Photosynthesis as an energy transfer process

Mark Scheme 2

Level	International A Level
Subject	Biology
Exam Board	CIE
Topic	Photosynthesis
Sub Topic	Photosynthesis as an energy transfer process
Booklet	Theory
Paper Type	Mark Scheme 2

Time Allowed : **64 minutes**

Score : **/ 53**

Percentage : **/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 (a)

1. *in C3 plants at high temperature*
   rubisco combines with oxygen;
2. less rubisco to combine with CO_2;
3. *in C4 plant such as maize*
   idea of spatial separation of light-dependent stage from carbon fixation;
4. rubisco/RuBP, in bundle sheath cells;
5. kept away from, oxygen/air;
6. mesophyll cells, absorb CO_2;
7. $_2$ released to combine with RuBP;
8. avoid/reduce photorespiration;
9. high optimum temperatures of enzymes involved;
10. Calvin cycle can continue;
11. AVP ; e.g. CO_2 reacts with PEP
    PEP carboxylase

[max 7]

(b) 12. light energy absorbed by chlorophyll**;**
A photosystems/pigments

13. electron, excited/raised to higher energy level**;**

14. (electron) emitted by chlorophyll**;**
A photosystems/pigments

15. passes to electron, acceptor/carrier**;**

16. passes along, chain of electron carriers/ETC/Electron Transfer Chain**;**

17. energy released used to pump protons**;**
I ATP production here

18. into thylakoid space**;**

19. thylakoid membrane impermeable to protons**;**

20. prot gradient forms**;**

21. protons move down gradient**;**

22. through/using, ATP synthase/ATP synthetase**;**
R ATPase

23. enzy rotates**;**

24. ATP produced from ADP and Pi**;**

[max 8]

[Total: 15]

2 **(a (i)** *in high light intensity*

1. (as temperature increased) the volume of oxygen released / rate of photosynthesis, increased to a peak **and** then fell**;**

in low light intensity

2. (as temperature increased) the volume of oxygen released / rate of photosynthesis, remained constant **and** then fell**;**

3. supporting figures (two oxygen values at two different temperatures plus units)**;** [3]

(ii) 1. light no longer limiting / temperature now limiting**;**

2. enzymes denatured / described**;**

3. so fewer enzyme-substrate complexes / AW**;**

4. so less photolysis (leads to less oxygen produced)**;** [2 max]

(b) (i) photolysis**;** [1]

(ii) P680**; A** (photosystem) II [1]

(iii) respiration uses oxygen**;** [1]

[Total: 8]

3 **(a)** *ignore references to function*
accept from diagram

1. 3 – 10 μm (diameter);
2. double membrane;
3. ground substance / stroma;
4. contains enzymes / named enzyme, e.g. rubisco;
5. also, sugars / lipids / starch;
6. 70S / AW, ribosomes;
7. circular DNA;
8. internal membrane system **/** fluid-filled sacs / thylakoids; **A** flattened sacs
9. grana are stacks of thylakoids;
10. (grana) membranes hold, photosynthetic pigments / ATP synthase / ETC; [7 max]

(b) 11. ethene (in plant);
12. stimulates production of gibberellin;
13. gibberellin stimulates, cell division / cell elongation / increase in stem length**;**
14. leaves / flowers, above water;
15. (so) photosynthesis can occur;
16. (so) sexual reproduction / pollination, can occur;
17. aerenchyma / description;
18. assists gas diffusion (within plant);
19. air can be trapped by specialised underwater leaves;
20. (submerged parts of plant) carry out anaerobic respiration;
21. produce ethanol;
22. can tolerate high concentrations of ethanol;
23. produce a lot of ethanol dehydrogenase; [8 max]

[Total: 15]

4 **(a) (i)** 1. 26 °C optimum temperature for, rubisco / enzyme of Calvin cycle ;

2. (at just over 40 °C) enzymes / rubisco, denatured ;

3. so less carbon dioxide fixed ;

4. reduction in Calvin cycle / AW ;

5. increased rate of transpiration / AW ;

6. so stomata close ;

7. less carbon dioxide uptake ;

8. oxygen more likely to combine with rubisco ;

9. so increased photorespiration ; [5 max]

(ii) curve of C4 drawn with optimum to the right of existing curve ; *1 mark*

1. C4 / sorghum, enzymes, have higher optimum temperature (than C3) ;

2. has leaf structural features to avoid photorespiration ;

3. adapted to hot climate ; *2 max* [3 max]

(b) (i)

light intensity /lux	total CO_2 uptake / µmol	rate of photosynthesis /µmol s^{-1}
5	36	1.8
10	84	**4.2**
13	104	**5.2**
15	120	**6.0**

all 3 correct = 1 mark [1]

(ii) axes correct ;
units ;
correct plotting ;
suitable curve ; *between 5 and 15 lux*

accept ecf from table [3 max]

(iii) when a process is affected by more than one factor / AW ;

the rate of photosynthesis is, restricted by / AW, the factor that is nearest its lowest value ; [2]

(iv) light intensity ; [1]

[Total: 15]