N14/4/SPEXS/SP2/ENG/TZ0/XX/M

International Baccalaureate®
Baccalauréat International
Bachillerato Internacional

MARKSCHEME

November 2014

SPORTS, EXERCISE AND HEALTH SCIENCE

Standard Level

Paper 2

37 pages

General Marking Instructions

Assistant Examiners (AEs) will be contacted by their team leader (TL) through RM™ Assessor, by e-mail or telephone – if through RM™ Assessor or by e-mail, please reply to confirm that you have downloaded the markscheme from IBIS. The purpose of this initial contact is to allow AEs to raise any queries they have regarding the markscheme and its interpretation. AEs should contact their team leader through RM™ Assessor or by e-mail at any time if they have any problems/queries regarding marking. For any queries regarding the use of RM™ Assessor, please contact emarking@ibo.org.

If you have any queries on **administration** please contact:

Helen Griffiths
Subject Operations
IB Assessment Centre
Peterson House
Malthouse Avenue
Cardiff Gate
Cardiff CF23 8GL
GREAT BRITAIN

Tel: +(44) 29 2054 7777

Fax: +(44) 29 2054 7778

E-mail: helen.griffiths@ibo.org

1. Follow the markscheme provided, award only whole marks and mark only in **RED**.

2. Make sure that the question you are about to mark is highlighted in the mark panel on the right-hand side of the screen.

3. Where a mark is awarded, a tick/check (✓) **must** be placed in the text at the **precise point** where it becomes clear that the candidate deserves the mark. **One tick to be shown for each mark awarded.**

4. Sometimes, careful consideration is required to decide whether or not to award a mark. In these cases use RM™ Assessor annotations to support your decision. You are encouraged to write comments where it helps clarity, especially for re-marking purposes. Use a text box for these additional comments. It should be remembered that the script may be returned to the candidate.

5. Personal codes/notations are unacceptable.

6. Where an answer to a part question is worth no marks but the candidate has attempted the part question, use the "zero" annotation to award zero marks. Where a candidate has not attempted the part question, use the "SEEN" annotation to show you have looked at the question. RM™ Assessor will apply NR once you click complete.

7. If a candidate has attempted more than the required number of questions within a paper or section of a paper, mark all the answers. RM™ Assessor will only award the highest mark or marks in line with the rubric.

8. Ensure that you have viewed **every** page including any additional sheets. Please ensure that you stamp "SEEN" on any additional pages that are blank or where the candidate has crossed out his/her work.

9. Mark positively. Give candidates credit for what they have achieved and for what they have got correct, rather than penalizing them for what they have got wrong. However, a mark should not be awarded where there is contradiction within an answer. Make a comment to this effect using a text box or the "CON" stamp.

Subject Details: Sports, Exercise and Health Science SL Paper 2 Markscheme

Mark Allocation

Candidates are required to answer **ALL** questions in Section A **[30 marks]** and **ONE** question in Section B **[20 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✓		**1 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 wording is indicated in the "Answers" column by a slash (**/**). Either wording can be accepted.

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

continued …

7. Words in angled brackets ‹ › in the "Answers" column are not necessary to gain the mark.

8. Words that are underlined are essential for the mark.

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

10. 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).

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

12. 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.

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

SECTION A

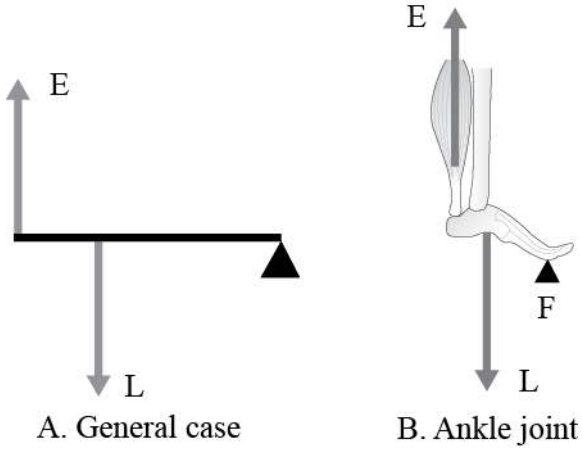
Question			Answers	Notes	Total
1.	a		running with shoes✓		1
	b		barefoot running (BF) results in the lowest total joint power absorption ‹–17› compared to running with shoes (RS) ‹–22›/BF ‹–17› demonstrates decreased total lower extremity power absorption compared to RS ‹–22›/BF running results in reduced total lower extremity power, hip power and knee power✓ with RS, the ankle joint has a lower joint power absorption rate compared to BF✓ with RS the knee joint has a greater joint power absorption rate compared to BF✓ with RS, the hip joint has a greater joint power absorption rate compared to BF✓ the data demonstrates that/with the majority of joints in the RS condition there is a greater negative power absorption rate compared with BF therefore the hypothesis is accepted✓ there is a shift of power absorption from the knee to the ankle for the BF condition compared with the RS condition ‹RS–13 to –6 and BF–8 to –7› ✓ the knee joint is a significant area of power absorption for the RS condition compared to the other joint areas ‹–13 versus 6 and 3›✓ the SD for knee absorption was very high indicating less consistent results for this joint✓	*Accept responses in the converse.*	**3 max**

