

Mark Scheme (Results)

Summer 2024

Pearson Edexcel Advanced Level
In Biology A Salters Nuffield (9BN0)
Paper 02: Energy, Exercise and Coordination

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response

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Question Number	Answer	Mark
1(a)(i)	The only correct answer is D - oxygen A is incorrect as R is not carbon B is incorrect as R is not hydrogen C is incorrect as R is not nitrogen	**1**

Question Number	Answer	Mark
1(a)(ii)	The only correct answer is A - CH_2OH B is incorrect P does not represent CH_3 group C is incorrect as P does not represent an COOH group D is incorrect as P does not represent an OH group	**1**

Question Number	Answer	Additional Guidance	Mark
1(b) (i)	A description that makes reference to the following: • (both) can assess brain activity (1) • image formed in real time (1)	ALLOW show areas of brain that are more active ALLOW brain function for brain activity ALLOW live imaging for real time	**2**

Question Number	Answer	Additional Guidance	Mark
1(b) (ii)	An answer that makes reference to the following: • { image 1 / CT } less detailed / { image 2 / MRI } more detailed (1)	ALLOW {resolution / contrast} for detail	**1**

Question Number	Answer	Additional Guidance	Mark
1(c)	A description that makes reference to the following: • P- inability to see / reduce visual perception (1) • Q - (change in ability to) balance / posture / (fine) motor skills / coordination (1)	ALLOW damage to vision ALLOW suitable descriptions	**2**

Question Number	Answer	Mark
2(a)	The only correct answer is B - adenosine triphosphate (ATP) A is incorrect as adenosine diphosphate (ADP) is not molecule X C is incorrect as nicotinamide adenine dinucleotide (NAD) is not molecule X D is incorrect as reduced nicotinamide adenine dinucleotide ($NADH + H^+$) is not molecule X	1

Question Number	Answer	Additional Guidance	Mark
2(b)	An explanation that makes reference to the following: • when there is insufficient oxygen / anaerobic condition (1) • so that reduced NAD can be {oxidised / made into NAD} (1) • (NAD) for use in glycolysis / so glycolysis can continue (1) • and (some) ATP can continue to be synthesised (1)	ALLOW during anaerobic respiration ALLOW to let NAD be regenerated / NAD_{ox} to be reformed	4

Question Number	Answer	Additional Guidance	Mark
2(c)	An answer that makes reference to four of the following: • use same volume of solution (for both) / use same { volume / concentration } of DCPIP (for both) (1) • add solution to DCPIP / titration using DCPIP and {vitamin C solution / extract} (1) • until DCPIP {decolourises / changes from blue to colourless } (1) • compare volume of the two solutions needed for the DCPIP to decolourise (1) • quantify the results by titration using a vitamin C standard solution (1)	ALLOW add DCPIP to each solution ALLOW DCPIP becomes colourless in correct context ALLOW DCPIP added to vitamin C solution until {DCPIP colour remains /DCPIP stays blue / solution becomes blue } ALLOW compare volume of DCPIP needed for the two solutions ALLOW correct description of comparison	**4**

Question Number	Answer	Additional Guidance	Mark
3(a)(i)	An explanation that makes reference to four of the following: • raised carbon dioxide (concentration) in blood / reduced blood pH (1) • (that is) detected by chemoreceptors (1) • (resulting in) impulses sent to the { ventilation centre / medulla (oblongata) } (1) • (so) more impulses sent along the motor neurones (to muscles involved in breathing) (1) • (so there is an) increase in rate of { diaphragm / intercostal muscle } contraction (and relaxation) (1)	ALLOW increased carbonic acid in blood ALLOW inspiratory centre ALLOW more impulses along the phrenic nerve ALLOW increased impulses along sympathetic nerve pathways	**4**

Question Number	Answer	Mark
3(a)(ii)	The only correct answer is B - number of troughs on the trace in 15 seconds divided by 0.25 A is incorrect as this equation would not calculate breathing rate C is incorrect as this equation would not calculate breathing rate D is incorrect as this equation would not calculate breathing rate	**1**

