Q1.

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

_____

_____

_____

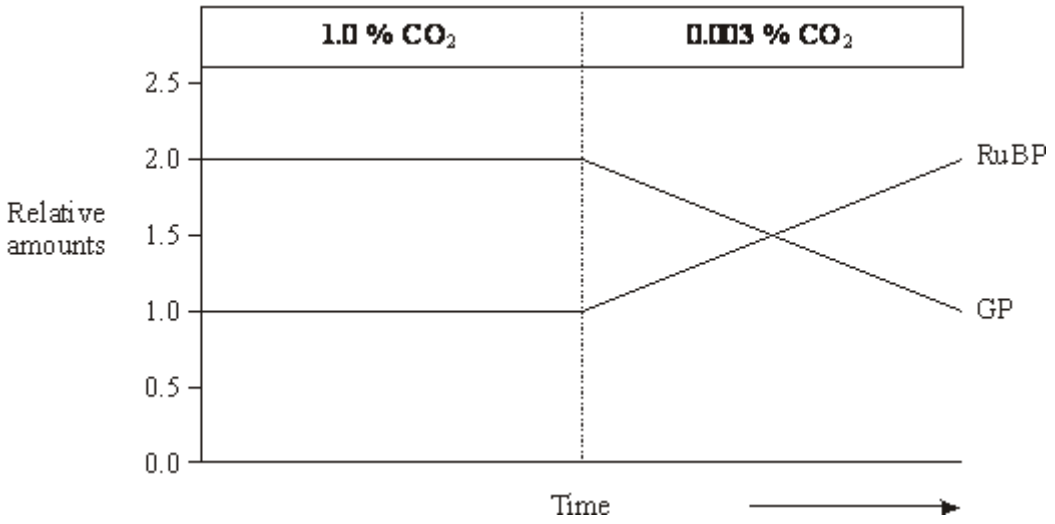
_____

(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.

_____

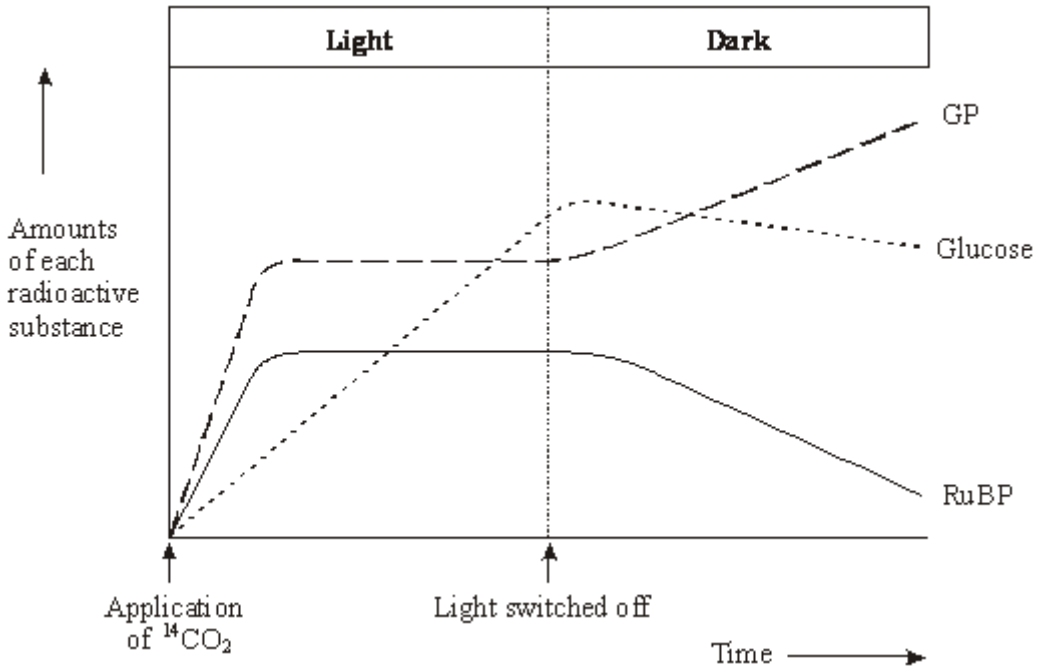
_____

(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)

Q2.

(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 _____

_____

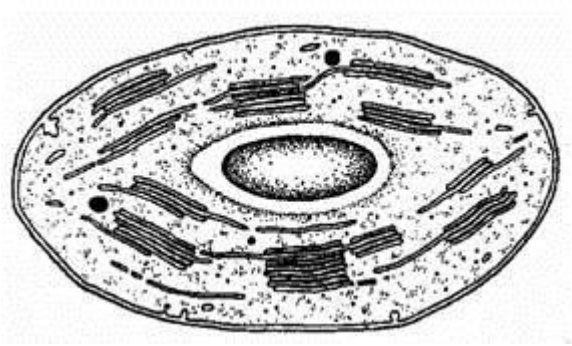
_____

(2)

(Total 9 marks)

Q3.

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)

Q4.

