BIOWELSH WORKSHEET FOR WJEC GCE A LEVEL BIOLOGY
UNIT 3 – ENERGY, HOMEOSTASIS AND THE ENVIRONMENT
TOPIC 3.8 THE NERVOUS SYSTEM: WORKSHEET 1 (BW-A2-3.8-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 139.

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)			Receptor: light-sensitive cells / rods and cones in the retina of the eye (1) Coordinator: brain (1) Effector: muscles of the hand / fingers (1)	1	2		3		
	(b)			17.1 (cm) (2) Award 1 mark for identifying trial 4 / 29.4 cm as anomalous and excluding it Mean of all five (19.6 cm) = 0 marks		2		2	1	1
	(c)			187 (ms) (2) Award 1 mark for $\sqrt{(2 \times 0.171 \div 9.81)}$ / 0.187 s Allow ecf from (b)		2		2	2	
	(d)			Catching the ruler is a voluntary response that involves the brain / conscious decision (1) The pathway is longer and has more synapses, which each slow transmission; a reflex arc passes through the spinal cord with few synapses (1)		2		2		
	(e)			Any two (×1) from: • Start with the zero of the rule level with the top of the hand / fingers each time (1) • Use the same hand / same distance between the fingers each time (1) • Vary the time before dropping so the drop cannot be predicted (1) • Carry out practice trials first / avoid distractions (1)			2	2		2
				Question 1 total	1	8	2	11	3	3

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
2	(a)			A white matter; B grey matter / dorsal horn; C central canal All three correct = 2 marks Two correct = 1 mark	2			2		1
	(b)			Region A contains mainly myelinated axons running up and down the cord (1) Region B contains cell bodies (and synapses / non-myelinated fibres); myelin is fatty / lipid, so A stains differently / looks white in fresh tissue (1)		2		2		
	(c)			M in either ventral horn of the grey matter (lower pink region) (1)		1		1		1
	(d)			× 8 (1)		1		1	1	
	(e)			Dorsal root: sensory neurones; into the cord; cell bodies in the dorsal root ganglion Ventral root: motor neurones; out of the cord; cell bodies in the ventral horn (of grey matter) 1 mark for each correct row	3			3		
				Question 2 total	5	4	0	9	1	2

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
3	(a)			P sensory; Q relay / intermediate / connector; R motor All three correct = 2 marks Two correct = 1 mark	2			2		
	(b)			Dorsal root ganglion, containing the cell bodies of sensory neurones (1) Both needed	1			1		
	(c)			Rapid: only three neurones / two synapses in the pathway (1) Protective: removes the foot quickly, reducing tissue damage (1) Involuntary: coordinated in the spinal cord, without conscious control by the brain (1)	2	1		3		
	(d)			The person would feel the pain but could not lift the foot / no reflex movement (1) Sensory impulses still reach the spinal cord and brain, but motor impulses cannot reach the muscle because the motor axons in the ventral root are cut (1)			2	2		
	(e)			Neurotransmitter / vesicles are only in the presynaptic knob (1) Receptors are only on the postsynaptic membrane (1)	2			2		
				Question 3 total	7	1	2	10	0	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
4	(a)			Central nervous system: Hydra none; mammal brain and spinal cord (1) Myelin sheath: Hydra absent; mammal present on many neurones (1) Direction of impulses: Hydra in all directions; mammal one direction only (1)	3			3		
	(b)			400 (1)		1		1	1	
	(c)			Neurones are non-myelinated / thin, so no saltatory conduction (1) Neurones are short, so impulses must cross many synapses, each causing a delay / impulses spread in all directions rather than a direct route (1)		2		2		
	(d)			Stimuli from any direction can be detected / the animal is radially symmetrical with no front end (1) Impulses spread to the whole body so the whole animal responds, e.g. all tentacles bring prey to the mouth / the body contracts; fast, localised responses are not needed (1)			2	2		
				Question 4 total	3	3	2	8	1	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
5	(a)			P cell body; Q nucleus; R dendron / dendrite / axon All three correct = 2 marks Two correct = 1 mark	2			2		1
	(b)			Cell body with nucleus and several dendrites, labelled (1) Long axon with myelin sheath, labelled (1) Nodes of Ranvier shown as gaps in the sheath, and a Schwann cell (with nucleus), labelled (1) Axon terminals / motor end plates / synaptic knobs at the far end, labelled (1)	4			4		
	(c)			12.5 (ms) (2) Award 1 mark for 1.0 ÷ 80 / 0.0125 s		2		2	2	
	(d)			Any two (×1) from: • ATP for the sodium–potassium pump / active transport to maintain the resting potential (1) • ATP to resynthesise neurotransmitter / acetylcholine (1) • ATP for moving vesicles / exocytosis / protein synthesis (1)			2	2		
				Question 5 total	6	2	2	10	2	1

