BIOWELSH WORKSHEET FOR WJEC GCE A LEVEL BIOLOGY
UNIT 3 – ENERGY, HOMEOSTASIS AND THE ENVIRONMENT
TOPIC 3.1 IMPORTANCE OF ATP: WORKSHEET 1 (BW-A2-3.1-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 155.

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)			R condensation / phosphorylation (1) S hydrolysis (1) Reject oxidation / reduction	2			2		
	(b)			Used in all {cells / organisms} (1) (Hydrolysis provides) the immediate source of energy for {almost all / most} energy-requiring reactions / energy released where it is needed (1) Ignore 'makes energy'	2			2		
	(c)			1.4×10^8 (2) Award 1 mark for 2.4×10^6 (per second) / 6.0×10^8 (per minute) / correct answer not in standard form (144 000 000)		2		2	2	
	(d)			Facilitated diffusion does not use ATP / is passive (1) Glucose moves down its concentration gradient through {carrier / channel} proteins (1) Reject 'uses less energy'	1	1		2		
	(e)			Neurones {conduct many impulses / have many action potentials} (1) Sodium–potassium pumps must restore the resting potential / ion gradients after each impulse (1)			2	2		
				Question 1 total	5	3	2	10	2	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
2	(a)			X reduced NAD (1) Y reduced FAD (1) Reject NADP / reduced NADP	2			2		
	(b)			Any three (×1) from: • Electrons passed from {carrier to carrier / pump to carrier} by redox reactions (1) • Electrons lose energy in steps (1) • Energy used by proton pumps to actively transport protons (1) • From the matrix to the intermembrane space (1) • Creating a proton / electrochemical gradient (1) Reject 'electrons are pumped'	3			3		
	(c)			More of the energy can be captured / used to pump protons (1) Less energy lost as heat / each step releases enough energy for one pump (1)		2		2		
	(d)			{Y / reduced FAD} delivers electrons after the first pump / at a lower energy level (1) So its electrons pass through only two pumps / fewer protons pumped / less steep proton gradient (so less ATP made) (1) ORA for X		2		2		
	(e)			Oxygen and water (1) Both needed	1			1		
				Question 2 total	6	4	0	10	0	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
3	(a)			A crista / cristae / fold of inner membrane (1) B matrix (1) Reject stroma, thylakoid	2			2		
	(b)			(In the) inner mitochondrial membrane / on the cristae (1) Allow stalked particles (on the inner membrane) Reject 'membrane' or 'mitochondrion' alone	1			1		
	(c)			× 100 000 / 1.0 × 10^5 (2) Accept 90 000 to 110 000 from a measured scale bar of 4.5 to 5.5 mm Award 1 mark for measured length of scale bar (in nm or with units converted) ÷ 50 nm		2		2	2	
	(d)	(i)		20.3 / 20 (μm^2) (2) Award 1 mark for 0.35 × 58		2		2	2	
		(ii)		More {electron transport chains / proton pumps / ATP synthetase} (1) So more protons are pumped / flow through ATP synthetase, so more ATP made by chemiosmosis (1)		2		2		
		(iii)		Very high rate of muscle contraction / wing beats / hovering needs a lot of ATP (1)			1	1		
				Question 3 total	3	6	1	10	4	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
