PEARSON EDEXCEL A-LEVEL BIOLOGY B · 9BI0

BIOLOGY



MARK SCHEME

TOPIC 5: ENERGY FOR BIOLOGICAL PROCESSES

PHOTOSYNTHESIS

SCORE	PERCENTAGE
/175	%

STEMUP

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Mark Scheme

Q1.

Question Number	Indicative content
*	Answers will be credited according to candidate's deployment of knowledge and understanding of 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. <u>Light:</u> **(L)** • more light at equator / less light at higher latitudes <u>Light dependent stage:</u> **(L)** • light excites electrons • photolysis occurs • ATP made / photophosphorylation • NADPH / reduced NADP made <u>Light independent stage:</u> **(L)** • Calvin cycle • NADPH / ATP used • Carbon fixation • to reduce carbon dioxide to carbohydrate / GP / GALP / glucose <u>Temperature:</u> **(L)** • temperature is higher at the equator / lower at higher latitudes • temperature affects enzymes • eg. RUBISCO enzyme • temperature affects active uptake of mineral ions • temperature affects rate of transpiration
	<u>Other abiotic variables:</u> **(A)** • identifies other abiotic variables eg carbon dioxide / water / mineral ions / pH • carbon dioxide unlikely to be a limiting factor • comment on lack of available water eg in deserts / polar regions or excess of water eg flooded areas • water needed for photolysis / mineral ion transport • use of named mineral ion eg. nitrate for amino acids / protein • soil edaphic factors • abiotic factors in the oceans discussed <u>Biotic factors:</u> **(B)** • biotic factors also affect productivity • disease / infection / bacteria / fungi / named pathogen • grazing / herbivore populations / pest populations • competition eg for light • decomposition is slower at higher latitudes (affects mineral ion availability) • human factors eg deforestation / pesticide use / fertilizer use / crop planting • biotic factors in the oceans discussed <u>Productivity factors</u> **(B)** • productivity subject to limiting factors • productivity in cool temperate can exceed warm temperate • productivity in the oceans not taken into account • unequal size of latitude ranges (makes comparison difficult) • idea of interaction between multiple / complex factors affecting productivity

Level	Marks	
0	0	No awardable content
1	1-3	Demonstrates isolated elements of biological knowledge and understanding to the given context with generalised comments made. Vague statements related to consequences are made with limited linkage to a range of scientific ideas, processes, techniques and procedures. The discussion will contain basic information with some attempt made to link knowledge and understanding to the given context. **Up to three from L, A or B**
2	4-6	Demonstrates adequate knowledge and understanding by selecting and applying some relevant biological facts/concepts. Consequences are discussed which are occasionally supported through linkage to a range of scientific ideas, processes, techniques and procedures. The discussion shows some linkages and lines of scientific reasoning with some structure. **At least two from L and at least two from A or B**
3	7-9	Demonstrates comprehensive knowledge and understanding by selecting and applying relevant knowledge of biological facts/concepts. Consequences are discussed which are supported throughout by sustained linkage to a range of scientific ideas, processes, techniques or procedures. The discussion shows a well-developed and sustained line of scientific reasoning which is clear and logically structured. **At least two from L plus at least two from A and two from B with no major errors**

Q2.

Question Number	Acceptable Answer	Additional Guidance	Mark
	An answer that makes reference to the following: **Similarities** • both use an electron transport chain on membranes (1) • both use ATPase driven by { H^+ gradient / chemiosmosis / eq } (1) • in both, electrons passed from one carrier to another lose energy which drives ATP production (1)	At least one similarity and one difference must be given to gain full marks. Max 2 marks if only 3 similarities provided Max 1 marks if only 2 similarities provided	**(5)**

	Differences • energy is provided by light in chloroplasts but by { glucose / pyruvate / eq } in mitochondria (1) • ATP is made by photophosphorylation in chloroplasts but by { substrate level / oxidative phosphorylation } in mitochondria (1) • in chloroplasts, electrons are provided by chlorophyll but in mitochondria, electrons are brought by reduced { NAD / FAD } (1) • in chloroplasts, (some) electrons return to chlorophyll whereas in mitochondria, electrons are accepted by oxygen (1)	Max 3 marks if only 4 differences provided Max 2 marks if only 3 differences provided Max 1 marks if only 2 differences provided	

Q3.

