Questions

Q1.

Climate change has been linked to the release of carbon dioxide from some power stations.

Name the plant organelle that fixes carbon dioxide from the atmosphere.

(1)

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(Total for question = 1 mark)

Q2.

Photosynthesis is a process that occurs in all green plants.

Describe how starch is formed from the products of the light-independent reactions of photosynthesis.

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(Total for question = 4 marks)

Q3.

Photosynthesis is a two-stage process by which plants fix carbon dioxide.

Describe the light-dependent reactions of photosynthesis.

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(Total for question = 5 marks)

Q4.

Tropical rainforests play a role in maintaining biodiversity and in storing carbon.

In a mature tropical rainforest, there is no net increase in biomass.

(i) Which statement describes the role of photosynthesis in the carbon cycle?

(1)

☒ **A** carbon dioxide is oxidised to form organic molecules

☒ **B** carbon dioxide is reduced to form organic molecules

☒ **C** organic molecules are combusted to produce carbon dioxide

☒ **D** organic molecules are decomposed to release carbon dioxide

(ii) The gross primary productivity (GPP) for one mature tropical rainforest was found to be 24 800 kJ m^{-2} $year^{-1}$. It was estimated that 65% of GPP was used in respiration.

Calculate the energy transferred to the next trophic level.

(2)

..... kJ m^{-2} $year^{-1}$

(Total for question = 3 marks)

Q5.

Photosynthesis is a process that occurs in all green plants.

Herbicides kill weeds by affecting their growth.

The effect of herbicides on the production of starch in the leaves of *Echinochloa crus-galli* (barnyard grass) has been investigated.

The table shows the results for four herbicides: Diuron, Propanil, Linuron and Swep.

Concentration of herbicide / µg cm^{-3}	Relative percentage of starch produced (%)			
	Diuron	Propanil	Linuron	Swep
0.0	100	100	100	100
0.1	0	50	50	100
1.0	0	0	0	50
10.0	0	0	0	0
100.0	0	0	0	0

It is thought that these herbicides act on the light-dependent reactions of photosynthesis.

Devise an investigation that would produce quantitative data on the effectiveness of the herbicides on the light-dependent reactions of photosynthesis.

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(Total for question = 6 marks)

Q6.

In some commercial glasshouses, the concentration of carbon dioxide in the atmosphere is increased.

Explain why this increase in carbon dioxide concentration affects the growth of plants in glasshouses.

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(Total for question = 3 marks)

Q7.

Answer the questions with a cross in the boxes you think are correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Photosynthetic plants use light as a source of energy for the synthesis of organic molecules. Photosynthesis is a two-stage process.

The light-dependent reactions take place in the chloroplast.

(i) Which of the following describes where, in the chloroplast, the light-dependent reactions take place?

(1)

- ☐ **A** cristae
- ☐ **B** matrix
- ☐ **C** stroma
- ☐ **D** thylakoids

(ii) Which of the following are the products of the light-dependent reactions?

(1)

- ☐ **A** carbon dioxide and reduced NADP
- ☐ **B** glucose and oxygen
- ☐ **C** reduced NAD, ATP and oxygen
- ☐ **D** reduced NADP, ATP and oxygen

(iii) Which of the following is the source of the hydrogen produced by the light-dependent reactions?

(1)

- ☐ **A** glucose
- ☐ **B** reduced NAD
- ☐ **C** reduced NADP
- ☐ **D** water

(Total for question = 3 marks)

Q8.

The pigment content of mountain plants can be affected by various environmental factors. These factors include altitude (height up a mountain), exposure to ultraviolet radiation (UV-B) and temperature.

These pigments include chlorophyll, found in chloroplasts, and flavonoids that are found in sap vacuoles.

Flavonoids can protect plants from ultraviolet radiation (UV-B) that can damage DNA.

State the location of chlorophyll in a chloroplast.

(1)

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(Total for question = 1 mark)

Q9.

Photosynthesis is a two-stage process by which plants fix carbon dioxide.

The products of the light-dependent reactions are used in the light-independent reactions.

(i) In which part of the chloroplast do the light-independent reactions take place?

(1)

- ☒ **A** envelope
- ☒ **B** granum
- ☒ **C** stroma
- ☒ **D** thylakoid

(ii) What is the name of the enzyme used by plants to fix carbon dioxide?

