OCR GCSE 21ST CENTURY BIOLOGY B · J257

BIOLOGY



MARK SCHEME

B3.1 WHAT HAPPENS DURING PHOTOSYNTHESIS? (HIGHER)

SCORE	PERCENTAGE
/73	%

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Question			Answer/Indicative content	Marks	Guidance
1	a		Substrate – hydrogen peroxide **AND** enzyme – catalase ✓	1	
	b		* Please refer to the marking instructions for guidance on how to mark this question. **Level 3 (5–6 marks)** *Describes in detail the pattern of the graph* ***AND*** *Links this to an explanation of the effect of all temperatures on enzyme function* ***AND*** *Identifies the optimum temperature for the enzyme* *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** *Describes the pattern of the graph* ***AND*** *Links this to an explanation of the effect of temperature on enzyme function* ***OR*** *Identifies the optimum temperature for the enzyme* *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.* **Level 1 (1–2 marks)** *Describes the pattern of the graph* ***AND*** *Makes reference to the effect of temperature on enzyme function between 0 and 30 °C* ***OR*** *Makes reference to the effect of temperature on enzyme function between 30 °C and 60 °C* *The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear.*	6	**AO3.1a Identification of patterns in graph**For examp • Rate of reaction increases between 0 °C and 30 °C • Rate of reaction decreases between 30 °C and 60 °C **AO2.1 Details of effect of temperature on enzyme function** For example: • Increase between 0 and 30 °C is because there is more kinetic energy • So more collisions • So more ESC form • Decrease between 30 °C and 60 °C is because enzyme is denatured • Loss of 3D structure • ESC can no longer form as substrate does not fit into the enzyme **AO3.2a Identification of the optimum temperature of the enzyme** For example: • Optimum temperature is 30 °C

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Question			Answer/Indicative content	Marks	Guidance
			0 marks *No response or no response worthy of credit.*		
			Total	7	

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Question			Answer/Indicative content	Marks	Guidance
2		i	*any two from the following correct parts – max 2 marks* mitochondria; cell membrane; nucleus or DNA; cytoplasm; *one mark for each correct function - max 2 marks* (mitochondria) – contain enzymes / proteins / site of **aerobic** respiration / produce ATP; (cell membrane) – allows gases / CO_2 / O_2 / water / reactants / products to pass through/in and/or out of the cell; (nucleus) – contains DNA / genetic code for **making enzymes** (for respiration); (cytoplasm) – where enzymes are made / site of **anaerobic** respiration;	4	**ignore** 'membrane' on its own **allow** ribosomes the function must be linked to correct structure. **do not accept** contains enzymes for **anaerobic** respiration if cell membrane mark not given, still **accept** correct function. **ignore** substances **accept** proteins instead of enzymes **accept** (ribosomes) site of enzyme/protein manufacture **accept** proteins instead of enzymes **accept** glycolysis/first part of respiration occurs in cytoplasm **Examiner's Comments** Most candidates were able to identify two cell parts correctly but did not always achieve the second mark for the function. They often omitted aerobic or anaerobic from their answer when referring to respiration in the cytoplasm or mitochondria; several stated that enzymes were made in the mitochondria. There was fairly common use of vague terms like substances in relation to the cell membrane along with equally vague statements like *keeps the cell together*, not understanding that the question was asking about the role in respiration. Many candidates who gave nucleus as a cell part then struggled to score for the function as they did not refer to containing genetic code for making enzymes. A few candidates still gave cell wall as an animal cell part and a very small minority gave

