Diploma Programme
Programme du diplôme
Programa del Diploma

Markscheme

May 2023

Sports, exercise and health science

Higher level

Paper 2

31 pages

Subject details: Sports, exercise and health science HL paper 2 markscheme

Mark Allocation

Candidates are required to answer **ALL** questions in Section A **[50 marks]** and **TWO** questions in Section B **[40 marks]**.
Maximum total = **[50 marks]**.

Markscheme format example:

Question			Answers	Notes	Total
5	**c**	**ii**	this refers to the timing of the movements ***OR*** the extent to which the performer has control over the timing of the movement ✓ external paced skills are sailing/windsurfing/receiving a serve ✓ internal paced skills are javelin throw/gymnastics routine ✓		**2 max**

1. Each row in the "Question" column relates to the smallest subpart of the question.

2. The maximum mark for each question subpart is indicated in the "Total" column.

3. Each marking point in the "Answers" column is shown by means of a tick (✓) at the end of the marking point.

4. A question subpart may have more marking points than the total allows. This will be indicated by "**max**" written after the mark in the "Total" column. The related rubric, if necessary, will be outlined in the "Notes" column.

5. An alternative word is indicated in the "Answers" column by a slash (*/*). Either word can be accepted.

6. An alternative answer is indicated in the "Answers" column by "***OR***". Either answer can be accepted.

7. An alternative markscheme is indicated in the "Answers" column under heading **ALTERNATIVE 1** *etc*. Either alternative can be accepted.

8. Words inside chevrons **« »** in the "Answers" column are not necessary to gain the mark.

9. Words that are <u>underlined</u> are essential for the mark.

10. The order of marking points does not have to be as in the "Answers" column, unless stated otherwise in the "Notes" column.

11. If the candidate's answer has the same "meaning" or can be clearly interpreted as being of equivalent significance, detail and validity as that in the "Answers" column then award the mark. Where this point is considered to be particularly relevant in a question it is emphasized by ***OWTTE*** (or words to that effect) in the "Notes" column.

12. Remember that many candidates are writing in a second language. Effective communication is more important than grammatical accuracy.

13. Occasionally, a part of a question may require an answer that is required for subsequent marking points. If an error is made in the first marking point then it should be penalized. However, if the incorrect answer is used correctly in subsequent marking points then **follow through** marks should be awarded. When marking, indicate this by adding **ECF** (error carried forward) on the script. "ECF acceptable" will be displayed in the "Notes" column.

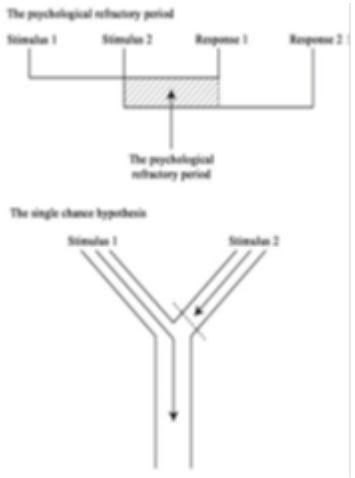
14. Do **not** penalize candidates for errors in units or significant figures, **unless** it is specifically referred to in the "Notes" column.

Question			Answers	Notes	Total
1.	a	i	800<ml>;		1
1.	a	ii	80-63=17<cm>;	*Accept 79-80,61–64, i.e., difference of 19–15 cm (calculations must be accurate for values presented to be credited e.g., 79-64 = 15)* *Accept 0.5 cm increments* *Workings must be demonstrated to be credited the mark*	1
1.	b		Safety/ethics: The experimenter must make all reasonable efforts in order to ensure the safety of the participants and minimise the chances of injury; ✓ Validity of data: A warm-up helps to prepare the body's muscles/nerve tissue/joints/ mental focus to optimise performance in the maximal test to provide more valid results; ✓ Reliability: A standardised warm-up is used so that every subject is prepared in the same manner/ allows a common baseline therefore greater chance of collecting reliable data; ✓	*Note: practice effect not relevant because warm-up has not been described, therefore can't say they are practicing during the warm-up.* *Do not accept 'warm up- makes you prepared for the test' there needs to be reference to psychological or physiological aspects.*	3
1.	c		Greater forearm volume suggests greater muscle size/cross section; ✓ (Larger cross section) therefore possible greater strength; ✓ (Larger cross section) therefore possible greater power; ✓ Larger forearm volume is linked to peak finger strength; ✓		2