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

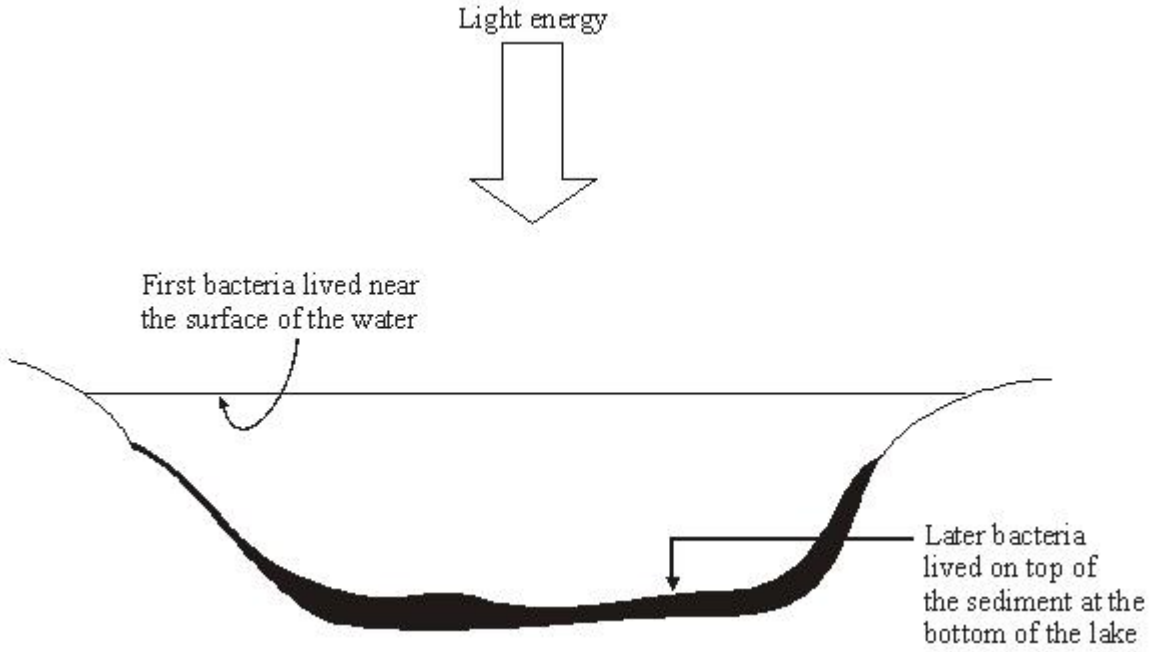
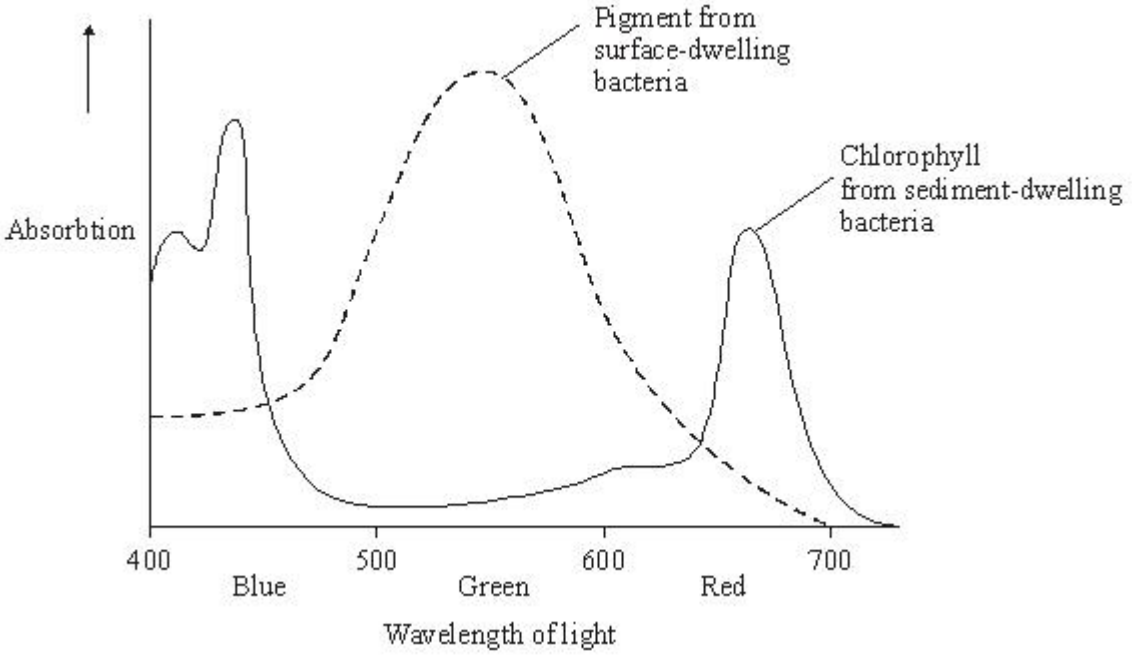


Figure 2



(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)

Q5.

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)

Q6.

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)

Q7.

(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)

Q8.

