Mark scheme

Limiting factors of photosynthesis

Biology 0610 · Questions from Paper 3, Paper 4 and Paper 6

Total marks

66

MARKS FOR EACH QUESTION

1	2	3	4	5	6	7	Total
6	6	7	9	12	12	14	**66**

Question 1 [6]

1	*independent variable* **1** (at least) *idea of* two / different, light intensities **;** *dependent variable* **2** (measuring) volume of, gas / oxygen, produced OR counting (number of) bubbles **;** **3 and 4** *detail of method* **;;** *max **two** from:* • method of changing light intensity e.g. different lamp distances / dimmer switch altered / different bulbs • method of, collecting gas / measuring volume of gas e.g. use of a gas syringe / *ref to* any quantitative displacement method • method to avoid heating effect of light e.g. heat shield / use LED bulbs to prevent heating • keep plant submerged / water added to cover the plant / weighing the plant down • *idea of* time for acclimatisation at each new light intensity / equilibration **5 and 6** *constant variables* **;;** *max **two** from:* • time or volume (depending on method used) e.g., time to collect a set volume of oxygen / time to count number of bubbles OR volume / number of bubbles, in a set time • concentration of hydrogencarbonate added or same source of carbon dioxide • colour / wavelength, of light • temperature • same, type / species / (named) plant / age **7** two or more repeats **;** **8** relevant safety **;**	**6**	

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Question 2 [6]

2	*independent variable* **1** at least three different light intensities ; *dependent variable* **2** the colour of the indicator ; **3 and 4** *details of the method* ;; • method of changing light intensity e.g. different lamp distances / dimmer switch altered / different bulbs / different lamps / different power lamps / detail of how to make one in the dark ***and*** one in the light • method to avoid heating effect of light e.g. heat shield / beaker of water between lamp and plant / use LED bulbs to prevent heating • keeping the plant under the water / weighting the plant down • sample the water around the plant and test with indicator **5 and 6 and 7** *variables kept constant* ;;; • colour / wavelength, of light • temperature • type / species / age, of plant • size / mass / length / height / surface area / number of leaves, of plant • volume of water (covering plant) • volume / number of drops, of (hydrogencarbonate) indicator • concentration of (hydrogencarbonate) indicator • set (stated) time for equilibration (to the new light intensity) • set (stated) time before noting colour **8** two or more repeats ; **9** relevant safety ;	**6**	

Question 3 [7]

3(a)(i)	02:00 **and** 05:00 ;	**1**	
3(a)(ii)	11 (arbitrary units) ;	**1**	**A** 10.8 to 11.1
3(a)(iii)	sunrise / light is present ; carbon dioxide, absorbed / used ; (for) photosynthesis ; photosynthesis is using carbon dioxide faster than respiration can provide it ;	**3**	 **A** photosynthesis is faster than respiration
3(b)	rain ; wind ; humidity ; temperature ; shade / clouds / time of year ;	**2**	

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Question 4 [9]

4 (a)	1 2 3 4 5 6	carbon dioxide is required for photosynthesis ; (more carbon dioxide) more, glucose is produced ; carbon dioxide concentration is a limiting factor ; more carbon dioxide = faster rate of photosynthesis ; prevents concentration falling below that of atmosphere / AW ; ref to more, growth / yield ;	[max 2]	
(b)		carbon dioxide will diffuse out of the glasshouse ; carbon dioxide is wasted ; *idea that* extra, growth / yield, does not cover the cost of the carbon dioxide ;	[max 2]	

(c) (i)		plants respire at night and do not photosynthesise ;	[1]	*both ideas are needed for the mark*
(ii)	1 2 3 4 5 6 7 8	decrease temperature on hot days / AW / avoid plants overheating ; denaturing of enzymes ; avoids plants wilting ; *idea that* open to allow carbon dioxide to enter during the day / ref to **F** ; *idea that* open to allow oxygen to enter at night ; to allow plants to respire ; allow water vapour to escape / avoids air becoming too humid ; reduces chances of (fungal) disease ;	[max 4]	
			[Total: 9]	

Question 5 [12]

