BIOWELSH WORKSHEET FOR WJEC GCE A LEVEL BIOLOGY
UNIT 3 – ENERGY, HOMEOSTASIS AND THE ENVIRONMENT
TOPIC 3.2 PHOTOSYNTHESIS: WORKSHEET 1 (BW-A2-3.2-W1) MARK SCHEME

GENERAL INSTRUCTIONS

Recording of marks

Mark in red ink. One tick equals one mark, except in the extended response question, where a level of response scheme is used.

Write each question total in the box at the end of the question, and copy the totals onto the grid on the front cover of the worksheet. Add them to give the worksheet total out of 154.

Marking rules

Look at all of the work. Where the scheme says working is needed, the working must be seen. Mark crossed-out work if it has not been replaced. Give credit for correct, relevant answers that are not listed in the scheme.

Extended response question

Read the whole answer first. Decide which level descriptor fits the answer best, judging the overall quality. Then choose the mark within the level: the top mark when the answer matches both the content and the communication statements well, the middle mark when most of the content is there and the communication statement is partly met, and the bottom mark when only the content statements are matched.

Marking abbreviations

cao	=	correct answer only
ecf	=	error carried forward
bod	=	benefit of doubt
ORA	=	or reverse argument
owtte	=	or words to that effect

Notation: / separates alternatives; { } groups alternatives within a point; words in ( ) are not needed for the mark; underlined words are essential; (1) is one mark.

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
1	(a)			A upper epidermis, B palisade mesophyll, C spongy mesophyll All three correct = 2 marks Two correct = 1 mark	2			2		
	(b)			Most chloroplasts are in the palisade (mesophyll) cells / near the upper surface (1) Fewer in spongy mesophyll; (almost) none in epidermis (except guard cells) (1)	2			2		
	(c)			Cells are elongated / tightly packed / at right angles to the surface, close to the upper surface (1) So light passes through few cell walls before reaching many chloroplasts / light that passes one chloroplast is absorbed by another (1)		2		2		
	(d)	(i)		Sun leaf 50 (%) (1) Shade leaf 40 (%) (1)		2		2	2	
		(ii)		Less light reaches shade leaves / light would not penetrate far into a thick layer (1) Extra cells would not receive enough light but would still respire / use resources (1)			2	2		
				Question 1 total	4	4	2	10	2	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
2	(a)			E envelope / double membrane, F granum / stack of thylakoids, G stroma All three correct = 2 marks Two correct = 1 mark Reject matrix for G	2			2		
	(b)			They convert one form of energy into another (1) Light energy into chemical energy (in ATP / reduced NADP / glucose) (1)	2			2		
	(c)			Light-dependent: thylakoid membranes (of the grana) (1) Light-independent: stroma (1) Reject 'grana' alone	2			2		
	(d)			Dim light: maximises the area of chloroplasts facing the light / absorbs as much light as possible (1) Bright light: reduces absorption of excess light / prevents damage to chlorophyll / photosystems (1)			2	2		
	(e)			2.5 (%) (1)		1		1	1	
	(f)			Any two (×1) from: • Light reflected / transmitted / misses chloroplasts (1) • Some wavelengths (green) are not absorbed (1) • Energy lost as heat (in reactions / transfers) (1) • Glucose used in respiration (1)			2	2		
				Question 2 total	6	1	4	11	1	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
3	(a)			More oxygen released (by photosynthesis) where those wavelengths were absorbed (1) Oxygen comes from photolysis / splitting of water; bacteria need it for aerobic respiration (1)		2		2		
	(b)			420 to 480 nm and 650 to 700 nm (1) Allow blue / violet and red Both needed		1		1		
	(c)	(i)		7.3 (1)		1		1	1	
		(ii)		Green light is not absorbed / is reflected by chlorophyll (1) So little photosynthesis / photolysis, so little oxygen is released (1)		2		2		
	(d)			Action spectrum shows the rate of photosynthesis at each wavelength (1) Absorption spectrum shows how much light a pigment absorbs at each wavelength (1)	2			2		
	(e)			Accessory pigments / carotenoids / chlorophyll *b* absorb light at 500 nm (1) They pass the energy to chlorophyll *a* at the reaction centre (1)			2	2		
				Question 3 total	2	6	2	10	1	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
4	(a)			Ink would dissolve in the solvent / separate and mix with the pigments; pencil (graphite) does not dissolve (1)		1		1		1
	(b)			Otherwise the pigments would dissolve into the solvent in the tube (rather than move up the plate) (1)		1		1		1
	(c)	(i)		Spot 2: 0.71 (1) Spot 4: 0.45 (1)		2		2	2	2
		(ii)		1 carotene, 2 xanthophyll, 3 chlorophyll *a*, 4 chlorophyll *b* All four correct = 2 marks Two or three correct = 1 mark Allow ecf from (i)		2		2		
	(d)			Pigments have different solubilities in the solvent (1) And different attraction to / adsorption on the plate / stationary phase, so more soluble or less attracted pigments move further (1)	2			2		
	(e)			Reason: difficult to judge the centre of each spot / distances uncertain / pigments may be misidentified (1) Improvement: use a longer plate / a different solvent / two-way chromatography / a smaller, more concentrated spot (1)			2	2		2
				Question 4 total	2	6	2	10	2	6

