1.19 Photosynthesis: 30-minute Pack

AQA 8464 · Calculator allowed · about 30 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 A gardener measures dry mass of leaves to estimate plant growth. State one reason why dry mass is a better measure of biomass than fresh mass and give one step in preparing a sample to measure dry mass accurately.

(a) Give reason and one preparation step. **(2)**

(Total for Question 1 is 2 marks)

2 A student balances the symbol equation for photosynthesis. Balance the equation below by adding whole-number coefficients where needed.

$CO_2 + H_2O \rightarrow C_6H_{12}O_6 + O_2$

(a) Write the fully balanced equation using whole-number coefficients. **(2)**

(b) State the physical state symbols appropriate for CO_2, H_2O (inside leaf cells), $C_6H_{12}O_6$ and O_2 in the equation. **(1)**

(Total for Question 2 is 3 marks)

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3 Plants make their own food using a process called photosynthesis.

(a) Define the term 'photosynthesis'. **(1)**

(b) State the two raw materials (reactants) needed for photosynthesis. **(2)**

(c) State the two products of photosynthesis. **(2)**

(d) State the type of energy that is required for photosynthesis to take place. **(1)**

(Total for Question 3 is 6 marks)

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4 A group investigated the effect of light intensity on the rate of photosynthesis of pondweed at two different carbon dioxide concentrations, keeping temperature constant. Their results are shown in the table below.

Light intensity (arbitrary units): 0, 10, 20, 30, 40, 50
Rate of photosynthesis at low CO_2 concentration (arbitrary units): 0, 5, 9, 11, 11, 11
Rate of photosynthesis at high CO_2 concentration (arbitrary units): 0, 5, 9, 13, 16, 18

Light intensity (arbitrary units)	Rate of photosynthesis at low CO2 concentration (arbitrary units)	Rate of photosynthesis at high CO2 concentration (arbitrary units)
0	0	0
10	5	5
20	9	9
30	11	13
40	11	16
50	11	18

(a) Explain why the rate of photosynthesis is the same for both carbon dioxide concentrations at light intensities of 0 to 20 units. **(2)**

(b) Explain why the high carbon dioxide concentration curve reaches a higher rate of photosynthesis than the low carbon dioxide concentration curve at light intensities above 20 units. **(2)**

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(c) At light intensities beyond those shown in the table, the high carbon dioxide concentration curve reached a plateau where temperature was the limiting factor. The experiment was repeated at a higher constant temperature, still below the optimum temperature for photosynthesis, with sufficient light and carbon dioxide that neither limited the rate. Predict and explain the effect this would have on the maximum (plateau) rate of photosynthesis reached. **(2)**

(Total for Question 4 is 6 marks)

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5 A gardener named Kwame compared the mean mass of tomatoes produced per plant under three different glasshouse conditions over one growing season.

Condition A (no additional carbon dioxide or light): 2.4 kg per plant
Condition B (additional carbon dioxide only): 3.0 kg per plant
Condition C (additional carbon dioxide and additional light): 3.9 kg per plant

(a) Calculate the percentage increase in mean mass per plant between Condition A and Condition C. **(3)**

(b) Suggest why Condition C produced a greater mean mass per plant than Condition B, even though both conditions included additional carbon dioxide. **(2)**

(Total for Question 5 is 5 marks)

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6 A student named Freya investigated the effect of distance from a lamp on the rate of photosynthesis of pondweed, by counting bubbles of oxygen produced per minute. Her results are shown in the table below.

Distance from lamp (cm): 10, 20, 30, 40, 50
Bubbles of oxygen produced per minute: 58, 33, 19, 34, 8

Distance from lamp (cm)	Bubbles of oxygen produced per minute
10	58
20	33
30	19
40	34
50	8

(a) Identify the anomalous result in Freya's data, and explain why it is anomalous. **(2)**

(b) Suggest one improvement Freya could make to her method to obtain more reliable results. **(2)**

(Total for Question 6 is 4 marks)

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Mark scheme · 1.19 Photosynthesis: 30-minute Pack

Question 1

(a) because fresh mass varies with water content whereas dry mass reflects actual biomass more reliably **B1**

(a) dry samples in an oven at a set temperature until mass is constant or dry to constant mass and then weigh, oe **B1**

(a) Answer: Dry mass is better because fresh mass varies with water content; to measure dry mass, dry the leaves in an oven at a set temperature until the mass is constant, then weigh.

