

BIOWELSH WORKSHEET FOR WJEC GCE A LEVEL BIOLOGY
UNIT 3 – ENERGY, HOMEOSTASIS AND THE ENVIRONMENT
TOPIC 3.5 POPULATIONS AND ECOSYSTEMS: WORKSHEET 1 (BW-A2-3.5-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 147.

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)			All the organisms of one species in one area / habitat at one time (1) Reject 'group of organisms' without 'one species'	1			1		
	(b)			2019: 31 (1) 2020: 37 (1) Allow ecf for 2020 from an incorrect 2019 value		2		2	2	
	(c)			54.2 (%) (2) Award 1 mark for $(37 - 24) \div 24 \times 100$ Allow ecf from (b)		2		2	2	
	(d)			Population is very small, so few births (1) Immigrants add new individuals / breeding adults (and genetic variation) (1)			2	2		
	(e)			Reaches carrying capacity (1) Limited by number of territories / food (fish) / breeding sites, so births + immigration = deaths + emigration (1)		1	1	2		
				Question 1 total	1	5	3	9	4	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
2	(a)			Slow growth at first, then rapid / exponential growth from about day 2 to day 7 (1) Levels off / stationary at about 400 cells per cm ³ from about day 10 (1)		2		2		
	(b)			250 cells per cm ³ (1) Accept 245 to 255		1		1		
	(c)			Intraspecific competition for food / bacteria (1) So birth rate falls to equal death rate / waste products build up (1)		2		2		
	(d)	(i)		Rises to about 120 cells per cm ³ by day 6, then falls to below 20 by day 20 (1) Interspecific competition for the same food (1) <i>P. aurelia</i> grows faster / obtains food more efficiently, so <i>P. caudatum</i> is outcompeted (competitive exclusion) (1)		2	1	3		
		(ii)		20 (%) (2) Award 1 mark for $(400 - 320) \div 400$ Accept 18 to 22 from readings		2		2	2	
	(e)			Its effect increases as population density increases / more individuals share the same resources (1)	1			1		
				Question 2 total	1	9	1	11	2	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
3	(a)			Axes correct way round with labels and units: x = breeding density / pairs per km ² ; y = mortality / % (1) Suitable linear scales using more than half of the grid (1) All points plotted correctly $\pm$ half a small square (1) Two ruled lines of best fit, each labelled (mild / severe) (1)		2	2	4	4	4
	(b)			Mortality increases as density increases / positive correlation (1) Use of data: from 18 % at 10 pairs to 52 % at 60 pairs / about 7 % for each extra 10 pairs per km ² (1)		2		2		
	(c)			Mild: density dependent because the proportion dying rises with density (1) Severe: density independent because the same proportion (about 70 %) dies at all densities (1) Suitable causes, e.g. mild: competition for food / roosting sites; severe: cold / frost / snow cover (1)		1	2	3		
	(d)			Survivors have less competition / more food and territories, so a high birth rate / low death rate (1)			1	1		
				Question 3 total	0	5	5	10	4	4

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
4	(a)			29 (%) (1) Accept 28 to 30		1		1	1	1
	(b)			Lay out two tapes at right angles to form axes / grid across the area (1) Use random numbers (from a table / generator / calculator) as coordinates (1) Place the quadrat at each coordinate; this avoids bias (1)	2		1	3		3
	(c)			8 to 10 quadrats (1) Running mean levels off / changes very little after this, so more quadrats would not change the estimate (1)			2	2		2
	(d)	(i)		The mean $\pm$ one standard deviation ranges do not overlap (25 to 37 and 4 to 14) (1) So the difference is likely to be significant / not due to chance (1)		1	1	2	1	1
		(ii)		Tall grasses in the unmown area shade the low-growing clover (1) Less interspecific competition for light in the mown area (1)			2	2		
				Question 4 total	2	2	6	10	2	7

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
5	(a)			There is an environmental gradient / a change in conditions (light) across the area (1) A transect shows how the distribution changes along the gradient; random sampling might miss parts of it (1)		2		2		2
	(b)			A tape is laid out along the gradient (from woodland into meadow) (1) Quadrats placed at regular intervals (every 5 m) along the tape and percentage cover recorded (1)	2			2		2
	(c)			Bluebells most abundant / 60 % cover where light is lowest (8 %) in the woodland (1) Cover decreases as light intensity increases and they are absent above 75 % / beyond 25 m (1)		2		2		
	(d)			Grasses cover most of the ground / grow taller and shade bluebells (1) Interspecific competition for light / space / water / mineral ions (1)			2	2		
	(e)			Habitat: the place where an organism lives, e.g. the woodland floor for bluebells (1) Community: all the populations of different species living in one area at one time, e.g. bluebells, bramble and trees in the wood (1)	2			2		
	(f)			Secondary succession (1) Grasses replaced by shrubs such as bramble, then trees, forming woodland (climax community) (1)		1	1	2		
				Question 5 total	4	5	3	12	0	4

