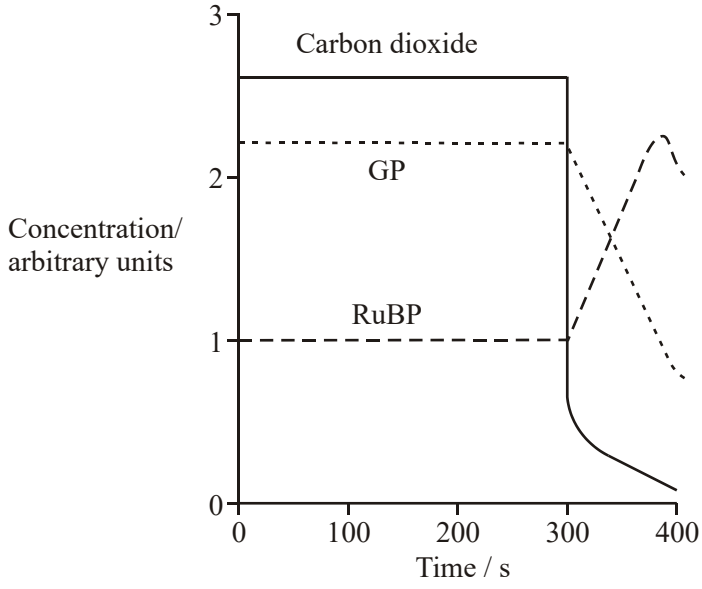
(3)

(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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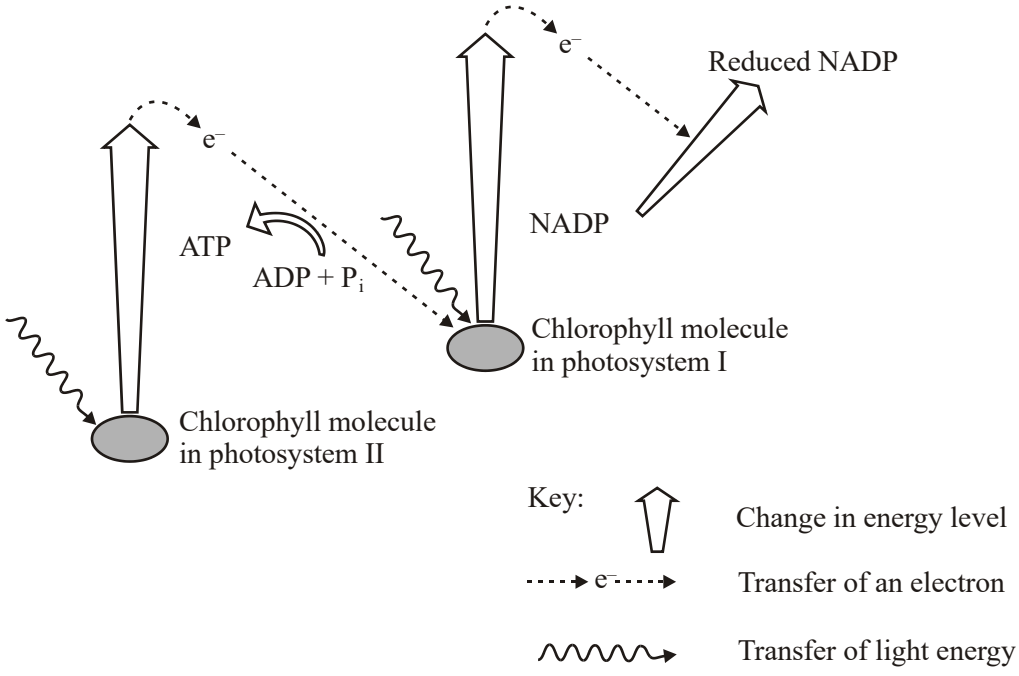
(2)
(Total 15 marks)

13. (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)

14. 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

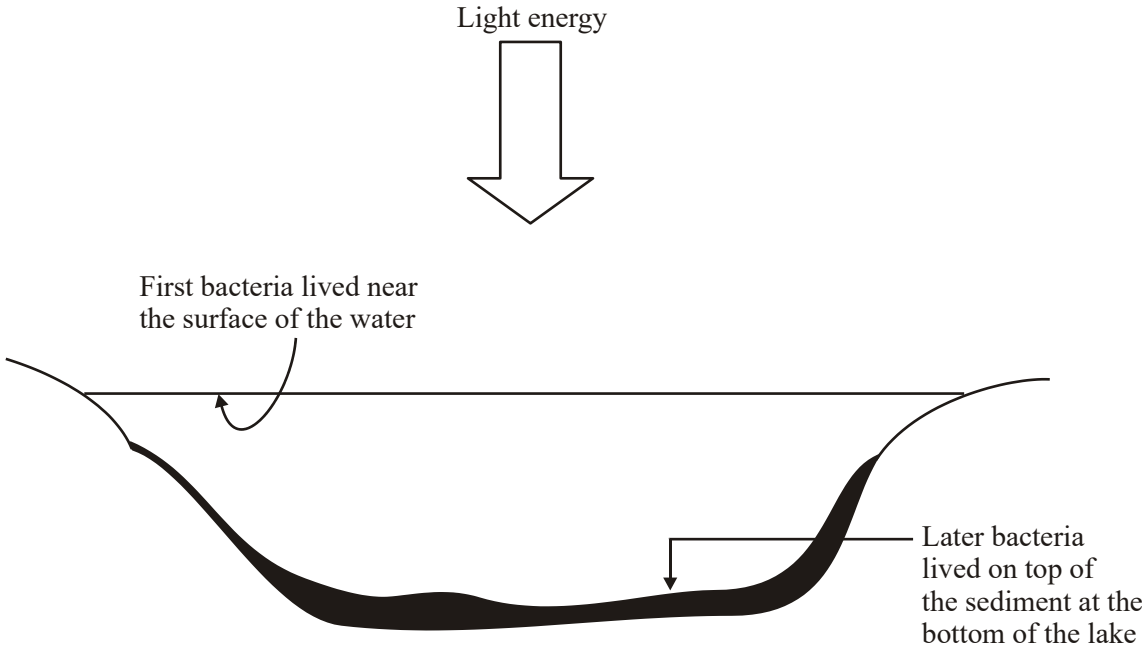
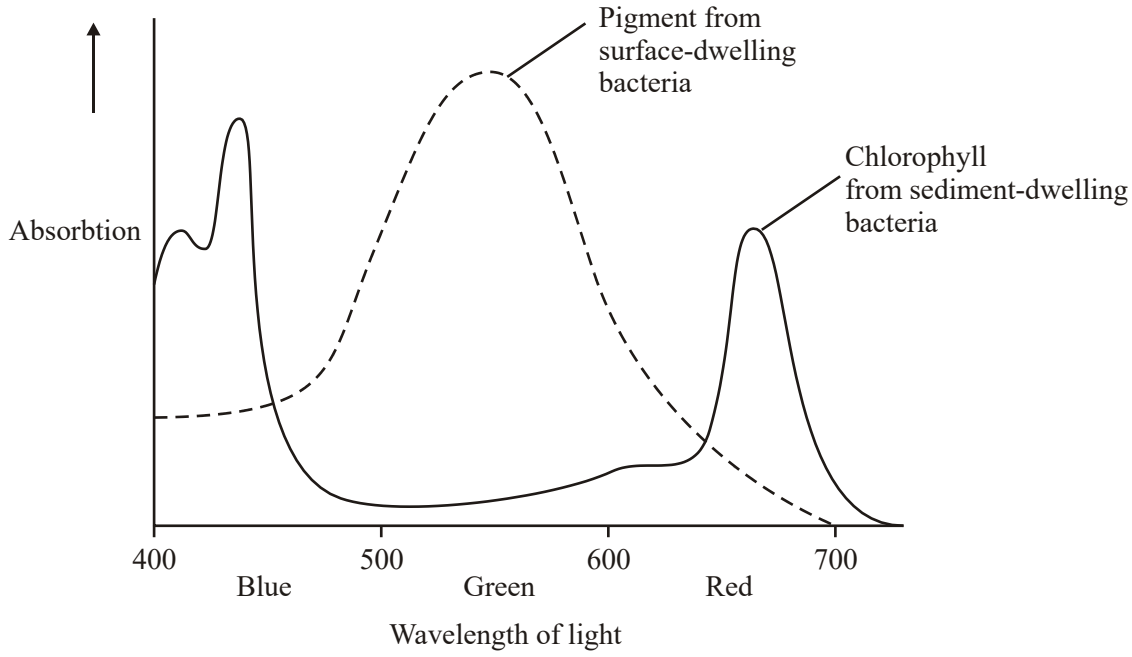