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
5	(a)			Chlorophyll *a* (1) Reject chlorophyll alone	1			1		
	(b)			Any three (×1) from: • Light absorbed by (accessory / antenna) pigment molecules (1) • Energy (not electrons) passed from pigment to pigment (1) • To (chlorophyll *a* in) the reaction centre (1) • An electron is excited / raised to a higher energy level (1) • Electron is emitted and accepted by the electron acceptor / M (1)	3			3		
	(c)			Different pigments absorb different wavelengths (1) So a wider range of wavelengths / more light energy can be used (1)	1	1		2		
	(d)			PSI 700 nm and PSII 680 nm (1) Both needed	1			1		
	(e)	(i)		1.6 (1) (62 ÷ 38)		1		1	1	
		(ii)		710 nm excites only PSI, so PSII does not lose electrons / no photolysis, so very little oxygen (1) Non-cyclic photophosphorylation needs both photosystems to be excited (1) Together, electrons flow from PSII to PSI (and PSI to NADP), so photolysis and oxygen production increase more than the sum of each alone (1)			3	3		
				Question 5 total	6	2	3	11	1	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
6	(a)			Photolysis (1) Stroma (1)	2			2		
	(b)			Electrons cannot pass from PSII to the electron carriers (1) So PSII / chlorophyll *a* in PSII cannot accept electrons from water / its lost electrons are not replaced (1) So photolysis stops and no oxygen is produced (1)		3		3		
	(c)			Cyclic photophosphorylation / the dashed route (1) Excited electrons from PSI return through the electron carriers, which pump protons / cause ATP synthesis (1)		1	1	2		
	(d)			Electrons still flow from water through PSII and PSI, so photolysis continues (1) Electrons are passed to paraquat instead of NADP (1)		2		2		
	(e)			No reduced NADP to reduce GP to triose phosphate / light-independent stage stops (1) So no glucose / organic molecules made / RuBP not regenerated (1)			2	2		
				Question 6 total	2	6	3	11	0	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
7	(a)			Cyclic: PSI only; no; no; no Non-cyclic: PSI and PSII; yes; yes; yes All eight correct = 3 marks Six or seven correct = 2 marks Four or five correct = 1 mark	2	1		3		
	(b)			No (active) PSII so no photolysis (1) Only cyclic photophosphorylation takes place (which releases no oxygen) (1)		2		2		
	(c)			Oxygen would inactivate nitrogenase, so nitrogen fixation would stop (1)			1	1		
	(d)			No reduced NADP (from non-cyclic photophosphorylation), so GP cannot be reduced to triose phosphate (1) So heterocysts cannot make carbohydrate and receive sucrose from vegetative cells (for respiration) (1)		2		2		
	(e)			Supply nitrogen that the cells cannot obtain otherwise / when nitrate is scarce (1) To make proteins / enzymes / chlorophyll / nucleic acids for growth (1)			2	2		
				Question 7 total	2	5	3	10	0	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
8	(a)			J ribulose bisphosphate / RuBP, K glycerate-3-phosphate / GP, L triose phosphate / TP, E rubisco All four correct = 2 marks Two or three correct = 1 mark	2			2		
	(b)			J 5 and K 3 (1) Both needed	1			1		
	(c)			Reduced NADP provides hydrogen / electrons to reduce GP (1) ATP provides the energy / phosphate for the reaction (1)	2			2		
	(d)			ATP 18 (1) Reduced NADP 12 (1)		2		2	2	
	(e)			16.7 (%) (1)		1		1	1	
	(f)			RuBP / J is the carbon dioxide acceptor (1) Without regeneration, RuBP would be used up and carbon dioxide fixation / the cycle would stop (1)		2		2		