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Question			Answer/Indicative content	Marks	Guidance
					named plant organelles, or even referred to blood and lungs.
		ii	*any three from* similar shape in methanol and ethanol / tip of methanol and ethanol (which fits into active site) same shape **ethanol** will fit into the <u>active site</u> / has a complementary / similar shape to <u>active site</u>; idea that prevents methanol from binding/ reduces methanol entering active site; methanol is not broken down; idea of reducing the (concentration of) toxic product / harmful substances;	3	**ignore** 'same shape' on its own **ignore** ethanol has same shape as active site **Examiner's Comments** Many candidates failed to score here for lack of precision in their answers e.g. same shape was often seen. Common misconceptions included ideas such as ethanol breaks down methanol, that they both reacted with the enzyme at the same time, that ethanol itself was an enzyme, or that the products of ethanol breaking down would neutralise or remove the toxins produced by methanol. Few candidates appeared to understand that the ethanol would prevent the methanol from binding to the active site. The most common mark achieved was for the idea that ethanol would also fit into the active site of the enzyme. Most candidates did not appear to know what methanol poisoning was, which may have impaired their ability to answer this question successfully. A large proportion talked about lock and key model, but failed to mention the active site and so failed to score a mark.

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Question			Answer/Indicative content	Marks	Guidance
		iii	*one from the following* (making) bread; (producing) biogas;	1	**do not accept** alcohol production **accept** sewage (processing) **ignore** biofuel **Examiner's Comments** Bread making appeared to be the most common correct response but a significant minority of those who did score gave biogas. There seemed to be a high level of candidates giving no response, and some rather obscure answers such as microbes under the skin. Making lactic acid, getting energy anaerobically and references to fermentation were common incorrect answers.
			Total	8	

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Question			Answer/Indicative content	Marks	Guidance
3	a	i	all correctly plotted (2 marks) five or six correctly plotted (1 mark)	2	**allow** 1 square error margin **if plotted points are dots, and are invisible**, score marks from line of best fit. **ignore** bar chart points to be plotted: 0.00, 0 0.02, 20 0.04, 28 0.06, 35 0.08, 40 0.12, 43 0.14, 43 **Examiner's Comments** A significant number of candidates failed to plot the origin point and therefore failed to score full marks. Candidates should be reminded to use an *X* when plotting points or a dot within a circle as, with scanned scripts, it is sometimes difficult to determine a dot by itself. Where these were not visible, candidates were given credit if the line of best fit passed through the correct points.

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Question			Answer/Indicative content	Marks	Guidance
		ii	continuous, correct and smooth line of best fit, going through all plotted points, including the origin	1	**accept** points joined with straight lines dot-to-dot **accept** 1 square error margin. **if plotted points are dots and are invisible**, score marks if line passes through the correct points on the graph **accept** ecf **do not accept** straight line of best fit **Examiner's Comments** Many candidates struggled to draw a single, smooth and complete line of best fit. When candidates failed to achieve the mark it was generally due to them failing to include the point of origin, or they drew a straight line. A considerable number of candidates failed to realise that it was imperative that the line of best fit reflected the idea of 'no CO_2 = no photosynthesis', and as such, had to go through the origin. Candidates would also re-draw their line in a section which they considered to be incorrect, without erasing the original section of line. Extra lines, wobbles and feathery lines were common, and were penalised with no marks. Only a few joined the points dot-to-dot with a ruler.
		iii	42	1	**accept** 41 – 43 **accept** ecf - correct reading of data from line **Examiner's Comments** Most candidates achieved a correct answer, or the ecf mark. Generally, even candidates who had not achieved the line of best fit mark still managed to score as they recognised the need for the value to fit within the pattern of the data presented. Of those who did not score, the majority seemed to mis-read the value on the graph, for example writing 0.41 as opposed to 41.

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Question			Answer/Indicative content	Marks	Guidance
		iv	**any two from** as carbon dioxide increases (the rate of) photosynthesis/reaction increases **OR** there is a positive correlation; idea that increasing carbon dioxide has no further effect/ rate remains constant/ rate plateaus; because there is another limiting factor / named limiting factor / CO_2 is no longer a limiting factor;	2	**do not accept** rate of photosynthesis decreases **do not accept** in reverse: as photosynthesis increases, carbon dioxide increases / OWTTE **Examiner's Comments** Most candidates recognised that increasing the concentration of carbon dioxide would result in an increased rate of photosynthesis. However only a minority were able to score a second mark for recognising that the rate then plateaued and the idea of limiting factors was very rarely seen.
		v	(it is an) outlier / anomalous result / anomaly it does not fit the trend / pattern / line of best fit	2	**accept** does not fit in **ignore** does not match/look similar to other results **Examiner's Comments** Most candidates used the key term outlier (or anomaly), but there was a general failure to relate the outlier to the pattern/trend with only around half scoring this marking point on the scripts seen. Simply stating that it wasn't 'close enough/similar to/didn't match the other results was a common error, with some also referring to points on the graph in detail.