4	(a)			Protons are pumped from the matrix into the intermembrane space (1) So the intermembrane space has a higher concentration of protons / H^+ (1) Reject electrons pumped	2			2		
	(b)	(i)		1.6×10^{-8} (mol dm^{-3}) (2) Award 1 mark for $10^{-7.8}$ / 0.000 000 016 / correct value not in standard form		2		2	2	
		(ii)		6.3 (1) Accept 6.2 to 6.3 / $10^{0.8}$ Allow ecf from (i)		1		1	1	
	(c)			There is a difference in the concentration of protons (1) And a difference in charge / the intermembrane space is more positive (than the matrix) (1)	2			2		
	(d)			Protons diffuse back to the matrix through the gramicidin channels, not through ATP synthetase (1) The proton gradient is lost so there is no flow of protons through ATP synthetase / no chemiosmosis (1)		2		2		
	(e)			pH rises / becomes less acidic / closer to 7.8 (1) No final electron acceptor so the electron transport chain stops and protons are no longer pumped, but protons still flow back through ATP synthetase (1)			2	2		
				Question 4 total	4	5	2	11	3	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
5	(a)			P intermembrane space and Q matrix (1) ATP is made in the matrix / the head (T) where ADP and P_i are joined faces the matrix (1)		2		2		
	(b)			Arrow from P to Q through the membrane part of the enzyme (next to / through R), labelled H (1)		1		1		
	(c)			Any three (×1) from: • Protons diffuse down their {electrochemical / concentration} gradient through the channel (1) • Flow of protons causes R / the rotor to turn (1) • Stalk / S turns, changing the shape of the head / T / active sites (1) • ADP and P_i are joined to form ATP / phosphorylation of ADP (1) • Chemiosmosis (1) Reject 'protons pumped' through ATP synthetase	3			3		
	(d)	(i)		2.7 (1) (8 ÷ 3)		1		1	1	
		(ii)		25 (%) (2) Award 1 mark for 10 ÷ 3 = 3.3 (protons per ATP) Allow 22 to 25 from rounded values; allow ecf from (i)		2		2	2	
	(e)			More ATP made per {molecule of glucose / reduced NAD / oxygen used} / respiration more efficient (1)			1	1		
				Question 5 total	3	6	1	10	3	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
6	(a)			Inside (1) Bacteriorhodopsin pumps protons into the vesicle / arrow shows protons moving in (1)		2		2		
	(b)			Light provides the energy for bacteriorhodopsin to pump protons into the vesicle (1) A proton / electrochemical gradient forms across the membrane (1) Protons diffuse out through ATP synthetase, which joins ADP and P_i to make ATP (outside the vesicle) (1)		3		3		
	(c)			Vesicle 2: no light so no proton pumping / no gradient (1) Vesicle 3: no proton pump so no proton gradient (1) Vesicle 5: protons leak back through gramicidin (not through ATP synthetase) so no gradient is maintained (1)			3	3		3
	(d)			ATP is made only when a proton gradient is present / a proton gradient alone is enough to drive ATP synthesis (1) No electron transport chain is needed; the gradient can be made by any proton pump / the energy source for pumping does not matter (1)			2	2		
	(e)			To show that bacteriorhodopsin does not make ATP itself / that ATP synthetase is needed (1)			1	1		1
				Question 6 total	0	5	6	11	0	4