Question Number	Answer	Additional Guidance	Mark
(i)	• length of scale line given in µm • magnification calculated	1.7 × 10000 / 17000 1.7×10^{3} / 0.0017×10^{6}	

Question Number	Answer	Additional Guidance	Mark
(ii)	width of GM aperture divided by width of non-modified aperture	In the range of 1.3 to {4 / 4.0} to no more than 1 decimal place DO NOT ACCEPT with units or %	

Q4.

Question Number	Answer	Additional Guidance	Mark
(i)	1×10^{11}	**Accept** 10^{11} / 100 000 000 000 / 10×10^{10} / any other equivalent ways of expressing this answer	**(1)**

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to two of the following: • because the number of carbon (atoms) in the cell has been under-estimated **(1)** • because not all the ATP is used in (light-dependent reaction / Calvin cycle / carbon fixation} **(1)** • because {photons differ in energy / not all wavelengths of light are absorbed by the plant} **(1)**	**Accept** there are more carbons in the cell **Accept** cyclic photophosphorylation is happening **Accept** process is not 100% efficient / some light is reflected / not all photons of light are absorbed	**(2)**

Question Number	Answer	Additional Guidance	Mark
(iii)	A description that makes reference to three of the following: • carbon dioxide diffuses into stroma **(1)** • carbon dioxide binds to {ribulose bisphosphate / RuBP} **(1)** • using {ribulose bisphosphate carboxylase / RUBISCO} **(1)** • resulting in the formation of {(intermediate) 6C compound / GP} **(1)**	**Accept** attaches / joins / reacts / added to **Accept** rubisco	**(3)**

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. **Descriptions of graph or diagram:** • as the leaf size increases so does the number of chloroplasts per cell • as the leaf size increases cpDNA per chloroplast increases then decreases • as the leaf continues to grow the number of chloroplasts per cell continues to increase but the number of cpDNA per cell drops **Explanations of graph or diagram:** • as the leaf increases in size more chloroplasts needed for photosynthesis • cpDNA replicates to provide the cpDNA for newly made chloroplasts • this ensures that the new chloroplasts have identical genetic information • the cpDNA per chloroplast begins to drop as the leaf cells get older, since there are more chloroplasts per cell **Interpretation of the genes found in the cpDNA :** • cpDNA codes for RNAs and ribosomal proteins that will be needed for transcription and translation of proteins needed in the new chloroplasts • cpDNA codes for proteins needed in photosynthesis e.g.RUBISCO

Level 0	Marks	No awardable content
Level 1	1-2	An explanation may be attempted but with limited interpretation or analysis of the scientific information with a focus on mainly just one piece of scientific information. The explanation will contain basic information with some attempt made to link knowledge and understanding to the given context. **Description given of the changes shown in the graph in the number of chloroplasts, cpDNA and increase in leaf size**
Level 2	3-4	An explanation will be given with occasional evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The explanation shows some linkages and lines of scientific reasoning with some structure. **An explanation given for these changes**
Level 3	5-6	An explanation is made which is supported throughout by sustained application of relevant evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The explanation shows a well-developed and sustained line of scientific reasoning which is clear and logically structured. **Links made between the genes in the cpDNA and the processes of photosynthesis and protein synthesis**

Q6.

Question Number	Answer	Mark
	The only correct answer is D ***A*** *is not correct because there is no cytoplasm inside the chloroplast* ***B*** *is not correct because the matrix is found inside mitochondria* ***C*** *is not correct because nucleoplasm is found inside the nucleus*	**(1)**

Q7.

