

GCE

Physical Education

H555/01: Physiological factors affecting performance

A Level

Mark Scheme for June 2025

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

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MARKING INSTRUCTIONS

PREPARATION FOR MARKING RM ASSESSOR

1. Make sure that you have accessed and completed the relevant training packages for on-screen marking: *RM Assessor Online Training: OCR Essential Guide to Marking*.
2. Make sure that you have read and understood the mark scheme and the question paper for this unit. These are available in RM Assessor
3. Log-in to RM Assessor and mark the **required number** of practice responses (“scripts”) and the **required number** of standardisation responses.

MARKING

1. Mark strictly to the mark scheme.
2. Marks awarded must relate directly to the marking criteria.
3. The schedule of dates is very important. It is essential that you meet the RM Assessor 50% and 100% (traditional 40% Batch 1 and 100% Batch 2) deadlines. If you experience problems, you must contact your Team Leader (Supervisor) without delay.
4. If you are in any doubt about applying the mark scheme, consult your Team Leader by telephone or the RM Assessor messaging system, or by email.
5. **Crossed Out Responses**
Where a candidate has crossed out a response and provided a clear alternative then the crossed out response is not marked. Where no alternative response has been provided, examiners may give candidates the benefit of the doubt and mark the crossed out response where legible.

Multiple Choice Question Responses

When a multiple-choice question has only a single, correct response and a candidate provides two responses (even if one of these responses is correct), then no mark should be awarded (as it is not possible to determine which was the first response selected by the candidate).

When a question requires candidates to select more than one option/multiple options, then local marking arrangements need to ensure consistency of approach.

Contradictory Responses

When a candidate provides contradictory responses, then no mark should be awarded, even if one of the answers is correct.

Short Answer Questions (requiring only a list by way of a response, usually worth only **one mark per response**)

Where candidates are required to provide a set number of short answer responses then only the set number of responses should be marked. The response space should be marked from left to right on each line and then line by line until the required number of responses have been considered. The remaining responses should not then be marked. Examiners will have to apply judgement as to whether a 'second response' on a line is a development of the 'first response', rather than a separate, discrete response. *(The underlying assumption is that the candidate is attempting to hedge their bets and therefore getting undue benefit rather than engaging with the question and giving the most relevant/correct responses.)*

Short Answer Questions (requiring a more developed response, worth **two or more marks**)

If the candidates are required to provide a description of, say, three items or factors and four items or factors are provided, then mark on a similar basis – that is downwards (as it is unlikely in this situation that a candidate will provide more than one response in each section of the response space.)

Longer Answer Questions (requiring a developed response)

Where candidates have provided two (or more) responses to a medium or high tariff question which only required a single (developed) response and not crossed out the first response, then only the first response should be marked. Examiners will need to apply professional judgement as to whether the second (or a subsequent) response is a 'new start' or simply a poorly expressed continuation of the first response.

6. Always check the pages (and additional objects if present) at the end of the response in case any answers have been continued there. If the candidate has continued an answer there, ensure that the work is linked and has been marked. Annotate SEEN if there is no further credit awarded for an answer. Annotate BP on all blank pages.
7. There is a NR (**No Response**) option. Award NR (No Response):
 - if there is nothing written at all in the answer space
 - OR if there is a comment which does not in any way relate to the question (e.g., 'can't do', 'don't know')
 - OR if there is a mark (e.g., a dash, a question mark) which is not an attempt at the question.

Note: Award 0 marks – for an attempt that earns no credit (including copying out the question).

Team Leaders must confirm the correct use of the NR button with their markers before live marking commences and should check this when reviewing scripts.

8. The RM Assessor **comments box** is used by your team leader to explain the marking of the practice responses. Please refer to these comments when checking your practice responses. **Do not use the comments box for any other reason.**
If you have any questions or comments for your team leader, use the phone, the RM Assessor messaging system, or e-mail.
9. Assistant Examiners will send a brief report on the performance of candidates to their Team Leader (Supervisor) via email by the end of the marking period. The report should contain notes on particular strengths displayed as well as common errors or weaknesses. Constructive criticism of the question paper/mark scheme is also appreciated.
10. For answers marked by levels of response:
- To determine the level** – start at the highest level and work down until you reach the level that matches the answer
 - To determine the mark within the level**, consider the following

Descriptor	Award mark
On the borderline of this level and the one below	At bottom of level
Just enough achievement on balance for this level	Above bottom and either below middle or at middle of level (depending on number of marks available)
Meets the criteria but with some slight inconsistency	Either above middle and below top of level or at middle of level (depending on number of marks available)
Consistently meets the criteria for this level	At top of level

