Diploma Programme
Programme du diplôme
Programa del Diploma

Markscheme

November 2021

Sports, exercise and health science

Higher level

Paper 2

25 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** question 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 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.

Section A

Question			Answers	Notes	Total
1.	**a**		football;		**1**
1.	**b**		5.41 – 3.37; = 2.04 < kN s^{-1} >;		**2**
1.	**c**		*eccentric time*: basketball players have the highest / footballers have the lowest eccentric times; *total jump time*: baseball has the highest jump time / basketball and baseball players have similar jump time/ footballers have the lowest jump time; *eccentric rate of force development*: baseball players have the highest / basketballers have the lowest rate of eccentric force development; *jump height*: baseball players have the lowest height / basketball and baseball players have similar jump heights/ footballers have the highest jump height;		**3**

Question			Answers	Notes	Total
2.	**a**		chalk;		**1**
2.	**b**		*Condition 1:* Venice turpentine in dry finger–dry surface/Condition 1 has the greatest grip/coefficient of friction/greatest grip effectiveness; *Condition 2:* Venice turpentine in damp finger–dry surface/ Condition 2 has the greatest grip/coefficient of friction/greatest grip effectiveness; *Condition 3:* in wet environment/wet finger and dry surface/Condition 3, Venice turpentine yields lowest coefficient of friction/is the worst enhancing agent ***OR*** Venice turpentine yields the lowest overall coefficient of friction/has the poorest overall grip effectiveness; *Condition 4:* in wet environment/dry finger and wet surface/Condition 4, Venice turpentine yields lowest coefficient of friction/is the worst enhancing agent;		**3**

Question			Answers	Notes	Total
2.	**c**		a small SD small standard deviation indicates that the data is clustered around the mean *eg* bars on most conditions/ liquid chalk in condition 3 ***OR*** a higher SD *eg* Venice turpentine in any condition/liquid chalk in condition 2/Rosin in condition 3 indicates that the data is <more> spread from the mean; a smaller standard deviation can indicate greater reliability of the data; chalk has a relatively small standard deviation in all conditions which suggests that there is little variation in performance using this agent; Venice turpentine has a relatively large standard deviation in all conditions which suggests that there is a more significant variation in performance using this agent;	*Award **[1 max]** if there is no reference to data.* *Accept answer that refers to relative proportion of the SD to mean.* *Accept in the converse.* *Note: statistical significance cannot be determined from the data.*	**3**
2.	**d**		the **coefficient of friction** (COF, μ) is < a dimensionless scalar quantity which is > the ratio of < the force of > friction < F_f between two bodies > and the normal reaction force <R> ***OR*** $\mu = \frac{F_f}{R}$; the magnitude of the coefficient of friction depends on the materials in contact; the greater the interaction between the molecules of the interfacing surfaces/more rough the surfaces, the greater the size of the coefficient of friction;	*Accept any appropriate examples.* *Note on mp2: must say something more than repeating the question, eg give an appropriate example.* *Accept in the converse.* *Must have reference to effect of the surface on the coefficient of friction.*	**2**

Question			Answers	Notes	Total
3.	**a**		A: <proximal> epiphysis; B: diaphysis;		**2**
3.	**b**	**i**	superior ***OR*** proximal;		**1**
3.	**b**	**ii**	anterior;		**1**
3.	**c**		joins bone to bone ‹as in cartilaginous joints› / structural support; allows limited movement ‹in cartilaginous joints›; shock absorption; reduce friction / protection of bone;		**3**

<table>
<tr><th colspan="3">Question</th><th>Answers</th><th>Notes</th><th>Total</th></tr>
<tr><td>4.</td><td>a</td><td></td><td>
<table>
<tr><td>A</td><td>epidermis</td><td>surface of skin</td><td>;</td></tr>
<tr><td>B</td><td>dermis/subdermal tissue</td><td>inner layer of skin containing structures such as blood vessels</td><td>;</td></tr>
<tr><td>C</td><td><sweat> gland</td><td>structures that produce sweat</td><td>;</td></tr>
</table>
</td><td></td><td>3</td></tr>
<tr><td>4.</td><td>b</td><td></td><td>contraction/dilation of blood vessels in the skin allow for regulation of body temperature;
contraction and relaxation of hair follicle <arrector pilli> muscles to allow regulation of body temperature;
subcutaneous layer provides insulation which can help maintain body temperature;
sweat glands allow perspiration / excretion / thermoregulation;
as a barrier/outermost organ of the body skin protects the body from thermal/UV/physical injury/foreign material;
sebaceous glands secrete sebum which helps to fight against bacteria on the skins surface;
as the skin contains many neurons it provides sensory information / for feedback systems;
exposure to sunlight skin synthesizes vitamin D to <support bone health/ control infections/reduce inflammation>;</td><td>Award [1 max] total for two or more functions with no description.