continued …

			<table><tr><th></th><th>Running with shoes</th><th>Barefoot running</th></tr><tr><td>Ankle power</td><td>–6.00</td><td>–7.00</td></tr><tr><td>Knee power</td><td>–13.00</td><td>–8.00</td></tr><tr><td>Hip power</td><td>–3.00</td><td>–2.00</td></tr><tr><td>Total</td><td>–22.00</td><td>–17.00</td></tr></table>	*The table in the left hand column is for reference only.*	
	c	**i**	standard deviation (SD) measures how much a set of data varies from the mean of that data ***OR*** SD tells you the spread of the data about the mean✓ an estimate of the average variability ***OR*** the spread of a set of data measured in the same units of measurement as the original data ***OR*** the square root of the variance✓ a small SD indicates that the data is clustered very close around the mean value, whereas a large SD indicates the data are spread out over a large range of values✓ for example, the smaller SD for power absorption rates suggests that the participants were exhibiting similar in-shoe pressure responses to the different running conditions✓		**1 max**
		ii	a graphical representation of the variability/range of data / calculation error✓		**1**
	d		$\frac{(230+151+202)}{3} = 194/194.3$ ms✓	*Must see ms as the unit to award **[1]**.*	**1**

	e		concrete surface produced higher mean peak pressure ‹234› on in-shoe pressure compared to grass ‹209› ***OR*** grass surface produced lower mean peak pressure ‹209› on in-shoe pressure compared to concrete ‹234›✓ overall peak pressure is 74 ‹Kpa› higher on concrete surface✓ concrete surface produced higher peak pressure in the forefoot ‹242› region in comparison to grass ‹214›✓ concrete surface produced higher peak pressure in the rearfoot ‹349› region in comparison to grass ‹299›✓ concrete surface produced lower peak pressure in the midfoot ‹112› region in comparison to grass ‹116›✓ concrete surface produced higher peak pressure in the forefoot ‹242› region in comparison to grass ‹214› in a shorter period of contact time✓ concrete surface produced higher peak pressure in the rearfoot ‹349› region in comparison to grass ‹299› in a shorter period of contact time✓ concrete surface produced lower peak pressure in the midfoot ‹112› region in comparison to grass ‹116› in a shorter period of contact time✓ the rear foot has the highest peak pressure for both surfaces✓		**2 max**
	f		for every action there is an equal and opposite reaction✓		**1**

	g		the player applies force by extending his/her legs against the ground/pushing back against the ground/earth✓ the force from the extension of the legs is the action ***OR*** the action force is caused by muscle contraction✓ the ground/earth exerts an equal and opposite force on the athlete✓ the push back from the ground/earth is the reaction✓ because the ground/earth is a larger mass than the mass of the athlete, the effect on the athlete is greater than the effect on the ground/earth✓ the result of the reaction force is to displace the relatively small mass of the athlete/produces the uphill movement of the athlete✓ the faster/harder the athlete pushes ‹action› the greater the force will be✓	*Award **[1 max]** if response makes no reference to the starting block.*	**2 max**

2.	**a**		X: soleus Y: tarsals	*Both required to award **[1]**.*	**1 max**
	b		‹second class lever when standing on toes› lever consists of a rigid rod, a fulcrum ‹axis›, a resistance force/load ‹body weight› and effort force ‹muscle force› ✓ the effort/input ‹muscle force› is the gastrocnemius/soleus, the fulcrum is located at the other end opposite to the effort/input at the ball of the foot, and the load/output ‹bodyweight› is located in the middle ✓  [Source: adapted from B Davis, R Bull, J Roscoe, D Roscoe, (2000) *Physical Education and the Study of Sport*, page 231]	*Award **[1 max]** for description of lever and **[1 max]** for correct application of each component.* *Accept marking points in the form of a clearly annotated diagram.*	**2 max**