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

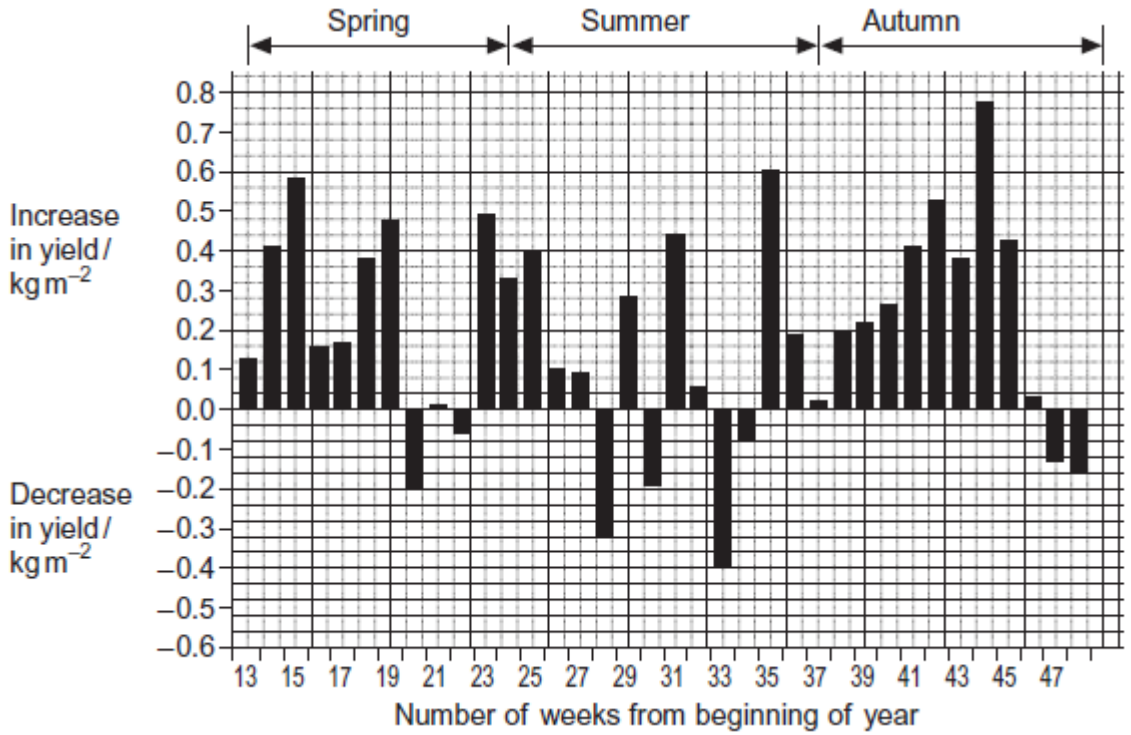
- The scientists used heating to maintain the tempera ture inside the glasshouses above 18 °C. They opened the windows to keep the tempera ture below 30 °C.
- From 1998 to 2000 they maintained the carbon dioxide concentration between 0.06 % and 0.08 % when the windows were closed and between 0.04 % and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

Q9.

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

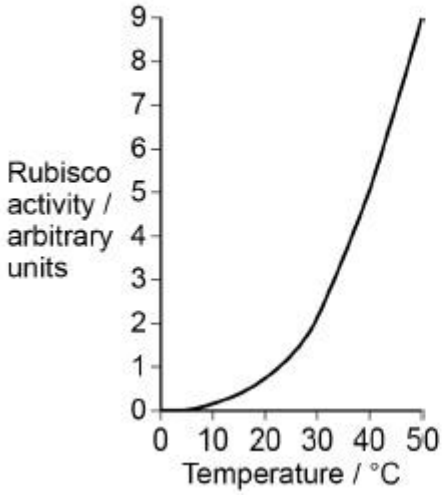
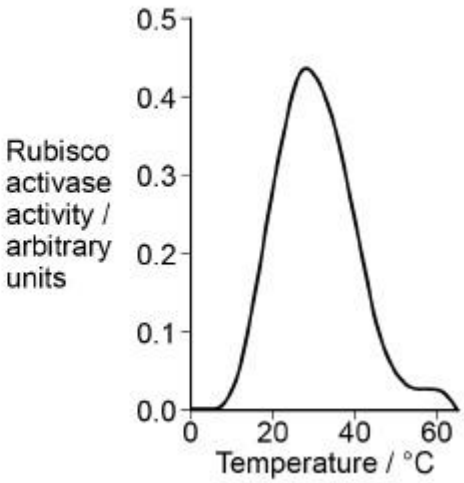


Figure 2



(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)

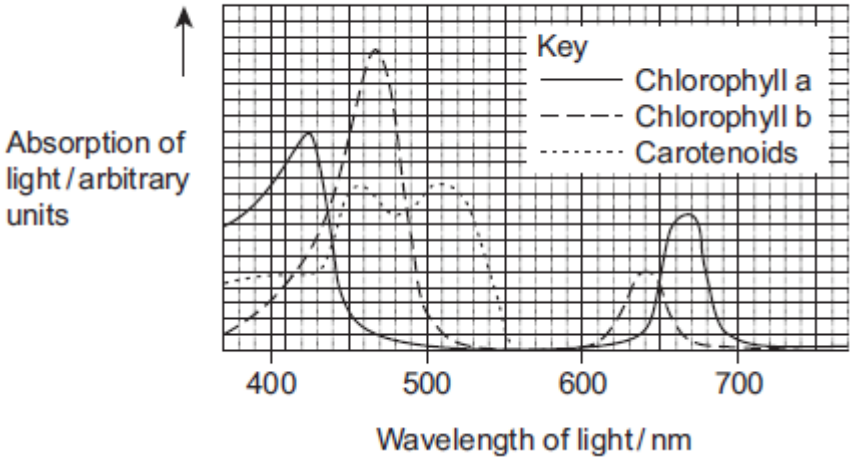
(Total 9 marks)

Q10.