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
7	(a)			J proton pump (1) K ATP synthetase / ATP synthase (1) Reject electron carrier for J	2			2		
	(b)			Liver 5.0 / 5 (1) Brown fat 0.5 (1)		2		2	2	
	(c)			Most protons return to the matrix through thermogenin (1) So they do not pass through ATP synthetase / K (1) The energy of the proton gradient is released as heat (instead of being used to make ATP) (1)		3		3		
	(d)			Proton gradient is kept low / protons do not build up in the intermembrane space (1) So pumping and electron transport are faster, using more oxygen as the final electron acceptor (1)		1	1	2		
	(e)			Generates heat to maintain body temperature (1) Babies have a large surface area to volume ratio / lose heat quickly / cannot shiver effectively (1)			2	2		
				Question 7 total	2	6	3	11	2	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
8	(a)			C mitochondrion (1) D thylakoid(s) / thylakoid membranes / grana / chloroplast lamellae (1) Reject chloroplast alone for D	2			2		
	(b)			1 mark for each correct row: Inner (mitochondrial) membrane / cristae; thylakoid membrane (1) Intermembrane space; thylakoid space / lumen (1) Oxygen; NADP (1) Matrix; stroma (1) Both cells in a row needed for the mark	2	2		4		
	(c)			Photolysis / water split by light (at photosystem II) (1) Protons released into the thylakoid space, increasing the proton concentration there (1) Reject 'in the thylakoid membrane'	2			2		
	(d)			NADP is reduced in the stroma / removes protons from the stroma (1) Keeping the proton concentration low in the stroma / steeper gradient across the thylakoid membrane (1)		2		2		
	(e)			In the dark no ATP is made by the chloroplast / photophosphorylation stops (1) ATP made in the chloroplast is used in the light-independent stage / Calvin cycle, so respiration supplies ATP for other processes (1)			2	2		
				Question 8 total	6	4	2	12	0	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
9	(a)			pH rises (quickly) then levels off (1) Use of data: from 6.50 to 6.80 / by 0.30 in about 2 minutes (1)		2		2		
	(b)			Light excites electrons in chlorophyll / photosystems (1) Energy from electrons passing along the chain is used by proton pumps (1) Protons are pumped from the solution / stroma side into the thylakoid space, so the solution has fewer protons (1)	1	2		3		
	(c)			50 (%) (2) Award 1 mark for 3.2×10^{-7} and 1.6×10^{-7} (mol dm^{-3}) / $10^{-6.5}$ and $10^{-6.8}$		2		2	2	
	(d)			Proton pumping stops (as electrons are no longer excited) (1) Protons diffuse out of the thylakoid space down their gradient (through ATP synthetase / by leaking) (1)		2		2		
	(e)			With ADP and P_i the rise in pH is smaller / pH falls faster in the dark (1) Because protons flow out through ATP synthetase as ATP is made, so fewer protons remain in the thylakoid space (1)			2	2		
				Question 9 total	1	8	2	11	2	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
10	(a)			Cell surface membrane / plasma membrane (1) Reject cell wall	1			1		
	(b)			Similarity: both use proton pumps to make a proton gradient / both have ATP synthetase / protons flow back through ATP synthetase (1) Difference: bacteria pump protons out of the cell (across the cell membrane), mitochondria pump protons into the intermembrane space (across the inner membrane) (1)	1	1		2		
	(c)			pH is lower outside the cell so the concentration of protons is higher outside (1) Protons diffuse down their concentration gradient (and ATP synthetase is the only route back) (1)		2		2		
	(d)			158 / 160 (2) Award 1 mark for $10^{2.2}$ / pH difference of 2.2		2		2	2	
	(e)			Pumping positive protons out makes the outside of the membrane positive / inside negative (1) The difference in charge attracts protons into the cell, which is greater than the concentration gradient in the opposite direction (1)			2	2		
	(f)			Enzymes / proteins would be denatured at pH 10.5 / to keep the pH near the optimum of its enzymes (1)			1	1		
				Question 10 total	2	5	3	10	2	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
11	(a)			ATP is the (immediate) source of energy for the reaction / luciferase reaction needs energy (1) Energy is released by hydrolysis of ATP / breaking bonds between phosphate groups (1)		2		2		
	(b)			5.2 (pmol) (1) Accept 5.1 to 5.3		1		1	1	
	(c)			3.1×10^{12} (2) Award 1 mark for $5.2 \times 10^{-12} \times 6.02 \times 10^{23}$ / correct answer not in standard form Allow ecf from (b)		2		2	2	
	(d)			ATP is found in all (living) cells / all organisms use ATP (1) Surfaces with no cells or food would have no / very little ATP (1)	1	1		2		
	(e)			Any one (×1) from: • ATP also comes from food residues / dead cells, not only from bacteria (1) • Does not identify the type of bacteria / whether they are harmful (1) • Does not show whether cells are living (ATP may remain for a short time) (1)			1	1		
	(f)			Area of surface swabbed / volume of reagent / time before reading / temperature (1)			1	1		1
				Question 11 total	1	6	2	9	3	1

