Markscheme

May 2024

Sports, exercise and health science

Higher level

Paper 3

21 pages

Subject details: Sports, exercise and health science HL paper 3 markscheme

Mark Allocation

Candidates are required to answer **ALL** questions from two of the options **[2×25 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 underlined 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.

Option A — Optimizing physiological performance

Question			Answers	Notes	Total
1.	**a**		280 <W>;	*Accept +/- 2*	**1 max**
1	**b**		there was no <significant> effect of condition during the first 20% of the time-trials; as days spent training in the heat increased, power output during the time trial increased/ decreased less/ power TTH1<TTH2<TTH3; power output during TTH-1/2/3 remained lower than TTC ***OR*** power output during TTC remained higher than all other time-trials; TTC power remained relatively constant over the trial ***OR*** TTH -1/2/3 showed more variability in power throughout the trial; between 30-40%, power output in TTC decreases, whereas TTH-1/2/3 are relatively stable/ decrease very slightly; from 30% of the distance covered onward TTH-1 remained significantly <p<0.01> lower than TTC; power output during TTH-2 became significantly <p<0.05> lower than TTC from 50% of the distance covered onward;	*Max [1] with no reference to data* *Accept any answer relating to trend of specific data*	**3 max**
1	**c**		cyclists acclimatised to the heat <after 14 days>;	*Candidates should look at the difference through TTH3-2-1* *Must relate to 'acclimatisation'*	**1 max**

				answers relating to power output/ responses should not be credited	
2.	**a**		at least part of their training should take place in the <midday> sun to fully prepare; training should be reduced to <60–70% of maximum> in the initial days of heat training <to reduce the risk of excessive heat stress/ heat disorders> and gradually increase the duration and intensity of rides over the two-week period; wear appropriate clothing to allow effective evaporation/ reduce conduction/ radiation e.g. light breathable clothing ***OR*** wear cooling vest; monitoring physiological markers, e.g. skin temperature, dizziness, nausea; monitor hydration status/ drinking more water/ electrolyte replacement;	*Don't award marks for reference to timing of arrival in city*	**2 max**
2.	**b**		sweat <produced within the sweat glands> is converted from liquid to vapour/ by heat from the skin and is transported away/ sweat evaporates cooling the skin;	*Must give an explanation along with sweat*	**1 max**
2.	**c**		typically accompanied by symptoms of extreme fatigue/ breathlessness/ dizziness/ vomiting/ muscle cramps/ fainting/ hypotension; if heat exhaustion is not treated, an individual may suffer from heat stroke which is a life-threatening heat disorder; individuals who are poorly conditioned or not acclimatised are more susceptible to heat exhaustion; heat exhaustion often occurs when blood plasma volume deceases by either excessive fluid loss/ mineral loss through sweating; blood often pools in the peripheral vessels reducing central blood volume required to maintain cardiac output; during heat exhaustion thermoregulatory mechanisms are unable to remove heat quickly enough due to low blood volume;		**3 max**

			reduction in sweating capabilities; typically, an increase in muscle sympathetic nerve activation increases core body temperature/ skin blood flow/ perfusion reducing blood flow to muscles causing a decline in muscle force production/ fatigue/ reduction in performance;		
3.	**a**		oxygen supply to cells is insufficient	*Do not accept oxygen supply to blood/ body is insufficient*	**1 max**
3.	**b**		athletes need to live/ stay at a moderate altitude/ >2000 m above sea level/ high enough to raise EPO levels; training low/ near sea-level allows athletes to maintain the high intensity and volume of training needed to improve training low/ near sea-level reduces the unwanted physiological side effects, e.g. altitude sickness; not all individuals benefit to the same degree from LHTL <non-responders> as they have limited increases in EPO production through exposure to altitude; they will have a competitive advantage as they will have the physiological benefits of living at altitude; increased endurance living at altitude encourages increase in number of red blood cells/ erythrocytes/ capillarization/ faster recovery in athletes' bodies; increase in VO_2 max;		**3 max**
4.	**a**		moderate/ light/ low aerobic exercise <30–60% VO_2max ($l \cdot min^{-1}$)> after training/in recovery: … accelerates blood lactate removal; … causes an increase in blood flow through the muscles which oxidizes lactate through the Krebs/ citric acid cycle; … increases delivery of blood to the liver and the heart compared to passive methods which also use lactate for energy;	*Only credit one effect of lactate removal*	**2 max**