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Question			Answer/Indicative content	Marks	Guidance
	b		$6H_2O$ $C_6H_{12}O_6$	2	**do not accept** H2O, C6H12O6: numbers should be subscript when required. **do not accept** lower case letters **Examiner's Comments** Most candidates scored the $6H_2O$ mark, and it was pleasing to see that a significant proportion, if still a slight minority, could also give the correct formula for glucose. Some candidates failed to score, despite giving the correct formula, as they put water and glucose on the wrong sides of the equation. Common errors here also included the inability to balance the equation i.e. simply giving H_2O, rather than $6H_2O$. There were also a significant number of candidates who did not score because they had failed to use appropriately sized subscript numbers, or because they failed to distinguish between capital letters and small letters. Very few candidates gave a word equation.

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Question			Answer/Indicative content	Marks	Guidance
	c		**Level 3 (5-6 marks)** Uses point(s) of information provided alongside biological knowledge. Quality of written communication does not impede communication of the science at this level **Level 2 (3-4 marks)** Uses point(s) of information provided. Quality of written communication partly impedes communication of the science at this level **Level 1 (1-2 marks)** States condition(s) required for growth. Quality of written communication impedes communication of the science at this level **Level 0 (0 marks)** Insufficient or irrelevant science. Answer not worthy of credit	6	**This question is targeted at grades up to C** **Indicative scientific points may include:** **Conditions** • temperature • use heaters/greenhouse (to raise temperature) • pH (of soil) • light (intensity) • use lamps (to increase light intensity) • water • minerals /nitrates • provide fertilisers (to provide minerals) • carbon dioxide levels should be above that of atmospheric levels • burn fuels (to produce CO_2) **Using information provided** • pH (of the soil) 6-8 / neutral ORA • temperature 28-35°C ORA **Biological knowledge** • optimising conditions for **enzymes** ORA • correct idea of limiting factors **Examiner's Comments** Almost all candidates were able to identify conditions needed for plant growth. The majority attempted to use the graphs, although occasionally their information was slightly inaccurate e.g. pH 4-8 or 25_oC. A sizeable minority were able to give excellent details about enzymes and active sites/denaturing at extremes of pH and high temperatures, but some omitted figures for correct pH and temperature from the graphs and so failed to gain full marks. A minority referred to the plant or cell denaturing. References to limiting factors were rarely seen.

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Question			Answer/Indicative content	Marks	Guidance
			Total	16	

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Question			Answer/Indicative content	Marks	Guidance
4	a	i	*any two from* starch; cellulose; (named) protein / amino acids / enzymes; chlorophyll; DNA / RNA / nucleic acids; fats / lipids / fatty acids / glycerol;	2	**ignore** ref to functions **Examiner's Comments** Candidates were asked to name two substances that algae convert glucose into. Many candidates seemed confused as to what the question was asking and the most common candidate response was to give at least one of products of respiration i.e. carbon dioxide and water. The other most common correct answers were starch and cellulose but many failed to gain the second mark as they gave sugar/ethanol/lactic acid/energy or food as their second response.
		ii	carbon dioxide / CO_2; Protection / shelter / safety / (suitable) habitat;	2	**Examiner's Comments** Some candidates had obviously not read and/or understood the information at the beginning of the question. A significant proportion of candidates did manage to gain the CO_2 mark however very few candidates scored on the idea of a suitable habitat or protection as a large proportion suggested that the algae gained oxygen as their second response. Vague references to 'food' or 'nutrients' were also quite common.