5(a)	40 (°C) **;**	**1**	
5(b)	*any six from:* *before 40 °C* 1 increasing temperature increases the kinetic energy (of reactants / molecules) **;** 2 increasing the, frequency / rate, of (effective) collisions **;** 3 more enzyme-substrate complexes are formed **;** 4 releasing more, oxygen / glucose / products **;** 5 temperature is the limiting factor **;** *at 40 °C* 6 (optimum temperature) maximum number of, enzyme-substrate complexes / collisions**;** *after 40 °C* 7 increasing temperature changes the shape of active site(s) (of enzyme(s)) **;** 8 ref**.** to denaturation **;** 9 substrate, no longer complementary (to active sites) / can no longer fit into active sites **;** 10 fewer / no, enzyme-substrate complexes are formed **;** 11 fewer / no, products are released **;** 12 AVP **;**	**6**	e**.**g**.** stomata close (as high rate of transpiration) so no CO_2 enters
5(c)	*any two from:* carbon dioxide is a limiting factor / so that carbon dioxide is **not** a limiting factor / AW **;** so that temperature is the only, variable / limiting factor **;** to ensure that the effects are caused (only) by temperature **;**	**2**	
5(d)	*any one from:* (some is) used, for (aerobic) respiration / to react with glucose **;** some remains in air spaces **;**	**1**	
5(e)	*any two from:* absorbs / traps / captures, light **;** transfers / converts, light energy into chemical energy **;** for the synthesis of, glucose / carbohydrates **;**	**2**	

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Question 6 [12]

6 (a)	1 2 3 4	carbon dioxide uptake of **J** is higher (at all temperatures except at 10 °C) ; peak / optimum / maximum / best, uptake of **J** is at a higher temperature **ora** ; data recorded in **J** between 35 – 40 °C / AW (but not for **H**) ; correct use of comparative data between **J** and **H** with correct units ;	[max 3]	**A** peak uptake for **J** is higher than **H** correct units must be stated at least once
(b) (i)	1 2 3 4 5 6	temperature is a limiting factor ; increases, (kinetic / heat) energy / the movement of molecules / diffusion ; more collisions between substrate and enzymes ; to speed up chemical reactions ; stomata open wider ; therefore increased carbon dioxide entering the leaf / AW ;	[max 2]	
(ii)	1 2 3 4	enzymes are denatured ; enzymes are no longer active / AW ; stomata close ; therefore reduced carbon dioxide entering the leaf / AW ;	[max 2]	

(c)	1 2 3 4 5 6 7 8 9 10 11 12	plant growth is likely to increase ; higher rate of photosynthesis ; means more glucose / starch, is produced ; glucose is used for respiration to provide energy (for growth) ; more cellulose for cell walls ; more protein for, enzymes / cell membranes ; other limiting factors / CO_2 no longer limiting ; carbon dioxide is a greenhouse gas / reference to (enhanced) greenhouse effect ; increase in global temperatures increases rate of photosynthesis ; reference to effect of temperature on enzymes ; any relevant consequence of global warming ; AVP ; e.g. relevant use of data	[max 5]	'more' need only stated once **A** 'global warming'

Question 7 [14]

7(a)	carbon dioxide + water ⟶ ; glucose + oxygen ;	**2**	
7(b)(i)	temperature is a factor that affects the rate of photosynthesis ; *reference to* kinetic energy ; *idea of* effect of temperature, on enzymes / diffusion rate (of carbon dioxide) ; *idea that* temperature is a variable that should be standardised ; AVP ;	**2**	
7(b)(ii)	74 ;;;	**3**	
7(b)(iii)	rate (of photosynthesis) increases and, reaches a plateau / AW ; rate (of photosynthesis) increases until 1750 (a.u) / 25 μmol per m^2 per s ; any comparative use of figures for rate ;	**3**	
7(b)(iv)	light intensity is the <u>limiting</u> factor, at all light intensities used / AW ; because rate of photosynthesis does not level off (even at high light intensities) ; carbon dioxide / temperature / chlorophyll / another factor, was not a <u>limiting</u> factor ; *correct reference* to (light) <u>energy</u> ; light is absorbed by chlorophyll ; AVP ;	**4**	

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