			accelerated raising of blood pH- by promoting lactate removal and restoring muscle pH balance; helps reduce muscle fatigue and allows hemoglobin to pick up more O_2; reduces recovery time;		
4.	**b**		the timing of cryotherapy use is important to the effectiveness of the method on recovery; evidence suggests that it can hinder the anabolic effects in muscles post strength/ high-intensity training reducing potential growth in muscle mass; associated risks with exposure to prolonged or extreme cold due to inappropriate length cryotherapy is applied: frostbite, hypothermia; more expensive and less accessible than easily accessible active recovery; evidence of effectiveness is largely anecdotal/ placebo rather than scientific research; benefits may be individual/ specific rather than general; health risks associated with exposure to prolonged or extreme cold, can temporarily increase heart rate and blood pressure as the body responds to the cold stress. For individuals with pre-existing cardiovascular conditions or hypertension, this increase in cardiovascular workload may pose risks;		**3 max**
5.	**a**		a substance/ device/ phenomenon that can improve an athlete's performance;		**1 max**
5.	**b**		***Proposed benefits:*** improves alertness/ concentration can increase performance at various intensities facilitates nerve transmission/ion transport within the muscle ***OR*** perceived improvement in reaction time; enhance motoneuronal excitability/ recruitment of motor units; effective placebo;	*Max 2 for benefits*	**4 max**

			benefit electrolyte balance/ glucose availability; extend endurance in moderately strenuous aerobic exercise; reduced fatigue; increased energy; consumed before exercise it can increase fat catabolism and reduce carbohydrate oxidation; caffeine can cross the blood–brain barrier and produce analgesic effects on the central nervous system; ***Possible harmful effects:*** caffeine consumption blunts the ergogenic effects of creatine supplementation on muscular power; can cause caffeine addiction, characterised by cravings and withdrawal symptoms if intake is reduced or ceased; can produce restlessness/ headaches/ arousal/ overstimulation/ insomnia/ nervous irritability/ muscle twitching; a potent diuretic reducing thermoregulation mechanisms such as evaporation ***OR*** dehydration reducing performance; excessive caffeine intake can cause gastrointestinal issues such as stomach discomfort, acid reflux, diarrhea, and dehydration; increase of blood pressure; potential death if the dose is significant enough; ***TOK*** insufficient data to link caffeine use to performance/ difficult to measure caffeine in blood;	*Max [2] for harmful effects*	

Option B — Psychology of sports

<table>
<tr><th colspan="3">Question</th><th>Answers</th><th>Notes</th><th>Total</th></tr>
<tr><td>6.</td><td>a</td><td></td><td>18;</td><td>Accept +/- 0.5</td><td>1 max</td></tr>
<tr><td>6.</td><td>b</td><td></td><td>15–18;
=<–>3;</td><td>Accept in the converse

Accept +/- 0.5 i.e. 14.5 to 15.5 and 17.5 to 18.5</td><td>2 max</td></tr>
<tr><td>6.</td><td>c</td><td></td><td><table><tr><td>Compare</td><td>Contrast</td><td></td></tr><tr><td>use of self-talk, goal setting and imagery all increase from low stress to high stress.</td><td>use of relaxation decreased from low stress to high stress.</td><td>;</td></tr></table></td><td>A list of individual observations from each graph alone is not sufficient;

Must refer to all four skills</td><td>1 max</td></tr>
<tr><td>6.</td><td>d</td><td></td><td>thought-stopping;
thought blocking;
relaxation techniques/ meditation/ PMR/ breathing techniques/ biofeedback;
mental imagery;
selective attention/ processing;</td><td></td><td>1 max</td></tr>
<tr><td>7.</td><td>a</td><td></td><td>money/ extrinsic reward can have a controlling influence;
money/ extrinsic/ controlling rewards reduce intrinsic motivation;
extrinsic rewards can decrease satisfaction/ intrinsic motivation leads to greater satisfaction with performance;
giving more rewards for something they love won’t help them to try harder, as they are already trying as hard as they can/ over-justification effect;
as extrinsic rewards increase they have a diminishing return;</td><td>No marks awarded for discussion of aspects that may enhance performance</td><td>3 max</td></tr>
</table>