Figure 2



(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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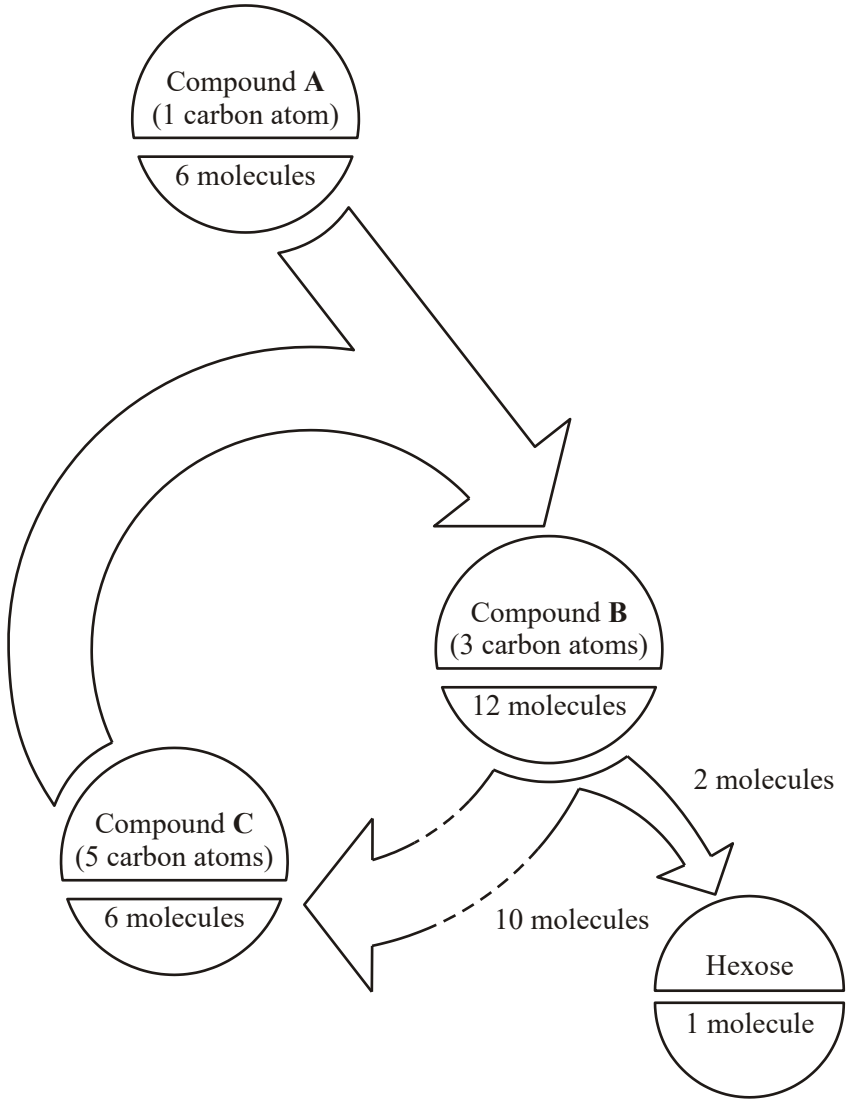
(6)
(Total 11 marks)

15. 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)

16. (a) Photosynthesis generally takes place in a leaf. Describe how the leaf is adapted to allow this process to occur effectively.

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(3)

(b) Explain the roles of water, light and ribulose bisphosphate in the process of photosynthesis.

(i) Water

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(ii) Light

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(iii) Ribulose bisphosphate

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(6)

(c) Explain why an increase in temperature will increase the rate of photosynthesis.

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(3)
(Total 12 marks)

17. The number of earthworms in a field may be estimated by using frame quadrats. The quadrats are placed at random on the surface of the area being sampled. The ground is then watered with a very dilute solution of formalin. The earthworms which come to the surface are collected and washed.

(a) (i) Explain why the quadrats should be placed at random.

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(1)

(ii) Throwing a quadrat does not ensure a random distribution. Describe a method by which you could ensure that the quadrats would be placed at random.

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(2)

(b) Give **one** advantage of describing the size of the population in terms of biomass rather than as the number of earthworms collected.

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(1)

(c) Similar sized populations of earthworms were kept in soils at different temperatures. The earthworms were fed on discs cut from leaves. The table shows the number of leaf discs eaten at each temperature.

Temperature/°C	Number of leaf discs eaten
0	0
5	178
10	204
15	174
20	124

Using information in the table, explain how mean soil temperature and feeding activity might affect the size of the earthworm population.

