

Question Number	Answer	Mark
1(a)	<ol style="list-style-type: none"> 1. idea of reflection ; 2. reference. to {incorrect / eq } {wavelength / colour / frequency} ; 3. idea of {not hitting the {chloroplast / chlorophyll}} / it is transmitted ; 4. idea of light being in excess e.g. at max. photosynthesis so more light can be used ; 	max (2)

Question Number	Answer	Mark
1(b)(i)	{joules / energy} per {square metre / metre squared / (unit) area} per {year / unit time} ;	(1)

Question Number	Answer	Mark
1(b)(ii)	Award 2 marks for correct answer (84.8 / 84.84) <ol style="list-style-type: none"> 1. correct subtraction (24.4 - 3.7 / 20.7) ; 2. correct multiplication by 100 ÷ 24.4 ; [consequential errors apply]	(2)

Question Number	Answer	Mark
1(b)(iii)	B ;	(1)

Question Number	Answer	Mark
1(c) [QWC]	<p>(QWC - Spelling of technical terms (<i>shown in italics</i>) must be correct and the answer must be organised in a logical sequence)</p> <ol style="list-style-type: none"> 1. reference to {<i>thylakoids / thylakoid</i> (membranes)} ; 2. in {<i>granum / grana</i>} ; 3. (light energy) raises energy level of <i>electrons</i> / {<i>chlorophyll / electrons</i>}excited / eq ; 4. <i>electrons</i> released from {<i>chlorophyll</i> /photosystem / eq} / eq ; 5. reference to <i>electron</i> {carrier / eq} ; 6. reference to series of {redox / oxidation & reduction / eq} reactions ; 7. reference to energy level of <i>electrons</i> {falls / eq} ; 8. reference to {synthesise ATP from ADP +P / phosphorylate ADP} ; 9. reference to <i>photophosphorylation</i> ; 10. reference to ATP {<i>synthetase / synthase / ase</i>} ; 11. reference to {<i>chemiosmosis</i> / eq} ; 12. idea of <i>electrons</i> from {<i>photolysis</i> / eq} used to replace those lost ; 13. reference to involvement of {accessory pigments / named example} ; 	max (6)

Number		
2(a)(i)	A ;	(1)

Question Number	Answer	Mark
2(a)(ii)	D ;	(1)

Question Number	Answer	Mark
2(a)(iii)	A ;	(1)

Question Number	Answer	Mark
2(b)	<ol style="list-style-type: none"> 1. ref to thylakoids ; 2. (made of) membranes ; 3. (arranged as) {stacks / grana / eq} ; 4. contain {pigment / chlorophyll} / eq ; 5. (arranged as) quantasomes / photosystems ; 	<p>maximum (3)</p>

Question Number	Answer	Mark
2(c)(i)	<ol style="list-style-type: none"> 1. $(62.4 / 162) \times 100$; [accept alternative correct working] 2. 38.5% ; [must be to 1 dp] 	(2)

Question Number	Answer	Mark
2(c)(ii)	<ol style="list-style-type: none"> 1. ref to different lighting has little effect / little variation in percentage grain yields ; 2. variation in percentage is less than 3 / eq ; 3. which is (probably) {not significant/ insignificant} ; 4. yield is {less / eq} for low pressure sodium lamps ; 5. the best yield is metal halide / eq ; 	<p>maximum (3)</p>

Question Number	Answer	Mark
2(c)(iii)	<p>Any two from</p> <ol style="list-style-type: none"> 1. crops can be grown {out of season / all year round} / eq ; 2. plants photosynthesise 24 hours a day / eq ; 3. idea of less physical damage from {weather / animals / eq} ; 4. pest control easier / eq ; 5. ref to control of other named factor, eg CO₂, temperature, humidity, water supply ; 	<p>maximum (2)</p>

Question Number	Answer	Additional Guidance	Mark
3(a)	1. idea that enzyme activity decreases ; 2. credit calculated reduction e.g. 0.6, 2.7 , 3.3 ; 3. idea that an increase in temperature results in increase in kinetic energy ; 4. causing changes in bonds (in the enzyme) / eq ; 5. idea that enzyme is denaturing (above 40 °C) ; 6. idea that carbon fixation is reduced ;	5 ACCEPT fewer enzyme-substrate complexes NOT starts to denature	(5)

Question Number	Answer	Additional Guidance	Mark
3(b)	{RuBP / ribulose biphosphate} AND {carbon dioxide / CO ₂ } ;	ACCEPT Rubp / ribulose biphosphate NOT CO / CO ²	(1)