Award [3 max] for one the description of one function.</td><td>4</td></tr>
</table>

Question			Answers	Notes	Total
4.	**c**		during prolonged exercise there is an increase in body temperature / blood flow is diverted to the skin; cooling/sweating causes fluid loss/decreases in blood plasma; this results in increased blood viscosity/decreased in stroke volume; to maintain homeostasis/cardiac output (Q) there is a «gradual» increase in HR ***OR*** reduction in venous return/ stroke volume causes the heart rate to increase to maintain cardiac output; during prolonged exercise an athlete can ingest drinks/stay hydrated to maintain blood volume/Q <to avoid/reduce cardiovascular drift>;	*Award **[3 max]** for cardiovascular drift.*	**4**

Question			Answers	Notes	Total
5.			ATP-CP is the dominant system; fuelled by CP stores; ATP production is achieved anaerobically; one CP yields one ATP; creatine kinase is the controlling enzyme; there is enough ATP stored in the muscles <for the initial 2–3 seconds of activity/sprint is short in duration>;		**3**

Question			Answers	Notes	Total
6.	a		*VO_2max/maximum oxygen consumption:* <absolute values> increase dramatically as people age/ up to peak VO_2max; peaks around age 20 for males and mid/late teens for females; steadily declines after peak as the individual ages; is higher in a trained vs untrained individual <of a similar age>; the effect of training can overcome decreases due to aging; relative scores tend to be stable or decrease <depending on gender>; the effect/impact of aerobic training on an individual's VO_2max is determined by their baseline VO_2max level;		4
6.	b		arm ergometry involves less muscle mass compared to running; arm ergometry has a lower VO_2max compared to running; previous training will influence the difference between VO_2max between the two modes;	*Accept in the converse.*	2

Question			Answers	Notes	Total
7.	**a**		learning is a relatively permanent change in performance <brought about by experience, excluding changes due to maturation and degeneration>;		**1**
7.	**b**		*coaching style:* coaches can adapt style to be appropriate to players; *difficulty of task:* need to differentiate tasks to be appropriate to the level of the players' ability; *teaching environment:* small group environment may be suitable for many skills ***OR*** group to maximise knowledge/learning; *motivation:* use a range of strategies to develop intrinsic motivation, *eg* appropriate use of competition; *physical fitness:* responsible for integrating appropriate fitness into training to underpin core skills;	*Award **[1 max]** per factor.* *Note: accept appropriate explanation as long as it affects rate of learning.* *Award **[1 max]** for a list of three factors with no explanation.*	**3**

Question			Answers	Notes	Total
7.	**c**		distributed practice: type of practice alternates periods of practice with periods of rest; *eg* practice of a certain move 5 times in gymnastics while being filmed, reviewing the recording, adjusting and practising again; massed practice: type of practice has little or no rest between simple skills; *eg* practice of many different passes of a soccer ball during a drill; fixed/drill practice: doing a drill repeating the skill/repetition of a task in a controlled way; *eg* shooting basketball from the same spot many times without a break; variable practice: mix of individual skills, group drills and minor games / practising a skill in a variety of contexts; *eg* performing free-throws, three-pointers and mid-range shots in a 3 *v* 2 situation; mental practice: imagining doing the skill; *eg* visualization of them performing a volleyball serve/rehearsing the skill in their mind;	*Award **[1 max]** for a list of two types of practice with no description.* *Award **[2 max]** for examples with no description and vice versa.* *Candidates can only be credited for two types of practice.*	**4**

Section B

Question			Answers	Notes	Total
8.	**a**		angular momentum is defined as angular velocity x moment of inertia; Newton's first law / a rotating body will continue to rotate with constant momentum unless an external force / torque is applied ***OR*** angular momentum of the diver is constant during the dive ***OR*** there is an inverse relationship between moment of inertia and angular velocity; *first point of the dive:* the diver starts off with a high moment of inertia before jumping; *during somersault*: in order to complete sufficient rotations in the dive, diver tucks body in towards centre of mass/ reduces the moment of inertia; therefore causing an increase in angular velocity; *preparation for entry:* in order to safely enter the water <in streamlined position> diver straightens out body / increases moment of inertia; therefore slows them down and reduces their angular velocity;	*Award **[1 max]** for aspects of definition of angular momentum.*	**6**