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(3)

(Total 7 marks)

18. (a) The process of photosynthesis can be subdivided into two stages, one dependent on light, the other independent of light.

(i) Complete the table to show the substances used in and the end products of each of these stages. (Do not include solar energy.)

	Light dependent stage	Light independent stage
Substances used	1. Water 2. Inorganic phosphate 3. ADP 4. NADP	1. Reduced NADP 2. ATP 3. ..... 4. .....
End products	1.ATP 2. ..... 3.	1. NADP 2. ADP 3. Inorganic phosphate 4. Carbohydrate

(2)

(ii) What are the functions of reduced NADP and ATP in the light independent stage of photosynthesis?

Reduced NADP.....

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ATP.....

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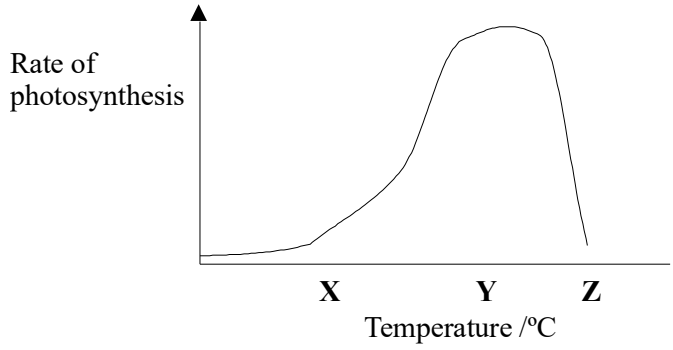
(2)

(b) The graph shows the effect of temperature on the rate of photosynthesis



(i) Explain why increasing the temperature from **X**° C to **Y**° C increases the rate of photosynthesis.

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(2)

(ii) Explain why increasing the temperature from **Y**° C to **Z**° C decreases the rate of photosynthesis.

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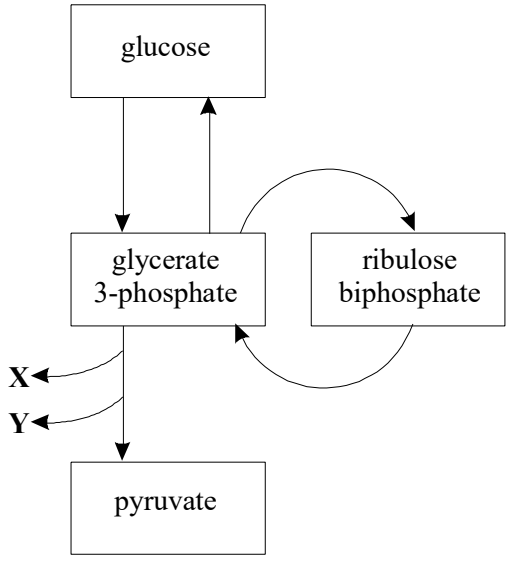
(2)
(Total 8 marks)

19. The diagram shows chemical pathways involved in respiration and photosynthesis.



(a) Name the process that produces pyruvate from glucose.

.....

(1)

(b) Name the compounds labelled **X** and **Y**.

X .....

Y .....

(2)

(c) (i) In which part of a chloroplast is glycerate 3-phosphate converted into ribulose bisphosphate?

.....

(1)

(ii) Describe the role of ribulose bisphosphate in photosynthesis.

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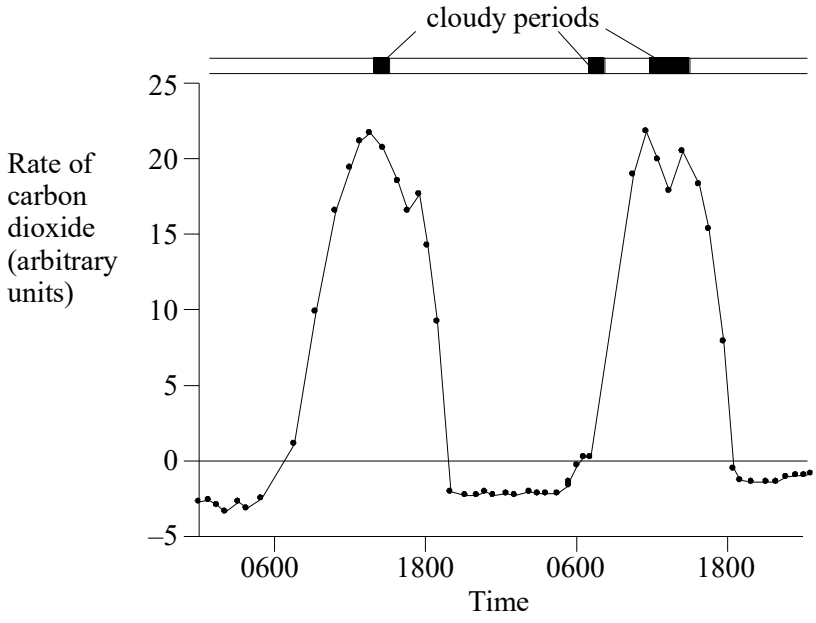
(1)

(Total 5 marks)

20. (a) The graph shows the rate of carbon dioxide uptake by a green plant over a two day period.



Explain why the rate of carbon dioxide uptake

(i) decreased in cloudy conditions;

.....

.....

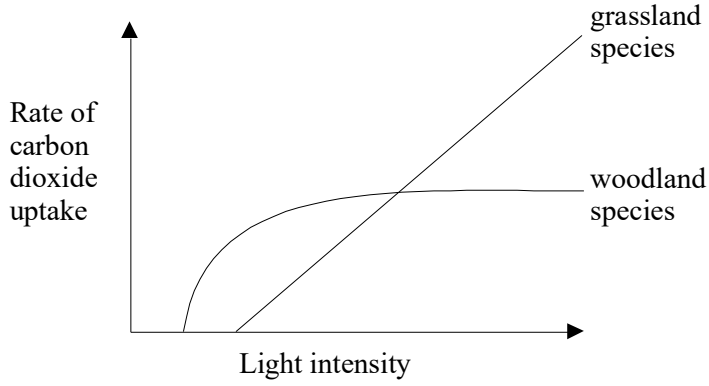
(ii) is lower at midnight than at midday.

.....

.....

(4)

(b) The graph shows how the rate of carbon dioxide uptake of two species of plant changes with increasing light intensity. The habitat of one species is open grassland. The habitat of the other is woodland.



Explain the advantage to the woodland species of the pattern shown in the graph.