Question Number	Answer	Additional Guidance	Mark
(i)	An explanation that makes reference to four of the following: • use same light intensity (1) • use red filter (1) • use tube {with clean sides / no scratches / holding opaque side} (1) • use a control tube with water to {calibrate / obtain zero absorbance} (1) • same {concentration / volume} of {chloroplasts / DCPIP} (1)	**DO NOT ACCEPT** same lamp / same bulb / same power / same distance	**(4)**

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to four of the following: • with herbicide DCPIP not {decolourised / reduced / stays blue} (1) • no electrons available / reduced electron transport (1) • less {reduced NADP / NADPH} (1) • therefore less ATP (1) • because the {Calvin cycle / light independent stage} are affected (1)	**ACCEPT** converse **DO NOT ACCEPT** absorbance does not change **DO NOT ACCEPT** if from ETC implies respiration	**(4)**

Q8.

Question Number	Answer	Additional Guidance	Mark
(i)	A description that makes reference to the following: • (µmol) carbon dioxide used / {oxygen / GP / GALP / glucose} made (1) • (m^{-2}) is the area of the {leaf / open stomata} (1) • (s^{-1}) in one second (1)	ACCEPT example e.g. measure for 120 seconds and divide by 120	

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to three of the following: • increase in light intensity increases photosynthesis (1) • increase is greater in GM plants because the wider aperture will result in a more {gas exchange / uptake of carbon dioxide} (1) • therefore {light-independent reactions / Calvin cycle / carbon fixation} is faster (1) • rate levels off when {another factor / carbon dioxide concentration / temperature} becomes rate limiting (1)	ACCEPT GM plants photosynthesise faster than non-GM ACCEPT carbon dioxide not limiting the rate of {light-independent reactions / Calvin cycle / carbon fixation}	

Q9.

Question Number	Answer	Additional Guidance	Mark
(i)	absorption spectrum shows absorption of light of different wavelengths and action spectrum shows rate of photosynthesis at each wavelength	**ACCEPT** absorption spectrum involves wavelengths only and action spectrum involves photosynthesis / oxygen production only	**(1)**

Question Number	Answer	Additional Guidance	Mark
(ii)	spectra are similar / spectra overlap / peaks and troughs follow similar pattern	**ACCEPT** similar peak at blue / similar peak at red / similar trough at green	**(1)**

Q10.

Question Number	Answer	Additional Guidance	Mark
(i)	Diagram marks : 1. two membranes shown ; 2. inner membrane folded into cristae ; Label marks (correct) : [max 2 marks] 3. outer membrane and {inner membrane / cristae} ; 4. matrix ; 5. stalked particles / ATPase / eq (labelled on inner membrane) ; 6. DNA (circular / loop) ; 7. ribosomes ;	**1 NOT** if cristae shown as a 3rd membrane **NB** do not choose which labels to accept eg 2 right + 1 wrong = 1 mark 2 wrong = 0 marks **5 ACCEPT** oxisome **6 ACCEPT** plasmids **7 IGNORE** size references	**(4)**

Question Number	Answer	Additional Guidance	Mark
(ii)	chloroplast ;	**IGNORE** chlorophyll	**(1)**

Q11.

Question Number	Acceptable Answer	Additional guidance	Mark
	An explanation that makes reference to the following: • light (intensity) will not be a limiting factor (1) • therefore carbon dioxide (concentration) is (only) limiting factor (1) • so the effect of carbon dioxide concentration can be seen (1)	Accept: {ATP / NADPH / eq} produced during light dependent reactions	**(3)**

Q12.

Question Number	Acceptable Answer	Additional guidance	Mark
(i)	An explanation that makes reference to four of the following: • reducing the carbon dioxide concentration causes the RuBP to increase (1) • (at higher carbon dioxide concentration) RuBP is low because it is converted to carbohydrate / used to fix carbon dioxide (1) • RuBP rises because being regenerated / eq (1) • RuBP falls as being used to {fix / eq} carbon dioxide (1) • RuBP level remains constant once (new) equilibrium reached (1)	Accept correct manipulation of figures Correct answer gains full marks	**(4)**

Question Number	Acceptable Answer	Additional guidance	Mark
(ii)	An explanation that makes reference to the following: • the rate of GP production falls for 150 s after carbon dioxide decreased (1) • drops because less carbon dioxide available to convert into GP / less carbon fixation / carbon dioxide is limiting / eq (1) • levels out at a lower level as carbon dioxide still available but at lower level (1)	Accept correct manipulation of figures Accept sophisticated answers based on reduction of photosynthesis	**(3)**

Q13.

