

BIOWELSH WORKSHEET FOR WJEC GCE A LEVEL BIOLOGY
UNIT 3 – ENERGY, HOMEOSTASIS AND THE ENVIRONMENT
TOPIC 3.7 HOMEOSTASIS AND THE KIDNEY: WORKSHEET 1 (BW-A2-3.7-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 148.

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)			Maintaining a (relatively) constant internal environment (1) Within narrow limits / around a set point, despite changes in the external environment / dynamic equilibrium (1)	2			2		
	(b)			0.4 (°C) (1) Accept 0.38 to 0.42		1		1		
	(c)			X: receptor / detector / thermoreceptors (1) Y: effector, e.g. skeletal muscles (shivering) / arterioles in the skin / hair erector muscles (1)	2			2		
	(d)			Fall in temperature below the set point detected by receptors / the hypothalamus (1) Effectors bring about a corrective response that raises temperature, e.g. shivering / vasoconstriction, so temperature rises from about 23 minutes even though the volunteer is still in the cold room (1) As temperature returns towards the set point the stimulus decreases, so the corrective response is reduced / switched off (1)		3		3		
	(e)			Time delay / lag in the feedback loop, so effectors / heat-producing responses were still active when the set point was reached (1) Overshoot is detected and corrected by the opposite response, bringing temperature back to 37 °C (1)			2	2		
				Question 1 total	4	4	2	10	0	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
2	(a)			Posterior pituitary (gland) (1) Reject anterior pituitary	1			1		
	(b)			The response increases / enhances the size of the original stimulus (1) Stronger contractions press the head harder on the cervix, causing more stretch and so more oxytocin release (1)		2		2		
	(c)			Increases slowly at first then increasingly rapidly, to a peak at birth / 6.5 hours (1) Falls rapidly after birth to about the starting concentration by 7.5 to 8 hours (1)		2		2		
	(d)			The baby no longer presses on the cervix, so the stretch receptors are no longer stimulated (1) The positive feedback loop is broken, so no more oxytocin is released and the oxytocin in the blood is broken down / removed (1)			2	2		
	(e)			Negative feedback reverses a change, restoring conditions to the set point / keeping them within narrow limits (1) Positive feedback would increase the change / move conditions further from the set point, so conditions would not be stable (1)	2			2		
				Question 2 total	3	4	2	9	0	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
3	(a)			Liver (1) Deamination (removal of the amino group) (1)	2			2		
	(b)			Ammonia is the main product at first (80 % on day 1) and falls to about 2 % (1) Urea rises to a peak of about 50 % at day 7 then falls, while uric acid rises to become the main product from about day 8 / over 90 % from day 17 (1)		2		2		
	(c)			Uric acid is insoluble / not toxic, so it can be stored inside the egg without harming the embryo (1) Very little water is needed to excrete it, which conserves the limited water in the egg (1)		2		2		
	(d)			The embryo is very small, so it produces very little nitrogenous waste (1) Ammonia is very soluble and is diluted in the large volume of water in the egg, so it does not reach a toxic concentration (1)			2	2		
	(e)			Fish are surrounded by water, so ammonia diffuses across the gills and is diluted immediately; birds must conserve water (1)			1	1		
				Question 3 total	2	4	3	9	0	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
4	(a)			A cortex; B medulla / renal pyramid; C (renal) pelvis All three correct = 2 marks Two correct = 1 mark	2			2		1
	(b)			Kidney held flat on a dissecting board and cut with a scalpel / sharp blade (1) Cut lengthways / longitudinally round the outer (convex) edge towards the hilum / ureter, through the whole kidney into two halves (1) Safety: cut away from the fingers / onto the board / wear gloves / disinfect equipment and wash hands after handling raw tissue (1)	2	1		3		3
	(c)			Loops of Henle and collecting ducts (and capillaries / vasa recta) (1) Run in parallel (radially) through the medulla towards the pelvis (1)		2		2		
	(d)			The cortex contains the glomeruli / many capillaries, so it contains more blood (1)			1	1		
	(e)			Any two (×1) from: • Clear, continuous lines with no shading (1) • Labels with ruled label lines that do not cross (1) • Correct proportions / fills most of the space (1) • A title and a statement of the plane of section / magnification or scale (1)			2	2		2
				Question 4 total	4	3	3	10	0	6