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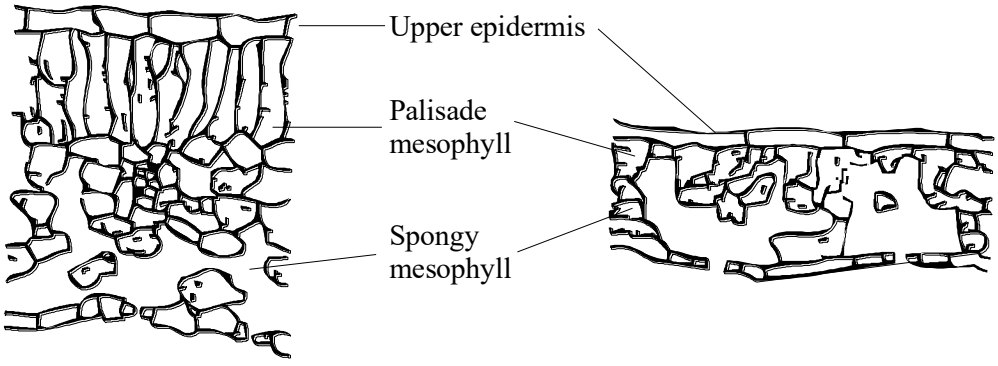
(1)

(c) The diagrams show sections through a leaf from the grassland species and a leaf from the woodland species.



Using the diagrams, describe and explain how the leaf of the woodland species is adapted for its habitat.

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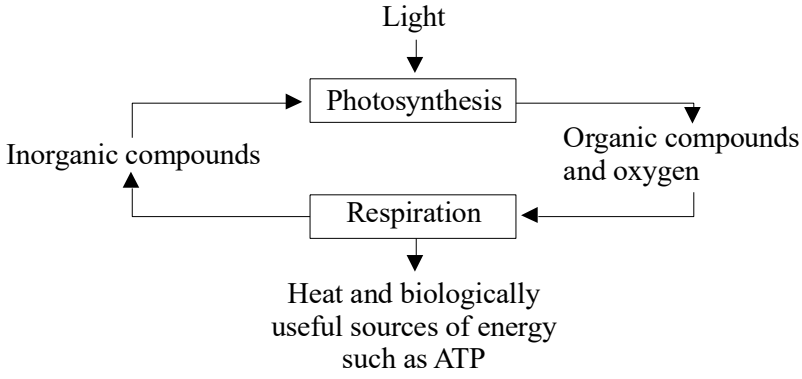
(3)
(Total 8 marks)

21. (a) The diagram summarises the relationship between photosynthesis and respiration.



(i) Name the inorganic compounds indicated on the diagram.

.....

(1)

(ii) Describe **two** features of an ATP molecule which make it a "biologically useful source of energy".

1.....

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2.....

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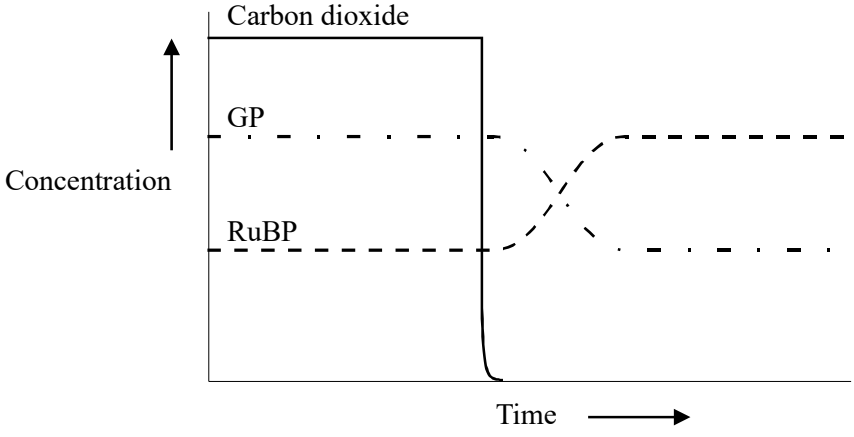
(2)

(b) In an investigation, a culture of single-celled algae was supplied with carbon dioxide and allowed to photosynthesise normally. The concentration of carbon dioxide in the culture medium was then reduced suddenly. The graph shows the effect of the reduction in carbon dioxide concentration on the concentration of glycerate 3-phosphate (GP) and ribulose bisphosphate (RuBP) in the algal cells.



(i) Write a simple equation summarising the reaction involving carbon dioxide, GP and RuBR

.....

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(1)

(ii) Explain the changes which occurred in the concentration of RuBP immediately after the concentration of carbon dioxide was reduced.

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(2)
(Total 6 marks)

22. **Table A** shows the nitrogen input on a dairy farm. Table **B** shows what happens to this nitrogen.

Table A

Nitrogen input	Nitrogen content/ kg per hectare
Inorganic fertiliser and manure	259
Animal food	60
Fixation	19
Total	338

Table B

Fate of nitrogen	Nitrogen content/ kg per hectare
In plants	112
In milk and meat	67
Leaching	56
Denitrification	55
Released to air as ammonia	48
Total	338

(a) Calculate the percentage of the total nitrogen input incorporated into milk and meat.

.....%

(1)

(b) (i) Use the data to explain why dairy farmers use fertilisers.

.....

.....

.....

(1)

(ii) A farmer plants clover, which is a leguminous plant, in the fields used for grazing cattle. Explain how the clover might affect the amount of fertiliser that the farmer needs to use.

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(1)

(ii) Explain how environmental damage may arise from leaching of fertiliser.

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(4)

(Total 7 marks)

23. (a) Complete the table with a tick if the statement is true or a cross if it is not true.

Statement	Glycolysis	Light-dependent reaction of photosynthesis	Light-independent reaction of photosynthesis
ATP is produced			
ATP is required			
Process takes place in a mesophyll cell from a leaf which has been in the dark for 12 hours			

(3)

(b) Green bacteria are prokaryotes which are able to photosynthesise. One group of green bacteria requires light and carbon dioxide and uses hydrogen sulphide as a source of hydrogen.

Use this information to describe **two** differences between photosynthesis in these bacteria and photosynthesis in a mesophyll cell from a leaf

1 .....

.....

2 .....

.....

(2)

(Total 5 marks)

24. Each of the following statements refers to a process that occurs during photosynthesis or respiration. A 6-C compound refers to a compound with molecules that contain six carbon atoms, 5-C 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 6-C compound is broken down into 3-C compounds.

Stage .....

6-C compound .....

3-C compound .....

(2)

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

Stage .....

5-C compound .....

1-C compound .....

(2)

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

Stage .....