			Because the muscle group is significant in climbing; ✓		
1.	**d**		Striated; ✓ Involuntary; ✓ <Joined by>intercalated discs <that contain gap junctions for depolarization between cells>; ✓ Single nucleus; ✓ Branched; ✓ High fatigue resistance/does not fatigue; ✓ High mitochondrial density; ✓	*Do not accept it is found in the heart*	**2**
1.	**e**		peripheral fatigue occurs in high intensity activities <peak finger strength test>; ✓ peripheral fatigue depends on the rate of: depletion of energy sources (creatine phosphate/ATP/<muscle> glycogen) ***OR*** Accumulation of ADP; ✓ increased levels of fatiguing by-products such as phosphates/ lactates/hydrogen ions/H+ ***OR*** Inhibition of cross bridge formation; ✓ Reduction in calcium availability for muscular contraction; ✓	*Do not accept dehydration, overheating, electrolyte loss, or depletion of acetylcholine*	**2**

2.	**a**		Handball group; ✓		**1**
2.	**b**		<46.5–41.9 = 4.6> (4.6 ÷ 41.9) x 100 = 10.9 <%> ✓	*Accept 10.98 or 11.00 as alternative to 10.9.* *Note: increase not vital for this question*	**1**
2.	**c**		hypothesis is supported: Multistage fitness distance increases from 1880 to 2480 <m>/31.9% ***OR*** <Statistically> significant increase in Multistage fitness distance; ✓ VO2 max increases from 41.9-46.5 / 10.9% ***OR*** <Statistically> significant increase in VO2 max; ✓ The hypothesis is supported by the data ***OR*** Evidence suggests that regular exercise improves Cardiovascular health; ✓ Hypothesis is not supported: No change/slight increase in BP ***OR*** heart rate contradicts the hypothesis; ✓	*(Accept 32% for distance ran MSFT)* *(Accept 10.98 or 11% for V02 max)* *Allow ECF from 2b* *Accept any valid cardiovascular adaption from regular exercise for third marking point*	**3**

2.	**d**		Blood flow around the body is influenced through the processes of: Vasoconstriction of blood flow to region of low demand/<*e.g.,* kidney/liver> ***OR*** Contraction of smooth muscle around an artery to reduce blood flow to a region of low demand/<*e.g.,* kidney/liver>; ✓ Vasodilation of blood flow to a region of high demand ***OR*** Relaxing of smooth muscle around an artery to increase blood flow to a region of high demand; ✓ As the subject performs the test/warms up there is a <significant> shunt of blood flow from other organs / processes such as the stomach and digestive system; ✓ Actual blood flow to the heart/skin/brain increases <although relative percentage of blood flow remains the same or lower> ***OR*** Blood flow to liver/kidneys is reduced during exercise compared to rest; ✓ Blood is shunted to support the working leg muscles <and cardiovascular system/lungs> ***OR*** 80-85% blood flow is distributed to the working muscles <compared to 20-25% at rest; ✓ As the subject gets warmer with exercise, sensors detect the increase in body heat and trigger vasodilation / blood flow to the skin to cool the body down; ✓		**3**

2.	**e**		The player fakes to initiate an action in one direction, *e.g.*, a badminton player pretends that they will hit a serve in one direction ***OR*** This becomes stimulus one/S1 which the opponent first attends to; ✓ At the last moment the player changes their action/ / Stimulus 2 (S2) *e.g.,* the server hits the shuttle in the opposite direction; ✓ When a stimulus/S1 is closely followed by a second stimulus/S2, the first stimulus/ response 1 must be cleared before the second/ response 2 can be processed ***OR*** Due to the single channel hypothesis the opponent cannot immediately switch their attention to the second stimulus; ✓ The PRP therefore, slows down the opponent's response to S2 <gaining an advantage>; ✓ If fakes become predictable or there is a large time gap between S1 and S2 the advantage for the PRP is reduced ***OR*** PRP can be affected by the experience of the performer/ opponent; ✓	*Award [3] max if no example is given* *Accept a clearly annotated diagram*  	**4**

