Photosynthesis as an energy transfer process

Mark Scheme 2

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<thead>
<tr>
<th>Level</th>
<th>International A Level</th>
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<tbody>
<tr>
<td>Subject</td>
<td>Biology</td>
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<tr>
<td>Topic</td>
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<tr>
<td>Booklet</td>
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Time Allowed: 64 minutes

Score: / 53

Percentage: /100

Grade Boundaries:

<table>
<thead>
<tr>
<th>Grade</th>
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<tbody>
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<tr>
<td>A</td>
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<tr>
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<td>C</td>
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<td>D</td>
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<tr>
<td>E</td>
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<tr>
<td>U</td>
<td>&lt;45%</td>
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</table>
1. (a) 1. *in C3 plants at high temperature* rubisco combines with oxygen;

2. less rubisco to combine with CO₂;

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 CO₂;

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. CO₂ 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; 
   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; 
   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]
(a) **ignore references to function**

accept from diagram

1. 3 – 10 $\mu$m (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)  
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;  

(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  

(b) (i)  
<table>
<thead>
<tr>
<th>light intensity /lux</th>
<th>total CO₂ uptake / µmol</th>
<th>rate of photosynthesis /µmol s⁻¹</th>
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<tbody>
<tr>
<td>5</td>
<td>36</td>
<td>1.8</td>
</tr>
<tr>
<td>10</td>
<td>84</td>
<td>4.2</td>
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<tr>
<td>13</td>
<td>104</td>
<td>5.2</td>
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<tr>
<td>15</td>
<td>120</td>
<td>6.0</td>
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</tbody>
</table>

all 3 correct = 1 mark 

(ii) axes correct;  
units;  
correct plotting;  
suitable curve;  
assume ecf from table 

between 5 and 15 lux  

[5 max]  
[3 max]
(iii) when a process is affected by more than one factor, the rate of photosynthesis is restricted by the factor that is nearest its lowest value;

(iv) light intensity;