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

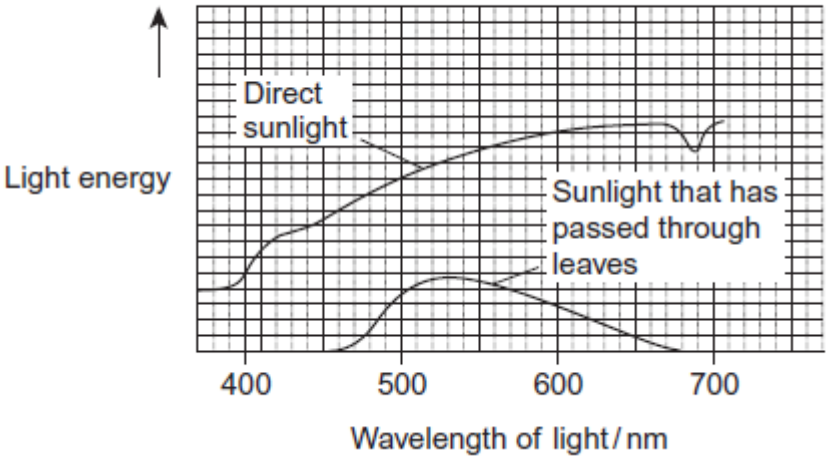


A scientist investigated the energy in light of different wavelengths reaching the ground in a forest. She measured the energy in

- 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.

(Extra space)

(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)

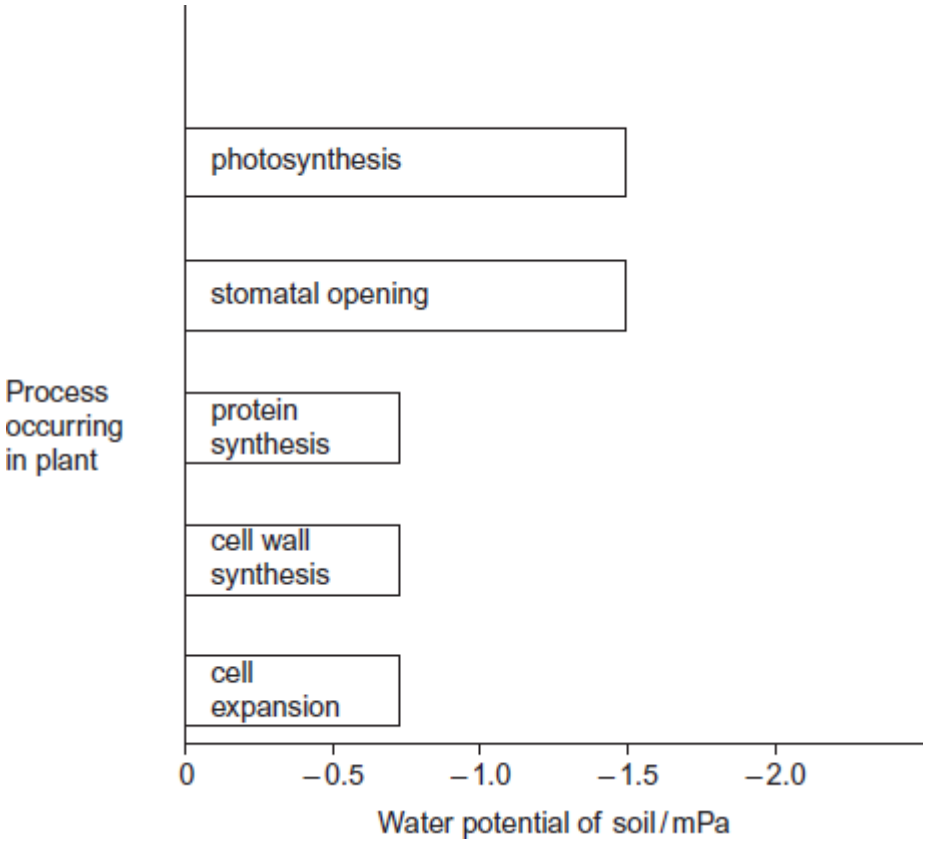
(Total 7 marks)

Q11.

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.

_____

_____

_____

_____

_____

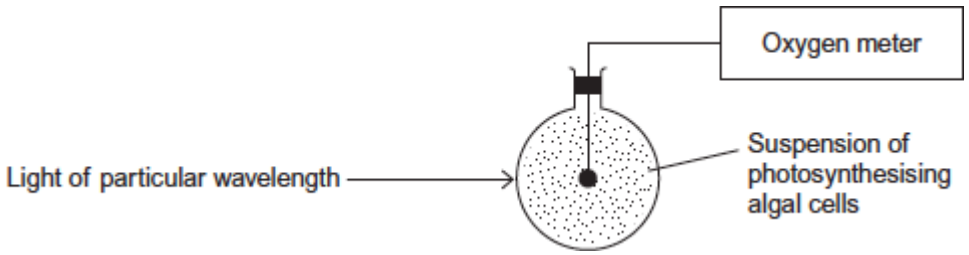
(3)

(Total 7 marks)

Q12.