Question Number	Acceptable Answer	Additional guidance	Mark
	An explanation that makes reference to the following: • RuBP concentration would be lower (1) • because low temperature reduces activity of {RUBISCO / Calvin cycle} (1) • because there is less carbon dioxide fixation / less GP or GALP available to regenerate RuBP (1)	Accept sophisticated answers based on an initial increase in RuBP concentration	**(3)**

Q14.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to five of the following: • because there would be less water to take up from the soil (1) • therefore there will be fewer {mineral ions / minerals} (transported to the rest of the plant / taken up) (1) • example of a mineral ion deficiency on the plant explained (1) • there will be less water for {photolysis / light-dependent reaction / photosynthesis} (1) • therefore there will be less GALP produced in the {light-independent reaction / Calvin cycle} (1) • therefore less {NPP / plant biomass} (1)	**ACCEPT** plants will {wilt / die} without water **ACCEPT** less glucose produced	(5)

Q15.

Question Number	Answer	Additional Guidance	Mark
	1. idea that carbon dioxide dissolves (in the water / in the oceans) ; 2. for {carbon fixation / light-independent reaction / eq} ; 3. by {photosynthesis / eq} of {seaweed / algae / (phyto) plankton / autotrophs / eq} ;	**1 ACCEPT** absorbed / reacts with /diffuses into / becomes carbonic acid **3 ACCEPT** plants (that live in the sea) **IGNORE** organisms	**(2)**

Q16.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to three of the following: • because (faster photosynthesis will result in) more {GALP / glucose} produced (1) • to form a named plant molecule (1)	ACCEPT biomass / other organic molecules more {oxygen / glucose} for ATP production	
	• because transpiration stream will be faster (1) • therefore more mineral ions for named product (1)	e.g. Mg^{++} for chlorophyll, nitrates for protein	

Q17.

Question Number	Answer	Additional Guidance	Mark
	1. idea that light is reduced by the deeper water ; 2. idea that carbon dioxide levels might be lower deeper down ; 3. idea that temperature might be lower deeper down ; 4. idea that {photosynthesis / eq} will be reduced ; 5. idea that less {glucose / hexose / GALP / GP / eq } produced to convert into {biomass / NPP / eq} ; 6. idea that GPP goes down but respiration {stays the same / increases} ;	**NB ACCEPT** converse of mp 1 - 5 if in context of shallow water **5 IGNORE** energy	

Q18.

Question Number	Answer	Additional Guidance	Mark
(a)	1. (rate of) { energy incorporated into / production of / eq} {biomass / organic material} ; 2. in {plants / producers} ;	**2. Accept** from photosynthesis	**(2)**

Question Number	Answer	Additional Guidance	Mark
(b)(i)	1. very little GPP in seagrass / majority present in {microphytobenthos and phytoplankton / phytoplankton} ; 2. (roughly) equal distribution (of GPP) between microphytobenthos and phytoplankton ;	**1. Accept** only 2.5 to 5% in seagrass, 95% in micro and phyto, more than 50% or about 55% of phyto 2. **Accept** about 50% in each **Accept** idea that GPP in microphytobenthos is slightly lower than in phytoplankton	**(2)**

Question Number	Answer	Additional Guidance	Mark
(b)(ii)	1. idea of obtaining a value from the chart e.g. percentage, area, degrees, ratio ; 2. idea of how to use this to calculate GPP ;	**Ignore** units **1. Accept** appropriate figures in range 50 – 55 % **2. Accept e.g. (**percentage) multiplied by 8.4 x 10^6 **NB** $\frac{\text{angle}}{360} \times 840 \times 10^6$ = 2 marks $\frac{\text{area of segment}}{\text{area of circle}} \times 840 \times 10^6$ = 2 marks	**(2)**

Question Number	Answer	Additional Guidance	Mark
(b)(iii)	1. {more / fast / high / eq} photosynthesis ; 2. water less {cloudy / churned up } / shallow water / high light penetration / eq ; 3. high {nutrient / carbon dioxide} levels in the sea / eq ; 4. {high / optimum} temperatures ; 5. high light intensity (in this area) / eq ; 6. idea of less respiration ;	**2. Accept** less current, less tidal	**(2)**

Question Number	Answer	Additional Guidance	Mark
(c)	1. NPP = GPP – R / eq ; 2. energy lost as heat / eq ; 3. named use of energy (released by respiration);	**1. Accept** correct description in words **3. Accept** e.g. movement, opening of flowers, glycolysis, metabolic processes	**(2)**

Q19.