3.	**a**		Phase 3, right carpals begin inferior to the right clavicle; ✓ Phase 4 right carpals are superior to the right clavicle; ✓ Right carpal will move more lateral to the right clavicle as they move from phase 3 <to phase 4> ***OR*** Right carpal will abduct from the clavicle in phase 3 <to phase 4>; ✓		**2**
3.	**b**		Reciprocal inhibition is a neuromuscular reflex that inhibits opposing muscles <to enable voluntary movements> <it is usual for the antagonist to relax so that the agonist is not being opposed>; ✓ At take off: *e.g.,* knee: Quadriceps are the agonist/contract; ✓ Hamstrings are the antagonist/inhibitor/relaxes; ✓ To allow force to be applied and extension of the leg at the knee; ✓ *e.g.,* ankle: Gastrocnemius/soleus is the agonist/contract; ✓ Tibialis anterior is the antagonist/inhibitor/relaxes; ✓ To allow force to be applied and plantar flexion/ extension of the leg at the ankle; ✓ *e.g.,* hip: Gluteus maximus is the agonist/contraction; ✓ Iliopsoas/hip flexor is antagonist/inhibitor/relaxes; ✓ To allow force to be applied and extension of the leg at the hip; ✓	*Accept reference to individual quadriceps or hamstrings.* *Do not accept Quad*  1	**3**

3.	**c**		Incorporation of sufficient recovery time into training programmes/reduce overtraining ***OR*** Ensure sufficient sleep; ✓ Avoid close contact with people identified with infections / wear mask / temperature check / quarantine; ✓ Maintain oral hygiene ***OR*** Maintain good personal hygiene (*e.g.,* wash hands, avoiding hand-to-mouth contact); ✓ Maintain a suitable/healthy/varied diet ***OR*** Maintain hydration status; ✓ Ensure water is pathogen-free; ✓		**4**

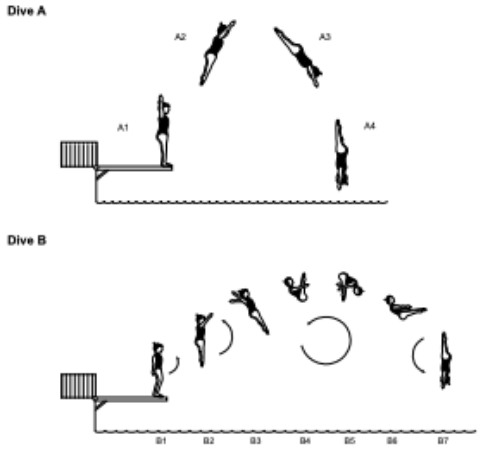
3.	**d**		Hormones are regulated by <complex> feedback loops; ✓ Regulated by chemical changes within extracellular fluids *e.g.*, blood; ✓ *e.g.,* insulin: increase in blood glucose level stimulates release of insulin <from pancreas>; ✓ *e.g.,* glucagon: decrease in blood glucose levels stimulates release of glucagon; ✓ Signals from the nervous system / once the substance reaches a certain level, it sends a signal that stops further release of the substance; ✓ *e.g.,* adrenaline: released due to fight or flight response through autonomic nervous system / sympathetic nerve; ✓ Endocrine glands release hormones when stimulated by hormones released by other endocrine glands; ✓ *e.g.,* growth hormone: stressors stimulate GHRH release from hypothalamus, which in turn stimulates pituitary to release GH; ✓	*Award [1] max per example* *Examples must be explained, not merely listed* *Accept an appropriately annotated diagram*	**4**