			might become more motivated by status than by performance, thus negatively affecting performance;		
7.	**b**		***Stability:*** a tennis player should attribute the defeat to unstable factors by framing the defeat as a temporary setback rather than a reflection of their abilities, the player can maintain confidence in their skills and resilience; ***Causality:*** a tennis player should attribute the defeat to external factors; unstable-external factors: e.g. bad officials/ weather/ luck/ crowd; unstable-internal factors: e.g. bad form/ ill/ injured/ personal/ emotional problems; stable-external factors: e.g. bad on a particular surface/ don't like opponent's style of play/ previous history with official; by framing the defeat as a temporary setback rather than a reflection of their abilities, the player can maintain confidence in their skills and resilience;		**3 max**
7.	**c**		***Forethought (planning) phase:*** athletes must see value in task to spend time planning for it; more motivated to plan better/ set more ambitious goals/ invest the time and energy; ***Monitoring phase:*** intrinsic motivation affects level of effort in completing tasks and use of self-regulation strategies; kinesthetic awareness/ flow improves performance; ***Reflection phase:*** athlete attributions affect future engagement in self-regulation strategies/ result in clearer goal-setting; higher self-efficacy beliefs increase the use of self-regulation strategies;	*Note: must include reason as well as phases (don't need to use exact phase names)*	**3 max**

			success with the process can add to the motivation of the athlete and encourage further improvement;		
8.	**a**		a natural aptitude/ skill/ a multidimensional concept identified by characteristics that are both genetic, <physiological/ psychological>, and environmental <sociological>;		**1 max**
8.	**b**		potential lack of opportunities <e.g. work with specialist coach does not align with athlete talent/ opportunity to increase hours of deliberate practice may not be available> ***OR*** access to better coach; obstacles <e.g. injury, deselection, burnout OTS>; coach may use same/ outdated techniques; coaches' access to improved facilities/ technology to learn new/ improve skills; coach-athlete relationship may go stale; progressions (to next stage) present new challenges; psychological skill family influence, e.g. family-coach relationship; goals agreed with coach may not be appropriate/ over/ under ambitious;		**3 max**
8.	**c**		gymnasts tend to have short careers/ performance may have plateaued/ get injured/ burnout therefore may transfer to prolong their sporting career; a gymnast will have the physiological traits/ motor skills to transfer to other sports, e.g. diving/ pole vaulting; a gymnast will have the psychological traits to transfer to other sports, geographical reasons may make it easier to transfer to their new sport e.g. athletic facilities may be more accessible than gymnastics;		**3 max**

			desire for a greater success than that in the first sport/ financial reasons;		
9.			difficulty to define the term athlete; personality is complex and multifaceted/ some researchers believe that personality is closely related to athletic performance, others argue that personality is not related to athletic success; difficulties comparing data between different questionnaires; controversy between the value of personalities impact on performance/ personality alone does not account for behaviour in sport and exercise; no single personality trait exists that determines successful sports performance/ distinguishes athletes from non-athletes; no single personality profile has been found that sports performers are all people and sport is only one facet of their life; dominance of certain personality types in some sports, e.g. boxer, will skew a sample ***OR*** biasing effects of culture/ gender/ socio-economic group;	*Answers about ethics are not relevant to personality research, do not credit.* *Personality questionnaires can be valid and reliable, therefore do not credit statements of invalid/ unreliable*	**4 max**