Question Number	Answer	Mark
	B light-independent reaction	**(1)**

Q20.

Question Number	Correct Answer	Additional guidance	Mark
(a)	An explanation that makes reference to the following: • the shaded leaves have a larger surface area to mass ratio and are therefore bigger and thinner than leaves in the sun (1) • bigger allows more {chloroplasts / chlorophyll} for absorption of light (1) • thinner allows shorter diffusion path for entry of carbon dioxide (1)		**(3)**

Question Number	Correct Answer	Additional guidance	Mark
(b)	An explanation that makes reference to five of the following: • growing nettles in {pots / eq} to ensure soil pH / {mineral/ named mineral} content in pots is the same (1) • {measure / control} the {light intensity / duration} for both treatments to ensure light intensities are different (1) • watering regime is the same in both treatments to ensure same potential for leaf growth (1) • use {groups of pots / measure more leaves} so that data collected is reliable (1) • use genetically identical nettles in each treatment as some genes may affect growth (1) • make sure that all pathogens / consumers are prevented from access as they can reduce growth (1)		**(5)**

Q21.

Question Number	Answer	Additional Guidance	Mark
(a)(i)	NPP = 4680 ; R = 5720 ;	**NB** If there are no answers in the box, look for answers in the space below question If answers are the wrong way round, award 1 mark If both answers are wrong, **accept** R = 10168.9 / 10169	**(2)**

Question Number	Answer	Additional Guidance	Mark
(a)(ii)	1. NPP = GPP – R / eq; 2. 55% (GPP energy) is lost / eq ; 3. energy lost as heat / eq ; 4. to provide energy for {active transport / any other named energy-requiring process} ; 5. NPP is {(stored) energy / energy available for next trophic level / eq} ;	**Accept** correct description in words eg movement (opening of flowers, turning of leaves), glycolysis **Ignore** idea that energy is **used** for respiration unqualified **Accept** biomass	**(3)**

Question Number	Answer	Additional Guidance	Mark
(b)	1. cattle {are primary consumers / herbivores / eat grass / eat plants / eq} ; 2. (therefore) gain energy (available as NPP) ; 3. idea of grazing capacity of the grassland ; 4. idea of affect on yield of {meat / milk / eq} ; 5. idea of changing to a more {efficient / NPP yielding} crop ;	**Accept** idea that farmer is ensuring that there is enough NPP available for his cattle **Accept** growth rate	**(3)**

Question Number	Answer	Additional Guidance	Mark
(c)	1. idea of variation over short periods of time; 2. idea that whole year gives an {average / overall / eq} value ; 3. idea that biomass includes {all / undigestible / inedible / eq} organic material ; 4. idea that rate of productivity may influence how much grazing is possible ;	eg more NPP on a sunny day, seasonal	**(2)**

Q22.

Question Number	Indicative content
* (i)	Answers will be credited according to candidates' 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. <u>Indicative content</u> **Table 1** • Ponta Grossa: transgenic plants have higher mineral content than non-transgenic plants • Londrina: transgenic plants have lower mineral content that non-transgenic plants • Transgenic plants: plants grown in Ponta Grossa have lower mineral content than plants grown in Londrina • Non-transgenic plants: plants grown in Ponta Grossa have lower mineral content than plants grown in Londrina • Londrina:both types of soybean have more mineral content than both types in Ponta Grossa
	Table 2 • Ponta Grossa: transgenic plants have higher protein and lipid but lower carbohydrate content than non-transgenic plants • Londrina: transgenic plants have higher lipid but lower protein and carbohydrate content than non-transgenic plants • Transgenic plants: plants grown in Ponta Grossa have higher lipid but lower protein and carbohydrate content than plants grown in Londrina • Non-transgenic plants: plants grown in Ponta Grossa have higher lipid but lower protein and carbohydrate content than plants grown in Londrina • Londrina: both types of soybean have more protein and carbohydrate but lower lipid than both types in Ponta Grossa **Examples of Conclusions** • Londrina soybeans are (generally) the most nutritious • In Londrina, non-transgenic soybeans are more nutritious