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
5	(a)			P glomerulus / glomerular capillaries; Q Bowman's space / lumen of the capsule; R (outer wall of) Bowman's capsule All three correct = 2 marks Two correct = 1 mark	2			2		1
	(b)			Cortex (1) It contains a glomerulus / Bowman's capsule, which are found only in the cortex (1)		2		2		1
	(c)			× 400 (2) Award 1 mark for $60\,000 \div 150$ / conversion of 60 mm to 60 000 μm		2		2	2	
	(d)			The tubules are coiled / convoluted, so they are cut at different angles / in different planes (1)		1		1		
	(e)			Proximal tubule has a brush border / fuzzy edge of microvilli, with a narrow irregular lumen (1) Distal tubule has no brush border and a wider, clearer lumen / its cells are smaller and stain less deeply (1) ORA			2	2		2
				Question 5 total	2	5	2	9	2	4

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
6	(a)			A glomerulus; B Bowman's capsule / renal capsule; C proximal convoluted tubule; D descending limb (of loop of Henle); E ascending limb (of loop of Henle); F collecting duct All six correct = 3 marks Four or five correct = 2 marks Two or three correct = 1 mark	3			3		
	(b)			X on the glomerulus / Bowman's capsule / between the glomerulus and the capsule (1)	1			1		
	(c)			The afferent arteriole is wider than the efferent arteriole (1) So a high hydrostatic pressure builds up in the glomerulus, forcing fluid and small molecules out into the capsule (1)		2		2		
	(d)			D, E and F (1) All three needed		1		1		
	(e)			Any two (×1) from: - The whole blood volume must be filtered many times each day to remove urea / regulate water (1) - A high rate of flow keeps the hydrostatic pressure high for ultrafiltration (1) - Tubule cells need a lot of oxygen for respiration to make ATP for active transport / reabsorption (1) - Reabsorbed substances must be carried away quickly to maintain diffusion gradients (1)			2	2		
				Question 6 total	4	3	2	9	0	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
7	(a)			P endothelium (of capillary, with pores / fenestrae); Q basement membrane; R podocytes / foot processes (with filtration slits) All three correct = 2 marks Two correct = 1 mark	2			2		
	(b)			Glucose is a small molecule, so it passes through all three layers and has the same concentration in the filtrate (1) Plasma proteins are too large to pass through the basement membrane / filtration slits, so they stay in the blood (1)		2		2		
	(c)	(i)		1.7 (kPa) (1)		1		1	1	
		(ii)		-0.1 (kPa) (2) Award 1 mark for new $P_G = 5.4 \text{ (kPa)} / 7.2 \times 0.75$		2		2	2	
		(iii)		The net pressure is below zero / too low, so no filtrate is formed / ultrafiltration stops (1) Little or no urine is produced, so blood volume is conserved but urea builds up in the blood (1) Allow ecf from (ii)		1	1	2		
	(d)			180 (dm ³) (1)		1		1	1	
				Question 7 total	2	7	1	10	4	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
8	(a)			Sodium ions are actively transported out of the tubule cells into the blood / tissue fluid (by a sodium–potassium pump), lowering the sodium ion concentration in the cell (1) Sodium ions diffuse into the cell from the filtrate through a co-transporter protein that carries glucose with them / co-transport (1) Glucose moves out of the cell into the blood by facilitated diffusion (1)	3			3		
	(b)			The rate of reabsorption reaches a maximum of $2.0 \text{ mmol minute}^{-1}$ because all the co-transporter / carrier proteins are working at their maximum rate / are saturated (1) More glucose is filtered than can be reabsorbed, so the excess stays in the filtrate / urine (1)		2		2		
	(c)			66.7 (%) (2) Award 1 mark for $2.0 \div 3.0 \times 100$ Accept 66.0 to 67.0 from readings		2		2	2	
	(d)			Less glucose is reabsorbed from the filtrate (1) More glucose is excreted in the urine / removed from the body (1)			2	2		
	(e)			Glucose remaining in the filtrate lowers its water potential (1) So less water leaves the filtrate by osmosis / is reabsorbed, and more water stays in the urine (1)			2	2		
				Question 8 total	3	4	4	11	2	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
9	(a)			A microvilli / brush border; B tight junction; C mitochondrion; D basal infoldings / basal channels All four correct = 2 marks Two or three correct = 1 mark	2			2		
	(b)			A: microvilli give a large surface area (1) For many carrier / co-transporter proteins / faster diffusion and transport (1) C: many mitochondria make ATP (by aerobic respiration) for active transport of sodium ions (1)	2	1		3		
	(c)	(i)		117 (dm ³) (1)		1		1	1	
		(ii)		Water is reabsorbed, so the concentration of urea in the filtrate rises above that in the blood (1) Urea diffuses (down its concentration gradient) through the cells / membranes into the blood (1)		2		2		
	(d)			They stop reabsorbed substances leaking back between the cells into the filtrate / make all transport pass through the cells (1)			1	1		
				Question 9 total	4	4	1	9	1	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
10	(a)			Increases from 300 to 1200 mOsm kg ⁻¹ (1) The descending limb is permeable to water (1) Water leaves by osmosis into the tissue fluid of the medulla, which has a lower water potential / higher solute concentration (1) Accept sodium ions diffuse in from the medulla		3		3		
	(b)			Sodium (and chloride) ions leave the ascending limb, actively transported out in the thick part / diffusing out at the bottom (1) The ascending limb is impermeable to water (1) So solutes are removed without water and the filtrate becomes more dilute (1)	1	2		3		
	(c)			Ions pumped out of the ascending limb build up a high solute concentration / low water potential in the tissue fluid of the medulla, increasing deeper into the medulla (1) The collecting duct passes through the medulla, so water leaves it by osmosis (1)	1	1		2		
	(d)			Lower / stays at about 100 mOsm kg ⁻¹ (1) Less ADH is released, so the distal convoluted tubule is less permeable to water and less water is reabsorbed from it (1)			2	2		
				Question 10 total	2	6	2	10	0	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
11	(a)			P hypothalamus (1) Q posterior pituitary (gland) (1) Reject anterior pituitary	2			2		
	(b)			Below 280 mOsm kg ⁻¹ ADH concentration is low and changes very little (1) Above 280 mOsm kg ⁻¹ ADH increases steadily / in proportion, to 10 pg cm ⁻³ at 304 mOsm kg ⁻¹ (1)		2		2		
	(c)			Any four (×1) from: - ADH binds to (specific) receptors on the membrane of the collecting duct / distal tubule cells (1) - Activates an enzyme / cyclic AMP (second messenger) inside the cell (1) - Vesicles containing aquaporins move to and fuse with the membrane facing the lumen (1) - The membrane becomes more permeable to water (1) - Water leaves the filtrate by osmosis into the medulla, which has a lower water potential (1) - A small volume of concentrated urine is produced (1)	3	1		4		
	(d)			Reabsorbing more water raises the water potential of the blood back towards the set point (1) So the osmoreceptors are stimulated less and less ADH is released / the corrective response is switched off (1)		1	1	2		
				Question 11 total	5	4	1	10	0	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
12	(a)			Larger volume of urine (720 cm^3 compared with 480 cm^3) (1) Urine is more dilute / lower solute concentration (110 compared with 180 mOsm kg^{-1}) (1)		2		2		
	(b)			50 (%) (2) Award 1 mark for $(720 - 480) \div 480 \times 100$		2		2	2	
	(c)			Less ADH, so fewer aquaporins in the membranes / collecting duct less permeable to water (1) Less water reabsorbed by osmosis, so a larger volume of more dilute urine (1)	1	1		2		
	(d)	(i)		As a control / to show that the increase in urine is caused by the drink (1)			1	1		1
		(ii)		Any one from: time since the last drink or meal / salt intake / body mass / activity / temperature of the room / time of day (1)			1	1		1
	(e)			First type: the receptors are normal, so desmopressin binds to them and aquaporins are inserted / water reabsorption is restored (1) Faulty receptor: its shape is not complementary, so desmopressin / ADH cannot bind and no aquaporins are inserted, however much is given (1)		1	1	2		
				Question 12 total	1	6	3	10	2	2

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
13	(a)	(i)		Dialyser / artificial kidney (1)	1			1		
		(ii)		Any two (×1) from: - Urea / toxic waste builds up in the blood (1) - Excess water is retained, causing oedema / high blood pressure (1) - Ion concentrations (e.g. potassium) are not controlled, affecting the heart / nerves (1) - Water potential of the blood is not regulated (1)	2			2		
	(b)			Glucose (reducing sugar) is a small molecule that diffuses through the pores of the partially permeable tubing, down its concentration gradient (1) Starch and protein molecules are too large to pass through the pores (1)		2		2		1
	(c)	(i)		2.75 / 2.8 (1)		1		1	1	1
		(ii)		Any two (×1) from: - Temperature (1) - Starting concentration / volume of glucose solution in the tubing (1) - Length / surface area of the tubing (1) - Volume of water (1) - Time (1)			2	2		2
		(iii)		Replacing the water kept its glucose concentration low, so a steep concentration gradient was maintained and more glucose diffused out (1) Countercurrent flow keeps a concentration gradient for urea along the whole length of the dialyser, so more urea diffuses out of the blood (1)		1	1	2		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(d)			No concentration gradient for glucose, so there is no net loss of glucose from the blood (1) No urea in the fluid gives a steep concentration gradient, so urea diffuses out of the blood (1)		2		2		
				Question 13 total	3	6	3	12	1	4

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
14	(a)			Axes correct way round with labels and units: x = relative medullary thickness; y = maximum solute concentration of urine / mOsm kg⁻¹ (1) Suitable linear scales using more than half of the grid (1) All six points plotted correctly $\pm$ half a small square (1) Single straight line of best fit through the trend of the points (1)		2	2	4	4	4
	(b)			Positive correlation: the thicker the medulla, the more concentrated the urine (1) Use of data, e.g. beaver 1.3 and 520 mOsm kg⁻¹ compared with kangaroo rat 8.5 and 5500 mOsm kg⁻¹ / camel does not fit the trend exactly (1)		2		2		
	(c)			More sodium / chloride ions are pumped out of the longer ascending limb (1) Giving a higher solute concentration / lower water potential in the tissue fluid deep in the medulla (1) So more water leaves the collecting duct by osmosis (1)	1	2		3		
	(d)			Any two ($\times 1$) from: - Active at night / stays in a cool, humid burrow during the day, so less evaporation (1) - Produces very dry faeces (1) - Few or no sweat glands / does not sweat (1) - Excretes very concentrated urine / small volume of urine (1) Ignore gaining metabolic water (not a way of reducing loss)			2	2		
				Question 14 total	1	6	4	11	4	4

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
15				Indicative content	3	3	3	9		
				A Effects of kidney failure A1 Less / no ultrafiltration, so urea (and other toxic wastes) are not excreted and build up in the blood A2 Water is not excreted, so fluid builds up / oedema / high blood pressure A3 Ions such as potassium are not regulated; high potassium affects the heart / nerve impulses A4 The water potential of the blood is not controlled, so water may enter cells by osmosis and cause them to burst / lyse A5 Homeostasis fails: the internal environment is no longer kept within narrow limits						
				B Haemodialysis B1 Blood passes through a dialyser, separated from dialysis fluid by a partially permeable membrane B2 Dialysis fluid has no urea, so urea diffuses out of the blood down its concentration gradient B3 Glucose and ions are at normal plasma concentrations, so there is no net loss of glucose and ion levels are corrected B4 Countercurrent flow maintains the concentration gradient along the whole dialyser B5 Excess water is removed by pressure / ultrafiltration across the membrane B6 Blood cells and plasma proteins are too large to cross the membrane and stay in the blood						

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
				C Comparison using Graphs 15.1A and 15.1B C1 With dialysis, urea falls from about 22 to 28 mmol dm ⁻³ to about 9 mmol dm ⁻³ in each session, then rises by about 7 mmol dm ⁻³ per day C2 Urea is always above the normal range and is highest (about 28 mmol dm ⁻³) after the two-day gap at the weekend C3 After the transplant, urea falls to about 6 mmol dm ⁻³ within about 6 days and stays steady, within the normal range C4 A transplant works continuously and restores homeostasis; dialysis only removes waste intermittently C5 Dialysis takes several hours three times a week and needs diet and fluid restrictions C6 Transplant problems: shortage of donors; risk of rejection, so tissue matching and lifelong immunosuppressant drugs, which increase the risk of infection						
				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	3	3	3	9	0	0

UNIT 3: ENERGY, HOMEOSTASIS AND THE ENVIRONMENT, TOPIC 3.7
SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	TOTAL MARK	MATHS	PRAC
1	4	4	2	10	0	0
2	3	4	2	9	0	0
3	2	4	3	9	0	0
4	4	3	3	10	0	6
5	2	5	2	9	2	4
6	4	3	2	9	0	0
7	2	7	1	10	4	0
8	3	4	4	11	2	0
9	4	4	1	9	1	0
10	2	6	2	10	0	0
11	5	4	1	10	0	0
12	1	6	3	10	2	2
13	3	6	3	12	1	4
14	1	6	4	11	4	4
15	3	3	3	9	0	0
TOTAL	43	69	36	148	16	20



A Tutor Meets Tutee project

BioWelsh mark scheme BW-A2-3.7-W1 (MS). Not an official WJEC mark scheme.