(1)

- ☒ **A** GALPase (glyceraldehyde-3-phosphatase)
- ☒ **B** GPase (glycerate-3-phosphatase)
- ☒ **C** RUBISCO (ribulose bisphosphate carboxylase/oxygenase)
- ☒ **D** RuBPase (ribulose bisphosphatase)

(iii) Which of the following is the immediate product of the light-independent reactions of photosynthesis?

(1)

- ☒ **A** glucose
- ☒ **B** GP
- ☒ **C** RuBP
- ☒ **D** starch

(Total for question = 3 marks)

Q10.

Photosynthesis in green plants involves light-dependent reactions and the Calvin cycle.

The Calvin cycle uses the products of the light-dependent reactions.

(i) State the location of the Calvin cycle.

(1)

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(ii) Describe the roles of the products of the light-dependent reactions in the Calvin cycle.

(3)

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(Total for question = 4 marks)

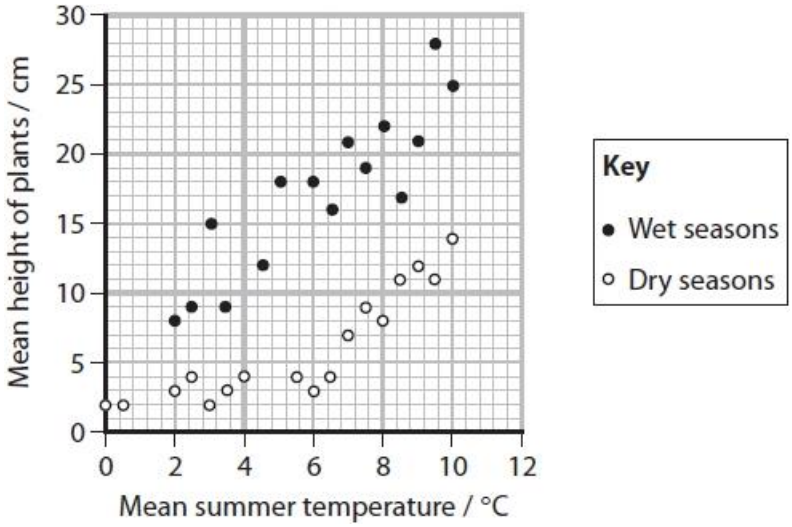
Q11.

Anthropogenic climate change is linked to an increase in carbon dioxide in the atmosphere.

A study has investigated the effect of temperature changes on plants growing in the Arctic. This is an area with cold and short growing seasons.

Warming in the Arctic is leading to a change in the community of plants. The mean height of plants in the area was studied in both dry and wet growing seasons over a 30-year period. The summer temperatures over this period were recorded.

The results are shown in the graph.



Explain the effect of these environmental factors on the mean height of the plants.

(2)

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(Total for question = 2 marks)

Q12.

Explain the importance of RUBISCO to the productivity of an ecosystem.

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(Total for question = 2 marks)

Q13.

Photosynthesis is a process that occurs in all green plants.

The electron micrograph shows part of a chloroplast in a plant cell.

(i) The labelled starch grain in the chloroplast is 2.2 µm long.
Calculate the width of this chloroplast between T and U.

(2)

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(ii) Explain the relationship between the structure and functions of a granum in photosynthesis.

(3)

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(Total for question = 5 marks)

Mark Scheme

Q1.

Question Number	Answer	Additional guidance	Mark
	Chloroplast		**(1)**

Q2.

Question Number	Answer	Additional Guidance	Mark
	A description that makes reference to the following: • two GALP used to produce a glucose molecule • (glucose molecules are) joined together by glycosidic bonds to form starch • by condensation reactions • producing amylose and amylopectin	ALLOW triose phosphate instead of GALP ALLOW maltose / polysaccharide	**(4)**

Q3.

Question Number	Answer	Additional Guidance	Mark
	A description that makes reference to the following: • use of light (energy) to excite electrons in chlorophyll (1) • {photolysis / splitting of water} to produce oxygen, electrons and hydrogen ions (1) • electrons used { in the electron transport chain / to replace those lost by chlorophyll } (1) • generation of ATP / photophosphorylation (1) • reduction of NADP (1)	ALLOW electrons promoted to higher energy level ALLOW photosystem (PS) I or II for chlorophyll ALLOW correct equation ALLOW electrons used in redox reactions / electrons move along electron carrier proteins	**5**

Q4.