Option C — Physical activity and health

<table>
<tr><th colspan="3">Question</th><th>Answers</th><th>Notes</th><th>Total</th></tr>
<tr><td>10.</td><td>a</td><td></td><td>2.11/4.48 x 100;
= 47.10%/ 47.09%;</td><td>Full equation is required for mark Accept +/- 1.0</td><td>2 max</td></tr>
<tr><td>10.</td><td>b</td><td></td><td>anaerobic exercise leads to <statistically significant> decrease in waist-to-hip ratio compared with aerobic;
no <statistically significant> effect on triglyceride levels;
anaerobic exercise leads to <statistically significant> higher HDL levels compared with aerobic;
no <statistically significant> effect on LDL levels;
no <statistically significant> effect on total cholesterol levels;
not possible to make a clear conclusion about the link between the type of exercise and health;</td><td>Award [2] max for p values
[1] max for a conclusion
Accept any answer relating to trend of specific data</td><td>3 max</td></tr>
<tr><td>10.</td><td>c</td><td></td><td><table>
<tr><td>BMI</td><td>waist circumference</td><td></td></tr>
<tr><td>not valid for trained athletes</td><td>more valid for trained athletes</td><td>;</td></tr>
<tr><td>artefact of weight and height</td><td>artefact of waist measurement alone</td><td>;</td></tr>
<tr><td>two measurements / double uncertainty</td><td>one measurement / single uncertainty</td><td>;</td></tr>
<tr><td>relatively common / lots of norm data</td><td>relatively unknown</td><td>;</td></tr>
</table></td><td>Note: two versus one measures could be either positive or negative MP</td><td>2 max</td></tr>
<tr><td>10.</td><td>d</td><td></td><td>Environmental:
target classes for beginners, intermediate, advanced/ inclusive;
Reinforcement:</td><td>Award [1] max for list</td><td>2 max</td></tr>
</table>

			provide rewards for continued attendance; provide feedback on fitness records for regular attendees/ educational seminars; ***Goal setting:*** create specialized classes/ fitness routines; offer new routines monthly/ open day to try new routines/ classes; set-up fitness challenges/ leader board; using technology to enhance goal setting/ enhance experience to provide additional support; ***Social:*** friends and family membership plan; provide free parking/ transport to club; maintain fitness records of participants; providing specialized training/ specialized equipment; match gym times to working times; creating social gym classes to encourage regular participation;		
10.	**e**		low levels of HDL lead to lower longevity; low levels of HDL cholesterol can weaken protective mechanisms of the blood vessels/ blood vessel function/ high blood pressure/ makes blood clots more likely to form; low HDL commonly means that one has higher LDL, increasing the risk of CVD; low levels of HDL increase the risk of atherosclerosis/ linked to increased inflammation and oxidative stress; low levels of HDL cholesterol can disrupt lipid metabolism, leading to an imbalance in cholesterol levels in the bloodstream; atherosclerosis increases chances of angina and heart attack;	*Accept in the converse*	**3 max**

10.	**f**		genetic/ inherited cardiac conditions <such as HCM>; atherosclerosis; heart arrhythmia; impact to the chest; have major changes in the amount of potassium and magnesium in your blood; obesity; overtraining/ training at a high intensity that a person is not used to; diabetes; take recreational drugs or drugs that can increase the risk of life-threatening arrhythmias;		**2 max**
11.	**a**		the percentage/ proportion of public health burden that is caused by a particular risk factor; males have higher testosterone levels than females; testosterone levels in males decrease with age; older baseball players are more at risk from vertebral fractures due to lower testosterone levels; female baseball players who are older are at a higher risk than males when playing at advancing years; higher testosterone levels in older men would lower the risk of the fracture;		**3 max**
11.	**b**		sliding into base on bones of the leg/ obstacle on field; collision with another player; collision with the ball/ collision with the bat;		**1 max**
11.	**c**		everyone has a role: coaches understand risk, umpires understand rules, athletes understand what they need to do; appropriate gear;		**4 max**

			appropriate techniques shown by the coach such as skills, warm up and cool down/ prepare body for exercise; clear and enforced rules to reduce unexpected styles of play; monitor player fatigue/ injuries to prevent injury ***OR*** manage training load ***OR*** sufficient rest periods; ensuring that environmental conditions are safe; coach should be aware of any preexisting injuries/ medical conditions to limit risk; regular medical checks by athletes are conducted;		
12			loss of muscular strength/ power/ stability means it is more difficult to regain balance/ increased likelihood of musculoskeletal injuries ***OR*** reduced flexibility and range of motion in joints injury; lower levels of stamina, they may not be able to complete the course; higher risk of severe injury due to lower bone density/ osteoporosis <femur/ hip fracture>; increased susceptibility to cold-related injuries; more likely to have underlying medical issues which may be exacerbated by strenuous exercise/ increased risk of medical issues; more likely to get injured if they do not use the correct techniques/ overexert themselves; cardiovascular stress leading to increased risk of medical issues;		**3 max**