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Question			Answer/Indicative content	Marks	Guidance
	b		**Level 3 (5–6 marks)** Explanation uses ideas from: photosynthesis, temperature and enzymes Quality of written communication does not impede communication of the science at this level **Level 2 (3–4 marks)** Explanation uses ideas from two of: photosynthesis, temperature and enzymes Quality of written communication partly impedes communication of the science at this level **Level 1 (1–2 marks)** Makes ref. to either photosynthesis OR temperature OR enzymes Quality of written communication impedes communication of the science at this level **Level 0 (0 marks)** Insufficient or irrelevant science. Answer not worthy of credit	6	**This question is targeted at grades up to C** **Indicative scientific points may include** **Photosynthesis** • (If enzymes do not function) the rate of photosynthesis drops / stops • If there is no photosynthesis less / no glucose will be made • Less / no respiration • idea of (temp) limiting factor for P/S **Temperatures** • temperature is **too,** hot / high / low / cold, (algae die) **Ignore** ref to figures • Reaction slows (photosynthesis) • fewer collisions / ref to kinetic energy changes N.B. Credit 'reaction slows' only once (either temperature or photosynthesis) **Enzyme** • enzyme works best / fastest at optimum temperature • enzyme is damaged / denatured / changes shape (at **high** temperatures); **Ignore** Killed / dies • Ref. To active site • ref to lock and key / substrate no longer complementary A **Examiner's Comments** Virtually all candidates were able to make relevant points about enzymes such as active sites/ lock and key/denaturing /enzyme-substrate complexes. However, a significant proportion were then not able to link this specifically to photosynthesis and/or temperature and were consequently limited to Level 1 despite some good science in their responses.

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Question			Answer/Indicative content	Marks	Guidance
					A significant proportion of candidates managed to achieve Level 2 on the basis of a single comment relating to temperature being too hot/cold in addition to multiple enzyme points. Again, many missed out due to references to temperature that were often too vague to credit e.g. just 'increased' or 'decreased' or were simply incorrect e.g. the optimum temperature causes enzymes to denature. There were also incorrect references to temperatures being too low causing enzymes to denature. Some better candidates did link temperature with reaction rates and particle collisions. Only the better candidates realised that photosynthesis is needed to produce glucose for respiration and it was a lack of this that caused death. Good candidates also recognised temperature as a limiting factor for photosynthesis.

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Question			Answer/Indicative content	Marks	Guidance
	c		*any three from* sample or look at different areas of coral (where algae dead and alive); measure / change temperature; measure / change UV / light record amount of living / dead algae; ref. to correlation between either factor and dead algae; **Total**	3 **13**	Award marks for natural habitat ONLY Experimental sit **Accept** appropriate sampling techniques **e.g.** more UV, less algae **Examiner's Comments** Most candidates failed to see that the question asked for an investigation in the natural habitat of algae. Some candidates obviously did not understand what UV light was – some seemed to assume it could only be created by some sort of special lamp. Many answers were muddled and failed to describe accurately what they were looking for - living/ dead algae and just said 'compare results'. Common errors included vague mentions of testing light or temperature but did not describe how this would be changed or measured using thermometers or light meters, only a minority could then relate this back to algae survival (or not). Better candidates did score marks by mentioning transects and sampling and many did give at least partial descriptions of lab based investigations. There were also a few candidates who focused on how to make the test fair rather than what they would actually do. A few descriptions of global warming killing algae rather than any mention of an investigative approach and a few links to enzymes and photosynthesis (a carryover from the previous section of the question) were also seen.

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Question			Answer/Indicative content	Marks	Guidance
5			<table><tr><td>Genes to control temperature.</td><td></td></tr><tr><td>Genes to make chlorophyll.</td><td>✓</td></tr><tr><td>Genes to make a neurotransmitter.</td><td></td></tr><tr><td>Genes to make a cell membrane</td><td>✓</td></tr><tr><td>Genes to make carbon dioxide.</td><td></td></tr><tr><td>Genes to control diffusion.</td><td></td></tr><tr><td>Genes to make enzymes.</td><td>✓</td></tr></table>	3	One tick one mark Each extra tick negates one correct tick **Examiner's Comments** This question required candidates to tick correct boxes concerning genes switched on in cells for photosynthesis to take place. Three marks were available and many candidates realised they should tick 3 boxes, generally scoring between 2-3 marks. Unfortunately, some only ticked 1, or more commonly, 2 boxes so couldn't gain the full 3 marks. Others ticked more than 3 boxes so lost a mark for each extra incorrect tick. There was no pattern to the wrong answers which suggests that candidates were unclear as to the function of a gene.
			Total	3	