Question Number	Answer	Mark
(i)	**B** - carbon dioxide is reduced to form organic molecules *The only correct answer is **B*** ***A** is incorrect because carbon dioxide is not oxidised to form organic molecules* ***C** is incorrect because organic molecules are not combusted in photosynthesis* ***D** is incorrect because organic molecules are not decomposed in photosynthesis*	**(1)**

Question Number	Answer	Additional Guidance	Mark
(ii)	• correct percentage transferred • correct answer	<u>Example of calculation</u> 35 % / 0.35 = 8680 (kJ m^{-2} yr^{-1}) Correct answer without working gains full marks	**(2)**

Q5.

Question Number	Indicative content
*	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. Basic information • Use of all 4 herbicides • Control of a variable e.g. temperature, pH or light intensity • Variable related to barnyard grass considered e.g. age of plant Evidence of linkages • Sensible herbicide concentration selected, either a range from 0 to 10 μg cm^{-3} or 0.1 μg cm^{-3} • Hill reaction / use of DCPIP to measure light dependent reactions • Isolate chloroplasts • Method for controlling abiotic variables Evidence for sustained scientific reasoning • Suitable control described e.g. tubes in the dark • Description of how the reaction would be quantified e.g. time taken to decolourise DCPIP / use of a colorimeter • Statistical analysis to compare effectiveness of herbicides on photosynthesis • Measure of effectiveness described e.g. the more effective the herbicide the longer the time taken to decolourise the DCPIP, the herbicide that had most effect on decolourisation of DCPIP at the lowest concentration

Level	Mark	Descriptor	
0	Marks	No awardable content	
Level 1	1-2	An explanation of how the investigation should be modified may be attempted but with limited analysis, interpretation and/or evaluation of the scientific information. Generalised comments made. The explanation will contain basic information with some attempt made to link knowledge and understanding to the given context.	Description of use of herbicides Control of a variable e.g. temperature, pH or light intensity Variable related to barnyard grass considered e.g. age of plant
Level 2	3-4	An explanation of how the investigation should be modified will be given with occasional evidence of analysis, interpretation and/or evaluation of the scientific information. The explanation shows some linkages and lines of scientific reasoning with some structure.	Sensible range of herbicide concentrations between 0 and 100 μg cm^{-3} Hill reaction / use of DCPIP to measure light dependent reactions Isolate chloroplasts Method for controlling abiotic variables
Level 3	5-6	An explanation of how the investigation should be modified is given which is supported throughout by evidence from the analysis, interpretation and/or evaluation of the scientific information. The explanation shows a well-developed and sustained line of scientific reasoning which is clear, coherent and logically structured.	Focus on range of herbicide concentrations between 0 and 1 μg cm^{-3} Suitable control described e.g. tubes in the dark Description of how the reaction would be quantified e.g. time taken to decolourise DCPIP / use of a colorimeter Statistical analysis to compare effectiveness of herbicides on photosynthesis

Q6.

Question Number	Answer	Additional guidance	Mark
	An explanation that makes reference to three of the following points • description of carbon dioxide as a limiting factor (1) • carbon dioxide is fixed to produce { GP / GALP } (1) • (therefore increased carbon dioxide) results in more { carbohydrate / polysaccharides / glucose } being produced (1) • which would lead to a greater rate of { growth / cell division } (1)	ALLOW other relevant biological molecule e.g. amino acids, lipids, nucleic acids ALLOW faster growth	**(3)**

Q7.

Question Number	Answer	Mark
(i)	**The only correct answer is D thylakoids** ***A*** *is not correct because the cristae are not found in the chloroplast* ***B*** *is not correct because the matrix is not found in the chloroplast* ***C*** *is not correct because the stroma is not the site of the light-dependent reactions*	**(1)**

Question Number	Answer	Mark
(ii)	**The only correct answer is D reduced NADP, ATP and oxygen** ***A*** *is not correct because carbon dioxide is not a product of photosynthesis* ***B*** *is not correct because glucose is the end product of the light independent reactions* ***C*** *is not correct because reduced NAD is not a product of the light-dependent reactions*	**(1)**

Question Number	Answer	Mark
(iii)	**The only correct answer is D water** ***A*** *is not correct because glucose is not the source of hydrogen in the light-dependent reactions* ***B*** *is not correct because reduced NAD is not the source of hydrogen in the light-dependent reactions* ***C*** *is not correct because reduced NADP not the source of hydrogen in the light-dependent reactions*	**(1)**

Q8.