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
6	(a)			−70 mV (1) Accept −60 to −80 mV; must be negative	1			1		
	(b)			20 (1)		1		1	1	
	(c)			Any four (×1) from: • Protein A / the sodium–potassium pump actively transports 3 Na^+ out for every 2 K^+ in (1) • Using ATP (1) • Protein B / K^+ channels are open, so K^+ diffuse out down their concentration gradient (1) • Protein C / Na^+ channels are closed, so few Na^+ diffuse back in / membrane less permeable to Na^+ (1) • More positive charge outside than inside, so the inside is negative (1) • Large negative ions / proteins stay inside the axon (1)	3	1		4		
	(d)			The resting potential would gradually decrease / become less negative / be lost (1) Na^+ and K^+ continue to diffuse down their gradients but are not pumped back, so the concentration gradients run down (1)			2	2		
				Question 6 total	4	2	2	8	1	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
7	(a)			110 (mV) (1)		1		1	1	
	(b)			0.9 (ms) (1) Accept 0.8 to 1.0		1		1		
	(c)			Threshold is reached / stimulus opens (voltage-gated) sodium ion channels (1) Na^+ diffuse rapidly into the axon (1) Inside becomes positive compared with outside / membrane is depolarised (to +40 mV) (1)	3			3		
	(d)			Y: sodium ion channels close and potassium ion channels open (1) K^+ diffuse out of the axon, so the membrane repolarises (1) Z: potassium channels are slow to close, so too many K^+ leave and the membrane is hyperpolarised / below −70 mV (1)	1	2		3		
	(e)			250 (s^{-1}) (1)		1		1	1	
				Question 7 total	4	5	0	9	2	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
8	(a)			The stretch caused only a small depolarisation (about 10 mV) (1) Threshold was not reached, so not enough Na^+ channels opened / all-or-nothing (1) Reject 'sodium' unqualified		2		2		
	(b)			180 (s^{-1}) (2) Award 1 mark for 9 ÷ 0.050 / 9 action potentials counted in 50 ms		2		2	2	
	(c)			All action potentials are the same size / amplitude (all-or-nothing) (1) Stronger stimuli produce a higher frequency of action potentials (4 in B, 9 in C) (1)		2		2		
	(d)	(i)		8 (%) (1) Allow ecf from (b)		1		1		
		(ii)		Refractory period: after each action potential the Na^+ channels cannot reopen / the membrane cannot be depolarised again for a short time (1) So there is a minimum interval of 2.5 ms between action potentials, however strong the stimulus (1)		1	1	2		
				Question 8 total	0	8	1	9	2	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
9	(a)			Axes correct way round with labels and units: x = axon diameter / μm; y = conduction speed / m s^{-1} (1) Suitable linear scales using more than half of the grid (1) All six points plotted correctly ± half a small square (1) Smooth curve of best fit through or close to all points (1)		2	2	4	4	4
	(b)			Conduction speed increases as diameter increases (1) But the increase is smaller at larger diameters / not proportional, e.g. 10 times the diameter (50 to 500 μm) gives only about 3 times the speed (1)		2		2		
	(c)			17 / 17.1 (1)		1		1	1	
	(d)			Myelin insulates the axon, so ion movement / depolarisation occurs only at the nodes of Ranvier (1) Local currents flow from node to node, so the action potential jumps between nodes / saltatory conduction (1) Less of the membrane has to be depolarised, so the impulse travels further in a given time (1)	2	1		3		
	(e)			Invertebrates / squid cannot make myelin, so a large diameter is the only way to achieve fast conduction for a rapid escape (1)			1	1		
				Question 9 total	2	6	3	11	5	4