Option D — Nutrition for sports, exercise and health

Question			Answers	Notes	Total
13.	**a**	**i**	condition 1; drinking as much water as they want;		**1 max**
13.	**a**	**ii**	1.6–1.0; =<->0.6%;	Accept +/- 0.5 *Accept in the converse*	**2 max**
13.	**a**	**iii**	males drank significantly lower amounts of water in condition 1 compared to condition 2; whereas females drank similar amounts of water in the two sessions; body mass change in females did not vary comparing condition 1 versus condition 2; end of training session males are more dehydrated compared to females; sweat loss was consistent across all groups regardless of amount of liquid consumed;	*Max [1] for no reference to data* *Accept any answer relating to trend of specific data*	**2 max**
13.	**a**	**iv**	urine colour/ osmolarity/ concentration; frequency of urination;		**1 max**
13.	**b**		the more energy an athlete expends, the greater their needs for hydration are; water is required to reduce cardiovascular drift; dehydration causes the blood to become more viscous; drinking adequate fluids helps cool the body through sweating and supports thermoregulation, reducing the risk of overheating and heat-related complications;		**3 max**

			excess heat in the body is mainly managed by the evaporation of sweat, meaning that more water needs to be taken in ***OR*** fluids lost during breathing; water is a medium for cellular processes in the body which keep the athlete moving/ dehydration can impair these metabolic processes, leading to decreased energy production and reduced physical performance; water is essential for the movement of sugars and waste in the blood stream; environment can change the water loss;		
13.	**c**		***The benefit of consuming a drink with high sodium content*:** at the end of a match, body will have low blood electrolyte balance from sweat loss, and a sodium rich sports drink will elevate that electrolyte balance/ sodium in sports drink stimulates water and sodium absorption; drink would return blood plasma viscosity to normal; sodium increases thirst (i.e. stimulates the soccer player to ingest more); sodium assists in the absorption of water and carbohydrates from the digestive tract into the bloodstream, which speeds up rehydration and restores fluid stores that were depleted during exercise. Loop de Henle; helps promote recovery and replenishment of energy stores;		**2 max**
13.	**d**		suppression of nervous response/ reduce hand tremor; compromised motor skills/ balance; delayed reactions ***OR*** impaired judgement; increase in urine output/ dehydration; impaired thermoregulation/ reduced core body temperature;		**3 max**

			dehydration caused by the effect of alcohol on the release of ADH/ loss of coordination/ reduced ability to concentrate; reduced inhibitions <become more aggressive>; markedly reduced heart rate, potentially leading to unconsciousness or coma; cognitive impairment/ difficulty focusing/ slurred speech/ vision impairment; alcohol influences muscular contraction and relaxation, leading to muscle weakness and reduced strength affecting power output and sports performance;		
14.			exercise results in a higher amount of GLUT4 transporters; glucose uptake into a cell is facilitated by the glucose transport proteins GLUT4 and GLUT1 ***OR*** muscle fibres also contain glucose transport proteins GLUT1 and GLUT4; GLUT4 transporters can also be stimulated during physical exercise. This is the result of other stimuli such as calcium ions; glucose taken into the muscle cells is quickly converted to glucose-6-phosphate; this ensures that the concentration gradient for glucose movement is maintained; insulin sensitivity, whereby muscle cells become more responsive to insulin, allowing for increased uptake of glucose from the bloodstream into the cells.		**3 max**
15.	**a**		A/ C/ E;		**1 max**
15.	**b**		oxidative stress is the imbalance between antioxidants and free radicals; root is the reactive oxygen molecule;		**4 max**

			free radicals are derived from normal metabolic processes in the body; oxidative stress/ free radical production is increased with exhaustive exercise; oxidative stress/ free radical production from ultraviolet light, and chemicals; extra electrons attack and cause cellular damage; smoking causes oxidative stress by damaging genetic material; oxidative stress/ free radical production is reduced with appropriate levels of training;		
15.	**c**		***Free radicals can:*** remove electrons from cell; impair DNA replication; cause oxidative stress; this causes DNA damage, potentially leading to many negative health effects; free radicals can damage parts of the cell by removing electrons to create paired electrons in their structures; removing electrons from cell and mitochondrial membranes, so affecting their permeability; removing electrons from molecules impairing the function of enzymes;		**3 max**