Question Number	Answer	Additional Guidance	Mark
3(b)	An explanation that makes reference to three of the following: • K represents { ventricular systole / the QRS complex } (1) • (AVN) picks up electrical activity from atria / allows electrical activity to travel from atria to ventricles (1) • (but) delays transmission of electrical activity from atria / allows time for atria to empty (1) • passes electrical activity to { Purkyne fibres / bundle of His } (1)	ALLOW depolarisation, electrical impulses, action potentials for electrical activity ALLOW contraction of ventricles ALLOW (AVN) picks up electrical activity from the SAN ALLOW delay gives time for ventricles to fill with blood ALLOW Purkinje fibres	**3**

Question Number	Answer	Additional Guidance	Mark
3(c)	An answer that makes reference to one of the following: • earlier in pregnancy when test can be carried out (1) • results available sooner (due to being carried out earlier in pregnancy) (1)	ALLOW reference to number of weeks to show CVS is done earlier in pregnancy (10-14 weeks) than amniocentesis (15-20 weeks) ALLOW longer time to consider the outcome IGNORE reference to miscarriage risk	**1**

Question Number	Answer	Additional Guidance	Mark
4(a)	• correct calculation (1)	$(2.5 \times 10^{-8}) \times (6 \times 10^{9}) =$ 150 OR 1.5×10^{2}	**1**

Question Number	Answer	Additional Guidance	Mark
4(b)(i)	An answer that makes reference to the following: • (only) U replaced by T (1) • (so the other) 10 bases out of 12 are the same (1)	 ALLOW DNA does not have uracil ALLOW (10 ÷ 12) x 100 = 83% OR {uracil / two} bases are different which makes up 17% of the bases	**2**

Question Number	Answer	Additional Guidance	Mark
4(b)(ii)	An explanation that makes reference to three of the following: • (change in DNA) may cause a change to { an amino acid / the amino acid sequence } / may result in a STOP codon (1) • protein { has a different shape / has a different tertiary structure / is not made } (1) • so {does not function / function altered } (1) • example of how the change in protein produced affects phenotype (1)	ALLOW primary structure for amino acid sequence ALLOW polypeptide for protein e.g. enzyme produced has a different specificity / change to active site of enzyme / pigment no longer produced / change in protein can alter structure or function of a cell	**3**

Question Number	Answer	Additional Guidance	Mark
4(c)	An explanation that makes reference to three of the following: • (glycogen provides) a store of { energy / glucose } (1) • glycogen provides glucose (1) • glucose for respiration / {energy / ATP} for contraction (1) • fewer {capillaries / blood vessels} in fast twitch muscles means less glucose supplied (1)	ALLOW reverse arguments for why slow twitch need less glycogen, e.g. slow twitch uses glucose from liver. IGNORE reference to anaerobic/aerobic ALLOW slow twitch needs less glycogen as they have more capillaries to supply glucose	**3**

Question Number	Answer	Additional Guidance	Mark
5(a)	• calculate the time of one cardiac cycle (1) • calculate time for systole (1)	<u>Example of calculation</u> 60 ÷ 90 = 0.666$^{.recurring}$ (ALLOW 0.67 s) x 0.3 = 0.2s ALLOW 0.201 seconds if rounded to 0.67 Correct answer with no working gains full marks	**2**

Question Number	Answer	Additional Guidance	Mark
5(b)(i)	• twice as likely / doubles the likelihood (to develop CVD) (1)	ALLOW doubles / x 2 the risk	**1**

Question Number	Answer	Additional Guidance	Mark
5(b)(ii)	An answer that refers to two of the following: {cough / cold / flu-like symptoms} / {dizziness / fainting} / headaches / fatigue (2)	ALLOW: diarrhoea, constipation, nausea, cold hands/feet, oedema/swollen ankles	**2**

Question Number	Answer	Additional Guidance	Mark
5(b)(iii)	An explanation that makes reference to four of the following: • reduce blood pressure (1) • (so) less likely to damage (artery) endothelium (1) • (so) less likely to have an inflammatory response (1) • less risk of {atheroma / plaque / atherosclerosis } (1) • (therefore) less risk of lumen of artery being {narrowed / blocked } (1)	ALLOW reduces chance of endothelial dysfunction	**4**

Question Number	Answer	Mark
6(a)	The only correct answer is C 0.50 A is incorrect as 0.00 is not the probability that non-identical twins are the same sex B is incorrect as 0.25 is not the probability that non-identical twins are the same sex D is incorrect as 1.00 is not the probability that non-identical twins are the same sex	**1**