11. Annotations

Annotation	Meaning
	Tick
	Cross
	Benefit of doubt
	Too vague
	Repeat
	Indicates sub-max reached where relevant
	Noted but no credit given
	Significant amount of material which doesn't answer the question
	Knowledge and understanding / indicates AO1 on Q9
	Example/Reference / indicates AO2 on Q9
	Development / indicates AO3 on Q9
	Level 1 response on Q9
	Level 2 response on Q9

Annotation	Meaning
L3	Level 3 response on Q9
L4	Level 4 response on Q9
BP	Blank page

Sub-maxes are indicated with **S**; the guidance section of the mark scheme shows which questions these are relevant to.

KU/EG/DEV used instead of ticks on the extended response question to indicate where knowledge or development points from the indicative content have been made.

On this extended response question, one **KU/EG/DEV** does not necessarily equate to one mark being awarded; the marking is based on a levels of response mark scheme which awards a level and mark holistically based upon the quality of the response overall against the levels descriptors.

12. Underlined/**emboldened** and (bracketed) text in the MS

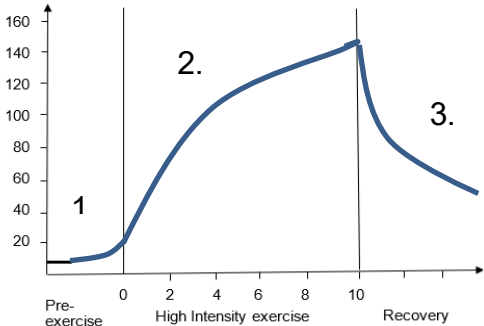
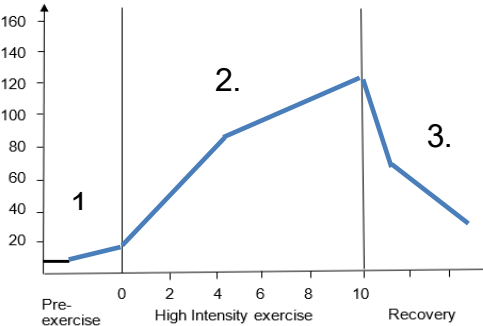
- If text is underlined in the mark scheme, the exact word/term/phrase must be used to award the mark.
- If text is **emboldened**, the word/term/phrase **or a synonym** must be used to award the mark.
- (Bracketed) text is used to give context. Candidates do **not** need to state bracketed terms to award the mark.

Section A				
Question		Answer	Marks	Guidance
1	(a)	One mark for: 1. C (Soleus and tibialis anterior)	1 (AO2)	No marks to be awarded if more than 1 box is ticked. Annotate 'rep'
1	(b)	One mark for: 1. A (Adductor brevis and iliopsoas)	1 (AO2)	No marks to be awarded if more than 1 box is ticked. Annotate 'rep'
2		Two marks from: 1. The contraction of the heart/cardiac muscle OR contraction phase of the cardiac cycle 2. The atria contract first OR the atria contract before the ventricles 3. (Atrial systole) - atria contract which forces blood into the ventricles 4. (Ventricular systole) – ventricles contract which forces blood out of the heart/ into the aorta and pulmonary artery/ to the body and the lungs	2 (AO1)	Accept: Pt1 Contraction of atria and / or ventricles
3	(a)	One mark for: 1. The volume/amount of oxygen (above resting levels) used/consumed to return the body to its pre-exercise/resting state. OR the elevation of the metabolic rate above resting values after exercise/during the recovery process	1 (AO1)	Accept: 'Back to rest/normal' as part of first option. 'Needed/required' instead of used (BOD)

Section A				
Question	Answer	Marks	Guidance	
3 (b)	One mark for: 1. The higher the intensity/anaerobic work the greater the EPOC OR direct relationship	1 (AO2)	Accept: Opposites: The lower the intensity, the lower the EPOC Higher intensity = EPOC lasts longer (BOD) Higher intensity = more O₂ needed (BOD) Do not accept: Higher intensity = longer recovery (TV)	
4	Two marks from: 1. Anti-inflammatory drugs OR NSAIDs OR pain medication 2. Physiotherapy 3. Hydrotherapy 4. Surgery/Arthroscopy 5. Use of a brace (knee or shoulder)	2 (AO2)	Mark 1st two answers only Accept: Pt 1 Anti-inflammatories = (BOD) Pt 1 If only a named anti-inflammatory drug e.g. ibuprofen/ or pain medication e.g. paracetamol (BOD) Pt 5 Alternative word for brace e.g. splint, sling, knee support, bandage, Tubi grip etc. Do not accept: PRICE or seek medical attention (excluded answers in the question) or stretching or massage or heat, cold or contrast therapies Pt5 Immobilise (TV)	
5	Two marks for: 1. According to Bernoulli's principle, faster moving fluids have lower pressure. which might create a lift force. 2. A downwards lift force causes an increase in friction.	2 (AO2)	Answers are: Lower Friction	

		Section B			
Question		Answer		Mark	Guidance
6	(a)	Five marks from:		5 (AO3)	Must have credit from both columns in table for each mark. Stamp KU for first column and tick when evaluation given. Accept: • Combined relevant disadvantage for pts 1 and 2, if both functional characteristics described. • Combined relevant advantages for pts 3 and 5 if both functional characteristics described • Other relevant hockey or ice/roller hockey examples throughout Do not accept: Pts 3 and 5. Play for large duration/last the whole game (TV)
		1.	Slow speed of contraction OR e.g. cannot sprint for ball as effectively (as if using FG fibres),		
		2.	Low force of contraction OR e.g. cannot tackle as effectively (as if using FG fibres),		
		3.	High aerobic capacity OR e.g. defender can track an opponent, perform repeated counter-attacks		
		4.	Low anaerobic capacity OR e.g. not as able to make repeated saves/ make repeated jab tackles whilst chasing opponent		
		5.	High fatigue resistance OR high endurance OR e.g. covering the pitch non- stop, maintain standard of push pass throughout the game		
		6.	Ability to generate/resynthesise large amounts of ATP OR e.g. maintain correct posture, GK maintaining position		

			Section B											
Question			Answer	Mark	Guidance									
6	(b)		Four marks from: 1. Temperature increases (in blood) which reduces blood viscosity 2. Temperature increases (in heart / cardiac muscle) which increases speed of nerve impulse transmission 3. Increase in venous return OR more blood enters the right atrium 4. (causing) Increase in stretch of right atrium 5. (causing) Increase in firing rate of SA node 6. Increase in stretch of ventricular walls / end diastolic volume / EDV 7. (causing) Increase in power/strength and speed of contractions OR increase in ventricular contractility 8. Heart rate increases	4 (AO1)	Guidance 'Increased temperature reduces blood viscosity and increases speed of nerve impulses' = ✓✓ award pts 1 and 2. Accept: Pt 5 increased firing of the SA node (BOD) Do not accept: Pts 6 or 7 Ref to Starlings Law/ SV (IRRL)									
6	(c)	(i)	Three marks for: <table><tr><th>Key term</th><th>Definition</th><th>Resting value for a performer</th></tr><tr><td>Frequency</td><td>The number of inspirations or expirations in one minute</td><td>1. 12 - 20 (breaths/min)</td></tr><tr><td>Tidal Volume</td><td>2.The volume of <u>air</u> inspired / expired in one breath</td><td>3. 0.5L or 500<u>ml</u></td></tr></table>	Key term	Definition	Resting value for a performer	Frequency	The number of inspirations or expirations in one minute	1. 12 - 20 (breaths/min)	Tidal Volume	2.The volume of <u>air</u> inspired / expired in one breath	3. 0.5L or 500 <u>ml</u>	3 (AO1)	Accept: Pt 1 Any value within the stated range. If a range is given by the candidate, both values must be between the stated range. Pt 3 Answers between 0.4 - 0.6L/400ml – 600ml = BOD Do not accept: Pt 2 inspired and expired = TV Pt 2 Oxygen (TV) Pt 3 Answer without correct units
Key term	Definition	Resting value for a performer												
Frequency	The number of inspirations or expirations in one minute	1. 12 - 20 (breaths/min)												
Tidal Volume	2.The volume of <u>air</u> inspired / expired in one breath	3. 0.5L or 500 <u>ml</u>												

			Section B		
Question			Answer	Mark	Guidance
	(c)	(ii)	Three marks for: (Pre-exercise) Slight rise from resting values prior to start of exercise (see 1. on either graph) (Exercise) Steep rise at start of exercise and less steep further rise to maximal value at or above 100l/m (see 2. on either graph below) (Recovery) Steep decline and less steep further decline towards resting values (see 3. on either graph below)  OR 	3 (AO2)	Accept: Slight inconsistencies as q says sketch Maximal value any value equal to or above 100l/min Do not accept: Pt 1 Rise above 40L/min (TV - not slight) Pt 2 Plateau Pt 3 Recovery line that clearly finishes below resting value (approx. 7.5l/min)
6	(d)		Five marks from: - Decrease in blood / plasma volume OR increased red blood cell density - Decrease in venous return - Decrease in stroke volume - Increase in heart rate - Decrease in diffusion gradient / oxygen diffusion to the (lung) <u>capillaries</u> - Reduced haemoglobin saturation (with oxygen) - Decrease in O₂ transport to muscle - Decrease in <u>maximal</u> cardiac output / <u>maximal</u> heart rate	5 (AO1)	Accept: Pt 1 Increased blood viscosity (BOD) Pt 7 Decrease in O₂ transport to body (BOD) Do not accept: Pt 1 increased red blood cells /RBC (long term adaptation so IRRL)

Question	Answer	Mark	Guidance
7 (a)	Four marks from: Must have benefit/risk and explanation for each mark. Creatine Benefits 1. Increased PC stores which means more energy from ATP-PC system / delays ATP-PC threshold OR less reliance on glycolytic/LA system / less lactate build-up OR delays fatigue in high intensity activities/ performer can work for longer at higher intensities OR faster training gains / benefit for sprinters / weightlifters OR increased force of muscle contraction/ maximum strength / explosive strength Risks 2. Gastro-intestinal problems / water retention / weight gain / muscle cramps which means reduced comfort OR reduced quality of training /performing OR (weight gain) can be unhealthy Nitrate Benefits 3. Dilation of blood vessels which means increased blood / oxygen supply (to working muscles) OR higher intensity (aerobic) performance OR delayed OBLA OR faster recovery OR reduced blood pressure Risks 3. Headaches / dizziness / gastro-intestinal problems / (possibly) carcinogenic which means reduced comfort OR training / performance quality reduced OR threat to health	4 (AO3)	Accept: 1st benefit and 1st risk only for each aid Do not accept: Pt 1-4 Benefits/risks without explanation (TV) Accept: Pt 4 Carcinogenic which means increased risk of cancer = ✓

Question			Answer	Mark	Guidance
7	(b)	(i)	Four marks from: - Stepping up and down on a box - Height of box is 41.3cm /16.25 inches (males) 24 steps/minute pace OR metronome set to 96 beats/min OR (females) 22 steps/minute pace OR metronome set to 88 beats/min - Subject completes <u>3</u> mins of stepping (to correct pace/metronome) - HR recorded (five seconds) after test completion for 15 sec OR HR taken at 20 seconds post-exercise if using a HR monitor HR recovery used to predict VO₂ max/aerobic capacity Formula used to estimate VO₂ max/aerobic capacity - Results compared to standardised / normative tables	4 (AO1)	Accept: Pt 1 Stepping on a box = BOD Pt 1 Platform/block/elevated surface instead of box Pt 2 41 cm (BOD) Do not accept: Pt 6 Without reference to HR recovery (TV)
		(ii)	Two marks from: - Head/pivot/centre of goniometer on the (knee) joint - Arms of goniometer along the articulating bones OR femur and tibia - Angle measured from fully extended to fully flexed position (or vice versa)	2 (AO2)	Accept: Pt 2 Arms lined up with upper leg and lower leg (BOD) Pt3 Angle measured for full range of motion (BOD) Do not accept: Pt1 Place/position goniometer on the knee joint (TV)

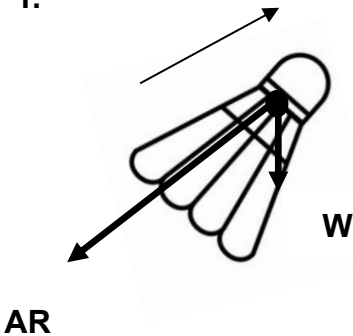
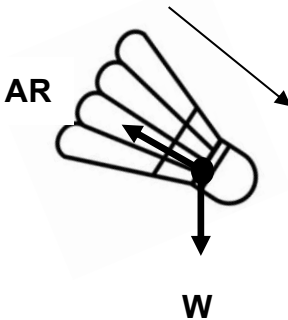
Question			Answer	Mark	Guidance
7	(c)	(i)	Two marks from: - Coronary heart disease/CHD/cardiovascular disease OR a form of arteriosclerosis - Narrowing of the (lumen of) <u>arteries</u> OR restricted blood flow in <u>arteries</u> (caused by) Fatty deposits/plaque /atheroma in <u>artery</u> - Increased likelihood of blood clot formation - Reduced vasodilation/vasoconstriction OR increased blood pressure / hypertension	2 (AO1)	Accept: Pt 2 Hardening of the arteries (BOD) Pt 2 Blocking of arteries (BOD) Pt 3 Fatty build-up in arteries (BOD) Pts 2 and 3 combined: e.g. Narrowing of arteries due to fatty deposits = 2 marks Do not accept: Pts 2,3 Blood vessels, arterioles or veins (TV)
		(ii)	Three marks from: - Reduces cholesterol / low density lipoproteins / LDL / (blood) lipids / fats - Increases (ratio of) high density lipoproteins / HDLs (to LDLs) - Decreases blood viscosity / blood pressure / hypertension (Regular vasoconstriction/vasodilation) prevents hardening of/loss of elasticity in arterial walls - Increases coronary circulation OR coronary arterioles increase in diameter / density - Reduces body fat / risk of obesity OR maintains healthy body composition	3 (AO2)	Accept: Mark 1st three answers only. Pt 4 Increases elasticity in arterial walls (BOD) Pt 5 Increased blood flow in coronary arteries (BOD) Do not accept: Pt 5 Increased blood flow due to vasodilation (TV) Pt 6 Burns fat (so not deposited in arteries) (TV)

7	(d)	Five marks from: Warm up (sub-max. 4 marks): (e.g. effective activities) HR-raising activity/ <u>dynamic</u> stretching/mobility exercises OR type of warm up depends on sporting activity to follow (effective WU) increases elasticity of muscles / connective tissue (effective WU) improves (antagonistic) muscle coordination (effective WU) reduces risk of muscle strains / tears (effective WU) reduces risk of joint injuries / sprains / torn cartilage - static stretches have no effect on reducing risk of injury - Warm up cannot prevent injury OR warm up can only reduce the risk of injury Cool down (sub-max. 4 marks): (e.g. effective activities) Low intensity/ aerobic exercise/(static) stretching (effective CD) speeds up/aids removal of toxins/waste products/lactic acid OR speeds up recovery (effective CD) reduces the risk of fatigue-related injuries, e.g. sprained ankles during a tournament - Little evidence that a cool down reduces DOMS - Little evidence that a cool down reduces the risk of injury (except where repeated periods of exertion are needed between breaks, e.g. in a sports tournament)	5 (AO3)	Warm up accept: Pt 1 pulse raiser = ✓ Warm up do not accept: Pt 1 warm-up increases HR (TV) Pt 2 increases stretch of connective tissue (TV) Pt 2 increased flexibility (TV) Pt 4 pulled muscle (TV) Pt 6 'avoid static stretches' on its own (TV) Pts 4,5 prevents the injury (TV) Cool down accept: Pt 8 e.g. of low intensity aerobic exercise - walk/slow jog etc Pt 9 cool down may reduce DOMS (BOD) (DNA prevent) (Check not a rep if awarding pt9 for this) Cool down do not accept: Pt 10 prevents the injury (TV) Pt 9 Removes lactic acid (TV because removed regardless of a cool down)
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8	(a)		Three marks from: (Must be applied to a javelin thrower) (Markers) Reflective markers/sensors placed on bony landmarks/joints of the thrower (Recording) Performance of the throw is recorded using multiple video/infra-red cameras (Computer software) converts the throwing motion into digital format /3D image OR gives a record of the throw in time and (3D) space (Technique) Used to assess/analyse/identify errors in throwing technique / example of part of technique e.g. run up/ preparation/ foot plant/ arm action during the throw (Calculate) Used to calculate release velocity/acceleration of throwing arm (Adjust) Used (by coaches) to adjust technique to optimise throwing performance OR to match to technical model/elite performer	3 (AO2)	Accept: Look for pts 4 and 6 in one sentence for 2 marks Do not accept: Pt 1 markers/sensors 'stuck on the body' (TV) Pts 3 or 4 3D images can be analysed (TV) Pt 6 Ref to minimising injury. (Is a benefit but not description of use of LK.)
	(b)	(i)	Two marks for: (definition) The quantity of angular motion possessed by a (rotating) body OR The quantity of rotation of a body. (formula) (angular momentum) = <u>moment of inertia</u> x <u>angular velocity</u> OR $MI \times AV$ OR $L = I\omega$	2 (AO1)	Accept: Pt 1 synonyms for quantity e.g. amount/how much Pt 1 alternative appropriate definitions e.g. the rotary inertia of an object or system of objects in motion about an axis Pt 2 reverse order i.e. $AV \times MI$. Do not accept: Pt 1 definitions of angular motion, velocity or acceleration

		(ii)	Five marks from: (during take-off / A) eccentric force/ torque/ moment/force applied off-centre/away from the centre of mass (from the diving board) creates angular momentum at take-off. (at start of flight / B) MI is high/AV is low due to extended body shape/ high distribution of mass from axis of rotation/transverse axis (conservation in flight) in flight/during the somersault the diver will continue with constant angular momentum (as there is no eccentric/ off-centre force/ torque/ moment.) (in flight) moment of inertia is inversely proportional to angular velocity OR if moment of inertia increases, angular velocity must decrease to conserve angular momentum (in flight / C) the diver tucks / brings their mass closer to the axis of rotation which decreases moment of inertia / increases angular velocity (in flight / C) (angular velocity increases to conserve angular momentum) so the diver can complete the rotation for the somersault (preparation for entry / D) the diver straightens their body position/untucks/ increases distribution of mass from axis of rotation which increases moment of inertia /decreases angular velocity (preparation for entry / D) (angular velocity decreases to conserve angular momentum) so the diver can control the entry/prevent over-rotation/enter safely (entry) as the diver enters the water, the water exerts an eccentric/ off-centre force/ torque/ moment onto the diver which decreases angular momentum or angular momentum is no longer conserved.	5 (AO2)	Accept: Pt 1 force away from the centre of mass... Pt 1 motion instead of momentum 9.Landing instead of entry (BOD) Do not accept: Pt 3 Throughout the dive (TV) Pt 4 Change in MI causes change in AV (TV) Guidance: Pts 6 and 8 – only award if specific to how the diver performs the relevant phase of the somersault

	(c)	One mark for: 1. (Name of force) Drag OR fluid friction OR fluid resistance OR water resistance Submax four marks from: (Factors:) 2. Increased speed/velocity = increased drag 3. Decreased frontal cross-sectional area = decreased drag 4. Streamlined/ tapered shape = decreased drag 5. Smooth (body) surface characteristics = decreased drag 6. Decreased water density = decreased drag 7. Swimming underwater generates less (wave) drag than near/at the surface	5 (AO1)	Accept: Mark 1st four factors only. Pts 2-7: Reverse arguments, e.g. lower speed = less drag Do not accept: Pt 1 friction (alone) TV Pt 1 air resistance (X) Guidance: If an incorrect force is stated, pt1 = X, but carry error forward to mark positively for pts 2-7 (BOD) e.g. more streamlined shape reduces friction = ✓(BOD) if friction given incorrectly for pt1
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	(d) (i) Two marks for: Both arrows must be correctly drawn and labelled for each mark. For max 2 marks AR on diagram 2 must be clearly shorter than AR on diagram 1 <u>and</u> weight must be the same length in both diagrams. 1. (Left shuttle) W from C of M directly downwards and longer AR opposite direction of motion. 2. (Right shuttle) W from C of M directly downwards and AR opposite direction of motion of length similar to/shorter than W or shorter than in 1 (See diagram below for each mark) 1.  2. 	2 (AO2) Do not accept: M instead of W Arrows without labels Annotations: Max 1 tick per diagram (2 ticks for max)
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		(ii) Three marks from: (Near the start of flight) AR is high/dominant/(much) larger than W OR shuttle is (mainly) under the influence of AR OR resultant force is close to the direction of AR - During the flight AR has effect of slowing the shuttle (as velocity is high and weight/mass is low) - Reduced velocity/speed reduces size of AR (Near the end of flight) AR is lower OR shuttle becomes more under the influence of W OR weight (may be) dominant OR resultant force is closer to the direction of W - The flightpath is non-parabolic/asymmetrical because of change in relative size of AR and W or change in the dominant force (during the flight)	3 (AO2)	Accept: Pt 1 Non parabolic flight occurs when AR is the dominant force = ✓ Pt 1 $AR > W$ = ✓
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Section C			
Question		Answer	Guidance
9*		Level 4 (17–20 marks) • detailed knowledge and excellent understanding (AO1) • well-argued judgements which are well supported by relevant practical examples (AO2) • detailed analysis and critical evaluation (AO3) • very accurate use of technical and specialist vocabulary • there is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.	At Level 4 responses are likely to include: • very accurate knowledge of Newton's 3 Laws applied in detail using correct technical language and showing understanding of the balanced / unbalanced / external forces acting on the sprinter. • detailed understanding of plyometrics shown for a sprinter covering a range of training guidelines • a wide range of adaptations from plyometrics training analysed in detail with relevant application to the benefits for a sprinter. Muscular/connective tissue, neural and metabolic adaptations are likely to be covered. • <u>At the top of this level</u> Newton application may relate to more than one phase of a sprint. e.g. the sprint start, during the run
		Level 3 (12–16 marks) • good knowledge and clear understanding (AO1) • judgements will be present but may not always be supported by relevant practical examples (AO2) • good analysis and critical evaluation (AO3) • generally accurate use of technical and specialist vocabulary • there is a line of reasoning presented with some structure. The information presented is in the most-part relevant and supported by some evidence.	At Level 3 responses are likely to include: • good knowledge of Newton's 3 Laws applied with some accuracy to a sprinter. Application is likely to be limited to a single phase of sprinting e.g. the sprint start. • good description of the use of plyometrics with some training guidelines for a sprinter • a range of adaptations from plyometrics training identified with good analysis of the benefits for a sprinter. More than one of muscular/connective tissue, neural or metabolic adaptations are likely to be covered.

Section C			
Question		Answer	Guidance
		Level 2 (7-11 marks) - limited knowledge and understanding (AO1) - judgement given but often unsupported by relevant practical examples (AO2) - some evidence of analysis and critical evaluation (AO3) - technical and specialist vocabulary used with limited success - the information has some relevance and is presented with limited structure. The information is supported by limited evidence.	At Level 2 responses are likely to include: - some knowledge of Newton's Laws is shown with attempted application to a sprinter. Use of key terms may be limited or inaccurate. Application is likely to be simple/a repetition of the terms of Newton's law(s). - a limited description of plyometrics training which is likely to focus exclusively on examples of exercises. - several beneficial adaptations from plyometrics training are identified, with some analysis present.
		Level 1 (1-6 marks) - basic knowledge and little understanding (AO1) - little or no attempt to give judgement (AO2) - little relevant analysis or critical evaluation (AO3) - little or no attempt to use technical and specialist vocabulary - the information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear.	At Level 1 responses are likely to include: - basic reference to one/some of Newton's Laws, that may contain errors and show little understanding. - application of Newton's Law(s) to the sprinter may be attempted but likely to have inaccuracies - description/identification of a plyometric exercise - a small number of adaptations from plyometrics training may be identified, likely to be limited to muscular/connective tissue. - little or no analysis or application to a sprinter
		(0 marks) No response or no response worthy of credit.	

Marks: 20 (AO1 x 7, AO2 x 7, AO3 x 6)

Guidance: Maximum of 7 marks to be awarded for AO1.
Maximum of 7 marks to be awarded for AO2
Maximum of 6 marks to be awarded for AO3

Indicative Content:

AO1- KU	AO2 – E.G.	AO3 - DEV
Define and apply Newton's laws to a sprinter.		
1. Law of inertia 2. (N1 definition) A body remains at rest or constant velocity unless acted upon by an external/unbalanced force.	(on blocks/at start) - sprinter remains at rest if forces balanced - sprinter does not remain at rest if external/unbalanced force acts (during the run) - sprinter remains at constant velocity if forces are balanced/$AR=F/\text{net force} = 0$ - sprinter accelerates/decelerates/does not remain at constant velocity if external/unbalanced force acts / $AR \neq F / \text{net force} > 0$	external force of friction acts on the sprinter
3. Law of acceleration 4. (N2/ definition) The acceleration/rate of change in momentum of a body is proportional to the size of force applied 5. $F=ma$ 6. And acts in the same direction that the force is applied	(on blocks/at start) - the larger the forwards force from the blocks, the greater the acceleration out of the blocks (during the run) - the larger the forwards/friction force from the track, the greater the acceleration - forwards/towards the finish line - deceleration after the finish because $AR>F$ or unbalanced/net force acting against direction of motion	acceleration is inversely proportional to mass
7. Law of action reaction 8. (N3/ definition) For every action there is an equal and opposite reaction	(on blocks/at start) - the sprinter/foot pushes backwards (and downwards) on the blocks, the blocks push forwards (and upwards) onto the sprinter/foot (during the run) - the sprinter pushes backwards on the track and the track pushes forwards onto the sprinter/foot.	the reaction force is equal in size/magnitude and opposite in direction to the action force

Plyometric training for a sprinter. Guidance: Pts 9 and 12 – 15. Annotate AO2 e.g. credit even if associated KU not given		
9. Plyometric training involves explosive exercises/ is a form of explosive strength training	(plyometrics exercises relevant to a sprinter) • e.g. Bounding, squat jumps, bench jumps, medicine ball exercises • or other relevant e.g. • focus on muscle groups relevant to a sprinter / legs / e.g. gluteus maximus (e.g. credit to be awarded for max 2 exercises)	
10. Eccentric contraction followed by concentric contraction	• e.g. (in squat jump) rectus femoris eccentric contraction in the downwards phase before concentrically contracting in the upwards/jump phase • or other relevant e.g.	• More powerful/fast muscle shortening/contraction if muscle is initially lengthened/pre-stretched
11. Warm up/cool down should be performed	• e.g. of relevant warm -up/cool down activity • Warm up reduces risk of DOMS	
12. Resistance guidelines should be tailored for explosive strength gains/ target FG muscle fibres	• Body weight/addition of medicine ball • high intensity / 75-85% for explosive gains	
13. Repetitions should be tailored for explosive strength gains / target use of the ATP-PC energy system	• (depending on exercise) 30 seconds/6-10 reps/jumps	
14. Sets should be tailored for explosive strength gains	• 2-6 sets/100-200 contacts per session	
15. Recovery designed to benefit explosive training/ allow full recovery between sets/sessions	• 3-5 minutes recovery between sets • W:R ratio 1:3+ • 2 rest days between plyometric sessions to ensure full recovery • 2-3 sessions a week	

Physiological adaptations from plyometric training that would benefit a sprinter			
Muscle and connective tissue	16. Muscle hypertrophy/ increased cross sectional area of FG muscle fibres	(e.g.) gluteus maximus, rectus femoris or other muscle relevant to a sprinter	- increases force of contraction - increases speed of contraction - increased intensity of performance - greater reaction forces/increased acceleration for the sprinter
	17. Increased number/size of contractile proteins or myofibrils or actin/myosin (filaments)	in fast glycolytic fibres	- increased contractile strength (of each fibre) - due to increased cross-bridging - increased speed/power output
	18. Hyperplasia/ Increased number of fibres	e.g.in rectus femoris	- splitting of fast glycolytic muscle fibres causes increased size and strength of muscle - increased power for the sprinter
	19. Increased strength of tendons/ligaments/connective tissue	- e.g. knee/ankle ligaments OR ACL/MCL etc - e.g. achilles/patellar tendon - or other ligament/tendon relevant to a sprinter - improved reaction time for the sprinter	- increased joint stability - increased efficiency of force generation increases running speed - decreased risk of (joint) injury - prevents de-training/reversibility due to injury lay-off
Neural	20. Increased recruitment of motor units/FG/FOG muscle fibres OR Improved coordination of firing of fast glycolytic motor units		- increased co-ordination/simultaneous stimulation of motor units allows greater force to be generated - increased acceleration/speed for the sprinter - plyometrics causes faster power/speed adaptations than other types of training
	21. Decreased inhibition from stretch reflex	- e.g. rectus femoris/gluteus maximus (agonist) and biceps femoris/iliopsoas (antagonist) - or other relevant agonist/antagonist muscles used in sprinting - Increased stride length	- increased force of contraction of the agonist - antagonist stretches further before the initiation of the stretch reflex causes relaxation of the agonist - reference to reciprocal inhibition - increased co-ordination of antagonistic pairs. - increased force/power to improve sprinting - decreased risk of (antagonist) muscle injury

Metabolic	22. Increased ATP/PC stores	sprinting uses ATP-PC energy system during very short duration/very high intensity work	- increased capacity for alactic energy production/use of PC energy system - maintain (very) high intensity work for longer - fast energy production increases peak power output
	23. Increased glycogen stores	200m-400m sprints (predominantly) use glycolytic energy system	increased fuel for glycolytic energy system for (200m-400m) sprinting
	24. Increased enzyme activity	ATPase / creatine kinase / GPP	increased efficiency of anaerobic energy production most relevant to sprinter
	25. Increased buffering capacity	glycolytic system used in high intensity sprinting	- sprinter benefits from increased anaerobic threshold or increased tolerance to lactic acid or delayed OBLA - delayed fatigue so maintains pace throughout race

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