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.

_____

_____

_____

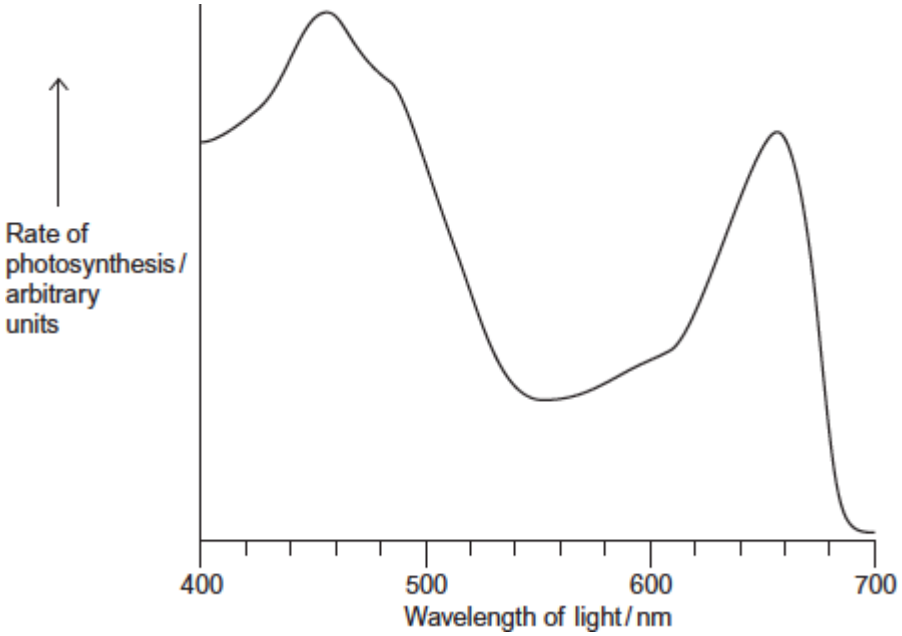
_____

_____

(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.

_____

_____

_____

_____

_____

[Extra space] _____

_____

(2)

(Total 7 marks)

Q13.

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:

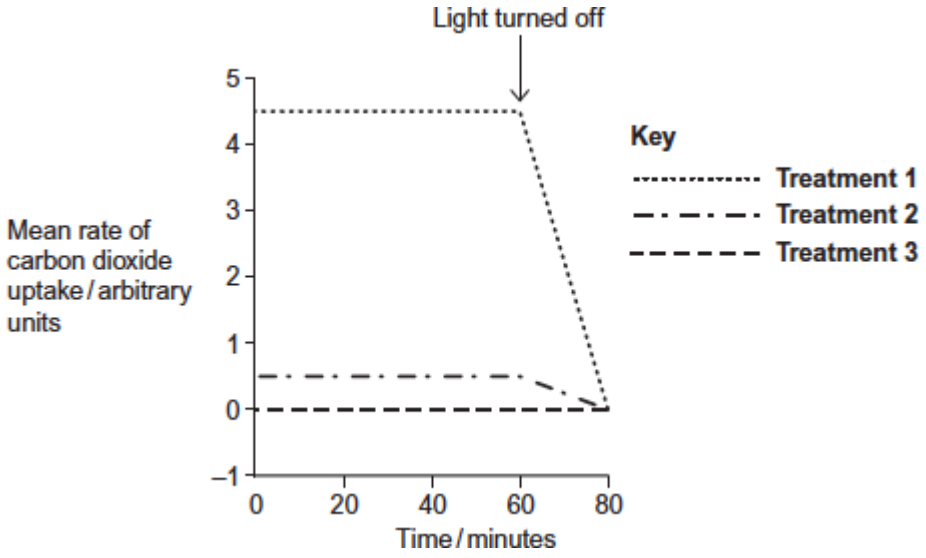
Treatment 1 − No air-sealing grease was applied to either surface of the leaf.

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)