Question Number	Answer	Additional Guidance	Mark
6(b)	An explanation that makes reference to three of the following: • acrosome to release {digestive / hydrolytic} enzymes to {digest / form a channel through / penetrate / break through } the zona (pellucida) (1) • mitochondria { to supply ATP / to carry out aerobic respiration } (1) • flagellum allows movement of sperm towards the egg (cell) (1) • haploid (nucleus) to produce a {2n / diploid} {number of chromosomes / zygote } at fertilisation (1)	ALLOW acrosome contains digestive enzymes to { get through the zona (pellucida) / reach the egg cell membrane } IGNORE to re-establish the {full/correct} complement of chromosomes	**3**

Question Number	Answer	Additional Guidance	Mark
6(c)(i)	A description that makes reference to three of the following: • totipotent stem cells have the potential to give rise to all cell types (1) • pluripotent stem cells can give rise to { most / some } cell types (1) • totipotent stem cells can give rise to a whole organism (pluripotent cannot) (1) • in totipotent stem cells no genes are inactivated / pluripotent stem cells have some genes inactivated (1)	ALLOW any cell type for all cell types ALLOW all cells except extra-embryonic cells / cannot give rise to extra-embryonic cells ALLOW placental cells for extra-embryonic cells ALLOW expressed for activated ALLOW differential gene expression	**3**

Question Number	Answer	Additional Guidance	Mark
6(c)(ii)	A description that makes reference to three of the following: • keep (pairs of) chromatids together (1) • {bind / attach} to spindle (fibres) (1) • during metaphase (1) • point at which the (sister) chromatids separate during anaphase (1)	ALLOW joined, attached, bind, for keep	**3**

Question Number	Answer	Additional Guidance	Mark
7(a)	An answer that makes reference to the following: • (retina) made of a group of (specialised / similar) cells (1) • working together for a (specific) { function / purpose } (1)	IGNORE same cells (not correct for retina) ALLOW reference to a stated function	**2**

Question Number	Answer	Additional Guidance	Mark
7(b) (i)	A description that makes reference to two of the following: • (rhodopsin reformation) occurs in the dark (1) • retinal joins to opsin (1) • trans retinal is converted to cis retinal (in the dark) (1)		**2**

Question Number	Answer	Additional Guidance	Mark
7(b) (ii)	An explanation that makes reference to the following: • (pedigree) 2 (1) • (as only pedigree 2) shows parents { without the condition / heterozygous parents / carriers } having a child with the condition (1)		**2**

Question Number	Answer	Additional Guidance	Mark
7(c) (i)	Y chromosome is {smaller / shorter} (than the X chromosome) (1)		**1**

Question Number	Answer	Additional Guidance	Mark
7(c)(ii)	• correct calculation of population size (1) • calculation of number of males in the sample (1) • number of males not colour blind (1)	<u>Example of calculation</u> 131 ÷ 0.045 = 2911 2911 x 0.55 = 1601 1601 - 118 = 1483 Correct answer with no working gains full marks	**3**

Question Number	Answer	Additional Guidance	Mark
7(c)(iii)	An explanation that makes reference to the following: • the allele for blue colour blindness is less common in the population (1) • lower numbers for females than males for red and green colour blindness (1) • (red and green colour blindness) less common in females as they need both alleles (on X chromosomes) to have the condition (1) • higher in males as {allele found on X chromosome / allele absent on Y chromosome} so only one allele for condition needed to express itself (1)	ALLOW – allele for red / green colour blindness more common in the population ALLOW (red/green) colour blindness more common in males than in females ALLOW females need to be homozygous recessive to have the condition ALLOW males only need one copy of the recessive allele to have the condition	**4**

Question Number	Answer	Mark
8(a)(i)	The only correct answer is D - rough endoplasmic reticulum A is incorrect as synthesis of the protein component of phytochrome does not occur at the centrioles B is incorrect as synthesis of the protein component of phytochrome does not occur at the Golgi apparatus C is incorrect as synthesis of the protein component of phytochrome does not occur in lysosomes	1

Question Number	Answer	Mark
8(a)(ii)	The only correct answer is B - Golgi apparatus A is incorrect as addition of the non-protein component to make phytochrome does not occur in the cytoplasm C is incorrect as addition of the non-protein component to make phytochrome does not occur in lysosomes D is incorrect as addition of the non-protein component to make phytochrome does not occur on the smooth endoplasmic reticulum	1