Question			Answers	Notes	Total
8.	b		*i. officiating:* *eg Hawkeye* can provide objective data for officials in tennis to support their decision making regarding a line call; *ii. sports performance:* *eg Dartfish* can be used to capture movement during a soccer game which then can be analysed and improved; *eg Prozone* can be used to aid in the analysis of soccer game; *iii. health:* *eg Bodybyte* can be used to monitor nutrition and fitness programs for runners;	*Award **[1 max]** for a list of three digital technologies with link to its use.* *Accept other appropriate technologies, eg Fitbit, Coach's Eye.*	**3**
8.	c		*information technologies*: provide data that is not available through traditional analysis techniques; data can be recorded over short or long timescales; data is often objective/accurate; processed data can improve visualization and allows image comparison; feedback is immediate and efficient; feedback information is manageable and is specifically adjusted for individual needs; many new software technologies are relatively inexpensive / accessible;		**6**

Question			Answers	Notes	Total
8.	**d**		progression: coach needs to ensure that challenge of sessions increases gradually, *eg* gradual increases in weights or repetition sets; overload: coach plans to increase intensity/frequency/time/FIT of sessions <with appropriate rest to elicit beneficial adaptations/ minimise risk of injury> *eg* increasing frequency of training per week; specificity: coach plans sessions that focus on developing muscles/skills/energy systems/movement patterns/strategy that are relevant for their performance, *eg* sprinter developing leg muscles; reversibility: coach managing appropriate rest periods to prevent detraining/loss of adaptation/managing workload to prevent injury/illness, *eg* setting rest day; variety: to maintain motivation/prevent boredom, coach plans a range of activities/methods, *eg* crossfit training;	*Award **[1 max]** for a list of two or more principles* *Award **[2 max]** per principle*	**5**

Question			Answers	Notes	Total
9.	**a**		lower leucocyte numbers <caused by the stress of exercise>; inflammation caused by muscle damage; greater exposure to airborne bacteria and viruses <because of an increased rate and depth of breathing>;		**3**
9.	**b**		*Marathon runner*: use more calories <than sedentary individuals> and therefore are recommended to have a higher calorie intake/ energy intake; has a high training volume and therefore have a much higher recommendation for carbohydrate intake; need some fat stores and are recommended a <slight> increase in fat consumption; need to recover after activity and are recommended a <slightly> higher protein intake; thermoregulate more and are recommended to have a higher water/ electrolyte intake; greater mineral and vitamin intake for bone strength/blood cell production/growth;	*Accept in the converse.*	**5**

Question			Answers	Notes	Total
9.	c		hypothalamus receives feedback from the body regarding homeostasis; pituitary and hypothalamus are endocrine organs; pituitary gland is located <in the brain> below the hypothalamus for efficiency of regulation; hypothalamus regulates the pituitary gland to maintain homeostasis/growth/water balance/reproduction/temperature; neurohormones <such as GHRH and somatostatin from the hypothalamus> directly influence the pituitary gland; nerve impulses from the hypothalamus stimulate the pituitary gland; regulatory/neurohormones are delivered through the portal/blood vessel; pituitary gland <posterior lobe> secretes hormones eg antidiuretic hormone (ADH) <into surrounding capillaries> ***OR*** pituitary gland <anterior lobe> secretes hormones eg growth hormone (GH)/ luteinizing hormone (LH) <into surrounding capillaries>;	*Award **[2]** if candidate accurately identifies specific lobes for pituitary gland and correct hormone NFP.*	**6**

Question			Answers	Notes	Total
9.	d		*nervous control:* increase in acidity/CO_2 concentration is detected by <chemo>receptors; <proprio>receptors detect an increase in muscle movement; receptors inform the brain/respiratory centre; the brain/medulla oblongata stimulates/sends nervous signals the inspiratory muscles to contract; nerve impulses are sent via the sympathetic nervous system <phrenic nerve>; nerve impulses stimulates an increase in the depth of breathing; *mechanics:* external intercostal muscles contract more forcefully; ribs move upwards **and** outwards further; diaphragm contracts **and** flattens; thoracic cavity volume increases further; pressure gradient of thoracic cavity with atmosphere increases ***OR*** thoracic cavity pressure decreases further; more air rushes into the lungs; strenuous exercise stimulates the use of accessory muscles <scalenes, sternocleidomastoid & pectoralis minor>;	*Award **[4 max]** for each nervous control and mechanics.* *Must be reference to mechanics during exercise compared to rest in order to credit mark.* *Award **[1 max]** for accurate mechanics of inspiration but with no reference to changes caused by exercise.*	**6**