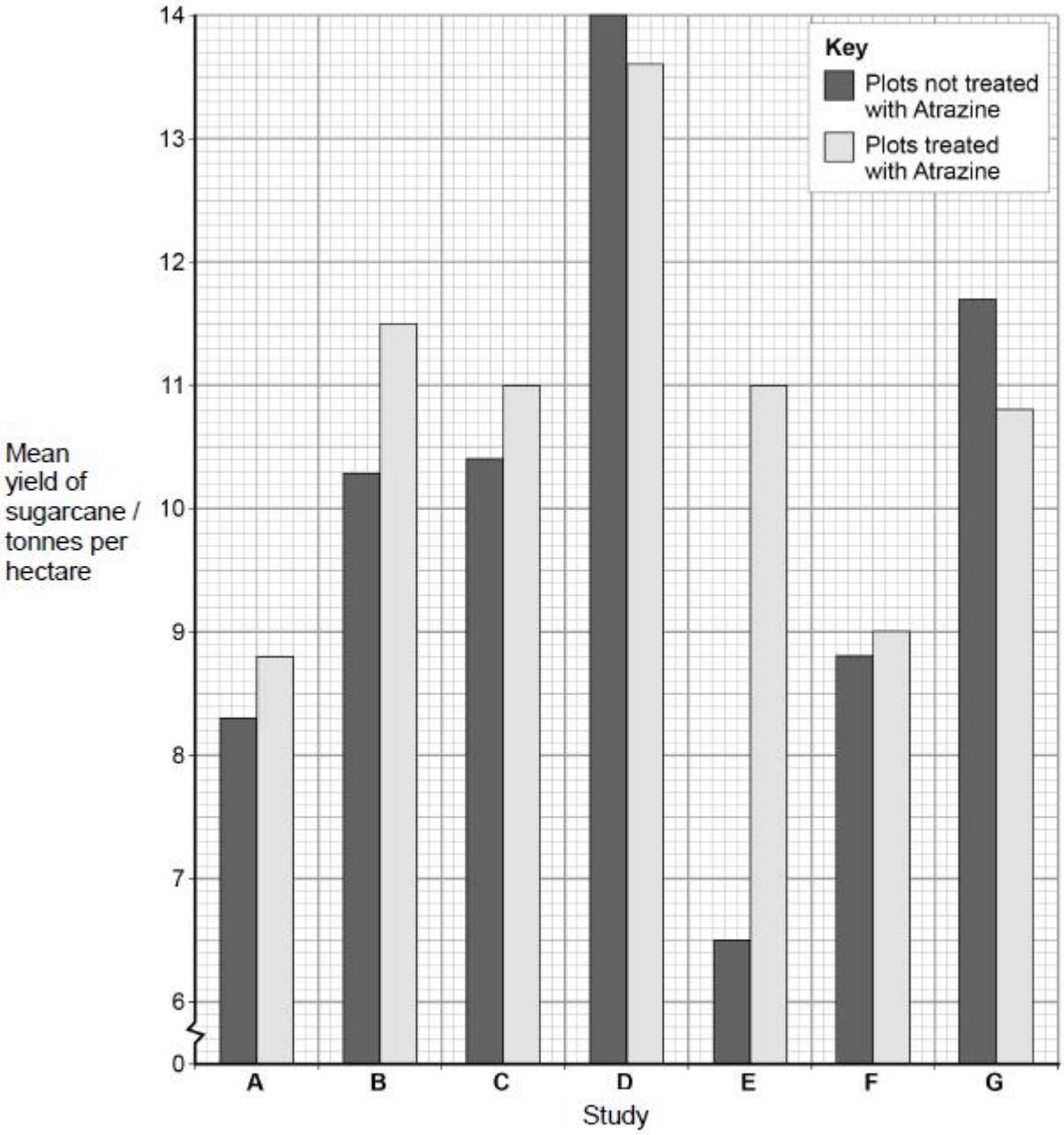
(Total 10 marks)

Q14.

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)

Q1.

(a) electrons;
from chlorophyll / photolysis;

2

(b) (i) RuBP combines with carbon dioxide to produce 2 x GP;

1

(ii) less used to combine with carbon dioxide /
less used to form glycerate 3-phosphate;

1

(c) (i) used in photosynthesis allows detection of products;

1

(ii) ATP and reduced NADP not formed;
GP is not being used to form RuBP / is being formed from RuBP;

2

(iii) used in respiration / formation of starch / cellulose;

1

[8]

Q2.

(a) ✓ ✓ x;
x x ✓;
✓ ✓ ✓
✓ x x

4

(b) (i) pyruvate / succinate / any suitable Krebs cycle substrate;

1

(ii) ADP and phosphate forms ATP;
oxygen used to form water / as the terminal acceptor;

2

(iii) Y X W Z;
order of carriers linked to sequence of reduction / reduced carriers cannot pass on electrons when inhibited;

2

[9]

Q3.

(a) <u>On diagram, correctly labelled:</u>

Light-dependent: granum / thylakoid membranes – labelled 'X'
AND
Light-independent: stroma – labelled 'Y';

1

(b) Any two from:

(Water) forms H^+ / hydrogen ions and electrons / e^- ;

O_2 / oxygen formed; [*NOT* 'O', *NOT* 'O^-']

(Light) excites electrons / raises energy level of electrons / electrons to chlorophyll / to photosystem;

max 2

(c) (ATP) Provides energy for GP → TP / provides P for RuP / TP → RuBP;

(Reduced NADP) Provides H / electrons for GP → TP / reduces GP to TP;

2

[5]

Q4.

(a) Excitation of chlorophyll molecule / electrons / energy of (pairs of) electrons raised to higher energy level;

Electron(s) emitted from chlorophyll molecule;

Electron(s) to electron transport chain;

Loss of energy by electron(s) along electron transport chain;

Energy lost by electron(s) is used to synthesise ATP;

From ADP + Pi;

"By electrons" need not be stated in each marking point if it can be reasonably inferred that the candidate is referring to electrons

max 5

(b) Little green light reaches bottom as absorbed by surface dwellers / water;
Red and blue not absorbed and so penetrate;
Variation in pigments of sediment dwellers;
Bacteria with chlorophyll at an advantage as chlorophyll absorbs red and blue;
(Survive to) reproduce in greater numbers and pass on advantageous alleles / genes in greater numbers / increase in frequency of advantageous alleles in subsequent generations;
Increase in frequency / numbers of bacteria with chlorophyll;

6

[11]

Q5.