Question Number	Answer	Mark
8(a)(iii)	The only correct answer is B – bond between a nitrogen atom on one amino acid and a carbon atom on another amino acid A is incorrect as a peptide bond is not a bond between a carbon atom on one amino acid and a carbon atom on another amino acid C is incorrect as a peptide bond is not a bond between a nitrogen atom on one amino acid and an oxygen atom on another amino acid D is incorrect as a peptide bond is not a bond between an oxygen atom on one amino acid and a carbon atom on another amino acid	**1**

Question Number	Answer	Mark
8(b)(i)	The only correct answer is A is incorrect as phytochrome is not converted to the far red form in the dark B is incorrect as phytochrome is not converted rapidly to the red form in the dark C is incorrect as phytochrome is not converted to the far red form in the dark	**1**

	Converted	To phytochrome
D [X]	Slowly	red

Question Number	Answer	Additional Guidance	Mark
8(b)(ii)	An explanation that makes reference to three of the following: • phytochrome far red formed (in light) (1) • (phytochrome far red) is the active form (1) • (so phytochrome far red) stimulates {mitosis / cell division / cell elongation } (1) • phytochrome far red {is a transcription factor / activates transcription factors / stimulates protein synthesis} (1)	ALLOW P_{fr} for phytochrome far red	**3**

Question Number	Answer	Additional Guidance	Mark
9(a)(i)	• correct conversion to same units – either mg or μg (1) • correct calculation of percentage difference (1)	<u>Example of calculation</u> 0.046 to 46 OR 25 to 0.025 84% ALLOW 46 /45.7 / 45.65% ALLOW 59 / 59.2 /59.15% Correct answer with no working gains full marks	**2**

Question Number	Answer	Additional Guidance	Mark
9(a)(ii)	A description that makes reference to three of the following: • (like humans) they are mammals / (may be a) good model for humans (1) • (therefore) will react in a similar way / metabolise the toxin in the same way (1) • no risk to humans / unethical to test in humans (1) • can control variables (1)	 ALLOW similar anatomy ALLOW to find out if safe to eat, only male fish safe to eat, liver edible e.g. genetically identical	**3**

Question Number	Answer	Additional Guidance	Mark
9(a)(iii)	An answer that makes reference to two of the following: • greater level of toxicity in tissues of female pufferfish (1) • for females, the level of toxicity (much) is higher in liver and in {gonads / ovaries} / highest toxicity is in ovaries (1) • for males and females {little / no} difference in / slightly higher level of toxicity in muscle and skin of female pufferfish (1)	ALLOW converse for males	**2**

Question Number		Mark
*9(b)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. <u>Indicative content</u> Conotoxin • leads to reduced exocytosis of neurotransmitter into synapse • so less stimulus of post-synaptic membrane • so could be used to reduce uncontrolled muscle movement • discussion of the effect of conotoxin on synaptic transmission of impulse e.g. at neuromuscular junction linked to reducing uncontrolled muscle movement. TTX • less likely for neurones to depolarise / repolarise • as Na^+ does not move in (during depolarisation) / move out (during repolarisation) • so fewer nerve impulses reach synapse • example of medicinal use - pain killer • discussion of the effect of prevention of impulse transmission on pain reduction Concerns regarding use as a treatment • study for pufferfish only done on one species • study for pufferfish only done on five individuals • mice studies only done to ascertain toxicity levels, not therapeutic levels • toxicity studies done on mice which may not be a good human model for neurotoxins • only two neurotoxins considered	**6**

			Additional guidance
Level 0	Marks	No awardable content	
Level 1	1-2	Limited scientific judgement made with a focus on mainly just one method, with a few strengths / weaknesses identified. A conclusion may be attempted, demonstrating isolated elements of biological knowledge and understanding but with limited evidence to support the judgement being made.	Reference to conotoxin affecting synapse and TTX affecting nerve impulse / depolarisation / action potential OR either TTX or conotoxin mode of action considered and a valid conclusion made.
Level 2	3-4	A scientific judgement is made through the application of relevant evidence, with strengths and weaknesses of each method identified. A conclusion is made, demonstrating linkages to elements of biological knowledge and understanding, with occasional evidence to support the judgement being made.	Reference to both conotoxin affecting synapses and TTX affecting nerve impulses, plus either Relevant discussion of role of calcium ion movement across membrane in the release of neurotransmitter at synapse OR Role of sodium ion movement in the transmission of nerve impulse Conclusion about toxicity of neurotoxins OR limitations of investigation evidence OR statement that conotoxin could reduce uncontrolled muscle movement / TTX could be used as a painkiller
Level 3	5-6	A scientific judgement is made which is supported throughout by sustained application of relevant evidence from the analysis and interpretation of the scientific information. A conclusion is made, demonstrating sustained linkages to biological knowledge and understanding with evidence to support the judgement being made.	Relevant roles of both calcium and sodium ions discussed Conotoxin to reduce uncontrolled muscle movement and TTX as a painkiller At least two relevant conclusions about use of neurotoxins and / or limitations of investigation and application to humans