continued …

			‹ankle as a first class lever› lever consists of a rigid structure with pivot in between the effort and load✓ the effort is from the gastrocnemius/soleus, the pivot is the ankle joint, the load is the forefoot region ***OR*** the effort is from the tibialis anterior, the pivot is the ankle joint and the load is the heel✓ ‹ankle as a third class lever› lever consists of a rigid structure with the pivot at one end followed by the effort and finally the load✓ the fulcrum is the ankle joint, the effort is from the tibialis anterior and the load is the foot beyond this point towards the toes✓	*Accept references to plantar flexion/dorsiflexion.*	

	c		initial energy provided from breakdown of ATP stored in muscle to ADP ***OR*** ATP is broken down by ATPase into ADP and release of a phosphate molecule✓ energy released for muscle contraction/release of Pi initiates power stroke/exothermic reaction/as part of coupled reaction ***OR*** ATP is a high-energy phosphate compound from which the muscle derives its energy/ATP is the main energy currency in muscle cells✓ energy used to reform ATP from ADP ‹and Pi›/endothermic reaction ***OR*** ATP regeneration provided by ATP-CP splitting/system✓ ATP-CP system is also a dominant system operating for this type of action✓ breakdown of CP/PCr by creatine kinase✓ ATP is used to transfer the chemical energy needed for metabolic reactions✓ no further energy can be created until ATP is resynthesized ***OR*** reversible process✓		**3 max**

continued …

			one ATP can be generated from the breakdown of one CP molecule✓ the ATP- CP system has no fatiguing by-products✓ does not require oxygen✓ is a quick source of ATP during these activities ✓ the ATP–CP system is used up very quickly ‹up to ten seconds› ***OR*** limited supply of CP✓		

<table>
<tr>
<td></td>
<td>d</td>
<td></td>
<td>carbohydrates are higher for the marathon runner than a student who takes part in no exercise/vice versa✓

protein is higher for the marathon runner than a student who takes part in no exercise/vice versa✓

fat is ‹slightly› higher for the marathon runner than a student who takes part in no exercise/vice versa✓

water is higher for the marathon runner than a student who takes part in no exercise/vice versa✓

carbohydrates:
higher carbohydrate intake is essential for marathon runners because they require more <u>energy</u> than a non-athlete OWTTE✓

higher carbohydrate intake helps prevent/delays the onset of fatigue during high intensity/long duration training/competition for marathon runners✓

higher carbohydrate intake is essential for marathon runners during periods of high-intensity/long-duration training, because they need to enhance recovery/maximize training effects compared to a non-athlete✓</td>
<td>Award credit if presented in numerical form for two macronutrients, for example:

<table>
<tr><th></th><th>Marathon runner</th><th>Non-athlete</th></tr>
<tr><td>Carbohydrates</td><td>55–75 %*</td><td>45–65 %*</td></tr>
<tr><td>Protein</td><td>10–35 %*</td><td>10–15 %*</td></tr>
<tr><td>Fats</td><td>20–35 %*</td><td>15–30 %*</td></tr>
</table>

Any figures quoted outside those in the table above must be checked.
Award [1 max] per component (carbohydrate, protein, fat).
Accept references to a specific carbohydrate/ protein/fat, for example “higher levels of muscle glycogen stores are required by marathon runners as muscle glycogen is the major source of energy during marathon running”.
Award [1 max] for carbohydrates.</td>
<td>2 max</td>
</tr>
</table>

continued …

* J Sproule (2012) *Sports, Exercise & Health Science: Course Companion*. Oxford University Press

			carbohydrate consumption by marathon runners/non-athletes that is out of proportion to other macronutrients is not a healthy choice✓ high-carbohydrate and low fat diets are sometimes followed by marathon runners as they are trying to remove the perceived weight gaining properties of dietary fat from their diet ‹reduce the so-called "good" cholesterol›✓ *protein:* protein recommendations are ‹slightly› higher for marathon runners compared to non-athletes to <u>maintain/build/repair muscle</u> mass and connective tissues✓ protein recommendations are ‹slightly› higher for marathon runners compared to non-athletes as they are essential to the formation of certain hormones and enzymes ‹even during intensive training› ✓ low protein/carbohydrate intake with marathon runners compared to non-athletes can result in loss of muscle mass/menstrual dysfunction/loss of bone density/increased risk of fatigue/injury/illness/prolonged recovery✓ *fats:* high-fat diets are not recommended for marathon runners✓ non-athletes should limit consumption of ‹saturated and trans› fats, the cause of increased ‹bad› cholesterol/LDL ‹which raises health risks/cardiovascular disease/CVD›, as these fats, in significant quantities, will impair athletic cardiovascular performance ***OR*** in sports nutrition, the majority of fats consumed should be monounsaturated✓	*Award **[1 max]** for protein.* *Award **[1 max]** for fats.*	