				Question 8 total	5	5	0	10	3	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
9	(a)			Rises quickly then levels off (after about 4 minutes) (1) Use of data: from 1.0 to about 2.6 au (1)		2		2		
	(b)			Less carbon dioxide to combine with RuBP / less RuBP used by rubisco (1) But RuBP is still regenerated from triose phosphate (using ATP from the light-dependent stage) (1)		2		2		
	(c)			Less GP made because less carbon dioxide is fixed (1) GP is still converted to triose phosphate using ATP and reduced NADP (1)		2		2		
	(d)			70 (%) (2) Award 1 mark for (2.0 − 0.6) ÷ 2.0 / 1.4 ÷ 2.0 Accept 69 to 71		2		2	2	
	(e)			Triose phosphate decreases (1) Less GP available to be reduced to triose phosphate (1)			2	2		
				Question 9 total	0	8	2	10	2	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
10	(a)			P starch, Q triglyceride / lipid, R amino acids All three correct = 2 marks Two correct = 1 mark Reject glycogen for P	2			2		
	(b)			Amino acids contain nitrogen (in the amino group) which comes from nitrate (1)	1			1		
	(c)	(i)		Triose phosphate falls because it is converted into other compounds (1) Sucrose and starch rise because they are made from triose phosphate (via glucose) (1)		2		2		
		(ii)		17 (%) (1)		1		1	1	
	(d)			Starch is insoluble so does not affect the water potential of the cell / osmotically inactive (1) Compact / large molecule that cannot leave the cell / easily hydrolysed when needed (1)			2	2		
				Question 10 total	3	3	2	8	1	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
11	(a)			Light intensity (1)		1		1		
	(b)			C: carbon dioxide concentration (1) Evidence: A has more carbon dioxide at the same temperature and a higher rate (85 compared with 34) (1) B: temperature, because A has the same carbon dioxide concentration at a higher temperature and a higher rate (1)		1	2	3		
	(c)			5 / 4.9 (1) mg CO_2 dm^{-2} h^{-1} klx^{-1} (1) (20 − (−5)) ÷ 5 Accept 4.8 to 5.0		2		2	2	
	(d)			1 klx (1) Rate of photosynthesis equals rate of respiration (compensation point) (1)	1	1		2		
	(e)			At 6 klx, curves A and C are almost the same / about 24 compared with about 23 (1) Light is the limiting factor, so extra carbon dioxide gives little benefit / adding lighting would be more effective (1)			2	2		
				Question 11 total	1	5	4	10	2	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
12	(a)			Source of carbon dioxide (1)	1			1		1
	(b)	(i)		52 (mm) at 1.00 % (1)			1	1		1
		(ii)		Mean at 1.00 %: 40.0 (1) Rates: 5.2 and 8.0 (1) Allow ecf for the 1.00 % rate from an incorrect mean		2		2	2	2
	(c)			6.3 (mm^3 min^{-1}) (2) Award 1 mark for 3.14 × 0.5^2 × 8.0 / 0.785 × 8.0 / 31.4 (mm^3 in 5 minutes) Allow ecf from (b)(ii)		2		2	2	
	(d)			Axes correct way round with labels and units: x = concentration of sodium hydrogencarbonate / %; y = rate / mm min^{-1} (1) Suitable linear scales using more than half of the grid (1) All points plotted correctly ± half a small square (1) Points joined with ruled straight lines (1) Allow ecf from (b)(ii)		2	2	4	4	4
	(e)			Rate hardly changes / levels off (at about 9.3 mm min^{-1}) (1) Carbon dioxide is no longer the limiting factor; light intensity / temperature is limiting (1)		2		2		
	(f)			To allow the rate to become constant / the plant to adjust to the new concentration (1)			1	1		1
				Question 12 total	1	8	4	13	8	9