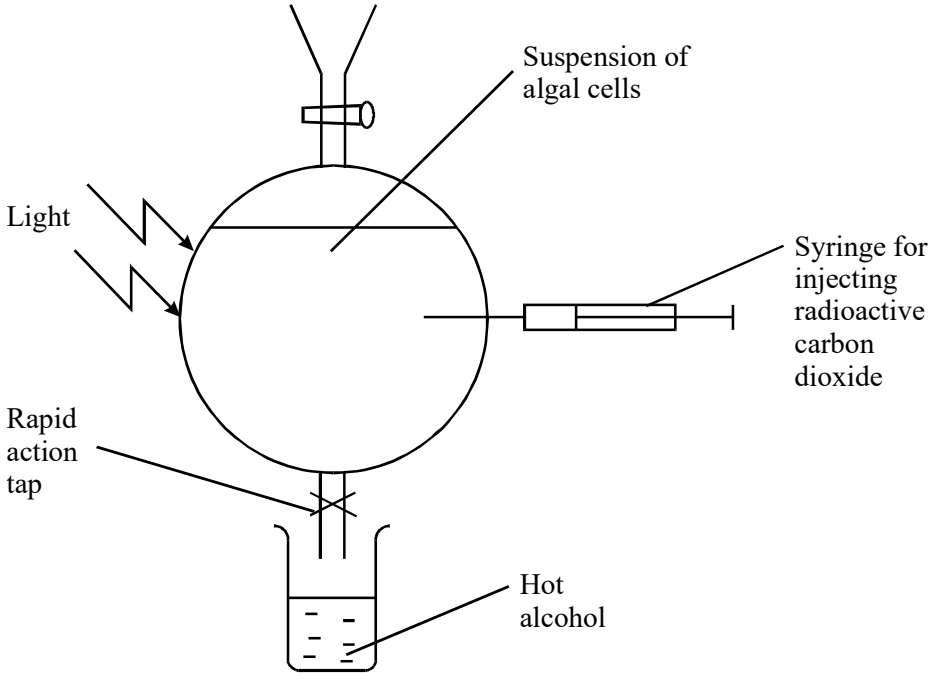
3-C compound .....

6-C compound .....

(2)

(Total 6 marks)

25. An investigation was carried out to find out the sequence of biochemical changes that occur during photosynthesis. Radioactive carbon dioxide was added to a suspension of algal cells, and they were allowed to photosynthesise. At intervals, samples of the suspension were removed into hot alcohol. These samples were analysed for different radioactively labelled compounds.



(a) Explain how the use of radioactive carbon dioxide in this investigation allows the sequence of biochemical changes in photosynthesis to be followed.

.....

.....

.....

(2)

(b) Suggest a reason for the use in this investigation of

(i) hot alcohol;

.....

.....

(1)

(ii) a rapid action tap.

.....

.....

(1)

Samples were removed from the suspension at five different times, between 5 seconds and 600 seconds after the start of the experiment. In each sample, the radioactivity in four different organic compounds, **P**, **Q**, **R** and **S**, was measured. The table shows the results.

Organic compound	Amount of radioactivity present / arbitrary units				
	5 s	**15 s**	**60 s**	**180 s**	**600 s**
P	0.01	0.02	0.08	0.17	0.67
Q	1.00	2.00	3.10	3.15	3.15
R	0.10	1.50	2.20	2.30	2.40
S	0.05	0.11	0.16	1.00	1.00

(c) Use this information to place the compounds **P**, **Q**, **R** and **S**, in the order in which they were formed in photosynthesis.

_____ → _____ → _____ → _____

(1)

(d) Using your knowledge of the light-independent reaction, explain why the level of radioactivity in compound **Q** remained steady after 180 seconds.

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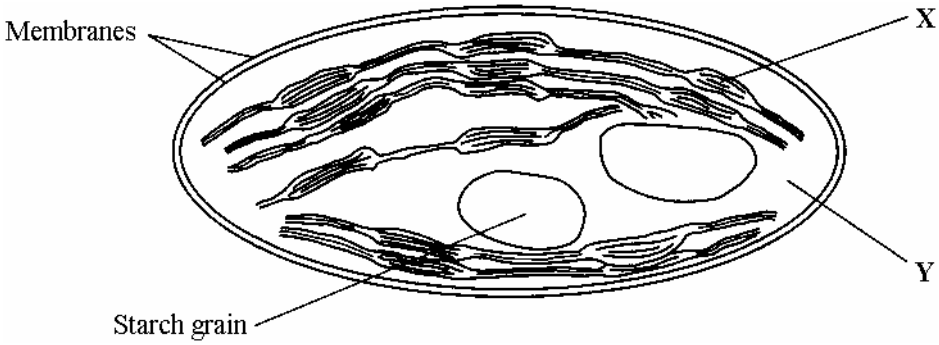
(2)

(Total 7 marks)

26. The diagram shows a cell organelle.



(a) Identify the parts labelled **X** and **Y**.

X .....

Y .....

(2)

Light was shone on a suspension of these organelles while it was kept in an atmosphere of pure nitrogen. During this time the organelles made large amounts of two different substances, and gave off oxygen.

(b) Name the two substances that were made when the organelles were illuminated.

1 .....

2 .....

(2)

The membranes around the outside of the organelles were then broken, and the parts labelled **X** and **Y** were separated from each other. In the dark, part **Y** was supplied with a substance, which it converted into a carbohydrate.

(c) What is the name of the substance which was converted into a carbohydrate?

.....

(1)

(d) (i) Name the part of the organelle where the enzymes of the light-independent reaction are located.

.....

(1)

(ii) Use the diagram to give the function of one other enzyme that is present in this part of the organelle.

.....

(1)

(Total 7 marks)

27. (a) Two of the products of the light-dependent reaction of photosynthesis are used in the light-independent reaction.

(i) Name these products.

Product 1 .....

Product 2 .....

(2)

(ii) Describe how each product is used in the light-independent reaction.

Product 1 .....

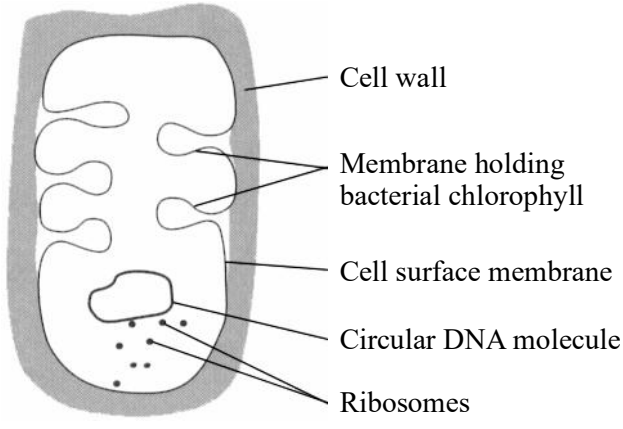
.....

