

## Mark schemes

## Q1.

- (a)  NADP, ADP, Pi and water; 1
- (b) 1. Chlorophyll absorbs light  
**OR**  
Light excites/moves electrons in chlorophyll;  
*Ignore photosystems.*
2. Electron/s are lost  
**OR**  
 (Chlorophyll) becomes positively charged;  
*Ignore site/molecule from where electrons are lost.*  
*Accept electrons go to electron transport/carrier chain for 'electrons lost'.* 2
- (c) Ink and (leaf) pigments would mix  
**OR**  
 (With ink) origin/line in different position  
**OR**  
 (With pencil) origin/line in same position  
**OR**  
 (With pencil) origin/line still visible; 1
- (d) 1. Level of solvent below origin/line;  
*Reject water or any named aqueous solution.*  
*Accept named organic solvent.*
2. Remove/stop before (solvent) reaches top/end; 2
- (e) Accept any answer in range of 0.58 to 0.62;  
*Accept 0.58 or 0.62.*  
*Ignore any numbers which follow numbers in range.* 1
- (f) (Absorb) different/more wavelengths (of light) for photosynthesis;  
*Accept wider/larger range of wavelengths.*  
*Accept frequency for wavelength.*  
*Accept light-dependent reaction /photophosphorylation /photoionisation for photosynthesis.* 1

**Q2.**

- (a) 1. (Less/no) ATP;  
2. (Less/no) reduced NADP;  
*Accept NADPH, NADPH + H, NADPH<sub>2</sub> NADPH + H<sup>+</sup>*  
*Reject reduced NAD, NADH etc,* 2
- (b) 1. (Less/no) carbon dioxide (reacts) with RuBP;  
2. (Less/no) GP; 2
- (c) 1. Stroma (of/in chloroplast);  
*Reject: stoma*  
*Reject stroma of cytoplasm/chlorophyll*  
*Reject stroma of mitochondrion*  
*Ignore references to Calvin cycle or the light-independent reaction* 1
- (d) 1. Rubisco activity increases with temperature  
**OR**  
Rubisco optimum temperature is above (**rubisco activase**);  
2. (Rubisco) **activase** activity decreases at high temperatures (allow any temperature above 25 °C.)  
**OR**  
(Rubisco) **activase** optimum (allow in range) 25 to 30 °C.;  
*Accept denatures at high temperature (allow any temperature above 25 °C)*  
3. (Results/graphs suggest) **activase** cannot/does not affect activity of rubisco;  
4. (Results are) only for cotton;  
*Accept may not be the same in other species/types of plant*  
*Ignore: only one study*  
5. (Results are) for isolated enzymes;  
6. No stats test;

4 max

**[9]**

**Q3.**

- (a) 1. Oxygen produced in light-dependent reaction;  
2. The faster (oxygen) is produced, the faster the light-dependent reaction.

2

- (b) 35–36  $\mu\text{mol}$  Oxygen per mg chlorophyll.

*Correct difference at 500  $\mu\text{mol photons m}^{-2} \text{s}^{-1}$  or  
incorrect difference but division by 4 shown = 1  
mark.*

2

- (c) At all light intensities, chloroplasts from mutant plants:  
1. Have faster production of ATP and reduced NADP;  
2. (So) have faster / more light-independent reaction;  
3. (So) produce more sugars that can be used in respiration;  
4. (So) have more energy for growth;  
5. Have faster / more synthesis of new organic materials.

*Accept converse points if clear answer relates to  
non-mutant plants*

4 max

**[8]****Q4.**

- (a) 1. Stirrer distributes heat (energy);  
*Accept stirrer ensures equal/even temperature or  
prevents build up of 'hot spots'.*
2. Insulation/space/air reduces loss/gain of heat

**OR**

Insulation/space/air reduces conduction/convection;  
*Reject vacuum.*

3. Water has high (specific) heat capacity;

2 max

- (b)  $3.28 / 3.3 \text{ (kJ g}^{-1}\text{)} = \mathbf{2 \text{ marks}};$

Incorrect answer but shows  $328 / 33$  (ignore any subsequent numbers and decimal point) = **1 mark**

**OR**

Incorrect answer of  $6.56 / 6.6 \text{ (kJ g}^{-1}\text{)}$  (ignore any subsequent numbers) = **1 mark**;

2

- (c) 1. (Light is) reflected;  
*Light is not absorbed on its own is not enough.*
2. (Light is) wrong wavelength;

*Accept frequency for wavelength.  
Accept reference to absorbing specified  
wavelengths/frequencies.*

3. (Light) misses chlorophyll/ chloroplasts/photosynthetic tissue;
4. CO<sub>2</sub> concentration or temperature is a limiting factor.

2 max

- (d) 1. ATP;
2. Reduced NADP;  
*Accept 1 and 2 in either order.  
Reject Reduced NAD.  
Accept NADPH/NADPH<sub>2</sub>.*

2

- (e) Correct answer of  $1.31/1.3 \times 10^8$  (ignoring any subsequent numbers after 1.31) = **2 marks**;;

Incorrect answer but shows  $2^{16}$  = **1 mark**

**OR**

65536 in any correct numerical form = **1 mark OR**

Incorrect answer but shows 131 ignoring any subsequent numbers and ignoring any decimal point = **1 mark**;

2

[10]

**Q5.**

- (a) 7.7(%);

1

- (b) 1. No error bars / SD;
2. To show if overlap occurs so difference (in means) is not significant / due to chance  
**OR**  
To show if no overlap occurs so difference (in means) is significant / is not due to chance.

*Do not accept 'no statistical test performed' as Chi squared / Spearman's rank would be inappropriate.*

*Ignore references to sample size as it can be assumed that scientists completed the study using appropriate methodology.*

2

- (c) 1. Reduced transfer of protons across thylakoid membrane  
**OR**  
Reduced chemiosmotic gradient / proton gradient across thylakoid membrane;

2. (So) less ATP produced;
3. (So) less reduced NADP produced;  
*Accept NADPH / NADPH<sub>2</sub> / NADPH<sup>+</sup>*  
*Reject reduced NAD*
4. (So) light-independent reaction slows / stops;  
**OR**  
Less reduction of GP to triose phosphate.

4

- (d) Idea that energy is released from high energy / excited electron/s (that were lost from chlorophyll)

1

**[8]**