**M1.**(a) 1. (No grease)
means stomata are open
OR
allows normal $CO_2$ uptake;
*Allow 'gas exchange' for $CO_2$ uptake.*
*'As a control' is insufficient on its own.*

2. (Grease on lower surface)
seals stomata
OR
stops $CO_2$ uptake through stomata
OR
to find $CO_2$ uptake through stomata
OR
shows $CO_2$ uptake through cuticle / upper surface;

3. (Grease on both surfaces) shows sealing is effective
OR
stops all $CO_2$ uptake.

**3**

(b) (i) 1. (Mean rate of) carbon dioxide uptake was constant *and* fell after the light turned off;
*Ignore absence of arbitrary units in both marking points.*
*Both ideas needed for mark.*
*Accept 'stayed at 4.5' as equivalent to 'was constant'.*

2. Uptake fell from 4.5 to 0 / uptake started to fall at 60 minutes and reached lowest at 80 minutes / uptake fell over period of 20 minutes;
*One correct use of figures required.*
*Accept fell to nothing / no uptake for 0.*

**2**

(ii) 1. (Because) water is lost through stomata;
2. (Closure) prevents / reduces water loss;
3. Maintain water content of cells.
*This marking point rewards an understanding of reducing water loss e.g. reduce wilting, maintain turgor, and is not related to photosynthesis.*

**2 max**

(c) (i) (Carbon dioxide uptake) through the upper surface of the leaf / through cuticle.

**1**

(ii) 1. No use of carbon dioxide in photosynthesis (in the dark);
2. No diffusion gradient (maintained) for carbon dioxide into leaf / there is now a diffusion gradient for carbon dioxide out of leaf (due to respiration).

**2**

**[10]**

**M2.**(a) Oxygen production / concentration and time.

*Accept: oxygen volume / concentration*

*Reject: oxygen uptake*

*Neutral: reference to carbon dioxide uptake*

**1**

(b) 1. Intensity of light;

*Accept: distance from light*

2. Amount / number / mass / species of algae / photosynthesising cells;
3. Carbon dioxide (concentration / partial pressure);
4. Time.

**2 max**

(c) 1. (pH) increases;

*Neutral: becomes more alkaline / less acidic*

2. As (more) carbon dioxide removed (for photosynthesis).

**2**

(d) 1. Less absorption / (more) reflection (of these wavelengths of light);

*Reject: no absorption or cannot absorb unless in context of green light.*

*Note: no green light absorbed or green light reflected = 2 marks.*

2. (Light required) for light dependent (reaction) / photolysis

*Accept: for excitation / removal of electrons (from chlorophyll)*

3. (Represents) green light / colour of chlorophyll.

**2 max**

**[7]**

**M3.**(a) 1. Geographic(al) isolation;

2. Separate gene pools / no interbreeding / gene flow (between populations);

*Accept: reproductive isolation*

*This mark should only be awarded in context of during the process of speciation. Do not credit if context is after speciation has occurred.*

3. Variation due to mutation;
4. Different selection pressures / different abiotic / biotic conditions / environments / habitats;

*Neutral: different conditions / climates if not qualified*

*Accept: named abiotic / biotic conditions*

5. Different(ial) reproductive success / selected organisms (survive and) reproduce;

*Accept: pass on alleles / genes to next generation as equivalent to reproduce*

6. Leads to change / increase in allele frequency.

*Accept: increase in proportion / percentage as equivalent to frequency*

**6**

(b) 1. Capture / collect sample, mark and release;
2. Method of marking does not harm lizard / make it more visible to predators;
3. Leave sufficient time for lizards to (randomly) distribute (on island) before collecting a second sample;
4. (Population =) number in first sample × number in second sample divided by number of marked lizards in second sample / number recaptured.

**4**

(c) 1. High concentration of / increase in carbon dioxide linked with respiration at night / in darkness;
2. No photosynthesis in dark / night / photosynthesis only in light / day;

*Neutral: less photosynthesis*

3. In light net uptake of carbon dioxide / use more carbon dioxide than produced / (rate of) photosynthesis greater than rate of respiration;
4. Decrease in carbon dioxide concentration with height;

*More carbon dioxide absorbed higher up*

*Accept: less carbon dioxide higher up / more carbon dioxide lower down*

5. (At ground level) less photosynthesis / less photosynthesising tissue / more respiration / more micro-organisms / micro-organisms produce carbon dioxide.

*Neutral: less leaves unqualified or reference to animals*

**5**

**[15]**

**M4.**(a) 1. Oxygen produced in light-dependent reaction;
2. The faster (oxygen) is produced, the faster the light-dependent reaction.

**2**

(b) 35–36 µmol Oxygen per mg chlorophyll.

*Correct difference at 500 µmol photons $m^{-2}$ $s^{-1}$ 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]**

**M5.**(a) Succession;

*Ignore any word in front of succession e.g. secondary / ecological succession.*

*Neutral 'forestation'.*

**1**

(b) 1. Greater variety / diversity of plants / insects / more plant / insect species;

*Neutral: more plants.*

2. More food sources / more varieties of food;

*Neutral: more food / more / greater food source (singular).*

3. Greater variety / more habitats / niches;

*Accept: more nesting sites.*

***Q*** *Neutral: more homes / shelters.*

**3**

(c) (i) Temperature and carbon dioxide;

*Neutral: water, chlorophyll.*

**1**

(ii) Shows (gross) photosynthesis / productivity minus respiration / more carbon dioxide used in photosynthesis than produced in respiration;

*Correct answers are often shown as: net productivity = (gross) photosynthesis – (minus) respiration.*

**1**

(iii) 1. (Shade plant) has lower (rate of) respiration / respiratory losses / less $CO_2$ released at 0 light intensity / in dark;

*Accept use of figures.*

*Accept: lower compensation point.*

2. Greater (net) productivity / less sugars / glucose used / more sugars / glucose available;

*Neutral: any references to rate of photosynthesis.*

**2**

**[8]**