

# Photosynthesis as an energy transfer process

## Mark Scheme 3

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 3

Time Allowed : 74 minutes

Score : / 61

Percentage : /100

Grade Boundaries:

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

- 1 (a) 1. photosystem I (PI) **and** photosystem II (PII) involved ;  
2. light harvesting clusters ;  
3. light absorbed by accessory pigments ;  
4. primary pigment is chlorophyll a ;  
5. energy passed to, primary pigment / chlorophyll a ;  
6. electrons, excited / raised to higher energy level ;  
7. (electrons) taken up by electron acceptor ;  
8. (electrons) pass down electron carrier chain (*to produce ATP*) ;  
9. PII has (water splitting) enzyme ;  
10. water split into protons, electrons and oxygen ; **A** equation  
11. photolysis ;  
12. electrons from PII pass to PI / electrons from water pass to PII ;  
13. to replace those lost ; *give either in relation to PI or PII*  
14. protons and electrons combine with NADP (*to produce reduced NADP*) ;  
*can award these marking points from a diagram*

[9 max]

- (b) 15. RuBP combines with carbon dioxide ;  
16. rubisco ;  
17. forms unstable 6C compound ;  
18. produces two molecules of, GP / PGA ;  
19. GP / PGA, converted to TP ;  
20. by reduced NADP and ATP ;  
21. from light dependent stage ;  
22. TP used to regenerate RuBP ;  
23. using ATP ;  
24. TP can form, hexose / fatty acids / acetyl CoA

[6 max]

**[Total: 15]**

CHEMISTRY ONLINE  
— TUITION —

- 2 (a) 1. (photosynthetic pigments) arranged in light harvesting clusters ;  
2. primary pigments / chlorophyll a ;  
3. at reaction centre ;  
4. P700 / PI, absorbs light at 700nm ;  
5. accessory pigments / chlorophyll b / carotenoids ;  
6. surround, primary pigment / reaction centre / chlorophyll a ;  
7. absorb light ;  
8. pass energy to, primary pigment / reaction centre / chlorophyll a ;  
9. (light absorbed results in) electron excited / AW ;  
10. emitted from, chlorophyll / primary pigment / reaction centre ;  
11. passes to electron, acceptor / carrier ;  
12. (electron) passes along, chain of electron carriers / ETC ;  
13. ATP (synthesis) ;  
14. electron returns to, P700 / PI ;

[8 max]

- (b) 15. photolysis of water ;  
16. releases  $H^+$  ;  $RH$  / hydrogen atoms  
17. by, P680 / PII ;  
18.  $e^-$  released from, P700 / PI ;  
19.  $e^-$  (from PI) and  $H^+$  combine with NADP ;  
20. used in Calvin cycle ;  
21. reduces, GP / PGA ;  
22. to TP ;  
23. ATP used (during reduction of GP) ;  
24. NADP, regenerated / oxidised ;

[7 max]

**[Total: 15]**

CHEMISTRY ONLINE  
— TUITION —

- 3 (a) (i) **J** – epidermis/epidermal cell ;  
**K** – mesophyll (cell) ;  
**L** – bundle sheath (cell) ; [3]
- (ii) 1 mesophyll cells tightly packed/AW ;  
2 so O<sub>2</sub> cannot reach bundle sheath cells ;  
3 light independent stage/Calvin cycle **or** RuBP, in bundle sheath cells ;  
4 ref. malate shunt ;  
5 maintains high CO<sub>2</sub> concentration (in bundle sheath cells) ;  
6 PEP carboxylase, has high optimum temperature/has higher affinity for CO<sub>2</sub> /doesn't accept O<sub>2</sub> ;  
7 (PEP carboxylase) not denatured ;  
8 photorespiration is avoided ; [4 max]
- (b) 1 reduces water loss/AW ;  
2 wax does not melt ;  
3 shiny surface reflects radiation ; [2 max]

CHEMISTRY ONLINE  
— TUITION —

- (c) (i) greater reduction in sorghum than in soybean ;  
use of comparative figures ; e.g. sorghum 5.5 to 1.2 **or** by 4.3  
soybean 5.2 to 1.6 **or** by 3.6

[2]

(ii) *reject 'no' for all points*

- 1 less surface area ;
- 2 less absorption of light ;
- 3 less, photophosphorylation / light dependent reaction ;
- 4 less chemiosmosis ;
- 5 (due to) smaller thylakoid space **or** reduced proton gradient ;
- 6 less ATP (produced) ;
- 7 less reduced NADP (produced) ;
- 8 light-independent reaction / Calvin cycle, slows down ;
- 9 less carbon dioxide, fixed / combined with PEP ; **R** uptake

[4 max]

**[Total: 15]**

CHEMISTRY ONLINE  
— TUITION —

- 4 (a) (i) glycolysis ; [1]
- (ii) cytoplasm/cytosol ; [1]
- (iii) 4 ;      **A** 4 – 2 = 2 [1]
- (b) (i) inner membrane/cristae/stalked particles ; [1]
- (ii) 1 reduced, NAD/FAD ;
- 2 dehydrogenase enzymes ;
- 3 release hydrogen ;      **A**  $H \rightarrow R H_2/H^+$
- 4 hydrogen splits into proton and electron ;
- 5 electrons flow down, ETC/AW ;
- 6 energy released ;
- 7 protons pumped (across inner membrane/from matrix) ;
- 8 into intermembrane space ;
- 9 proton gradient ;
- 10 protons pass through, ATP synthase/stalked particle ;
- 11 oxygen final, hydrogen/proton, acceptor ; [5 max]
- (c) (i) nuclei and ribosomes ; [1]
- (ii) 1 glycolysis, does not occur in mitochondrion/only occurs in cytosol or cytoplasm ;
- 2 pyruvate produced in glycolysis ;
- 3 pyruvate can enter mitochondrion/glucose cannot enter mitochondrion ;
- 4 carbon dioxide produced/decarboxylation, in, Krebs/link reaction ; [3 max]
- (iii) 1 cyanide, inhibits cytochrome oxidase is a non-competitive inhibitor ;
- 2 reduced NAD not oxidised/AW ;
- 3 Krebs cycle stops ;
- 4 alternative H acceptor needed/pyruvate is H acceptor/pyruvate is reduced ;      **R**  $H^+$
- 5 lactate produced in cytoplasm ;
- 6 by anaerobic respiration ; [3 max]

**[Total: 16]**