

# Photosynthesis as an energy transfer process

## Mark Scheme 7

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 7

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. ground substance / stroma ;
  2. for, light independent stage / Calvin cycle ;
  3. contains enzymes / named enzyme e.g. rubisco ;
  4. also, sugars / lipids / starch / ribosomes / DNA ;
  5. internal membrane system ;
  6. for, light dependent stage ;
  7. fluid-filled sacs / thylakoids ;
  8. grana are stacks of thylakoids ;
  9. (grana) hold (photosynthetic) pigments ;
  10. (grana) have large surface area for (maximum) light absorption ;
  11. (pigments are arranged in), light harvesting clusters / photosystems ;
  12. primary pigment / reaction centre / chlorophyll a, surrounded by accessory pigments ;
  13. (accessory pigments) pass energy to, primary pigment / reaction centre / chlorophyll a ;
  14. different photosystems absorb light at different wavelengths ;
  15. membranes hold, ATP synthase / electron carriers ;
  16. for, photophosphorylation / chemiosmosis ;
- [9 max]
- (b)
17. grind leaf with solvent ;
  18. example of solvent ; e.g. propanone
  19. leaf extract contains mixture of pigments ;
  20. ref. concentrate extract ;
  21. further detail ; e.g. pencil line drawn / extract placed on chromatography paper / repetitive spotting / drying between spots
  22. paper placed (vertically) in jar of (different) solvent ;
  23. solvent rises up paper ;
  24. each pigment travels at different speed ;
  25. pigments separated as they ascend ;
  26. distance moved by each pigment is unique ;
  27. R<sub>f</sub> value ;
  28. two dimensional chromatography ;
  29. better separation of pigments ;
- [6 max]

[Total: 15]

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— TUITION —

- 2 (a)
1. closely packed to absorb (maximum) light ;
  2. vertical / at right angles to surface of leaf to reduce number of cross walls ;
  3. large vacuole pushes chloroplasts to edge of cell ;
  4. chloroplasts at edge short diffusion path for carbon dioxide ;
  5. chloroplasts at edge to absorb (maximum) light ;
  6. large number of chloroplasts to absorb (maximum) light ;
  7. cylindrical cells **or** air spaces to circulate gases / provide a reservoir of CO<sub>2</sub> ;
  8. moist cell surfaces for diffusion of gases ;
  9. cell walls thin for (maximum) light penetration / diffusion (of gases) ;
  10. chloroplasts can move towards light to absorb (maximum) light ;
  11. chloroplasts can move away from high light intensity to avoid damage ;
- [7 max]

(b) *accept annotated diagram*

12. arranged in light harvesting, clusters / system ;
  13. primary pigments / chlorophyll a ;
  14. at reaction centre ;
  15. P700 / P<sub>I</sub>, absorbs at 700(nm) ;
  16. P680 / P<sub>II</sub>, absorbs at 680(nm) ;
  17. accessory pigments / chlorophyll b / carotenoids, surround, primary pigment / reaction centre / chlorophyll a ;
  18. pass energy to, primary pigment / reaction centre / chlorophyll a ;
  19. P700 / P<sub>I</sub>, involved (in cyclic photophosphorylation) ;
  20. (light absorbed results in) electron excited / AW ;
  21. emitted from, chlorophyll / photosystem ;
  22. flows along, chain of electron carriers / ETC ;
  23. ATP synthesis ;
  24. electron returns to, P700 / P<sub>I</sub> ;
- [8 max]

**[Total: 15]**

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- 3 (a) 1 absorb light ; **A** harvest light / trap light **R** collect light  
 2 pass energy to, primary pigment / chlorophyll / reaction centre ; [2 max]

- (b) *cyclic photophosphorylation*  
 1 electron emitted returns to, PSI / same photosystem or same chlorophyll molecule ;  
*non-cyclic photophosphorylation*  
 2 electron emitted from PSII absorbed by PSI ;  
 3 reduced NADP produced ;  
 4 photolysis occurs ; **A** splitting of water  
 5 (photolysis) only involves PSII ;  
 6 oxygen produced 3 max  
*accept ora for cyclic for marking points 3, 4 and 6*  
*mark to max 3 if cyclic and non-cyclic are described the wrong way round* [4 max]

- (c) (i) some other factor becomes limiting / temperature no longer limiting ;  
 CO<sub>2</sub> / light intensity ; [2]  
 (ii) line falls towards 70°C ; [1]  
 (iii) *rate of photosynthesis falls*  
 enzyme / rubisco, denatured / AW ;  
 substrates not able to fit active site / AW ; [2]

(d)

adaptation	how the adaptation helps photosynthesis
thin cell wall	greater light penetration / short diffusion distance (for gases) ;
cylindrical shape	air spaces ;
large vacuole	chloroplasts near outside of cell for better light absorption / maintains turgor ;
chloroplasts can be moved within the cell	absorb maximum light / avoid excessive light intensities ;

[4]

**[Total: 15]**

- 4 (a) 1 water lost by, evaporation / transpiration ;  
2 no water uptake (by roots) ; [2]
- (b) (i) 1 as water potential increases, oxygen uptake increases ;  
*must be stated*  
2 levels off (at 5 kPa / at 225 au) ;  
3 figures ; *two water potential plus two oxygen uptake figures plus kPa* [2 max]
- (ii) 1 succinate converted to oxaloacetate ;  
2 dehydrogenation / oxidation ;  
3 NAD, is reduced / accepts hydrogen ;  
4 (hydrogens move to) ETC ;  
5 hydrogen splits into protons and electrons ;  
6 electrons pass along ETC ;  
7  $\text{ADP} + \text{P}_i \longrightarrow \text{ATP}$  ;  
8 oxygen, receives protons and electrons / is final electron acceptor, to form water ; [4 max]
- (c) (i) 1 water leaves mitochondrion ; **A** other named organelle  
2 by osmosis / down water potential gradient ;  
3 idea mechanical disruption to membranes ;  
4 membranes made of phospholipid (bilayer) ;  
5 hydrophilic heads / glycoproteins / glycolipids, form fewer hydrogen bonds with water ;  
6 reduces, stability / fluidity (of membrane) ;  
7 ref. (proteins with) hydrophilic channels ; [3 max]

- (ii)
- 1 inner membrane (of mitochondrion) / cristae, site of ETC ;
  - 2 fewer carriers held in position ;
  - 3 fewer electrons pass along ETC ;
  - 4 less ATP produced / less energy released ;
  - 5 less oxygen required to act as electron acceptor ;
  - 6 protons can move freely through the damaged inner membrane ;
  - 7 proton gradient not formed ;

*accept ora for less damaged membranes for marking points 2–7*

[3 max]

- (d)
- 1 extensive / deep, roots ;
  - 2 leaves have small surface area ;
  - 3 leaves, are curled / are waxy / have bulliform cells / have hinged cells ;
  - 4 reduced stomata numbers / stomata in pits ;

[2 max]

**[Total: 16]**

CHEMISTRY ONLINE  
— TUITION —