4.	**a**		The predominant energy system involved is the lactic acid system/ anaerobic glycolysis; ✓ This system does not use oxygen/is anaerobic; ✓ Glucose is converted into pyruvic acid/ pyruvate; ✓ 1 glucose molecule produces 2ATP/4ATP gross; ✓ Due to insufficient oxygen supply / anaerobic conditions during high intensity activities pyruvic acid/ pyruvate is converted into lactic acid/ lactate; ✓ This system operates in the cytoplasm of the cell; ✓ This system produces of lactate/lactic acid/H^+, <which causes fatigue>; ✓	*Second marking point must be explicitly stated not simply in reference to the system.*	**3**
4.	**b**		Running has a larger VO_2max <up to 30% more> than arm ergometry; ✓ Running uses more/larger muscle groups <therefore requiring and accessing more O_2>; ✓ If someone is highly trained in arm ergometry, VO_2max would be closer to their own running VO_2max; ✓	*Remove more muscles from publishing and just leave larger muscle groups*	**2**

4.	**c**		1st law: Inertia/an object remains at rest or continues to move at constant velocity unless acted on by an unbalanced force; ✓ *e.g.,* at start of race, from stationary to moving can be maximised by having a light boat and light paddle ***OR*** *e.g.,* the kayak will remain at rest unless the kayaker moves the paddle to apply a force; ✓ Harder to change when inertia is greater; ✓ Once up to speed, kayaker needs to maintain inertia with less work, if too heavy, requires lots of work to maintain momentum; ✓ 2nd law: F=ma; ✓ Larger muscle groups to apply greater force to produce greater acceleration; ✓ Impulse=force x time / if force is applied for longer it creates greater acceleration; ✓ In the direction of force applied; ✓ *e.g.,* a lighter person who can generate the same amount of force as a larger person will kayak faster; ✓ 3rd law: Reactive force 'equal and opposite'; ✓ *e.g.,* the kayaker pushes the paddle through the water, so that the water pushes back on it and propels the kayak forward; ✓ May consider paddle size/face of paddle – apply greater force; ✓ And the direction of the force applied; ✓	*Credit only one of Newton's laws (award highest mark possible) remove the section in brackets for publication* *Not for publishing* *Credit for examples and description for a law. Do not penalise for incorrectly naming a law.*	**3**

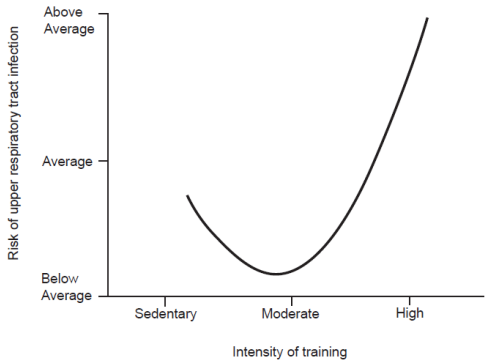
4.	**d**		Form drag is created by the kayak/paddle pushing against the water and the water pushing back; ✓ Therefore, the greater the size/non-streamlined shape of the kayak/paddle/kayaker moving through the water/air the greater the drag ***OR*** *e.g.,* Longer thinner boat will be more aero/hydrodynamic / shape of back of boat to reduce drag; ✓ Surface drag is created by the outer surface layer of the kayak/paddle/kayaker catching on the water/air; ✓ Therefore, the smoother the surface of the kayak/paddle/kayaker the less drag created ***OR*** *e.g.,* Kayak has a waxed hull/ a rounder hull compared to a flat hull/smooth clothing to reduce drag; ✓ Wave drag is created when the kayak/paddle moves along the surface of the water; ✓ Therefore, reducing the interaction between the water and boat will reduce the drag ***OR*** *e.g.,* Having a balanced position within the boat/ effective paddle entry/ avoiding rough water/ avoiding waves from other boats/ use of a kayak skirt to reduce drag; ✓ The greater the velocity of the kayak, the greater the potential drag ***OR*** Relative direction of water current/wind may affect drag acting on kayak/kayaker; ✓	*Award [2] max for a list* *Accept in the converse* *Only credit two types of drag*	**4**

4.	**e**		Genes code for the production of proteins responsible for the development of an individual *e.g.,* muscle fibre type; ✓ *e.g.,* although characteristics *e.g*., lung capacity are influenced by genes they can also be influenced by the environment; ✓ Genes can be switched on or switched off depending on internal or external factors, so that characteristics can change during a person's lifetime; ✓ Multiple genes determine the measurable characteristics for each individual, therefore unlikely a single/ few genes are associated with athletic performance; ✓		**2**