Product 2 .....

.....

(2)

(b) The diagram shows the structure of a photosynthetic bacterium.



(i) Describe **two** ways in which the structure of a chloroplast differs from the structure of this bacterial cell.

1 .....

.....

2 .....

.....

(2)

(ii) The process of photosynthesis in this bacterium is not the same as in green plants. The bacterium lives in an environment where there is a lot of hydrogen sulphide, H_2S. A simple equation for photosynthesis in this cell is shown below.

hydrogen sulphide + **carbon dioxide** $\xrightarrow{\text{light absorbed by bacterial chlorophyll}}$ **simple sugar** + **sulphur** + **water**

Suggest what the hydrogen sulphide is used for in photosynthesis.

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(2)

(Total 8 marks)

28. (a) NAD and NADP are coenzymes used in either aerobic respiration or photosynthesis. Complete the table.

	Process	
	Respiration	**Photosynthesis**
Name of coenzyme	NAD	NADP
Stage(s) in the process where coenzyme is reduced		
Stage in the process where coenzyme is oxidised		

(3)

(b) Explain how the reduced coenzyme produced in photosynthesis is used.

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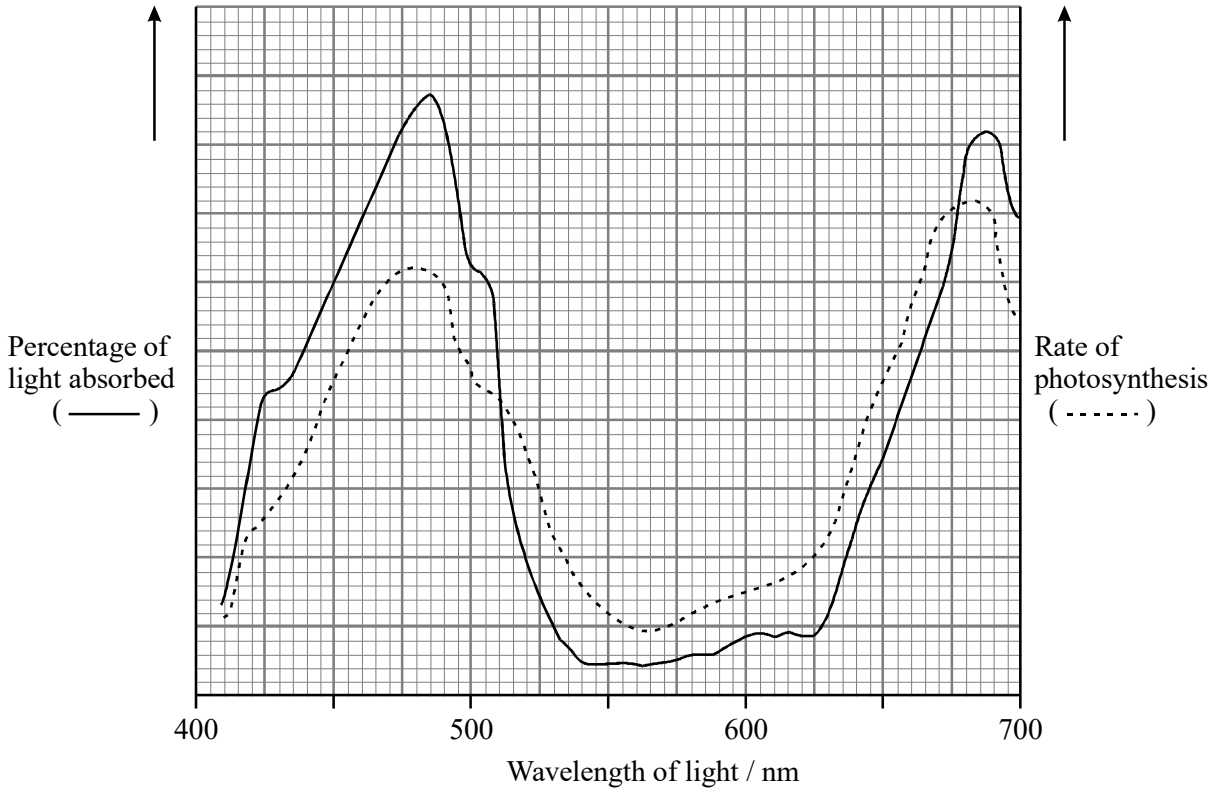
.....

(2)

(Total 5 marks)

29. 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.

.....

(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.

.....

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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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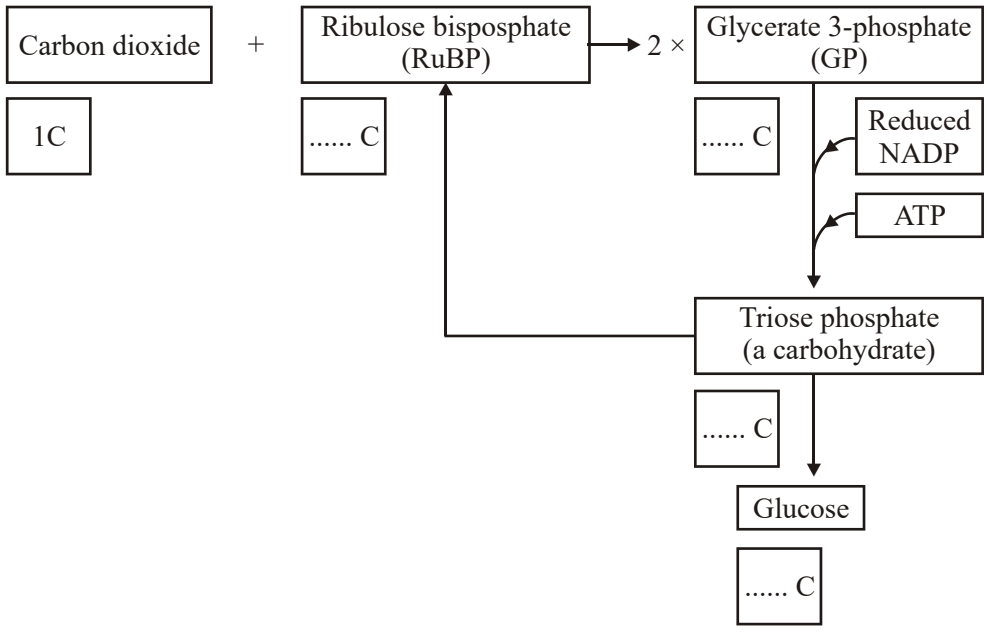
(2)

(Total 9 marks)

30. 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.