	• In Ponta Grossa, transgenic soybeans are more nutritious • Very little difference in nutritional content overall	
Level 0	Marks	No awardable content
Level 1	1-2	An explanation may be attempted but with limited interpretation or analysis of the scientific information with a focus on mainly just one piece of scientific information. The explanation will contain basic information with some attempt made to link knowledge and understanding to the given context. 2 / 3 comparisons / conclusions
Level 2	3-4	An explanation will be given with occasional evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The explanation shows some linkages and lines of scientific reasoning with some structure. 4 / 5 comparisons / conclusions
Level 3	5-6	An explanation is made which is supported throughout by sustained application of relevant evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The explanation shows a well-developed and sustained line of scientific reasoning which is clear and logically structured. 6 / more comparisons and conclusions

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to five of the following: • Londrina (has a more fertile soil therefore the) soya beans will have a higher {mineral / mineral ion / ion / named mineral ion} content (1) • Londrina (has a more fertile soil therefore the) soya beans will have a higher protein content as there will be more nitrates (1) • Londrina has a higher temperature so {photosynthesis / Calvin cycle / carbon fixation} will be faster (1) • as {enzymes / RUBISCO} will {increase rate of reactions / have more kinetic energy} (1) • therefore making more {organic molecules / carbohydrate / named carbohydrate / protein} (1) • Londrina has a higher rainfall therefore more water for {photolysis / transport of minerals} (1)	**ACCEPT** {photosynthesise faster as more magnesium ions for chlorophyll / be stronger as more calcium ions for cell walls / more phosphate for ATP or nucleic acid synthesis} **ACCEPT** greater activity / work faster **ACCEPT** light-dependent reactions	**(5)**

Question Number	Answer	Additional Guidance	Mark
(iii)	An explanation that makes reference to the following: • to compare the fatty acids in the two types of soya bean (1) • so that {the (transgenic) soybeans will be less likely to increase the risk of heart disease / oxidation is less likely} (1)	**ACCEPT** to see if there were less saturated fatty acids / less linoleic acid / more oleic acid **ACCEPT** converse less likely to go rancid oleic acid less likely to oxidise than linoleic acid	**(2)**

Q23.

Question Number	Acceptable Answer	Additional Guidance	Mark
	An explanation that makes reference to the following: • photosynthesis causes a decrease in concentration of CO_2 inside the cell, producing a concentration gradient (1) • therefore CO_2 diffuses from solution into cells (1)		**(2)**

Q24.

Question Number	Answer	Additional guidance	Mark
(a)	1. idea that products of light-dependent stage are {needed for / used in / eq} {light-independent stage / Calvin cycle} ; 2. reference to (products of light-dependent stage) are {reduced NADP / eq} and ATP ; 3. reference to use of {reduced NADP / eq} for {reduction / eq} of {carbon dioxide / GP / eq} ; 4. reference to use of ATP as source of energy ;	**3. Accept** source of hydrogen ions for GALP **Ignore** ref to ATP	**(3)**

Question Number	Answer	Mark
(b)(i)	D volume of oxygen produced ;	**(1)**

Question Number	Answer	Additional guidance	Mark
(b)(ii)	1. (minimum temperature) is {between 0 °C and 10 °C / above 0 °C but less than 10 / 10 °C} ; 2. idea of no photosynthesis at 0°C but photosynthesis is taking place at 10 °C ; 3. reference to no {data / readings / measurements / evidence / eq} between 0 °C and 10 °C ; 4. idea that at 0 °C water is frozen ;	**3. Accept** if correct temp range has been given already	**(2)**

Question Number	Answer	Additional guidance	Mark
(b)(iii)	1. reference to abiotic factors {are non-living / non-biological / do not involve organisms / eq} ; 2. idea that **other factors** need to be kept constant ;	**2. Ignore** controlled	**(2)**