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
10	(a)			28 (%) (2) Award 1 mark for (128 − 100) ÷ 100 × 100		2		2	2	
	(b)			Without myelin, saltatory conduction cannot take place / the action potential cannot jump from node to node (1) The whole length of the membrane must be depolarised, which takes longer (1)		2		2		
	(c)			Ions cross the membrane along the whole length of the damaged axon, not just at the nodes (1) So more sodium–potassium pumping / active transport is needed, using more ATP and respiration (1)			2	2		
	(d)			Any two (×1) from: • Blurred / loss of vision (1) • Muscle weakness / loss of coordination / difficulty walking (1) • Numbness / loss of feeling (1) • Slower reactions (1)			2	2		
	(e)			Different neurones / different parts of the brain and spinal cord are damaged in different patients (1)			1	1		
				Question 10 total	0	4	5	9	2	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
11	(a)			A presynaptic membrane; B mitochondrion; C (synaptic) vesicle containing acetylcholine; D synaptic cleft; E receptor protein; F postsynaptic membrane All six correct = 3 marks Four or five correct = 2 marks Two or three correct = 1 mark	3			3		
	(b)			5×10^5 / 5.0×10^5 (2) Award 1 mark for 500 000 not in standard form / 10 000 000 ÷ 20		2		2	2	
	(c)			Aerobic respiration produces ATP (1) ATP is used to resynthesise acetylcholine from choline and ethanoic acid / to fill vesicles / for exocytosis (1)		2		2		
	(d)			Acetylcholine / vesicles are released faster than acetylcholine can be resynthesised (1) So the supply of neurotransmitter runs out and not enough binds to reach threshold / synaptic fatigue (1)			2	2		
				Question 11 total	3	4	2	9	2	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
12	(a)			Order: R, Q, S, P, T, U All correct = 2 marks One pair of adjacent letters reversed = 1 mark	2			2		
	(b)			Removes acetylcholine from the receptors so the sodium channels close / the postsynaptic membrane repolarises (1) Otherwise the membrane stays depolarised / continuous stimulation, and separate impulses could not be passed (1)	1	1		2		
	(c)	(i)		−55 mV (1)		1		1		
		(ii)		Too little acetylcholine released / too few Na^+ channels opened, so the depolarisation (to about −62 mV) did not reach threshold (1)		1		1		
		(iii)		Temporal summation at B (1) Spatial summation at C + D (1) In both, the acetylcholine released adds together / the depolarisations add up, so threshold is reached (1)	1	1	1	3		
				Question 12 total	4	4	1	9	0	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
13	(a)			Acetylcholinesterase is inhibited, so acetylcholine is not hydrolysed / broken down (1) Acetylcholine stays in the cleft and keeps binding to receptors (1) The postsynaptic membrane stays depolarised / continuous action potentials, causing muscle spasms / paralysis (1)	3			3		
	(b)			28 (%) (1)		1		1	1	
	(c)			Most organophosphate entered through the skin (of the hands) (1) Wearing gloves reduced the fall in activity from 28 % to 6 %; organophosphates are lipid soluble so cross skin cells (1) Accept some still entered by breathing / other skin areas, as activity still fell with gloves			2	2		
	(d)			New acetylcholinesterase was synthesised / the organophosphate was broken down or excreted (1)			1	1		
	(e)			Atropine blocks the receptors, so acetylcholine cannot bind (1) Fewer Na^+ channels open, so the postsynaptic membrane is not continuously depolarised / over-stimulated (1)		2		2		
				Question 13 total	3	3	3	9	1	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
14	(a)			With cocaine, the peak concentration is higher (about 130 au compared with 100 au) (1) With cocaine, the concentration falls much more slowly / is still 20 au at 800 ms, whereas without cocaine it is almost 0 by 400 ms (1)		2		2		
	(b)			6 (2) Award 1 mark for readings of 480 ms and 80 ms Accept 5.5 to 6.5 from readings		2		2	2	
	(c)			Dopamine cannot be taken back into the presynaptic neurone because the transporter proteins are blocked (1) So dopamine stays in the cleft for longer at a higher concentration (1) It keeps binding to receptors, so the postsynaptic neurone is stimulated more / for longer / more action potentials (1)		3		3		
	(d)			With fewer receptors, less dopamine can bind / fewer channels open (1) So a higher dopamine concentration is needed to reach threshold / produce the same stimulation (tolerance) (1)			2	2		
				Question 14 total	0	7	2	9	2	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
15				**Indicative content**	3	3	3	9		
				A Action potential and conduction A1 Resting potential about −70 mV maintained by the sodium–potassium pump and K^+ diffusing out A2 Stimulus opens voltage-gated Na^+ channels; Na^+ diffuse in and the membrane depolarises A3 If threshold is reached a full action potential (about +40 mV) is produced / all-or-nothing A4 Na^+ channels close, K^+ channels open and K^+ diffuse out, repolarising the membrane A5 Local currents depolarise the next region; the refractory period makes the impulse travel one way A6 Myelin insulates, so depolarisation happens only at nodes of Ranvier / saltatory conduction, which is faster						
				B Transmission at the neuromuscular junction B1 Action potential arrives at the axon terminal and opens calcium ion channels; Ca^{2+} diffuse in B2 Vesicles move to and fuse with the presynaptic membrane, releasing acetylcholine by exocytosis B3 Acetylcholine diffuses across the cleft and binds to receptors on the muscle membrane B4 Na^+ channels open and the muscle membrane is depolarised, causing contraction B5 Acetylcholinesterase hydrolyses acetylcholine so the membrane repolarises						