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Question			Answer/Indicative content	Marks	Guidance
6			[Level 3] Gives good detailed description linked to an explanation of the complete shape of the graph. Quality of written communication does not impede communication of the science at this level. (5 – 6 marks) [Level 2] Gives at least one descriptive point AND some explanation of how enzyme works Quality of written communication partly impedes communication of the science at this level. (3 – 4 marks) [Level 1] Gives basic description of shape of graph OR how enzymes work Quality of written communication impedes communication of the science at this level. (1 – 2 marks) [Level 0] Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)	6	• lock and key • active sites • ref to substrate fits into active site • ref to enzyme-substrate complex • denaturing / change of shape of active site (in correct context) • ref to substrate no longer fits • reduces activity This question is targeted at grades up to A Indicative scientific explanation points may include: Indicative scientific description points may include • no reaction at 3 and below • as pH increases (from 3–6) / acidity decreases, rate increases ora • works best / optimum at pH 6 • as pH increases (from 6) / alkalinity increases, rate decreases • no reaction at 9 and above • works over a range of 3 to 9 • rate of reaction increases and then decreases Use the L1, L2, L3 annotations in Scoris; do not use ticks. Examiner's Comments Candidates were given a graph of rate of reaction of an enzyme against pH. They had to explain how enzymes worked and relate it to the graph. A considerable number just gave a general explanation of why pH affects rate, with excellent explanations but with no reference to the graph they could only achieve level 1. Many candidates scrapped into level 2 by discussing the graph and also mentioning

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Question			Answer/Indicative content	Marks	Guidance
					denaturing of enzymes. Candidates who got level 3 - 5 marks often lost the final mark by not discussing both sides of the graph, or by making an error such as the incorrect pH number for the optimum (usually pH7).Many candidates discussed temperature, which was a pity as their explanations were excellent but scored no marks. Many thought the rate was increasing (to pH 6) because the particles were moving faster. Candidates obviously understood why increased temperature increases rate but few understood why pH does. However, there were some excellent answers, including the idea of changed charges on atoms on the active site, denaturing, breaking of bonds and substrate unable to fit. This was then linked to both sides and the middle of the graph.
			Total	6	

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Question			Answer/Indicative content	Marks	Guidance
7	a		**any two from** enzyme / substrate has a certain **shape** / enzyme has an **active site** ; substrate / molecule **fits into** the shape / lock and key model ; other substrates **will not fit**	2	**ignore** molecule / substrate has an active site **accept** correct ref. to complementary (shapes) **Examiner's Comments** Most candidates appeared to have a good grasp of the topic, with references to active site and the substrate molecule. Some correctly referred to the lock and key hypothesis.
	b	i	the higher the temperature the greater the rate of reaction / positive	1	**reject** heat **ignore** references to values ~~Examiner's Comments~~ Many candidates correctly referred to a positive correlation, others described the features of the two factors involved.
		ii	**any two from** use more replicates / repeats ; plot more temperature values / obtain data across more temperatures / intermediate temperatures ; reproducibility / others do **same** experiment ; check / improve accuracy of equipment	2	**ignore** 'do more experiments' / excluding ~~outliers / use of control~~ **accept** compare the experiment with others / look at secondary data **ignore** reference to peer assessment **Examiner's Comments** Most candidates appreciated that an increase in replication would be a useful change to the experiment and others appreciated the importance of comparison of data. Very few candidates considered the temperature range but some did realise the value of secondary data.