Question Number	Answer	Additional guidance	Mark
(b)(iv)	**Supporting conclusion:** 1. idea that shape of graph is typical of an enzyme-temperature graph ; 2. rate increases (up to 30 °C) because more {enzyme-substrate complexes / collisions between enzymes and substrates} / eq ; 3. rate decreases (after 30°C) due to enzyme denaturation / eq ; **Not supporting conclusion:** 4. idea that other factors could be affecting photosynthesis ; 5. idea of {gas / oxygen / carbon dioxide} solubility changing with temperature ; 6. idea of {correlation / not causation} ;	**1.** idea that rate of photosynthesis is affected by temperature in a similar way to enzymes	**(4)**

Q25.

Question Number	Answer	Additional Guidance	Mark
(a)(i)	1. idea of {fast / maximum} {gas exchange / uptake of carbon dioxide / eq}; 2. idea of penetration of light ; 3. idea that carbon dioxide is used in the {light-independent stage / Calvin cycle / formation of GP}; **OR** idea that light is used in {light-dependent stage / photolysis / photophosphorylation / eq } ;	**Accept** CO_2 but **ignore** incorrect formula	**(2)**

Question Number	Answer	Additional Guidance	Mark
(a)(ii)	1. transport (in xylem) of water (to the leaves) / eq ; 2. transport (in phloem) of {sucrose / sugar / carbohydrates } (away from the leaves) / eq; 3. (water) for {light-dependent reaction / photolysis / source of hydrogen (ions)}; **OR** idea of (transporting sugar) to make more room for more carbohydrate synthesis ;	**Accept** H_2O but **ignore** incorrect formula **Accept** phosphates but **ignore** mineral ions **Not** glucose or any other name sugars **Accept** reducing power, NADPH **Accept** (phosphates) for ATP synthesis	**(2)**

Question Number	Answer	Additional Guidance	Mark
(b)(i)	Reaction / Details / Structure {thylakoid (membrane) / grana / granum} ; stroma ; stroma ;	**Not** thylakoid space **Ignore** electron transport chain **Not** stoma / stomata **Not** stoma / stomata	**(3)**

Question Number	Answer	Additional Guidance	Mark
(b)(ii)	C ;		**(1)**

Question Number	Answer	Additional Guidance	Mark
(b)(iii)	C ;		**(1)**

Question Number	Answer	Additional Guidance	Mark
(b)(iv)	1. reference to conversion (of GALP) to glucose / eq; 2. (which is) β glucose ; 3. reference to formation of glycosidic bonds ; 4. between C_1 and C_4 / these bonds are 1-4 (glycosidic bonds) ; 5. by condensation ; 6. reference to {straight / unbranched} (chains of glucose) ; 7. reference to cellulose as a {polysaccharide / polymer of glucose / eq} ;	**NB** this is a question about the **formation** of cellulose, not its structure **NB** a reference to these bonds being formed must be made	**(4)**

Q26.

Question Number	Answer	Additional Guidance	Mark
(a)(i)	Line to diagram feature {grana / thylakoids / thylakoid membrane / inter-granal membrane } ;	**Ignore** any labelling of the line	**(1)**

Question Number	Answer	Additional Guidance	Mark
(a)(ii)	A ; ATP		**(1)**

Question Number	Answer	Additional Guidance	Mark
(b)(i)	stroma ;	**Accept** phonetic spelling eg strona, stromma **Not** stoma / stomata	**(1)**

Question Number	Answer	Additional Guidance	Mark
(b)(ii)	Y. RuBP / ribulose bisphosphate ; Z. GP / glycerate (3) phosphate ;	**Y. Accept** ribulose biphosphate **Not** ribose **Z. Accept** (3) phosphoglyceric acid / (3) PG / PGA / 2-Hydroxy-3-phosphonooxypropanoic acid **Not** glyceraldehydes (3) phosphate / GALP	**(2)**

Question Number	Answer	Additional Guidance	Mark
(b)(iii)	RUBISCO / ribulose bisphosphate carboxylase (oxygenase) ;	**Accept** ribulose biphosphate carboxylase RUBISCO written in upper or lower case or a mixture **Not** ribose	**(1)**