(a) Temperature affects photosynthesis; Affects enzyme activity;
So that any change in photosynthesis rate is result of carbon dioxide / light intensity;

max 2

(b) Carbon dioxide increases rate of photosynthesis;
Up to max;

Something else / correct suggestion is a limiting factor;

3

[5]

Q6.

(a) dry conditions - stomata partially closed;
due to less turgor in guard cells;
OR
watered conditions - stomata more open;
due to greater turgor in guard cells;

2

(b) (i) *EITHER*
temperature *[Allow heat]* - higher causes more water evaporation / diffusion *[not just transpiration]*
OR
light - causes stomatal opening
OR
soil texture - determines availability of water
OR
humidity - reduces evaporation / reduces gradient / wind causes more (water) evaporation;

1

(ii) high CO_2 gives less variation AND watering gives less variation;
OR
insignificant difference in variability as small differences in SD;
reject 'no difference'

1

[4]

Q7.

(a) 1. Chlorophyll absorbs light energy;
Accept light energy 'hits' chlorophyll
Accept photon for light energy

2. Excites electrons / electrons removed (from chlorophyll);
Accept higher energy level as 'excites'

3. Electrons move along carriers / electron transport chain releasing energy;
Accept movement of H^+ / protons across membrane releases energy

4. Energy used to join ADP and Pi to form ATP;
Negate 'produces energy' for either mark but not for both
Accept energy used for phosphorylation of ADP to ATP
Do not accept P as Pi

5. Photolysis of water produces protons, electrons and oxygen;
3. and 4.

6. NADP reduced by electrons / electrons and protons / hydrogen;

Accept NADP to NADPH (or equivalent) by addition of electrons / hydrogen

Do not accept NADP reduced by protons on their own

5 max

(b) 1. Variation / variety;

2. Mutation;

Do not accept answers which suggest the mutation is caused by copper

3. Some plants have allele to survive / grow / live in high concentration of copper / polluted soils;

Reference to immunity disqualifies this mark

Do not disqualify mark for references to allele providing resistance to copper

4. (Differential) reproductive success / adapted organisms reproduce;

5. Increase in frequency of allele;

6. No interbreeding (with other populations) / separate gene pool / gene pool differs (from other populations);

Accept reproductive isolation

5 max

[10]

Q8.

(a) (i) Yield increases by 0.6 kg m^{-2} (when extra carbon dioxide present);

1

(ii) Temperature / light intensity so could be lower in these weeks (as temperature / light insensity not fully controlled / monitored) (over period 1998 – 2000);

1

(b) Two marks for correct answer of 50.6%;;
One mark for incorrect answer in which candidate has shown clearly that calculation based on an increase / 0.42 and original mass / 0.83

2

(c) Cost of supplying carbon dioxide;
Price of (very early) tomatoes;

2

(d) Lowest price paid for tomatoes;
Some carbon dioxide lost as windows open in summer;
Little / no mean increase in yield in summer;

2 max

(e) Grow with extra carbon dioxide in one glasshouse and without carbon dioxidein other glasshouse at same time;
So all environmental conditions / light and temperature same for experiment and control;

2

[10]

Q9.

(a) 1. (Less/no) ATP;

2. (Less/no) reduced NADP;

Accept NADPH, NADPH + H, $NADPH_2$ NADPH + H^+

Reject reduced NAD, NADH etc,

2

(b) 1. (Less/no) carbon dioxide (reacts) with RuBP;

2. (Less/no) GP;

2

(c) 1. Stroma (of/in chloroplast);

Reject: stoma

Reject stroma of cytoplasm/chlorophyll

Reject stroma of mitochondrion

Ignore references to Calvin cycle or the light-independent reaction

1

(d) 1. Rubisco activity increases with temperature
OR
Rubisco optimum temperature is above (**rubisco activase**);

2. (Rubisco) **activase** activity decreases at high temperatures (allow any temperature above 25 ºC.)
OR
(Rubisco) **activase** optimum (allow in range) 25 to 30 ºC.;

Accept denatures at high temperature (allow any temperature above 25 ºC)

3. (Results/graphs suggest) **activase** cannot/does not affect activity of rubisco;

4. (Results are) only for cotton;

Accept may not be the same in other species/types of plant

Ignore: only one study

5. (Results are) for isolated enzymes;

6. No stats test;

4 max

[9]

Q10.