5.	**a**		Angular momentum is defined as moment of inertia x angular velocity / angular velocity and moment of inertia are inversely proportional; ✓ Angular momentum is when a body is spinning about an axis; ✓ A moment of inertia is determined by the distance of the load from the rotational axis; ✓ *Similarities*: Angular momentum remains constant unless the diver is acted upon by an unbalanced force; ✓ Start: longer maximal radius <arms / legs> to correct body position/stability to execute chosen dive; ✓ Final phase: <maximized radius,> maximized moment of inertia, which reduces angular velocity / rotation and therefore diver can enter water vertically without rotation>; ✓ Rotating about the same <transverse> axis; ✓ *differences*: Change in arm position B1–B2 upward thrust to initiate rotation; ✓ Going into pike/phase B4, <radius is reduced,> moment of inertia reduced, angular velocity is increased, therefore spin faster to allow diver to complete somersault; ✓ Diver A does not change moment of inertia during dive ***OR*** Final phase: coming out of pike/phase B6 to maximise moment of inertia which reduces angular velocity, therefore reduce spin speed to allow diver to enter water vertically <without rotation>; ✓	*Award [2] max for definition* *Award [3] max if no similarities or differences given*  	**5**

5.	**b**		Internal noise, *e.g.*, worries/stresses/lack of confidence/self-talk, reward effort over outcome / create positive outcomes to increase confidence / simplify the task to the appropriate level; ✓ External noise, *e.g.*, sight, sound, unnecessary/irrelevant stimuli, *e.g.* audience/visual confusion/sound distraction, remove unnecessary/irrelevant <audio/visual>stimuli, *e.g.* play in a closed environment; ✓ Increase intensity of the stimulus, *e.g.*, change colour/size of ball/bat/ reduce number of stimuli; ✓ Efficiency of the sense organs, *e.g.*, poor eyesight, wear glasses/goggles, poor hearing can't hear a mishit, modify ball/wear hearing aid; ✓ Early signal detection, *e.g.*, look for relevant cues; ✓ Improve signal detection, *e.g.*, practice in a closed environment; ✓		**3**
5.	**c**		*similarities*: both runners will use ATP-PC in initial stages; ✓ both will use all three systems at any one time during the race; ✓ lactic acid will be used when pace goes above 85/90% maxHR; ✓ Both utilises carbohydrates as their substrates; ✓ *differences*: 10 000m race predominantly utilises the aerobic energy system. 400m race predominantly utilises the lactic acid system; ✓ 10,000m race has a larger age use of lipids, as a substrate as compared to the 400m; ✓	*Award [3] max if no similarities or no differences are given*	**4**

5.	**d**		Allows performers to prevent overtraining/injury ***OR*** Reduces the chance of the immune suppression; ✓ Recovery rates differ depending on the time of activity *e.g.,* alactic is faster <30-3 minutes>than lactic <1-24 hours>; ✓ Recovery rate depends on the type of activity (high-intensity, team sports, or endurance); ✓ Recovery rates depend on the experience and fitness of an individual; ✓ Allowing schedule recovery can allow performers to optimise their performance in training/competition ***OR*** Supercompensation/enabling the body to repair and build key tissues; ✓ Recovery allows for the restoration of: Restoration of muscle creatine phosphate stores ***OR*** Replenishment of myoglobin stores; ✓ Removal of H+ ***OR*** Resynthesis/removal of lactates /lactic acid; ✓ Replacement of muscle and liver glycogen stores; ✓		**5**

5.	**e**		An intense bout of exercise can cause tissue damage and so is accompanied by responses that are similar to those of an infection; ✓ When training loads are high and prolonged, there tends to be a decrease in <innate and adaptive> immune function; ✓ Sustained increases in levels of cortisol and adrenaline over long periods suppress the immune system; ✓ Leucocyte numbers drop <compared to sedentary people> therefore greater risk of illness/complications of infection ; ✓ Greater exposure to airborne bacteria and viruses because of greater depth and rate of breathing; ✓	*Award [1] Max for list of 2 or more factors* *Accept a J curve with appropriately annotated axes for the second marking point*  	**3**