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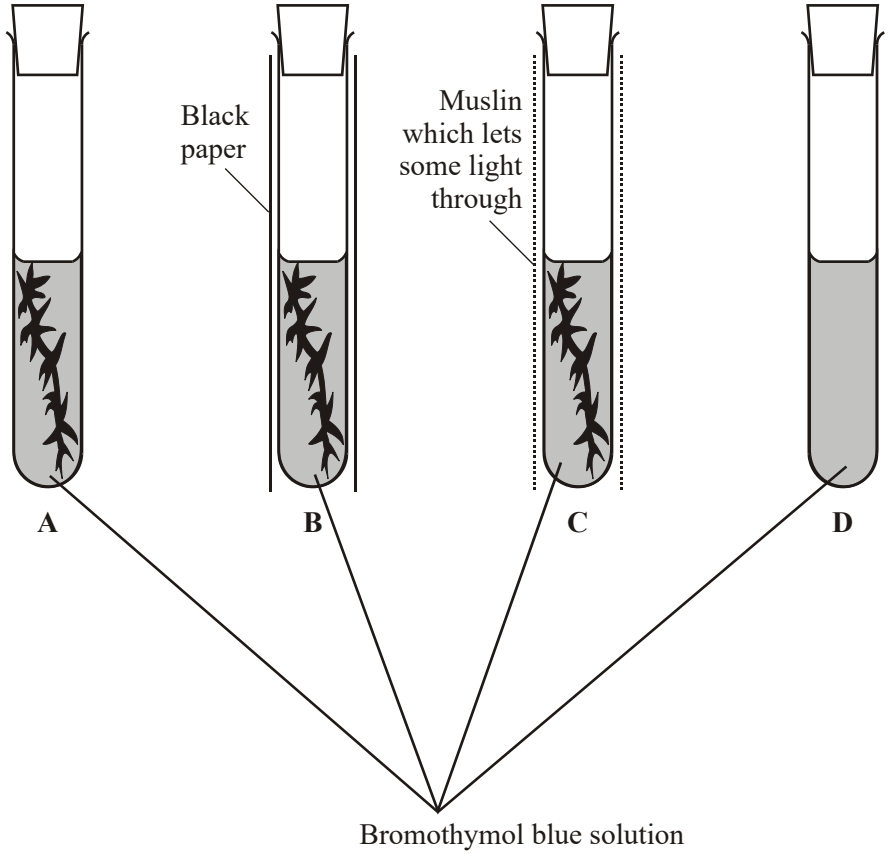
(2)
(Total 7 marks)

31. 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**; .....

.....

.....

.....

tube **C**. .....

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.....

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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.

.....

.....

(1)

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

.....

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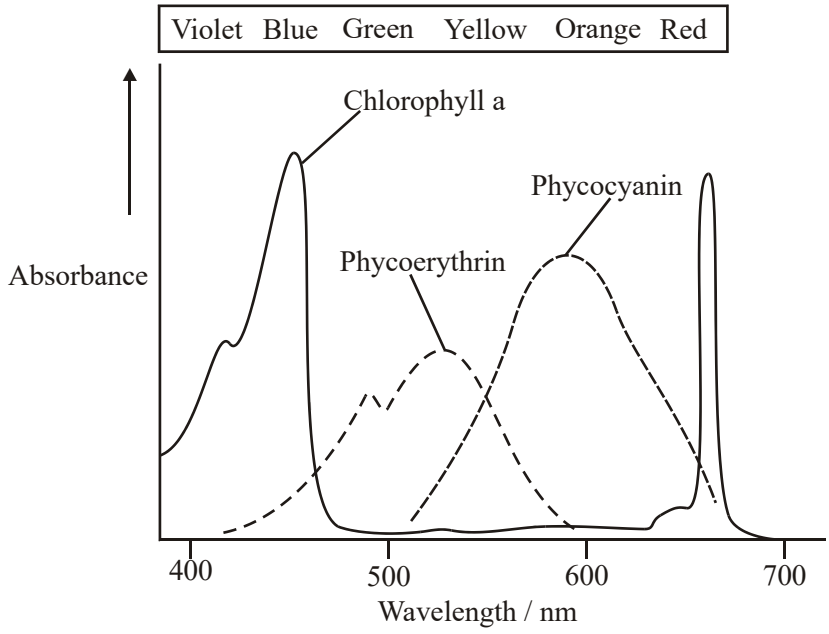
(1)
(Total 6 marks)

32. 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.

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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)

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

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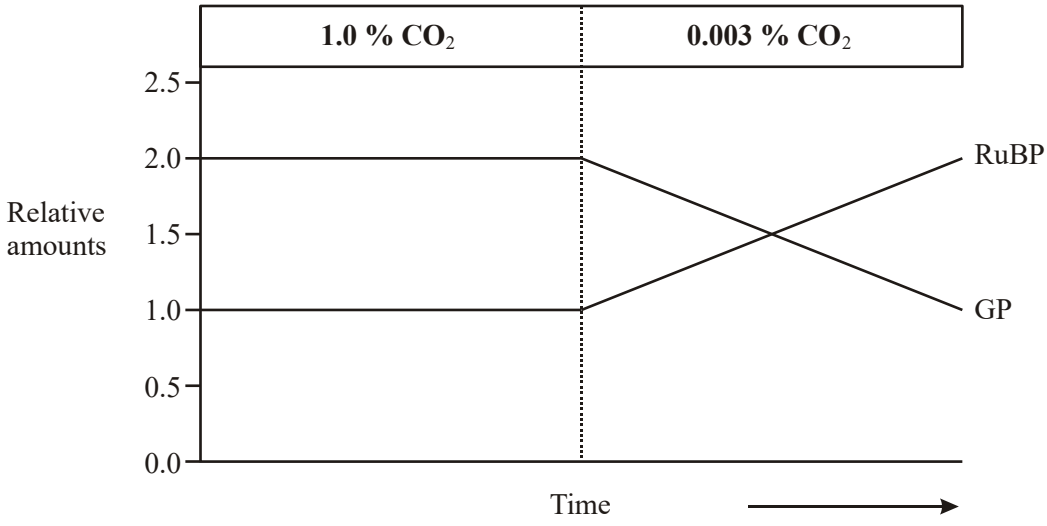
(2)

(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.

.....

.....

(1)

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

.....