Question Number	Answer	Additional Guidance	Mark
	An answer that makes reference to the following: • thylakoid membrane / grana / granum **(1)**	ALLOW phonetic spelling ALLOW lamella	**(1)**

Q9.

Question Number	Answer	Mark
(i)	**The only correct answer is C – Stroma** A is not correct because light-independent reactions take place in the stroma B is not correct because light-independent reactions take place in the stroma D is not correct because light-independent reactions take place in the stroma	**1**

Question Number	Answer	Mark
(ii)	**The only correct answer is C – RUBISCO (ribulose bisphosphate carboxylase/oxygenase)** A is not correct because RUBISCO (ribulose bisphosphate carboxylase/oxygenase) is the enzyme that fixes carbon dioxide B is not correct because is not correct because RUBISCO (ribulose bisphosphate carboxylase/oxygenase) is the enzyme that fixes carbon dioxide D is not correct because is not correct because RUBISCO (ribulose bisphosphate carboxylase/oxygenase) is the enzyme that fixes carbon dioxide	**1**

Question Number	Answer	Mark
(iii)	**The only correct answer is B – GP** A is not correct because glucose is made from the products of the light-independent reactions C is not correct because RuBP is the molecule that CO_2 combines with to form molecules of GP D is not correct because starch is formed from glucose	**1**

Q10.

Question number	Answer	Additional guidance	Mark
(i)	An answer that makes reference to the following: • stroma of the chloroplast (1)		**(1)**

Question number	Answer	Additional guidance	Mark
(ii)	An answer that makes reference to the following: • (the products) ATP and reduced NADP (1) • ATP is used (by the enzyme) converting {GP to GALP / GALP to RuBP} (1) • reduced NADP used to convert GP to GALP (1)	ALLOW $NADPH_2$ or NADPH for reduced NADP IGNORE $NADPH^+$ and reduced NAD ALLOW ATP is used to provide energy for the Calvin cycle	**(3)**

Q11.

Question Number	Answer	Additional guidance	Mark
	An explanation that makes reference to two of the following: • plants show increase in height as the temperature increases (from3°C to 10°C) in this period (1) • the rate of photosynthesis will increase (in the Arctic plants) as thetemperature increases, leading to an increase in growth (1) • the increase is greater in wet conditions because water is alsoneeded for { photosynthesis / growth } (1)		**(2)**

Q12.

Question number	**Answer**	**Additional guidance**	**Mark**
	An answer that makes reference to two of the following:		
	• fixes (inorganic) carbon (1)	ALLOW fixes CO_2 / combines RUBP and CO_2	
	• allowing formation of organic molecules (by the Calvin cycle) (1)	ALLOW suitable examples of organic molecules e.g. GP / GALP / glucose / hexose sugars / amino acids	
	• these organic molecules allow transfer of energy to next trophic level (1)	ALLOW these organic molecules can be converted into biomass	**(2)**

Q13.

Question Number	Answer	Additional Guidance	Mark
(i)	• correct measurements from the photograph (1) • correct answer	<u>Example of calculation</u> Starch grain 27mm and width of chloroplast 60mm 27000 ÷ 22 = 12 273 60000 ÷ 12 273 = 4.889 (µm) ALLOW 4.9 / 4.89 / 4.8 recurring (µm) (ALLOW one mark for correct calculation from different measurements)	**(2)**

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to three of the following: • (granum) is formed from many layers of thylakoid membranes to increase surface area (for absorbing light) • thylakoid membranes contain chlorophyll to absorb light • electron carrier molecules in thylakoid membrane involved in ATP production	ALLOW stacks of thylakoids provide a large surface area ALLOW photosystems / photosynthetic pigments in place of chlorophyll ALLOW for light dependent reaction in place of absorb light ALLOW ATP synthase / photophosphorylation	**(3)**