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Question			Answer/Indicative content	Marks	Guidance
		iii	**any two from** increasing / getting higher / faster ; active site ; permanent / irreversible / fixed ; denatured / broken down / destroyed	2	3 or 4 correct responses (2) 2 correct responses (1) 1 or 0 correct responses (0) **accept** inactive / deformed **reject** killed **Examiner's Comments** It was interesting to see that many candidates considered that the collision rate was decreasing, rather than increasing. Although many candidates identified the active site and the denatured feature of the enzymes, few appreciated the permanent change.
		iv	lock and key	1	**accept** induced fit **Examiner's Comments** Many correctly noted the lock and key model.
			Total	**8**	

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Question			Answer/Indicative content	Marks	Guidance
8	a		$6CO_2 + 6H_2O$ (1) $C_6H_{12}O_6 + 6O_2$ (1)	2	**allow any order** formulae must be correct including correct use of subscripts **allow** an unbalanced equation as long as all four compound formulae are correct = 1 mark **Examiner's Comments** Many candidates were able to correctly recall the balanced symbol equation for photosynthesis. Some were clearly confused between photosynthesis and respiration and the weakest candidates wrote a word equation instead of a symbol equation.
	b	i	C (1)	1	**Examiner's Comments** The vast majority of candidates correctly identified the species that was used by Jason as C. A few candidates incorrectly selected A, presumably because they had only looked at the number of bubbles produced at low light intensity.

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Question			Answer/Indicative content	Marks	Guidance
		ii	*(confident because):* the (mean) values are the same / similar / very close / closest (1) the results were repeated (ten times) (1) (repeats mean) results are repeatable / reliable / valid (1) *(not confident because):* size of bubbles vary (1) difficulty counting bubbles (1) size of pondweed might be different (in the two tubes) (1) the temperature might be different (in the two tubes) (1) need more data / tests (to be sure) (1)	2	mark whole answer crediting any twopoints must imply both values ignore accurate ignore ref to different species of pondweed (as given in the question) allow any other reasonable difference in variables ignore idea of human error ignore idea that data is wrong / inaccurate Examiner's Comments Most candidates obtained one mark here for correctly identifying that the mean of Jason's results in Table 1 and the mean number of bubbles of species C were the same (or very close). Fewer candidates achieved a second mark. Some recognised that Jason repeated his experiment allowed them to be more confident in their conclusion. A few candidates identified the problems associated with counting bubbles and used this to suggest why they could not be fully confident in their conclusion.

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Question			Answer/Indicative content	Marks	Guidance
		iii	*any TWO from:* control / measure the (water) temperature in the test tubes; control pH; control length / mass / amount / size of pondweed / number of leaves; control carbon dioxide levels; control volume / amount of water; control distance from light source; use more light intensities / measure the light intensity; leave experiment for a longer time; allow plant to equilibrate before measuring bubbles; collect the (oxygen) bubbles in a measuring cylinder / gas syringe / ref to measuring volume of oxygen (as more accurate than bubbles);	1	**two points required for one mark** **ignore** ref to repeats / using more species of pondweed (both given in question) **do not allow** extensions to the investigation, i.e. where a new variable is changed **do not allow** use different light intensities **Examiner's Comments** In order to score a mark here, candidates had to suggest two improvements. Unfortunately some candidates only suggested one so they were unable to score straight away. A significant number of candidates suggested repeating the experiment which was given in the stem and could therefore not be credited. However, some candidates were able to recognise that the experiment would be better if a range of light intensities were used, or if the volume of the oxygen produced was measured accurately. These were probably the most common points that gained credit.
			~~Total~~	~~6~~	
~~9~~		~~i~~	~~Osmosis~~	~~1~~	
		~~ii~~	~~carbon dioxide (1)~~ temperature (1)	~~2~~	~~deduct one mark for each additional tick~~
		~~iii~~	~~X placed anywhere on horizontal line of the~~ graph, level with or to the right of the second 'i' on 'intensity'	~~1~~	
			~~Total~~	~~4~~	

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Question			Answer/Indicative content	Marks	Guidance
10		i	chloroplast(s) ✓	1 (AO 1.1)	ALLOW chlorophyll
		ii	water availability ✓	1 (AO 1.1)	Examiner's Comments Question 1 (b) (i) and (b) (ii) tested candidate knowledge of elements of photosynthesis. Many candidates correctly identified the chloroplast as the correct structure in (b) (i), some candidates thought this process took place in the mitochondria. Those that did not score in (b) (ii) often stated that temperature would not limit the rate of photosynthesis.
			Total	2	

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