(a) 1. Peaks at 420-430 and 660-670;

2. No absorption of light between approximately 500 and 600;

3. Highest peak at 420-430;

2 max

(b) 1. Less (light) energy passes through leaves / reaches ground;

2. Smaller range of wavelengths passes through leaves;

Accept reference to only green (and yellow) light pass through

3. Little light for chlorophyll to absorb;
   Accept carotenoids can absorb this light

4. So insufficient photosynthesis (for growth);
   Sufficient photosynthesis for plants with carotenoids

5. Photosynthesis unlikely to exceed respiration;

3 max

(c) 1. Light not limiting / lots of light (as no shading);

2. Light-dependent reaction not limiting / fast;

OR

3. Temperature not limiting / Warm (as no shading);

4. Fast reactions of enzymes in light-independent reaction;

OR

5. High use of CO_2;

6. Light-independent reaction is limiting;
   Mark as a pair

2

[7]

Q11.

(a) 1. Protein synthesis **and** cell wall synthesis **and** cell expansion stop at −0.7 / at a *higher* water potential than other two;
   If all 3 are correctly identified in marking point 1, accept 'the others / the other two' in marking point 2, and vice versa

2. Photosynthesis **and** stomatal opening stop at -1.5 / at a *lower* water potential than other three;
   Correct processes must be named in at least one of marking point 1 or marking point 2
   Where reference to water potential differences are made, they must be comparative, eg 'higher'

2

(b) 1. Stomata allow uptake of carbon dioxide;

2. Carbon dioxide used in / required for photosynthesis;

2

(c) 1. Growth involves cell division / cell expansion / increase in mass;
   Marking point 1 is for the principle

2. Protein synthesis stops **so** no enzymes / no membrane proteins / no named protein (for growth / division);

Marking points 2, 3 and 4 require appreciation of 'why' before credit can be awarded

'named' protein must relate to proteins involved in growth or cell division

3. Cell wall synthesis stops **so** no new cells can be made;

Full credit is possible without a statement of the principle (marking point 1)

4. No cell expansion / increase in mass **because** (cells) stop taking up water;

3 max

[7]

Q12.

(a) Oxygen production / concentration <u>and</u> time.

Accept: oxygen volume / concentration

Reject: oxygen uptake

Neutral: reference to carbon dioxide uptake

1

(b) 1. Intensity of light;

Accept: distance from light

2. Amount / number / mass / species of algae / photosynthesising cells;
3. Carbon dioxide (concentration / partial pressure);
4. Time.

2 max

(c) 1. (pH) increases;

Neutral: becomes more alkaline / less acidic

2. As (more) carbon dioxide removed (for photosynthesis).

2

(d) 1. Less absorption / (more) reflection (of these wavelengths of light);

Reject: no absorption or cannot absorb unless in context of green light.

Note: no green light absorbed <u>or</u> green light reflected = 2 marks.

2. (Light required) for light dependent (reaction) / photolysis

Accept: for excitation / removal of electrons (from chlorophyll)

3. (Represents) green light / colour of chlorophyll.

2 max

[7]

Q13.

(a) 1. (No grease)
means stomata are open
OR

allows normal CO_2 uptake;

Allow 'gas exchange' for CO_2 uptake.

'As a control' is insufficient on its own.

2. (Grease on lower surface)
seals stomata
OR
stops CO_2 uptake through
stomata
OR
to find CO_2 uptake through
stomata
OR
shows CO_2 uptake through cuticle / upper surface;

3. (Grease on both surfaces) shows sealing is effective
OR
stops all CO_2 uptake.

3

(b) (i) 1. (Mean rate of) carbon dioxide uptake was constant *and* fell after the light turned off;

Ignore absence of arbitrary units in both marking points.

Both ideas needed for mark.

Accept 'stayed at 4.5' as equivalent to 'was constant'.

2. Uptake fell from 4.5 to 0 / uptake started to fall at 60 minutes and reached lowest at 80 minutes / uptake fell over period of 20 minutes;

One correct use of figures required.

Accept fell to nothing / no uptake for 0.

2

(ii) 1. (Because) water is lost through stomata;
2. (Closure) prevents / reduces water loss;
3. Maintain water content of cells.

This marking point rewards an understanding of reducing water loss e.g. reduce wilting, maintain turgor, and is not related to photosynthesis.

2 max

(c) (i) (Carbon dioxide uptake) through the upper surface of the leaf / through cuticle.

1

(ii) 1. No use of carbon dioxide in photosynthesis (in the dark);
2. No diffusion gradient (maintained) for carbon dioxide into leaf / there is now a diffusion gradient for carbon dioxide out of leaf (due to respiration).

2

[10]

Q14.

(a) 7.7(%);

1

(b) 1. No error bars / SD;

2. To show if overlap occurs so difference (in means) is not significant / due to chance
OR
To show if no overlap occurs so difference (in means) is significant / is not due to chance.

Do not accept 'no statistical test performed' as Chi squared / Spearman's rank would be inappropriate.

Ignore references to sample size as it can be assumed that scientists completed the study using appropriate methodology.

2

(c) 1. Reduced transfer of protons across thylakoid membrane
OR
Reduced chemiosomotic gradient / proton gradient across thylakoid membrane;

2. (So) less ATP produced;

3. (So) less reduced NADP produced;

Accept NADPH / $NADPH_2$ / $NADPH^+$

Reject reduced NAD

4. (So) light-independent reaction slows / stops;
OR
Less reduction of GP to triose phosphate.

4

(d) Idea that energy is released from high energy / excited electron/s (that were lost from chlorophyll)

1

[8]