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
6	(a)			240 (2) Award 1 mark for $(48 \times 60) \div 12$		2		2	2	1
	(b)			Any two ($\times 1$) from: - Marked beetles mix randomly with the population (1) - Marks are not lost / do not affect survival or behaviour (1) - No births, deaths, immigration or emigration between samples (1) - Marked and unmarked beetles are equally likely to be caught (1)	2			2		
	(c)			So beetles are not more visible to predators, which would reduce their survival and affect the estimate (1)		1		1		1
	(d)			Beetles must be released alive / not drowned; leaves give shelter and reduce predation of beetles in the trap (1)			1	1		1
	(e)			Any two ($\times 1$) from: - Births exceeded deaths (1) - Immigration from nearby habitats (1) - More food / fewer predators / milder conditions (1) - Sampling error / estimate uncertainty (1)			2	2		
				Question 6 total	2	3	3	8	2	3

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
7	(a)			A community of organisms (1) Interacting with each other and with the non-living / abiotic environment (1)	2			2		
	(b)			Named large ecosystem, e.g. an ocean / a tropical rainforest / a lake / the biosphere (1)	1			1		
	(c)			The Sun / sunlight (1) Producers (seaweed / algae) convert light energy into chemical energy by photosynthesis (1)	1	1		2		
	(d)			Herring gull (1) Secondary consumer (level 3, eating limpets) and tertiary consumer (level 4, eating crabs / blennies) (1)		2		2		
	(e)			Bacteria act as producers (1) Using chemical energy from substances such as hydrogen sulfide to make organic molecules (chemosynthesis) (1)			2	2		
				Question 7 total	4	3	2	9	0	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
8	(a)			12 000 (kJ m ⁻² year ⁻¹) (1)		1		1	1	
	(b)			GPP is the rate at which producers convert light energy into chemical energy / total energy fixed (1) NPP is what remains after the producers' respiration (NPP = GPP – R) and is available to the next trophic level (1)	2			2		
	(c)			1.5 (%) (1)		1		1	1	
	(d)			10 (%) (2) Award 1 mark for $1200 \div 12\,000 \times 100$ Allow ecf from (a)		2		2	2	
	(e)			Most energy (850 kJ / about 71 %) is lost as heat in respiration (1) Some energy is lost in faeces / undigested material (190 kJ) (1) Not all primary consumers are eaten / some parts are not eaten, and pass to decomposers (1)		3		3		
	(f)			Energy decreases at each level (about 90 % lost) (1) Too little energy remains to support a population at a higher level (1)			2	2		
				Question 8 total	2	7	2	11	4	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
9	(a)			Water content varies (between organisms / over time), so dry mass is a fair / reliable comparison (1)	1			1		1
	(b)			2.5 (%) (1)		1		1	1	
	(c)			Phytoplankton reproduce / divide very rapidly / have a high rate of production (1) They are eaten as fast as they are produced (1) The pyramid shows biomass at one moment, not production over time (1)		1	2	3		
	(d)			Producer biomass would be larger than zooplankton / pyramid upright, because of the spring bloom of phytoplankton (1)			1	1		
	(e)			Energy is lost (as heat / in respiration) at each transfer (1) So each trophic level must have less energy (per year) than the one it feeds on (1)		2		2		
				Question 9 total	1	4	3	8	1	1

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
10	(a)			Primary succession (1) Starts on bare rock with no soil (1)	1	1		2		
	(b)			Pioneer species that can survive with no soil / harsh conditions (1) Weather / break down rock (1) When they die, decomposers add organic matter / humus / nutrients, forming soil that retains water (1)	2	1		3		
	(c)			Soil depth increases throughout, from 0 to 25 cm (1) Species number rises to a maximum of 36 at 100 years then falls to 28 (1)		2		2		
	(d)			Tall trees shade the ground (1) Outcompete smaller plants for light, so some species are lost (1)			2	2		
	(e)			Sere: each stage / community in the sequence of succession (1) Climax community: the final, stable community / in equilibrium with the environment (1)	2			2		
				Question 10 total	5	4	2	11	0	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
11	(a)			7 / 7.0 (% per month) (2) Award 1 mark for $(100 - 58) \div 6 / 42 \div 6$		2		2	2	
	(b)			Detritivores / earthworms can enter the 5 mm bags and eat / break up the leaves (1) Increasing the surface area for bacteria and fungi to digest, so decomposition is faster (1)		2		2		
	(c)			Bacteria and fungi secrete enzymes onto dead material / extracellular digestion (1) Absorb the products and respire, releasing carbon dioxide (1) Mineral ions / ammonium / nitrogen / nutrients are released and recycled for plant uptake (1)	3			3		
	(d)			Water content varies with weather / soil moisture, so only dry mass shows the loss of organic material (1)			1	1		1
	(e)			Faster decomposition / respiration of decomposers at higher temperature (1) Releases more carbon dioxide, increasing warming further / positive feedback (1)			2	2		
				Question 11 total	3	4	3	10	2	1