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
12	(a)			Dehydrogenase enzymes remove hydrogen from {glucose / respiratory substrate / intermediates} (1) Methylene blue accepts the hydrogen (instead of NAD) and is reduced (1)	2			2		
	(b)	(i)		212 (s) at 40 °C (1)			1	1		1
		(ii)		Mean at 40 °C: 150 (1) Rates: 3.4 and 6.7 (1) Allow ecf for the 40 °C rate from an incorrect mean		2		2	2	2
	(c)			Axes correct way round with labels and units: x = temperature / °C; y = rate / 1000 ÷ mean time (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
	(d)			Stops oxygen (from the air) dissolving, which would re-oxidise the methylene blue / turn it blue again (1)		1		1		1
	(e)			Boiled yeast (cooled) with glucose and methylene blue, at each temperature (1) To show that the colour change is caused by (dehydrogenase) enzymes in living yeast / not by glucose or temperature alone (1)			2	2		2
				Question 12 total	2	5	5	12	6	10

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
13	(a)			Dehydrogenases remove hydrogen from glucose (during respiration) and DCPIP accepts it / is reduced (1) Reduced DCPIP is colourless so less (red) light is absorbed (1)	1	1		2		
	(b)			0.13 / 0.125 (1) au min^{-1} (1) (0.80 − 0.30) ÷ 4		2		2	2	
	(c)			Sucrose must first be hydrolysed (into glucose and fructose) (1) By an enzyme (sucrase / invertase), which takes time, so less respiratory substrate is available at first (1)			2	2		
	(d)			Absorbance hardly changes / same as the tube with water (1) So yeast cannot {respire / hydrolyse / take up} lactose / has no lactase, so no hydrogen is released for DCPIP (1)		1	1	2		
	(e)			To use up its stored respiratory substrate / glycogen, so any reduction of DCPIP is due to the sugar supplied (1)			1	1		1
	(f)			Quantitative / objective / not subjective, so results are more accurate / repeatable (1)		1		1		1
				Question 13 total	1	5	4	10	2	2

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
14	(a)			(Living cells) respire, so dehydrogenases remove hydrogen from substrates (1) TTC accepts the hydrogen / is reduced to a red compound (1)	2			2		
	(b)			20 years: 76 (1) 30 years: 42 (1)		2		2	2	2
	(c)			So the TTC can reach the cells of the embryo / the seed coat is impermeable to TTC (1)		1		1		1
	(d)			To activate enzymes / start respiration, so that living tissue reduces TTC quickly / softens the seed for cutting (1)			1	1		1
	(e)			TTC can be reduced by light / light could turn TTC red without any enzyme activity (1)			1	1		1
	(f)			Some embryo tissue is dead, so it is not clear whether the seed would germinate / the decision is subjective (1) Carry out a germination test (on a sample of the same seeds) / count how many seeds germinate (1)			2	2		1
				Question 14 total	2	3	4	9	2	6

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
15				**Indicative content** Credit correct reference to cyclic or non-cyclic photophosphorylation.	4	3	2	9		
				A Producing proton gradients in both organelles A1 Electron transport chain is an alternate arrangement of electron carriers and proton pumps A2 Mitochondria: excited electrons from reduced NAD and reduced FAD (from respiratory substrates) A3 Chloroplasts: electrons excited by light absorbed by chlorophyll / photosystems; replaced by photolysis of water A4 Electrons lose energy as they pass along the carriers; energy used by pumps to actively transport protons A5 Mitochondria: from matrix into intermembrane space; chloroplasts: from stroma into thylakoid space A6 Membranes are impermeable to protons, so a proton / electrochemical gradient is maintained A7 Photolysis adds protons to the thylakoid space and reduction of NADP removes them from the stroma						
				B Chemiosmosis B1 Protons diffuse down the electrochemical gradient through ATP synthetase B2 Flow of protons turns the rotor / stalk and changes the shape of the head B3 ADP and P_i are joined to form ATP / phosphorylation B4 ATP made in the matrix / stroma; this is chemiosmosis						

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
				C Using Graph 15.1 C1 Dark with cyanide: ATP falls from about 88 to about 17 au after 10 minutes C2 Cyanide stops electrons passing to oxygen, the final electron acceptor, so the mitochondrial chain stops C3 No proton pumping, no proton gradient, no ATP from mitochondrial ATP synthetase; in the dark chloroplasts make no ATP C4 Remaining ATP from glycolysis / anaerobic respiration only C5 Light with cyanide: ATP stays high, falling only slightly from 100 to about 93 au C6 Chloroplast electron transport chain is not blocked (final acceptor is NADP, not oxygen), so photophosphorylation continues C7 Dark without cyanide: ATP constant at about 88 au, supplied by aerobic respiration						
				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.						

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
				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.						
				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 3.1

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	TOTAL MARK	MATHS	PRAC
1	5	3	2	10	2	0
2	6	4	0	10	0	0
3	3	6	1	10	4	0
4	4	5	2	11	3	0
5	3	6	1	10	3	0
6	0	5	6	11	0	4
7	2	6	3	11	2	0
8	6	4	2	12	0	0
9	1	8	2	11	2	0
10	2	5	3	10	2	0
11	1	6	2	9	3	1
12	2	5	5	12	6	10
13	1	5	4	10	2	2
14	2	3	4	9	2	6
15	4	3	2	9	0	0
TOTAL	**42**	**74**	**39**	**155**	**31**	**23**

A Tutor Meets Tutee project

BioWelsh mark scheme BW-A2-3.1-W1 (MS). Not an official WJEC mark scheme.