6.	**a**		With exercise there is an increase in the production of CO_2; ✓ Increase in CO_2, increases blood acidity/low pH levels; ✓ Detected by the respiratory centre/ chemoreceptors; ✓ This results in an increase in the depth of ventilation; ✓		**3**
6.	**b**		Homeostasis is the maintenance of equilibrium in the body; ✓ The hypothalamus and pituitary gland are parts of the endocrine system / use hormones to control body systems; ✓ Hypothalamus receives messages from stressors around the body; ✓ Neurohormones/ GHRH/ somatostatin from the hypothalamus, directly influence the pituitary gland; ✓ Nerve impulses from the hypothalamus also stimulate the pituitary gland; ✓ The pituitary gland secretes hormones <such as antidiuretic hormone (ADH) and growth hormone (GH)> that help to regulate a wide range of bodily functions including growth, and water and temperature regulation; ✓	*Award [2] max for list of examples*	**4**

6.	**c**		HR & oxygen uptake relationship: regardless of age/sex or fitness the (linear) relationship between percentage max HR & percentage max oxygen uptake is maintained; ✓ activities with smaller muscle mass *e.g.,* arm ergometry percentage max HR may be affected; ✓ training heart rate range/zone: calculate max HR <using a formula>; ✓ training zone intensity is selected depending on the objective (*e.g.,* aerobic capacity); ✓ calculate a HR range using percentage of max HR for training zone range ***OR*** an upper and lower HR range using max HR are selected for the specific training zone; ✓ *Karvonen method:* Karvonen method calculates the heart rate reserve (HRR) ***OR*** Calculate max HR <using a formula>; ✓ HRR=maximal heart rate–resting heart rate; ✓ once HRR has been calculated, the next step is to calculate target heart rate (THR); ✓ THR = (HRR x exercise intensity) + resting HR; ✓	*Only award credit for the third or seventh marking point once*	**4**

6.	**d**		manipulating constraints may influence motivation, and therefore improve skill learning; ✓ Athlete/individual constraints: constraints related directly to the athlete/individual which can be structural <anatomical>/ functional <physiological/psychological>; ✓ <modify cognition> *e.g.,* provide simple closed skills to help focus on the elements of one skill; ✓ <modify decision making> *e.g.,* provide opportunities for performers to choose such as ways to travel around an obstacle course; ✓ <modify movement patterns|> *e.g.,* focus on reaching for a bar/height on take-off during long jump (without focus on distance jumped>; ✓ task constraints: constraints related directly to the goals, rules or equipment used to perform the skill; ✓ <modify rules> e.g., in rugby to be able to pass in any direction <to players to learn to catch and handle the ball> ***OR*** *e.g.,* playing 3 v 3 allows more opportunities to pass and receive the ball; ✓ <modify the goals> *e.g.,* in soccer you can only score using one touch < to introduce methods of goal scoring>; ✓ <modify equipment> *e.g.,* use a shorter handle/lighter racket to aid control in tennis; ✓ environmental constraints: Environmental are the physical features which can influence performance *e.g.,* playing surface and social factors *e.g*., peer pressure; ✓	*Award [1] max for a list of the three main areas of constraint (athlete, task and environmental)*	**5**

			<modify the surface> *e.g.,* practise running on a track rather than long grass to allow focus on good technique; ✓ <modify the size of playing area> *e.g.,* making an area smaller could increase chances to practice tackling in soccer; ✓ <modify social factors> *e.g.,* allowing performer to practise independently or in pairs during a dance routine ***OR*** Adding competition to place skills under pressure; ✓		
6	**e**		Physical maturation: decreased strength / height / weight / coordination / cognitive abilities will generally slow the rate of learning; ✓ Physical fitness: ability to be fit enough to perform the required skill being learned, *e.g.,* insufficient strength / endurance / flexibility will decrease rate of learning; ✓ Individual differences of coaches: poor coach's knowledge / inability to convey information / provide inaccessible feedback will decrease rate of learning; ✓ Age: lower cognitive ability / physical abilities will slow the rate of learning; ✓ Difficulty of task: increased complexity will slow rate of learning; ✓ Teaching environment: increased distractions / harsh conditions will decrease rate of learning ***OR*** Influence of performing with friends could increase <motivation, therefore increase> learning, the pressure of performing in front of peers can hinder learning; ✓ Motivation: low motivation will decrease rate of learning; ✓ Previous experience/previous learning/skill transfer*, e.g.,* passing in netball and passing in basketball; ✓	*Award [1] max for a list of 2 or more factors* *Accept in the converse*	**4**