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
12	(a)			2.4 (ppm year ⁻¹) (2) Award 1 mark for $(421.1 - 411.4) \div 4 \div 9.7 \div 4$ Accept 2.43		2		2	2	
	(b)			Summer in the northern hemisphere / more light and warmth, so plants photosynthesise more (1) Rate of photosynthesis exceeds rate of respiration, so more carbon dioxide is removed than released (1)		2		2		
	(c)			Burning / combustion of fossil fuels (1) Deforestation / burning forests, so less carbon dioxide removed by photosynthesis (1)	2			2		
	(d)	(i)		28 (m per decade) (1)		1		1	1	
		(ii)		Rising temperatures make lower altitudes unsuitable / species adapted to cold (1) Distribution moves upslope to cooler conditions (1) Less area near the summit / nowhere higher to go / competition from lowland species moving up, so population may fall to extinction (1)		1	2	3		
				Question 12 total	2	6	2	10	3	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
13	(a)			Root nodule (1) <i>Rhizobium</i> (1)	2			2		
	(b)			1 nitrogen fixation, 2 ammonification / putrefaction, 5 denitrification All three correct = 2 marks Two correct = 1 mark	2			2		
	(c)			3 <i>Nitrosomonas</i> and 4 <i>Nitrobacter</i> (1) Both needed Reject nitrifying bacteria without the genus names	1			1		
	(d)			To make amino acids / proteins (1) And nucleotides / nucleic acids / DNA / RNA (also ATP, chlorophyll) (1)	2			2		
	(e)			Ploughing and drainage let air into the soil / create aerobic conditions (1) Nitrifying bacteria are aerobic, so nitrification increases (1) Denitrifying bacteria are anaerobic, so less nitrate is converted to nitrogen gas (1)		3		3		
				Question 13 total	7	3	0	10	0	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
14	(a)			0 to 50: 0.04 (t per kg) (1) 200 to 250: 0.002 (t per kg) (1)		2		2	2	
	(b)			150 kg N ha ⁻¹ (allow 150 to 200) (1) From 150 to 200 the extra yield (0.3 t = £60) only equals the extra cost (50 kg = £60); beyond 200 the cost is greater than the value of extra yield (£20) (1)			2	2	1	
	(c)			The crop cannot take up all the nitrate / more is applied than the crop needs (1) Nitrate is very soluble, so the excess is washed out of the soil by rain (1)		2		2		
	(d)			Eutrophication / algal bloom (1) Nitrate (and phosphate) leached / run off into the pond, allowing rapid growth of algae (1)	1	1		2		
	(e)			Loss / destruction of wetland habitats for species adapted to wet conditions, e.g. wading birds / wetland plants (1)			1	1		
				Question 14 total	1	5	3	9	3	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
15				Indicative content	4	3	2	9		
				A Sources of nitrate A1 Fertiliser applied in excess of crop needs, especially in spring A2 Nitrate is soluble and is leached / washed off fields by rain A3 Ploughing and drainage make the soil aerobic, increasing nitrification by <i>Nitrosomonas</i> and <i>Nitrobacter</i> A4 Aerobic soil reduces denitrification, so more nitrate remains in the soil A5 Drainage ditches carry water, and the nitrate dissolved in it, quickly into the lake A6 Drainage removes wetlands that would otherwise take up nitrate / destroys habitats						
				B Eutrophication B1 Nitrate is a limiting nutrient for algae; extra nitrate allows rapid growth / algal bloom B2 Algae shade plants below, which die B3 Algae also die in large numbers B4 Decomposers / aerobic bacteria break down the dead organic matter and increase in number B5 Their respiration uses up dissolved oxygen (high biological oxygen demand) B6 Fish die from lack of oxygen, not from the nitrate itself						

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
				C Using Graphs 15.1A and 15.1B C1 Nitrate high in winter and early spring (about 11 mg dm ⁻³ in March) from run-off and leaching C2 Algae increase from April to a peak of about 50 thousand cells per cm ³ in June C3 Nitrate falls to about 2 mg dm ⁻³ by July as algae take it up C4 Dissolved oxygen falls from about 12 to 2.5 mg dm ⁻³ in July, after the algal peak, as algae die and decompose C5 Fish die in July when oxygen is lowest C6 From August, algae decline, oxygen recovers and nitrate rises again in autumn and winter						
				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 3.5
SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	TOTAL MARK	MATHS	PRAC
1	1	5	3	9	4	0
2	1	9	1	11	2	0
3	0	5	5	10	4	4
4	2	2	6	10	2	7
5	4	5	3	12	0	4
6	2	3	3	8	2	3
7	4	3	2	9	0	0
8	2	7	2	11	4	0
9	1	4	3	8	1	1
10	5	4	2	11	0	0
11	3	4	3	10	2	1
12	2	6	2	10	3	0
13	7	3	0	10	0	0
14	1	5	3	9	3	0
15	4	3	2	9	0	0
TOTAL	39	68	40	147	27	20



A Tutor Meets Tutee project

BioWelsh mark scheme BW-A2-3.5-W1 (MS). Not an official WJEC mark scheme.