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
				C Effect of the toxin using Graph 15.1 C1 Force falls from 100 % to about 25 % within 2 weeks and about 20 % at 4 weeks C2 Vesicles cannot fuse, so little acetylcholine is released / threshold not reached in muscle fibres C3 Fewer muscle fibres are stimulated, so the muscle is weakened / spasms stop C4 Force stays low until about 6 weeks, then rises to about 85 % by 16 weeks and 95 % by 24 weeks C5 Recovery is because new axon terminals grow, which are not affected by the toxin, so acetylcholine release returns C6 Treatment must be repeated every few months for a lasting effect						
				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	3	3	3	9	0	0

UNIT 3: ENERGY, HOMEOSTASIS AND THE ENVIRONMENT, TOPIC 3.8

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	TOTAL MARK	MATHS	PRAC
1	1	8	2	11	3	3
2	5	4	0	9	1	2
3	7	1	2	10	0	0
4	3	3	2	8	1	0
5	6	2	2	10	2	1
6	4	2	2	8	1	0
7	4	5	0	9	2	0
8	0	8	1	9	2	0
9	2	6	3	11	5	4
10	0	4	5	9	2	0
11	3	4	2	9	2	0
12	4	4	1	9	0	0
13	3	3	3	9	1	0
14	0	7	2	9	2	0
15	3	3	3	9	0	0
TOTAL	**45**	**64**	**30**	**139**	**24**	**10**