Question Number	Answer	Mark
3(c) (i)	D valid ;	(1)

Question Number	Answer	Mark
3(c) (ii)	C measuring the activity at 1°C intervals between 35°C and 45°C ;	(1)

Question Number	Answer	Additional Guidance	Mark
4(a)(i)	<p>1. solution should contain (all) the {mineral / ions} that duckweed needs ;</p> <p>2. at the minimum concentration / eq ;</p> <p>Any two correctly named ion and its corresponding function :</p> <p>e.g. {nitrate (ions) / NO_3^{2-}} for {amino acids / protein / nucleic acid / ATP / chlorophyll / eq}</p> <p>{magnesium ions / Mg^{++}} for chlorophyll</p> <p>{calcium ions / Ca^{++}} for {cell wall / pectate / middle lamella / eq }</p> <p>{phosphate (ions) / PO_4^{3-}} for { nucleic acid /ADP / ATP / NAD /phospholipid / eq} ; ;</p>	<p>1 IGNORE nutrients</p> <p>2 ACCEPT in excess</p> <p>IGNORE carbon dioxide and wrong formulae</p> <p>NOT nitrogen</p> <p>NOT magnesium</p> <p>NOT calcium</p> <p>ACCEPT membrane</p> <p>NOT phosphorous</p>	(3)

Question Number	Answer	Additional Guidance	Mark
4(a)(ii)	<p>1. idea of {extrapolation / drawing a line of best fit / eq} (to estimate number of fronds after 10 days) ;</p> <p>2. read value from graph / eq ;</p> <p>3. idea of subtracting { 50 / 10} from the number of fronds after 10 days ;</p>	<p>NB Apply this mark scheme even if they describe weighing the fronds and calculating the mass increase</p> <p>2 IGNORE time refs.</p>	(2)

Question Number	Answer	Additional Guidance	Mark
*4(b)	<p>(QWC – Spelling of technical terms must be correct and the answer must be organised in a logical sequence)</p> <p>1. idea of using {solution of ions / complete medium} ;</p> <p>2. idea of using a {range of / minimum of 5} temperatures ;</p> <p>3. idea that different temperatures will be achieved using {waterbaths / incubators / eq} ;</p> <p>4. idea of determining growth over a period of time ;</p> <p>5. credit appropriate named example of how growth is to be assessed eg {number / size / mass } of {fronds / plants}, length of roots ;</p> <p>6. credit named control variable e.g. same concentration of (each) inorganic ions ;</p> <p>7. idea of repeats to calculate a {mean / average} ;</p>	<p>QWC with an emphasis on logical sequence</p> <p>2. ACCEPT 5 quoted temperatures in between 1°C and 70°C</p> <p>IGNORE room temp if 6 or more values given</p> <p>5. IGNORE height / refs to germination</p> <p>7 ACCEPT for reliability</p>	(5)

Question Number	Answer	Mark
5(a)(i)	C ;	(1)

Question Number	Answer	Mark
5(a)(ii)	C ;	(1)

Question Number	Answer	Mark
5(b)(i)	temperature ;	(1)

Question Number	Answer	Mark
5(b)(ii)	<ol style="list-style-type: none"> 1. rate of growth increases as temperature increases {between 13°C and 22°C / up to 22°C} ; 2. rate of growth decreases {between 22°C and 25°C / above 22°C} ; 3. use of manipulated data to support above e.g. increases by {0.7 (a.u.) / 4.5 times}, decreases by 0.1 (a.u.) ; 4. reference to enzymes involved (in growth) ; 5. molecules {move about more / have more kinetic energy}, as temperature increases ; 6. (therefore) {enzyme and substrate (molecules) collide more / rate of enzyme-substrate complexes formation increases} as temperature increases ; 7. correct reference to denaturation of some {enzyme / protein / eq} (molecules) ; 8. (therefore) rate of {growth / reactions} decreases as fewer enzyme molecules available ; 	max (4)

Question Number	Answer	Mark
5(b)(iii)	<ol style="list-style-type: none"> 1. idea that (each temperature) has same light intensity ; 2. correct reference to must be above {threshold / compensation point} ; 3. (below which) no net photosynthesis takes place / eq ; 4. reference to {so light is not limiting factor / so temperature is the limiting factor}; 5. photosynthesis produces {material / eq} needed for growth / eq ; 	max (3)

Question Number	Answer	Mark
5(b)(iv)	<ol style="list-style-type: none"> 1. {wavelength / colour / frequency} of light ; 2. CO₂ concentration / eq ; 3. pH / eq (of solution) ; 4. reference to {mineral / eq} ; 	max (2)