Question Number	Answer	Additional Guidance	Mark
*(b)(iv)	QWC – Spelling of technical terms must be correct and the answer must be organised in a logical sequence 1. idea of conversion (of *GP / Z*) to *GALP* / eq ; 2. using *ATP* and reduced *NADP* / eq ; 3. idea of conversion (of *GALP*) to {*glucose* / hexose} eq ; 4. (which is) α *glucose* ; 5. reference to formation of *glycosidic bonds* ; 6. these bonds are 1-4 and 1-6 (*glycosidic bonds*) / eq ; 7. by *condensation* ; 8. ref to *amylose* and *amylopectin* ; 9. credit details of *amylose* e.g. straight chain, 1-4 bonds ; 10. credit details of *amylopectin* eg branched, 1-4 and 1-6 bonds ;	**QWC emphasis is spelling** **NB** this is a question about the **conversion** of GP and the **formation** of starch, not its structure 1. **NB** idea of conversion needed 3. **NB** idea of conversion needed **5. NB** a reference to these bonds being formed must be made	**(5)**

Q27.

Question Number	Answer	Additional Guidance	Mark
(i)	• calculate sum of d^2 and divide (1) • calculate square root (1)	Correct answer gains full marks, with no working shown 68.8 ÷ 4 = 17.2 square root of 17.2 = 4.1 / 4.147 / 4.15 One mark for 17.2 / 68.8	(2)

Question Number	Answer	Additional Guidance	Mark
(ii)	A description that makes reference to two of the following: • leaves at {same height / same age} on stem (1) • sample at same stated position of leaf (1) • same surface of leaf (1)	**DO NOT ACCEPT** same location / same part / same place **DO NOT ACCEPT** same area / same part / same place	(2)

Question Number	Answer	Additional Guidance	Mark
(iii)	An answer that makes reference to three of the following: • (reduced growth) because less carbon dioxide absorbed (1) • therefore less {GP / GALP / glucose / sucrose} (1) • less transpiration so less mineral ions (1) • therefore less named product (1)	**ACCEPT** converse **ACCEPT** cellulose / amino acids / protein / chlorophyll / DNA **DO NOT ACCEPT** starch	(3)

Q28.

Question Number	Acceptable Answer	Additional guidance	Mark
	An explanation that makes reference to the following: • electron carrier components are on chloroplast membranes (1) • detergents disrupt the phospholipid bilayer in the membranes (1) • therefore electrons can no longer move along the chain (1)		**(3)**

Q29.

Question Number	Acceptable Answer	Additional guidance	Mark
(a)	D		**(1)**

Question Number	Acceptable Answer	Additional Guidance	Mark
(b)	A description that makes reference to three of the following: • compartmentalisation from stroma (1) • site of light-dependant reactions (1) • they contain {chlorophyll / photosynthetic pigments / electron carrier proteins} (1) • membranes increase the number of {pigments / proteins} that can be held (1) • contain ATP synthase / ATP synthesised (1)		**(3)**

Q30.

Question Number	Answer	Additional Guidance	Mark
(i)	**The only correct answer is A** **B** is incorrect because light-dependent stage takes place on thylakoid membrane and not in the stroma **C** is incorrect because light-dependent stage takes place on thylakoid membrane and not on the inner membrane **D** is incorrect because light-dependent stage takes place on thylakoid membrane and not on the outer membrane		(1) COMP
(ii)	**The only correct answer is A** **B** is incorrect because hydrogen ions accumulate inside the thylakoids and not in the starch grain **C** is incorrect because hydrogen ions accumulate inside the thylakoids and not in the DNA loop **D** is incorrect because hydrogen ions accumulate inside the thylakoids and not in the inner membrane space		(1) COMP

Question Number	Answer	Additional Guidance	Mark
(iii)	**The only correct answer is D** **A** is incorrect because translation occurs on the ribosomes and not inside the thylakoids **B** is incorrect because translation occurs on the ribosomes and not in the starch grain **C** is incorrect because translation occurs on the ribosomes and not in the DNA loop		(1) COMP