3.	**a**		nose ***OR*** mouth ***OR*** pharynx ***OR*** larynx ***OR*** trachea ***OR*** bronchi ***OR*** bronchioles ***OR*** alveoli ***OR*** diaphragm ***OR*** lungs✓	*Award **[1]** for two correct answers.*	**1**
	b		the electrical impulse is initiated/generated at the sinoatrial/SA node✓ travels across the atria✓ to the atrio-ventricular/AV node ‹it delays the cardiac impulse allowing the atria to contract and empty into the ventricles›✓ conducts the impulse to the bundle of His ***OR*** bundle branches are located within the atrial septum/central ventricle walls and spreads towards the Purkinje fibres✓ stimulation of the Purkinje fibres increases pressure in the ventricles sufficiently to eject blood up and out of the ‹pulmonary/aortic› arteries✓		**2 max**

c

approximately 75–84 % of the cardiac output/most of the cardiac output goes to muscle ‹away from the organs not being used›
OR
skeletal muscles receive the largest proportion of blood ***OWTTE***✓

working muscle requires oxygen and to get rid of wastes so blood is redistributed to them✓

blood redistribution is accomplished through vasodilation/ vasoconstriction✓
OR
a shift in blood flow is accomplished partly by vasodilation in skeletal muscle
OR
blood/vascular shunting ‹and as a consequence of vasoconstriction to the kidneys/liver/stomach/intestines›✓

approximate percentage cardiac output to kidneys is 1–3 %
OR
volume distributed to kidneys is approximately half of that than at rest✓

blood may be transported/moved via vasodilation to the skin to cool down✓

approximate percentage cardiac output to brain during exercise is 4–5 %/is consistent with volume distributed to brain at rest✓

for example blood redistribution during exercise ‹ml min^{-1}› ✓

Organ	Exercise
brain	900 ml (4 %)✓
muscles	21 000 ml (84 %)✓
heart	1000 ml (4 %)✓
skin	600 ml (2 %)✓
liver	500 ml (2 %)✓
kidneys	250 ml (1 %)✓
other	780 ml (3 %)✓
total	25 000 ml✓

Award credit if presented in tabular form.

*Accept **[1 max]** for proportionate values within ± 5 %.*

2 max

4.	**a**		decision making✓		**1**
	b		selective attention (SA) is the selection of some of the information in the STSS for further processing ✓ individuals focus on relevant information while ignoring irrelevant information to filter out the relevant information ‹ball› from the noise or irrelevant information ‹ball boys› so that only relevant information is acted upon ***OR*** unselected stimuli are filtered out and selected stimuli are held in the STM and compared to information stored in long-term memory/LTM✓ SA allows a sports player to perceive and make decisions quickly✓ memory consists of the STSS, STM and LTM/is the persistence of the capacity for knowledge or action✓ the decision of what information is relevant/to be selected can come from LTM ***OR*** the information can be voluntarily looked for for its relevance to the task at hand or involuntarily selected due to signal intensity or its nature for example hearing your name✓ SA does not always work *eg* can attend to dummy arm movement in rugby when players should be focusing on hips/legs/footwork✓ SA can be improved with training/practice/learning as this adds to LTM knowledge of various situations✓ SA is important for processing both fast and slow responses in sports ***OR*** less time for the performer to correct actions in fast paced sports so getting it wrong shows up more clearly ***OR*** slow sports still need SA for a good performance✓ our capacity to process information in the STM has limitations ‹*ie* relevance for delivery of teaching/coaching points›✓		**2 max**

	c		*specificity:* involves training the muscles, skills, energy systems specific to the sporting needs of the athlete ***OR*** for example training should be sport-specific and planned for the individual performer ***OR*** specific exercise elicits specific adaptations, creating specific training effects/needs analysis✓ *progression:* for example small increases/gradual increase in weights/repetitions/sets✓ *frequency:* for example the number of trainings that an athlete would do in a week✓ *overload:* for example exercising at greater intensities than normal causes a range of specific adaptations that enable the body to function more efficiently ***OR*** for an individual to continue to adapt ‹physiologically›/increase their fitness they need to increase the intensity/frequency/duration of the exercise to levels greater than they have previously experienced✓ *reversibility:* for example the reversibility of training effects takes place rapidly when an athlete stops their exercise training regime ***OR*** any changes due to training will reverse once training is stopped✓	*Award **[1 max]** for a definition of one principle of training design.* *Award **[1 max]** for an example of one principle of training design application by sports player.*	**2 max**

continued …

			variety: for example athletes doing different things and using different methods of training to prevent boredom *OWTTE*✓ *periodization:* for example the gradual cycling of specificity, intensity and volume of training to achieve peak levels of fitness for competition ‹for example volume = sets × repetitions / volume – load = sets × repetition × load ›✓		