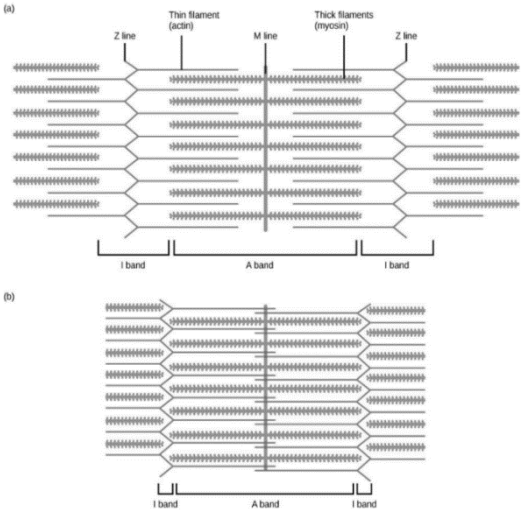
7.	**a**		Primary function of cerebellum is to evaluate how well motor areas of cerebrum are actually being carried out; ✓ Sends feedback to cerebral cortex; ✓ Important in coordination, precision, timing of movement / skeletal muscle contractions ***OR*** Adapts/fine-tune/smooth movements; ✓ Regulates posture and balance; ✓ Makes possible all skilled motor activities; ✓ *e.g.*: player can throw the ball in the air and hit it correctly / timing of ball toss and racquet position and follow through; ✓	*Award [3] max if not applied to tennis* *Accept any appropriate examples*	**4**
7.	**b**		Preparation phase: balanced/ready <*e.g.,* grip, stance, ball position>; ✓ Retraction phase: wind up/ ball toss <to maximise action phase *e.g.,* winding back>; ✓ Action phase: begins with a forward motion of the swing to hit the ball <to gather momentum and apply force at point of contact *e.g.,* downswing>; ✓ Follow-through: movement continues past the point of contact <to maximise direction of force, and maximal momentum transfer *e.g.,* continuation of downswing and forward momentum>; ✓ Coach can compare performance with an elite athlete to provide key pointers that they can improve on; ✓	*Award [1] max per phase* *Award [1] max for list of 4 correct phase titles in chronological order if marking points 1 – 4 have not been awarded* *Allow reference to the steps below, but do not credit more than [1] max for linking the four phases to each step*	**4**

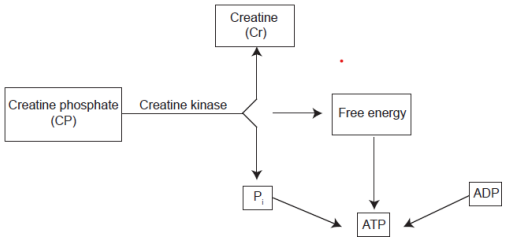
7.	**c**		The brain's principal source of energy is glucose and oxygen <which pass rapidly from the blood to the brain cells>; ✓ The brain has limited capacity for CHO storage ***OR*** Brain requires a constant supply of glucose to function; ✓ Fasting causes low blood glucose levels/stores ***OR*** Fasting causes a reduced supply of glucose to the brain; ✓ Potential consequences are dizziness / mental confusion / convulsions / loss of consciousness; ✓ Therefore fat/protein may have to synthesised into glucose via gluconeogenesis to provide energy for brain function; ✓		**3**

7.	**d**		Selective attention/SA is the ability to attend to relevant/important cues/signals/stimuli; ✓ *In cognitive phase:* A performer has reduced ability to select relevant cues ***OR*** A performer does not know what cues to selectively attend to; ✓ Reduced SA ability can result in information overload and confusion, as the brain would not be able to cope with streams of information; ✓ Reduced experience therefore reduced relevant long-term memory to draw from; ✓ Performance is commonly erratic/inconsistent/large errors; ✓ Still learning/building up memory of the skill requirements ***OR*** Should try to avoid overwhelming the short-term memory; ✓		**4**