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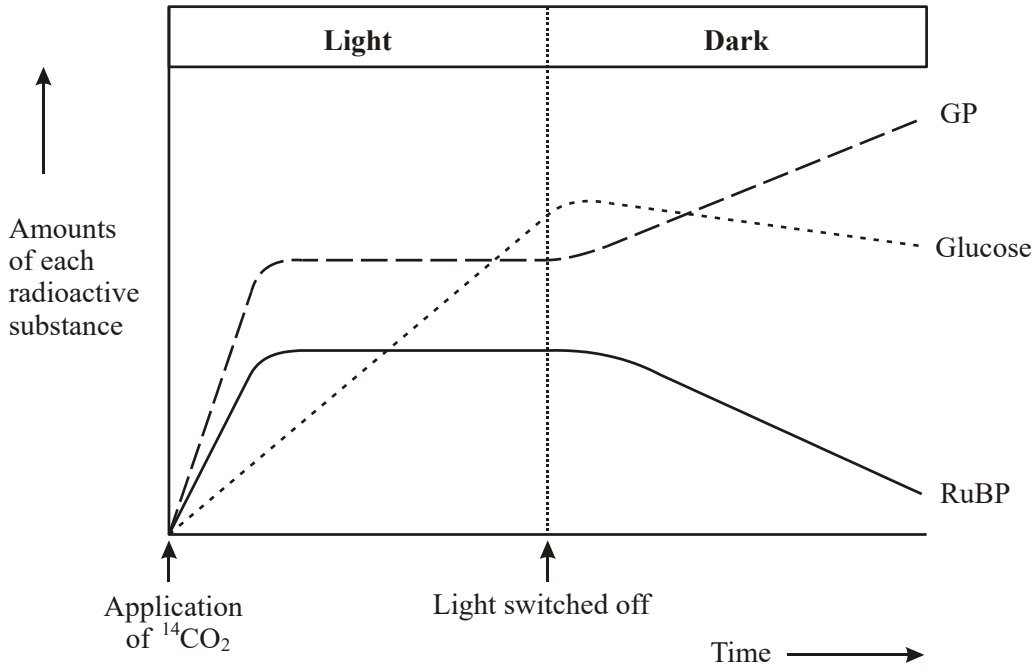
(1)

(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)

34. (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.

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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)

35. 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.

.....

.....

(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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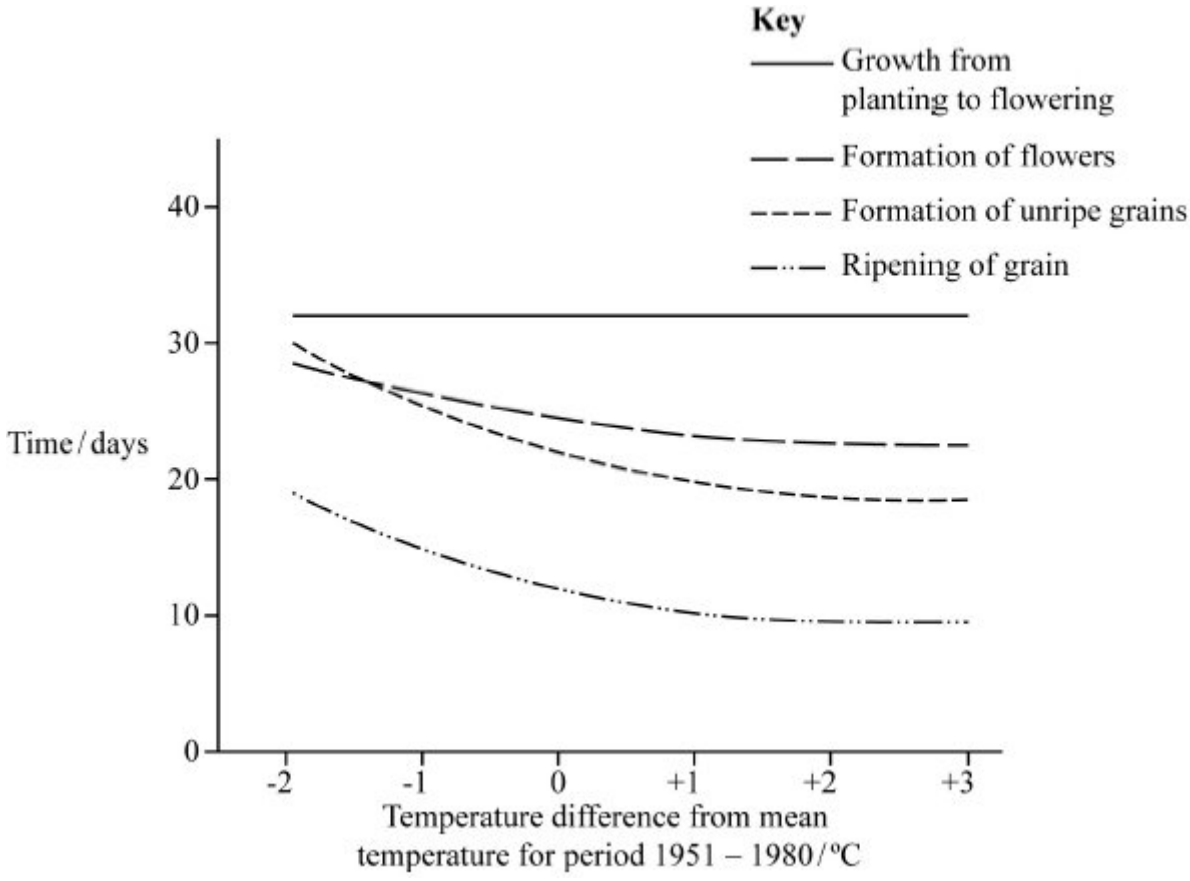
(2)

(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)

36. 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)

37. Roundabouts are common at road junctions in towns and cities. Ecologists investigated the species of plants and animals found on roundabouts in a small town.

(a) Ground beetles are large black insects. The mark-release-recapture method can be used to estimate the ground beetle population on a roundabout. Describe how.

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(5)

(b) The grass on the roundabouts was mown at different time intervals. The table shows the mean number of plant species found on the roundabouts.

Approximate interval between mowing/days	Mean number of plant species
7	15.8
14	21.2
40	30.6
365+	32.0

Mowing was also found to affect the number of insect species found on a roundabout. Use your knowledge of succession to explain how.

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(5)

(c) The carbon dioxide concentration was monitored at ground level in the centre of a small roundabout. The measurements were made on a summer day. Describe and explain how you would expect the concentration of carbon dioxide to fluctuate over the period of 24 hours.

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(5)

(Total 15 marks)