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
13	(a)			Photosynthesis / photolysis produces oxygen (1) Oxygen collects in the air spaces of the disc, lowering its density (1)		2		2		
	(b)			So that all discs sink and floating is caused only by oxygen produced during the experiment (1)		1		1		1
	(c)			Green 0.026 (1) Red 0.091 (1)		2		2	2	2
	(d)			Green light is (mostly) reflected / not absorbed by chlorophyll (1) So fewer electrons excited / less photolysis, so less oxygen produced (1)	1	1		2		
	(e)			Light intensity also affects the rate, so differences may not be due to wavelength alone (1) Measure intensity with a light sensor and adjust the distance of the lamp so it is the same for each filter (1)			2	2		2
	(f)			Provides carbon dioxide so that it is not limiting / so photosynthesis can continue (1)			1	1		1
				Question 13 total	1	6	3	10	2	6

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
14	(a)			Yellow stripes / yellowing between the (green) veins / interveinal chlorosis (1)		1		1		
	(b)			Magnesium is needed to make chlorophyll (1) Less chlorophyll so less light absorbed / less photosynthesis (1) Less triose phosphate / glucose / organic molecules for growth (1) Allow magnesium activates enzymes (e.g. ATPase)	1	2		3		
	(c)			66.3 (%) (2) Award 1 mark for (1.84 − 0.62) ÷ 1.84 / 1.22 ÷ 1.84		2		2	2	
	(d)			Nitrate needed to make amino acids / proteins / enzymes / nucleic acids / ATP (1) So both photosynthesis (chlorophyll and enzymes such as rubisco) and making new cells are affected (1)			2	2		
	(e)			Water content varies (with conditions), so dry mass is a better measure of growth / organic material (1)			1	1		1
	(f)			Supplies oxygen for aerobic respiration in the roots (1) Providing ATP for active uptake of ions (1)		2		2		1
				Question 14 total	1	7	3	11	2	2

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
15				**Indicative content**	4	3	2	9		
				A Non-cyclic photophosphorylation A1 Light absorbed by pigments in PSII and PSI; energy passed to chlorophyll *a* at the reaction centres A2 Electrons excited / raised to a higher energy level and passed to electron acceptors A3 Electrons pass along electron carriers from PSII to PSI, losing energy A4 Energy used to pump protons into the thylakoid space; ATP made by chemiosmosis through ATP synthetase A5 Photolysis of water replaces electrons lost from PSII, releasing protons and oxygen A6 Electrons from PSI and protons reduce NADP in the stroma						
				B Light-independent stage B1 Carbon dioxide combines with RuBP, catalysed by rubisco, forming two molecules of GP B2 GP reduced to triose phosphate using reduced NADP (hydrogen) and ATP (energy) B3 Five out of six triose phosphate molecules used to regenerate RuBP, using ATP B4 Remaining triose phosphate used to make glucose and other organic molecules						

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
				C Using Graph 15.1 C1 Low light: rate stays at about 17 to 19 au between 10 and 35 °C C2 Light intensity is the limiting factor; light-dependent reactions are not (much) affected by temperature C3 High light: rate rises from about 14 au at 5 °C to a maximum of about 80 au at about 31 °C C4 Temperature is limiting; enzyme-controlled (rubisco) reactions of the Calvin cycle speed up as kinetic energy increases C5 Above about 32 °C the rate falls steeply because enzymes are denatured C6 At low temperatures both curves are similar because temperature limits both						
				7-9 marks Indicative content of this level is detailed information from all three lists. The candidate constructs an articulate, integrated account, correctly linking relevant points in a logical sequence. The answer fully addresses the question with no irrelevant inclusions or significant omissions. Scientific conventions and vocabulary are used appropriately and accurately.						
				4-6 marks Indicative content of this level is detailed information from two of the lists, or less detail from all three. The candidate constructs an account correctly linking some relevant points, showing some reasoning. The answer addresses the question with some omissions. Scientific conventions and vocabulary are usually used appropriately and accurately.						
				1-3 marks Indicative content of this level is some information from at least one of the lists, or a little information from more than one. The candidate makes some relevant points, showing limited reasoning. The answer addresses the question with significant omissions. Use of scientific conventions and vocabulary is limited.						

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
				0 marks The candidate does not make any attempt or give a relevant answer worthy of credit.						
				Question 15 total	4	3	2	9	0	0

UNIT 3: ENERGY, HOMEOSTASIS AND THE ENVIRONMENT, TOPIC 3.2

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	TOTAL MARK	MATHS	PRAC
1	4	4	2	10	2	0
2	6	1	4	11	1	0
3	2	6	2	10	1	0
4	2	6	2	10	2	6
5	6	2	3	11	1	0
6	2	6	3	11	0	0
7	2	5	3	10	0	0
8	5	5	0	10	3	0
9	0	8	2	10	2	0
10	3	3	2	8	1	0
11	1	5	4	10	2	0
12	1	8	4	13	8	9
13	1	6	3	10	2	6
14	1	7	3	11	2	2
15	4	3	2	9	0	0
TOTAL	**40**	**75**	**39**	**154**	**27**	**23**

A Tutor Meets Tutee project

BioWelsh mark scheme BW-A2-3.2-W1 (MS). Not an official WJEC mark scheme.