1 **(a)**	$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$;;	[2]	one mark for the correct chemical formulae one mark for balancing the equation correctly **R** word equation
(b)	as <u>wavelength</u> increases, rate (of photosynthesis) decreases and increases ; high rates in, blue and violet and red / 400–475 nm and 675 nm ; low(est) rate in, green and yellow / 550–600 nm ; *either* maximum rate = 0.9 cm^3, at 675 nm / red *or* minimum rate = 0.2 cm^3, at 550 nm / green ;	[max 3]	units must be used once in the answer **A** volume of gas for rate
(c)	divide the volumes by, five (minutes) / time ;	[1]	
(d) (i)	to keep the <u>light intensity</u> the same ;	[1]	**R** temperature **I** 'fair test' **A** 'control light intensity' / 'light intensity is a control(led) variable'
(ii)	to provide carbon dioxide / so carbon dioxide is not a limiting factor / so the only limiting factor is wavelength ;	[1]	
(e)	for, respiration / energy ; converted to sucrose ; used to make, nectar / fruits ; used to make, cellulose / lignin ; used in cell walls ; used to make, starch / oils / fats ; storage ; used to make, amino acids ; used to make, chlorophyll ;	[max 3]	**I** protein synthesis / growth / active transport **R** produces energy **I** 'makes food', but **A** 'stores food' for 1 mark
		[Total: 11]	

Question		Mark	Guidance
2 (a) (i)	retina ;	[1]	
(ii)	optic (nerve) ;	[1]	**I** sensory neurone
(iii)	(light is) refracted ;	[1]	**A** description of refraction
(iv)	sensitive to / detect, light ; in low intensity / night ; pass impulse to, sensory neurone / optic nerve ; AVP ;	[max 2]	sensitive in dim light = 2 marks **A** provides night vision
(b) (i)	gravity ;	[1]	
(ii)	negative / away from (gravity) ; (gravi)tropism / (geo)tropism ;	[2]	

Question		Mark	Guidance
2 **(iii)**	*upwards* grow towards (where) light (should be) **;** more, light absorbed / photosynthesis **;** more growth **;** flowers more likely to attract, insects / pollinators **;** more likely to, release / shed / disperse, seeds **;** *downwards* better, anchorage / AW **;** absorb, water / mineral ions **;** AVP **;** ref to competition / damage	[max 2]	
(iv)	auxins <u>made</u> in shoot tip **;** (auxin) spread / move / diffuse **;** *idea of* unequal distribution of auxin **;** auxins collect, in <u>lower</u> side of stem **;** auxin stimulates (cell) elongation (where it accumulates) **;** AVP **;**	[max 4]	**I** found in tip **I** growth **e**.g. (by) absorption of water (osmosis) / ref to turgor pressure (and) stretching of cell walls / statoliths / detect gravity
		[Total: 14]	

3 **(a (i)**	maintain constant temperature / prevent heat from the lamp heating the water / absorbs heat from the lamp / heat shield **;** (thermometer) to measure / check / monitor / record, water **;** prevent temperature (change), influencing / affecting, the results / rate of photosynthesis **;** temperature is a, control(led) / standardised, variable **;**	**[max 2]**	1 mark for 'controlling' 1 mark for 'measuring'
(ii)	maintain constant light intensity **;** (light meter) to measure / check / monitor / record, the light intensity **;**		1 mark for 'controlling' 1 mark for 'measuring'

Question	Answers	Marks	Additional Guidance
3	prevent light intensity (change) influencing / affecting the, results / rate of photosynthesis ; make sure the lamp is always, in the same place / at right distance ; light, intensity / level, is dependent on distance ; light intensity is, a controlled / standardised, variable ;	[max 2]	**A** (ruler) to measure the distance between lamp and plant
(b) (i)	rate / photosynthesis / bubbles: increases as carbon dioxide concentration increases and then, levels off AW ; increases to 0.40 % ; **A** rate remains constant above 0.40% little / slow, increase up to 0.1 % ; **ora** one data quote with CO_2 concentration and rate with units ;	[max 3]	units must be used at least once anywhere in the answer to award marking points that require them **A** bpm for bubbles per minute
(ii)	carbon dioxide / CO_2, concentration / % / level / availability ;	[1]	**R** 'amount of carbon dioxide'
(iii)	ref to <u>limiting factor</u> in suitable context ; carbon dioxide (concentration), is no longer limiting / AW ; light, intensity / level, could be limiting / AW ; reference to light providing <u>energy</u> for photosynthesis ; temperature could be limiting / AW ; reference to temperature influencing the activity of enzymes ;	[ma 4]	

Question	Answers	Marks	Additional Guidance
3	chloroplast / chlorophyll / number of leaves / size of plant, could be limiting factor ;		
(c)	measure <u>volume</u> (of oxygen / gas) ; use, inverted test-tube / measuring cylinder / syringe (barrel) ; reference to, graduations / markings ; **A** 'take readings from…' / 'record results…' filled with water ; gas collects at the top and pushes out the water / downward displacement of water; gas syringe ; attached by (delivery) tube to, flask / AW ; oxygen sensor ; data logger for any other suitable electronic method ; reference to equilibration / described ; reference to time period ; **A** rate = volume divided by time	**[max 3]**	
(d) (i)	use / combustion / burning, of fossil fuels ; reason for increased demand for energy ; carbon dioxide from, volcanic activity / volcanoes ;	**[max 2]**	**A** named fossil fuel(s) **A** named example, e.g. increased use of cars / heating / air-conditioning

Question	Expected Answers	Marks	Additional Guidance
3	deforestation **;** burning of, forests / trees **;**		
(ii)	carbon dioxide is a greenhouse gas **;** (enhanced) greenhouse effect (in context of carbon dioxide) **;** heat / infra-red / long wavelength radiation, radiated / emitted, from / absorbed / trapped / AW, by, carbon dioxide / greenhouse gases **;** travels / AW, back to the surface **;** heat cannot, leave (from the atmosphere) / pass into outer space **;**	**[max 4]**	**R** 'ozone causes greenhouse effect' **A** reflected as an alternative to radiated **ignore** UV light / visible light / (solar) radiation
		[Total: 21]	