Question 2

(a) shows correct partial balancing or correct coefficients for at least two species (for example $6CO_2$ and $6H_2O$) or demonstrates correct atom count for C and H **M1**

(a) $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$ cao **A1**

(a) Answer: $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$

(b) $CO_2(g)$, $H_2O(l)$, $C_6H_{12}O_6(aq)$ and $O_2(g)$ oe **B1**

(b) Answer: $CO_2(g)$, $H_2O(l)$, $C_6H_{12}O_6(aq)$, $O_2(g)$

Question 3

(a) the process by which plants (and algae) make glucose (food), using carbon dioxide and water, with light energy, oe **B1**

(a) Answer: The process by which plants (and algae) make glucose using carbon dioxide and water, using light energy.

(b) carbon dioxide **B1**

(b) water **B1**

(b) Answer: Carbon dioxide and water.

(c) glucose **B1**

(c) oxygen **B1**

(c) Answer: Glucose and oxygen.

(d) light energy cao **B1**

(d) Answer: Light energy.

Question 4

(a) at these light intensities, light intensity (not carbon dioxide concentration) is the limiting factor for both curves, oe **B1**

(a) so increasing the carbon dioxide concentration has no effect on the rate until light intensity is no longer limiting, oe **B1**

(a) Answer: Light intensity, not carbon dioxide concentration, is the limiting factor at these light intensities for both curves, so extra carbon dioxide makes no difference until light is no longer limiting.

(b) above a light intensity of 20 units, carbon dioxide concentration becomes the limiting factor for the low CO_2 curve, oe **B1**

(b) since the high CO_2 curve has more carbon dioxide available, the rate can keep increasing to a higher value before another factor becomes limiting, oe **B1**

(b) Answer: Above 20 units, carbon dioxide becomes the limiting factor for the low-CO_2 curve. With more carbon dioxide available, the high-CO_2 curve can reach a higher rate before another factor limits it.

(c) the maximum rate reached would be higher than before, oe **B1**

(c) because temperature was below the optimum, increasing it increases the rate of the enzyme-controlled reactions of photosynthesis, allowing a higher rate to be reached provided light and carbon dioxide are not limiting, oe **B1**

(c) Answer: The maximum rate would be higher, because temperature was below the optimum, so raising it speeds up the enzyme-controlled reactions of photosynthesis (provided light and CO_2 are not limiting).

Question 5

(a) 3.9 - 2.4 = 1.5, oe **M1**

(a) (1.5 / 2.4) x 100, oe **M1**

(a) 62.5% cao **A1**

(a) Answer: 62.5%

(b) in Condition B, light intensity may still have been limiting the rate of photosynthesis, even with extra carbon dioxide supplied, oe **B1**

(b) adding extra light as well, in Condition C, removed this second limiting factor, allowing a higher rate of photosynthesis (and so more glucose for growth), oe **B1**

(b) Answer: In Condition B, light intensity may still have been limiting the rate of photosynthesis. Adding extra light too, in Condition C, removed this limiting factor, allowing a higher rate of photosynthesis and more growth.

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Question 6

(a) the result at 40 cm (34 bubbles per minute) is anomalous, oe **B1**

(a) because it does not fit the pattern of decreasing bubble production with increasing distance shown by the rest of the data (it is higher than the neighbouring results at 30 cm and 50 cm), oe **B1**

(a) Answer: The result at 40 cm (34 bubbles per minute) is anomalous, because it is higher than the neighbouring results at 30 cm and 50 cm and does not fit the decreasing pattern shown by the rest of the data.

(b) repeat each distance (e.g. three times) and calculate a mean rate, oe **B1**

(b) this would allow anomalous results to be identified and excluded, and reduce the effect of random errors on the conclusion, oe **B1**

(b) Answer: Repeat each distance (e.g. three times) and calculate a mean, so anomalous results can be identified and excluded and random error is reduced.

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