Question			Answers	Notes	Total
10.	a		deficit is calculated as the difference between the oxygen required for a given rate of work and the oxygen actually consumed ***OR*** deficit takes place during the initial stages of exercise; muscles generate ATP through anaerobic pathways; oxygen transport system is not immediately able to supply the needed quantity of oxygen to the active muscles ***OR*** oxygen consumption requires several minutes before a homeostatic level is reached; homeostatic level is reached when the aerobic system meets the demands; the greater the intensity of exercise, the greater the oxygen deficit; deficit is repaid during rest period/after exercise; oxygen deficit can be minimised by the athlete doing a <suitable> warm-up; if the exercise intensity is too high the athlete will have to stop exercising or reduce their intensity; <aerobically> trained individuals may have a smaller deficit/smaller EPOC compared to an untrained individual at the same intensity;	*Accept appropriate labelled diagram 1st and 6th mp.*	**5**

Question			Answers	Notes	Total
10.	**b**		*slow twitch fibres:* higher myoglobin content; higher capillary density allows for increased oxygenation; higher triglyceride storage; lower glycogen storage; higher mitochondrial density; lower phosphocreatine stores; smaller fibre diameter; lower sarcoplasmic reticulum amounts;	*Contrast for each function must be provided.* *Accept in the converse for fast-twitch.* *Do not accept colour.*	**6**

Question			Answers	Notes	Total
10.	c		ensure the athlete plans sufficient recovery within their training/avoid overtraining ***OR*** ensure that the athlete achieves sufficient sleep; maintain a varied diet providing suitable vitamins and minerals ***OR*** ensure the athlete maintains fluid levels; drink pathogen-free water ***OR*** maintain good food hygiene standards when preparing food; athlete maintains good personal hygiene ***OR*** maintains oral hygiene; cleaning of shared equipment after each use; maintain good ventilation in spaces where individuals congregate ***OR*** limit numbers of individuals/groups that can congregate together ***OR*** minimize/avoid close contact with infectious individuals ***OR*** test individuals to reduce infectious individuals coming into contact with others ***OR*** do not train during illness; wear face coverings to reduce risk of breathing in / transmission of pathogens;	*Award **[1 max]** for a list.*	**3**

<table>
<tr><th colspan="3">Question</th><th>Answers</th><th>Notes</th><th>Total</th></tr>
<tr><td>10.</td><td>d</td><td></td><td>
<table>
<tr><td>target heart rate</td><td>;</td><td>use of heart rate based upon its relationship with oxygen uptake (percentage of maximal oxygen uptake)</td><td>;</td></tr>
<tr><td>training heart rate range/zone</td><td>;</td><td>training range = HR max x lower limit % intensity to HR max x upper limit % intensity
OR
eg 220–20 = 200 x 0.7 = 140, 200 x 0.8 = 160, training range 120–160bpm</td><td>;</td></tr>
<tr><td>Karvonen method</td><td>;</td><td>training HR = ((HR max-resting HR) %intensity) + resting HR
OR
eg ((220–20)–60) %) + 60;</td><td>;</td></tr>
<tr><td>ratings of perceived exertion (Borg/OMNI/ CERT scale)</td><td>;</td><td>quantified self-identified levels of exertion</td><td>;</td></tr>
</table>
</td><td>Credit max 3 methods.</td><td>6</td></tr>
</table>

Question			Answers	Notes	Total
11.	**a**		consistent: gymnast is able to perform a set of movements consistently; accurate: archer hits centre of target; learned: dancer performs the routine automatically; control: fencer displays no unnecessary movement; efficient: basketball player movements look effortless; fluency: hockey player has flowing movements; goal-directed: cross-fit athlete is focused on the goals of the practice;		**6**
11.	**b**		form drag and wave drag; an example for overcoming form drag is cyclists adopting a low-profile position; an example of overcoming wave drag is swimming underwater for as long as is allowed at the start of a race;	*Must include both types of drag for **[1].*** *Accept other suitable examples.*	**3**

Question			Answers	Notes	Total
11.	**c**		both environmental and genetic factors may influence sporting performance; the contribution of genetic factors may not determine the tennis player's performance; currently it isn't possible to ascertain the relative contribution of genetics or training to elite sporting performance ***OR*** only possible to elucidate via twin studies; characteristics that are influenced by genetics include height/muscle fibre type/anaerobic threshold/lung capacity/flexibility; environmental factors that also influence performance include physical training/nutrition/ technological aids/climate; exposure to stress/training can switch on dormant genes; training maximizes the likelihood of obtaining 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;		**6**
11.	**d**		peripheral fatigue is a reduction in muscular force; aerobic performance is hindered by a depletion in glycogen stores as ATP resynthesis slows; a reduction in Ca^{2+} release reduces the ability of muscles to contract effectively; depletion of acetylcholine reduces the ability of an action potential to pass to the muscle fibres; electrolyte loss occurs through sweating, which can lead to cramp; dehydration can occur due to loss of essential fluids used to help with temperature regulation; overheating can impair muscle function;	*Award **[1 max]** for a list of two or more causes of peripheral fatigue*	**5**