7.	**e**		Genetic factors that influence performance include height / muscle fibre type / anaerobic threshold / lung capacity / flexibility; ✓ Environmental factors that influence performance include physical training / nutrition / technological aids / climate; ✓ Training maximizes the likelihood of reaching a performance level with a genetically-controlled ceiling; ✓ Elite athletes can be distinguished from less well performing athletes with respect to both inherited (genetic) characteristics and training histories; ✓ It is presently not possible to ascertain the relative contribution of genetics or training to elite sporting performance, and this contribution is likely to differ for different sports; ✓ Genetic research indicates genotype dependency responding to aerobic and anaerobic power training; ✓	*Award [3] max for a list*	**5**

8.	**a**		*similarities*: when they stop exercising, heart rate will decrease; ✓ heart rate will return to resting rate; ✓ *differences for trained athlete*: speed of recovery is faster for trained athlete; ✓ has lower O_2 debt/ EPOC; ✓ faster to return to resting heart rate; ✓ PC stores restored more quickly; ✓ Lactic acid/ lactate/H^+ removed more quickly ***OR*** Glycogen stores are restored more quickly; ✓	*Accept in the converse for untrained* *Award [2] max if no similarities or differences given*	**3**

8.	**b**		Calcium ions are released from the sarcoplasmic reticulum <when stimulated by an action potential>; ✓ Calcium ions bind to troponin; ✓ Tropomyosin/troponin complex exposes the binding site «on actin»; ✓ ATP on the myosin head is broken <into ADP & Pi>, causing myosin heads to recoil <storing potential energy>; ✓ <Myosin «head» creates a cross-bridge with the actin; ✓ Power stroke takes place <releasing ADP & Pi>; ✓ Pulling Z lines together/shortening the sarcomere; ✓ Cross bridge is broken <via the breakdown of ATP>; ✓ Crossbridge cycling continues until the muscle fiber is no longer stimulated; ✓ H zones shrink/ I band disappears/ a band is unchanged; ✓	Accept an annotated diagram where appropriate. 	**6**
8.	**c**		Pacemaker/SA node fires/initiates/sends <electrical> impulse; ✓ impulse travels across the atria walls and arrives at AV node ***OR*** Impulse is delayed at AV node <to allow atria systole/ventricular diastole>; ✓ Impulse passes from the AV node down to the bundle of His/AV bundle <through the septum into the bundle branches to the apex of the heart>; ✓ Travels up through the Purkinje fibres <to stimulate the rest of the ventricles>; ✓	*Accept an annotated diagram with arrows* *Responses must be in chronological order as shown in the MS to be credited* *Just listing the main structures is considered a list e.g SA Node, AV Node, Bundle of his/bundle branches, Purkinje fibres.* *Award (1) Max for a list.*	**4**

8.	**d**		ATP-PC system <is operating as the predominant energy system>; ✓ phosphate is released from PC/CP <and made available for ADP>; ✓ 1PC/CP gives 1ATP ***OR*** ATP gain replenish a phosphate for around 10-15 secs; ✓ process is anaerobic; ✓ PC/CP is broken down by enzyme creatine kinase ***OR*** Reaction occurs in the cytoplasm; ✓	*accept an annotated diagram*  	**3**
8.	**e**		Coefficient of friction (μ) is <a dimensionless scalar quantity which> is the ratio of the force of friction (Ff) between two bodies and the normal reaction force (R) ***OR*** Friction is a force acting in the opposite direction to the direction in which the object is moving, or trying to move; ✓ The magnitude of the coefficient of friction depends on the materials in contact; ✓ *e.g.,* Rubber sole on the dry gym floor has a high coefficient of friction; ✓ The greater the interaction between the molecules of the interfacing surfaces, the greater the size of the coefficient of friction; ✓ *e.g.,* Sports shoes (including spikes/cleats) and playing surface (grass, artificial surfaces, wood) / use of a golf glove / chalk on hands for rock climbing; ✓	*Award [1] max per type of example* *Award [3] max if no examples given*	

References: