

Separate Science (Biology) Unit 4 Bioenergetics – mark scheme

Foundation

Question number	Description	Marks	Page number
4.4.1. Photosynthesis			
1	Pondweed rate photosynthesis experiment, naming gas produced by pondweed, describing change to method, describing how to use apparatus to measure rate of photosynthesis, reading a graph, giving factors that affect rate of ps	8	3
2	Rate of ps experiment, recalling products of ps box tick, importance of light source not getting hot, calculating number of bubbles from a results table, plotting results from results table, making a conclusion from results.	10	4
5	Ps word equation, naming pigment for ps, recalling where ps reactants are obtained from, (4.3.3 plant disease recall), calculating how many times larger one cell is than another, explaining why an infected a rose bush with rose black spot will not grow (4.3.3 identifying plant disease from picture)	14	6
4.4.2 Respiration			
1	(4.2.2 heart/blood vessels structure and function recall), effect of exercise on resting heart rate, calculating mean value in results table, calculating total number of heart beats in one day based on 82 beats per minute.	10	8
3	Differences between aerobic and anaerobic rs	3	10
4	Rs in yeast investigation, identifying control variables, predicting a result in results table, writing a conclusion from results table, explaining results, anaerobic rs recall	9	11
4	Comparing breathing rates for different exercises from a graph, explaining why breathing rate for different exercises changes (4.2.2 describing why the heart is a double pump, suggesting reason for thick left ventricle wall)	10	13
6	(4.2.2 heart structure and function), calculation using a given equation and based on results table, explaining how beta blockers cause breath shortness when exercising using data from results table	12	16

Common content

Question number	Description	Marks	Page number
4.4.1. Photosynthesis			
1	(4.2.2 soluble molecules from sweet potato that are absorbed after digestion), ratio based calculation using a results table, explain how starch in sweet potato is produced from carbon dioxide in air.	9	18
3	Rate of ps investigation, ps word equation, suggesting improvements to method, calculating value using results in results table, plotting graph from results table, graph interpolation, identifying rate of ps graph multiple choice	12	20
4.4.2 Respiration			
2	Naming metabolic reaction, conclusions from results table, calculating percentage decrease using equation and results table, describing difference in results table for the heart rate of different people, plotting results on a graph, using results table for calculations, designing investigation to test hypothesis (6 marks)	20	22

Higher

Question number	Description	Marks	Page number
4.4.1. Photosynthesis			
3	Rate of ps investigation, photosynthesis balanced symbol equation, suggesting method improvements to improve rate of ps accuracy, explaining importance of constant temperature, inverse square law calculations to explain how light intensity changes as lamp is moved away, using inverse square law to predict results, describing method to investigate a different independent variable.		25

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	oxygen	name takes precedence allow O ₂ ignore O ² / O / O2	1	AO1 4.4.1.1 4.4.1.2
01.2	(use) a lamp / light (source) (and) move away and / or towards pondweed	allow use different power ratings or use a dimmer switch allow change the opacity of the beaker for 2 marks	1 1	AO1 4.4.1.2
01.3	count the number of bubbles in a given time	allow measure the volume of gas collected allow for 2 marks measure time taken to collect a specific number of bubbles	1 1	AO1 4.4.1.2 AO2/2 4-5 RPA5 WS2.3
01.4	34 (arbitrary units)	allow a value in the range 33.5 – 34.5 (arbitrary units)	1	AO2 4.4.1.2
01.5	200 lumens		1	AO3 4.4.1.2
01.6	any one from: <ul style="list-style-type: none"> • temperature • carbon dioxide (concentration) • amount of chlorophyll 	ignore light (intensity) ignore heat ignore oxygen allow light colour / wavelength allow water ignore pH	1	AO1 4.4.1.2
Total			8	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	glucose	extra ticks negates marks	1	AO1 4.4.1.1
	oxygen		1	
02.2	count the number of bubbles produced in 1 minute	extra ticks negates marks	1	AO3 4.4.1.2
	measure the volume of gas produced in 30 seconds		1	
02.3	any one from: <ul style="list-style-type: none"> • to control the temperature • temperature affects the rate of photosynthesis 	ignore reference to 'it' allow so pondweed / solution did not warm up allow correct description of effect of temperature on rate allow high temperatures denature enzymes ignore references to limiting factors	1	AO3 4.4.1.2
02.4	52		1	AO2 4.4.1.2
02.5	all points plotted correctly	(where a bar chart has been plotted) allow 1 mark for all bars plotted correctly if points are plotted as well as bars, ignore bars allow $\pm \frac{1}{2}$ a square allow 1 mark for three points correctly plotted	2	AO2 4.4.1.2
	smooth curve drawn through all points	ignore extensions of line / curve unless inconsistent with line / curve drawn	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.6	any one from: <ul style="list-style-type: none"> • the nearer the light source to the pondweed the faster the rate of photosynthesis • the greater the light intensity the faster the rate of photosynthesis 	allow converse statements for all marking points allow the nearer the light source to the pondweed the faster the bubbles produced allow the greater the light intensity the faster the bubbles produced allow the closer the light source the more the plant photosynthesises ignore more bubbles are produced with no reference to rate allow oxygen for bubbles do not accept carbon dioxide	1	AO3 4.4.1.2
Total			10	

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	oxygen	word takes precedence allow O ₂ ignore O ² / O2 / O	1	4.2.2.5 AO1
05.2	chlorophyll	allow phonetic spelling ignore chloroplast(s)	1	4.2.2.5 AO1
05.3	air / atmosphere	this order only	1	4.2.2.2 4.2.2.5 AO1
	soil / ground	ignore rain	1	
	sun	allow sunlight / light	1	
05.4	fungus		1	4.2.2.8 AO1
05.5	move the diseased rose bush to a different area		1	4.2.2.8 AO2
	remove the spotty leaves and burn them		1	
05.6	7 / 7.0 / seven (times)	answer line takes precedence	1	4.1.3.2 AO2
05.7	less chlorophyll	allow absolutes throughout, e.g. no chlorophyll allow less chloroplasts allow less green pigment	1	4.2.2.5 AO2
	less photosynthesis	allow cannot absorb as much light	1	AO2
	(so) less glucose / sugar		1	AO2
	(so) less proteins / lipids / cellulose (needed for growth)	allow less respiration so less energy released (for growth)	1	AO2

05.8	TMV or Tobacco Mosaic Virus	ignore tmv allow Tomato Mosaic Virus / ToMV or Cucumber Mosaic Virus / CMV	1	4.2.2.8 AO3
Total			14	

Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	valve(s)	ignore names of valves	1	AO1 4.2.1.3
01.2	arteries		1	AO1 4.2.1.3
01.3	blood in arteries has less carbon dioxide	do not accept if also ticked blood in arteries has more carbon dioxide	1	AO2 4.2.1.3
	blood in arteries has more oxygen	do not accept if also ticked blood in arteries has less oxygen	1	
01.4	resting heart rate would decrease		1	AO2 4.2.1.3
01.5	67		1	AO2 4.2.1.3
01.6	any one from: (the student) <ul style="list-style-type: none"> • was (more) active • was stressed / anxious / nervous • slept less • was ill • drank (more) caffeine 	allow did exercise allow took drugs / alcohol allow warm(er) weather	1	AO3 4.2.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
<p>01.7</p>	<p>82 × 60 or 4920</p>	<p>an answer of 118 080 scores 3 marks</p>	<p>1</p>	<p>AO2 4.2.1.3</p>
	<p>(beats per minute or beats per hour) × 24</p>	<p>allow incorrect value of beats per hour × 24 if working shown</p>	<p>1</p>	
	<p>118 080</p>	<p>if no other mark awarded, allow 24 × 60 for 1 mark</p>	<p>1</p>	
<p>Total</p>			<p>10</p>	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	trachea		1	AO1 4.2.1.3
03.2	any one from: <ul style="list-style-type: none"> • can see more detail in lungs • you can see the bronchus / bronchioles / soft tissues 	ignore gives clearer image ignore bones allow it doesn't use ionising radiation allow X-rays can cause cancer / mutations	1	AO3 4.2.1.3
03.3	you can see the ribs / bones	allow cheaper allow takes less time	1	AO3 4.2.1.3
03.4	any three from: (aerobic) <ul style="list-style-type: none"> • uses / needs / requires oxygen (and anaerobic does not) • transfers more energy (than anaerobic) • produces carbon dioxide / water (anaerobic does not) • does not produce lactic acid (anaerobic does) • does not cause an oxygen debt (anaerobic does) 	allow converse in terms of anaerobic allow releases more energy (than anaerobic) do not accept energy is created / produced / made allow aerobic takes place in mitochondria and anaerobic takes place in cytoplasm	3	AO1 4.2.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	temperature		1	4.4.2.1 AO3
	volume of yeast and water		1	
04.2	28		1	4.4.2.1 AO2
04.3	carbon dioxide		1	4.4.2.1 AO2
04.4	the greater the mass of sugar, the greater the volume of foam / gas produced	allow reference to weight / amount of sugar allow reference to amount of foam / gas allow positive correlation ignore names of gases ignore directly proportional	1	4.4.2.1 AO3
04.5	no respiration occurs or sugar / glucose is needed for respiration	ignore no reaction occurs	1	4.4.2.1 AO2
04.6	for comparison / to compare	allow as a control (experiment) allow as a base line do not accept as a control variable	1	4.4.2.1 AO2
	or to check that no other factor / variable is influencing the results or to ensure validity	allow answers in the context of the investigation e.g. to prove that the results obtained were due to the sugar (and nothing else) ignore fair test / accuracy		
04.7	(it) stops the oxygen / air getting in / through	ignore (it) stops the oxygen / air getting out ignore gases unqualified	1	4.4.2.1 AO2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.8	ethanol		1	4.4.2.1 AO1
Total			9	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	<p>breathing rate when walking is twice that at rest</p> <p>breathing rate when jogging is 5 times that at rest</p> <p>breathing rate when jogging is 2.5 times that when walking</p>	<p>max 2 marks if written in terms of heart rate</p> <p>allow breathing rate when walking is 12 (breaths / minute) more than at rest</p> <p>allow breathing rate when jogging is 48 (breaths / minute) more than at rest</p> <p>allow breathing rate when jogging is 36 (breaths / minute) more than when walking</p> <p>allow for 1 mark if no other marks gained: breathing rate at rest is 12 (breaths per minute), breathing rate when walking is 24 (breaths per minute) and breathing rate when jogging is 60 (breaths per minute)</p> <p>or</p> <p>breathing rate increases with increasing activity</p>	<p>1</p> <p>1</p> <p>1</p>	<p>AO2 4.4.2.2</p>

Question	Answers	Extra information	Mark	AO / Spec. Ref.
<p>04.2</p>	<p>(breathing rate increases)</p> <p>to supply more oxygen / O₂ or to supply oxygen / O₂ faster</p> <p>for (aerobic) respiration or to reduce anaerobic respiration or to reduce lactic acid build up</p> <p>(so) that more energy is transferred / released or (because) more energy is required</p>	<p>reference to more / faster required at least once for full marks</p> <p>allow to remove more carbon dioxide / CO₂ or to remove carbon dioxide / CO₂ faster</p> <p>do not accept incorrectly written formulae</p> <p>do not accept used / produced / created or energy made</p>	<p>1</p> <p>1</p> <p>1</p>	<p>AO1 4.4.2.2</p>
<p>04.3</p>	<p>right ventricle / side of the heart pumps (blood) to the lungs</p> <p>left ventricle / side of the heart pumps (blood) to the body</p>	<p>if no other marks scored allow 1 mark for one side pumps blood to the lungs and the other side pumps blood to the body</p>	<p>1</p> <p>1</p>	<p>AO1 4.2.2.2</p>

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4	any one from: <ul style="list-style-type: none"> • (the left ventricle) has to pump blood further (than the right ventricle) • (the left ventricle) has to pump blood with a greater force (than the right ventricle) • (the left ventricle) has to pump blood at a higher pressure (than the right ventricle) 	there must be a comparative statement allow (the left ventricle) has to pump blood all around the body allow (left ventricle) has to pump blood harder	1	AO2 4.2.2.2
04.5	any one from: <ul style="list-style-type: none"> • strengthens heart (muscle) • reduces chance of another heart attack • reduces / controls weight • improves circulation 	ignore prevents / no heart attacks allow decreases chance of fatty deposits or fat building up (in arteries / blood vessels) allow reduces resting heart rate	1	AO2 4.2.2.2 4.2.2.6
Total			10	

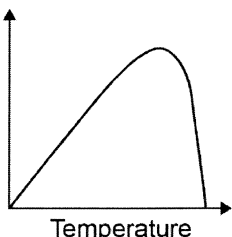
Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	B		1	AO2 4.2.2.2
06.2	right atrium		1	AO1 4.2.2.2
06.3	foxgloves		1	AO1 4.3.1.9
06.4	X = 2800 / 52 53.846153 54 (cm ³)	an answer of 54 (cm ³) scores 3 marks allow correct rounding of an incorrectly calculated value of stroke volume	1 1 1	AO2 4.2.2.2

Question	Answers	Mark	AO / Spec. Ref.
06.5	Level 3: Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.	5–6	AO3 4.2.2.2 4.2.2.4 4.4.2.1 4.4.2.2
	Level 2: Relevant points (reasons / causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.	3–4	AO2 AO1
	Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.	1–2	AO1
	No relevant content	0	
	<p>Indicative content</p> <p>effect of exercise</p> <ul style="list-style-type: none"> • during exercise body needs to transfer (more) energy • energy transferred during respiration • rate of respiration increases during exercise • (so) more oxygen is needed <p>effect of beta blockers</p> <ul style="list-style-type: none"> • beta blockers reduce (the increase in) heart rate (during exercise) • beta blockers reduce stroke volume (or described) • beta blockers reduce cardiac output • (so) heart cannot supply oxygen fast enough / in sufficient quantity to muscle cells <p>effect on breathing rate</p> <ul style="list-style-type: none"> • breathing rate increases to increase rate / amount of oxygen absorbed • breathing rate increases to increase rate / amount of carbon dioxide removed from body • (but) increased breathing rate cannot fully compensate for changes in heart function <p>A level 3 response should make links between all three sections of indicative content</p> <p>A level 2 response should attempt to link effect of exercise with oxygen / energy requirement and beta blockers to effect on heart function.</p>		
Total		12	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	any two from: <ul style="list-style-type: none">• amino acids• glycerol• fatty acids	do not accept fat allow salt / minerals allow vitamins	2	AO1 4.2.1.5
01.2	11.79 (g)	allow 11.8 (g) or 12 (g)	1	AO2 4.2.1.5

Question	Answers	Mark	AO / Spec. Ref
01.3	Level 3: Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.	5–6	AO2
	Level 2: Relevant points (reasons / causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.	3–4	AO1
	Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.	1–2	AO1
	No relevant content	0	
	Indicative content <ul style="list-style-type: none"> • carbon dioxide enters the leaf through stomata • glucose / sugars produced by photosynthesis (in leaves) • some detail of photosynthesis • transport / translocation (of glucose / sugars) • in phloem • glucose is converted to starch • (starch is a) long chain of glucose / sugar molecules • starch as storage (of glucose / sugars) 		4.2.1.5 4.2.2.5 4.2.2.7
Total		9	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	LHS: carbon dioxide and water RHS: glucose	words take precedence over symbols allow correct symbols (ignore balancing) in any order do not accept starch ignore carbohydrates / sugar	1 1	4.4.1.1 AO1
03.2	power output of bulb		1	4.4.1.2 AO2
03.3	any two from: <ul style="list-style-type: none"> • repeat and calculate a mean or repeat and to eliminate anomalies • control the (water) temperature • control the concentration of carbon dioxide • control the distance of the bulb from the pondweed • control the mass / length / species / age of the pondweed • give pondweed time to equilibrate 	ignore do a control experiment unqualified allow a method of controlling (water) temperature allow a method of controlling carbon dioxide concentration allow use the same piece of pondweed allow do experiment with the bulb off / in the dark	2	4.4.1.2 AO3
03.4	3.3 (cm ³ /hour)		1	4.4.1.2 AO2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.5	correct scale and axis labelled	max 3 marks for bar chart	1	4.4.1.2 AO2
	all points plotted correctly	allow points plotted to within $\pm \frac{1}{2}$ small square allow 3 or 4 correct plots for 1 mark allow correct plot from incorrect value calculated in question 03.4	2	
	correct curved line of best fit	ignore line extended beyond 60 / 250 (W) ignore line joined point to point with straight lines	1	
03.6	correct answer from their line drawn on Figure 4	allow $\pm \frac{1}{2}$ small square tolerance allow 1.8 / 1.9 if no line of best fit or incorrect graph is drawn	1	4.4.1.2 AO2
03.7	Rate of photosynthesis 		1	4.4.1.2 AO2
Total			12	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	any one from: <ul style="list-style-type: none"> • respiration • formation of proteins • formation / breakdown of glycogen • breakdown of (excess) protein or formation of urea • photosynthesis or formation of glucose / starch (in plants) 	allow other correct reference to metabolic reactions in cells ignore reference to digestion ignore formation of carbohydrates	1	AO1 4.4.2.3
02.2	males have a higher metabolic rate than females after five years of age the mean metabolic rate of females decreases faster than males up to 25 years of age	each additional tick negates a mark	1 1	AO3 4.4.2.3
02.3	$\frac{17}{53} \times 100$ 32.075472... 32.1	an answer of 32.1 scores 3 marks allow correct rounding of this to at least 4 significant figures allow a correct reduction to 3 significant figures from an incorrect calculation for marking point 2	1 1 1	AO2 4.4.2.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4	any two from: <ul style="list-style-type: none"> (person) R heart rate rose / increased more slowly than (person) S (person) R heart rate levelled off whereas (person) S continued to increase (person) R heart rate rose less (overall / after 5 minutes of exercise) than S 	allow converse allow correct use of figures eg R increased (overall) by 39 bpm / 65% and S by 54 bpm / 69% ignore lack of units	2	AO3 4.4.2.2
02.5	correct scale and axis labelled all points plotted correctly (to within $\pm \frac{1}{2}$ square) line joined point to point or correct curved line of best fit	allow min(s) do not accept 'm' the zero is not required on the x-axis allow 4 or 5 correct plots for 1 mark	1 2 1	AO2 4.4.2.2
02.6	$\frac{132 - 78}{12}$ 4.5 (minutes) / 4½ minutes / 4 minutes 30 seconds / 4:30	an answer of 4.5 minutes scores 2 marks allow $\frac{54}{12}$ allow sequential deductions of 12 four or five times do not accept 4:50 or 4 minutes 50 seconds	1 1	AO2 4.4.2.2

Question	Answers	Mark	AO / Spec. Ref.
02.7	Level 3: The method would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	5–6	AO3 4.4.2.2
	Level 2: The method would not necessarily lead to a valid outcome. Most steps are identified, but the method is not fully logically sequenced.	3–4	
	Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	1–2	
	No relevant content	0	
	Indicative content <ul style="list-style-type: none"> • two groups of people - non-smokers and smokers • have at least five people in each group or large groups • get each person to do (named) exercise • controlled variables: <ul style="list-style-type: none"> - same number of people in each group or large groups - same gender - same level of activity / exercise - same age - no health issues / illnesses - same type of exercise - same time for exercise • record heart rate for each person before and after exercise • calculate increase in heart rate for each person after exercise • compare results for each group <p>for level 3, students should refer to at least 5 smokers and 5 non-smokers, carrying out exercise with control variables and a means of determining an increase in heart rate</p> <p>for level 2, students should refer to 'groups' of smokers and non-smokers exercising</p>		
Total			20

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	$6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$		1	AO2 4.4.1.1
03.2	endothermic		1	AO1 4.4.1.1
03.3	measure the volume of gas released increase length of time	allow use a measuring cylinder / capillary tube / (gas) syringe allow sensible length of time allow video the investigation so you could re-count the bubbles later allow repeat the measurement at each distance several times and calculate a mean ignore references to using other distances	1 1	AO3 4.4.1.2
03.4	temperature affects rate of photosynthesis or temperature affects rate of bubble production (because) reaction / photosynthesis is controlled by enzymes	allow correct description of effect of temperature on rate allow high temperatures denature enzymes enzymes being denatured must be linked to high temperature	1 1	AO3 4.4.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.5	evidence of squaring for two distances that double: 25 and 100 or 100 and 400	allow 2 marks for these calculations without working ignore calculations for a third distance as long as two where the distance doubles are correct	1	AO2 4.4.1.2
	calculate $1/d^2$ for two distances that double: 0.04 and 0.01 or 1/25 and 1/100 or 0.01 and 0.0025 or 1/100 and 1/400		1	AO2 4.4.1.2
	(therefore as distance doubles) light intensity is quartered		1	AO3 4.4.1.2
03.6	2 (bubbles would be produced)	do not accept no light allow 2 marks for a quarter of the bubbles are produced as light distance doubles so 2 bubbles would be expected	1	AO3 4.4.1.2
	(as) very little light / energy for photosynthesis to occur		1	AO2 4.4.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.7	<p>(independent variable) use different concentrations of sodium hydrogencarbonate solution</p> <p>(control variables) any two from:</p> <ul style="list-style-type: none"> • distance from light source • temperature of solution • same plant • time for plant to equilibrate 	<p>allow three concentration values ignore different concentrations of carbon dioxide</p> <p>ignore different amounts of sodium hydrogen carbonate solution</p> <p>max 2 marks for control variables</p> <p>allow light intensity ignore light unqualified ignore same lamp</p> <p>allow type / size of plant allow time for plant to adjust to different solution ignore time unqualified</p>	<p>1</p> <p>2</p>	<p>AO3 4.4.1.2</p>
Total			14	