Question Number	Answer	Mark
10(a)	A 0.7 : 1 B is incorrect as 1: $1^2/_5$ is not the simplest ratio to show female and male athletes C is incorrect as 1.4 : 1 is not the simplest ratio to show female and male athletes D is incorrect as 12 : 17 s not the simplest ratio to show female and male athletes	**1**

Question Number	Answer	Additional Guidance	Mark
10(b)(i)	An explanation that makes reference to three of the following: • could increase their mass (1) • reducing the estimated level of sweat produced (1) • (temperature of food / drink could) alter recorded temperature (1) • would introduce an uncontrolled variable / reduce validity of results (1)	ALLOW method cannot be used to measure sweat production	**3**

Question Number	Answer	Additional Guidance	Mark
10(b)(ii)	An explanation that makes reference to three of the following: • both increase the same during warm-up due to doing same {warm-up / level of exercise } / environmental temperature had little effect during warm-up (1) • increase in core body temperature during { warm-up / exercise } due to { respiration / muscle contraction } (1) • during exercise core body temperature increased to a higher level at 32°C than at 16°C (1) • (because) less heat lost at higher environmental temperature (1)	ALLOW converse e.g. 39.1°C and 38.4°C at 50 minutes ALLOW converse ALLOW reference to thermoregulatory mechanism	**3**

Question Number	Indicative content	Mark
***10(b)(iii)**	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. <u>Indicative content</u> Evidence used to make judgements • Greater duration of exercise at lower environmental temperature • Greater power output at lower environmental temperature • Higher rate of sweating at higher temperature • Core body temp rising faster at higher temperature (from graph if referred to) Conclusions • Performance is increased at lower temperatures • Increased sweating related to thermoregulation and not necessarily athletic performance • Only elite athletes selected for investigation / need to take into account other variables considering athletes • Limited as only done at two environmental temperatures • Only two types of sport considered • Other environmental variables not controlled • No relevant statistical analysis of data collected	**6**

			Additional guidance
Level 0	Marks	No awardable content	
Level 1	1-2	Limited scientific judgement made with a focus on mainly just one method, with a few strengths / weaknesses identified. A conclusion may be attempted, demonstrating isolated elements of biological knowledge and understanding but with limited evidence to support the judgement being made.	Judgement based on **one** piece of evidence e.g. longer duration of exercise or greater power output at lower temperature or lower rate of sweating A **single** conclusion made from: effect of environmental temperature on performance / only 2 environmental temperatures / only 2 sports / other variables not controlled / no relevant statistical analysis given
Level 2	3-4	A scientific judgement is made through the application of relevant evidence, with strengths and weaknesses of each method identified. A conclusion is made, demonstrating linkages to elements of biological knowledge and understanding, with occasional evidence to support the judgement being made.	At least **two** separate pieces of evidence used to support judgements linked to biological knowledge e.g. longer duration of exercise or greater power output at lower temperature or lower rate of sweating Conclusion linking at least **two** aspects from - effect of environmental temperature on performance / only 2 environmental temperatures / only 2 sports / other variables not controlled / no relevant statistical analysis given
Level 3	5-6	A scientific judgement is made which is supported throughout by sustained application of relevant evidence from the analysis and interpretation of the scientific information. A conclusion is made, demonstrating sustained linkages to biological knowledge and understanding with evidence to support the judgement being made.	At least **three** separate pieces of evidence used to support judgements linked to biological knowledge e.g. duration of exercise, power output and sweating Conclusion linking at least **three** aspects from - effect of environmental temperature on performance / only 2 environmental temperatures / only 2 sports / other variables not controlled / no relevant statistical analysis given

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