SECTION B

Question			Answers	Notes	Total
5.	a		differences in the partial pressures of the gases in the alveoli and blood create a pressure gradient across the respiratory membrane✓ PO_2 of air at the alveoli is 105 mmHg/higher and PO_2 of the blood in the pulmonary capillaries is 40 mmHg/lower✓ PCO_2 in blood in pulmonary capillaries passing beside alveoli is 46 mmHg/higher and air in the alveoli has a PCO_2 of 40 mmHg/is lower✓ the pressure gradient for CO_2 is less than for oxygen exchange✓ if the pressures on each side of the membrane were equal, the gases would be at equilibrium and would not move✓ the amount and rate of gas exchange that occurs across the membrane depends on the partial pressure of each gas ***OR*** Fick's law✓ gases move from an area of higher pressure to one of lower pressure✓ gases diffuse across the cellular membranes✓ transfer of gases, specifically O_2 and CO_2/oxygen/O_2 enters the blood and carbon dioxide/CO_2 leaves it✓ oxygen diffusion capacity increases as one moves from rest to exercise✓ while exercising, muscles require more O_2 to be used in the metabolic process, venous oxygen is depleted and O_2 exchange at the alveoli is facilitated✓		**4 max**

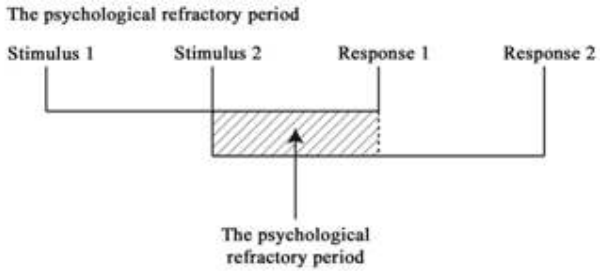
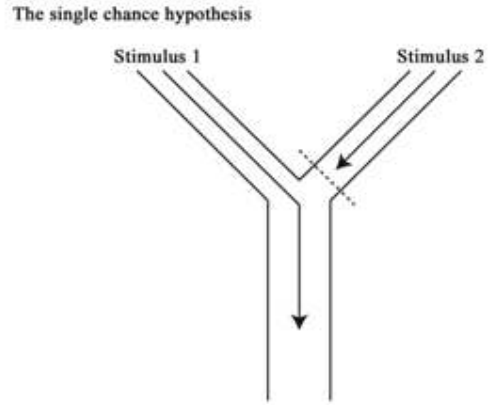
continued …

			CO_2 crosses the alveolar membrane more readily than oxygen without a large pressure gradient✓		
	b		*nervous system:* breathing is controlled by the nervous system which automatically increases or decreases the rate ‹pneunotaxic area›, depth ‹apneustic› and rhythm of breathing ***OR*** breathing rate is manipulated by the autonomic nervous system/ sympathetic and parasympathetic nerves✓ respiratory centre is found in the medulla oblongata in the brain✓ during inspiration, nerve impulses are generated and sent via phrenic nerve and intercostal nerves to the inspiratory muscles ‹external intercostals and diaphragm› causing them to contract✓ breathing rate increases during exercise as the expiratory centre sends impulses to the expiratory muscles ‹internal intercostals› which speeds up the expiratory process ***OR*** breathing rate increases during exercise due to stimulation to the respiratory centre from the action of muscles/spindles/joint receptors✓ higher brain centers can affect breathing rate via emotions, speech, or voluntary changing breathing✓ regulation of breathing is aided by stretch receptors in the lungs and bronchioles, which prevent over inflation of the lungs✓ *chemical composition of blood:* increased CO_2/lactic acid in the blood during exercise is detected by the chemoreceptors which relays the information to the respiratory centre in the medulla of the brain✓	*Award **[3 max]** for nervous system.* *Award **[3 max]** for chemical composition of blood.*	**5 max**

continued …

			increased CO_2 causes the acidity of the blood to increase ‹decrease blood pH› ***OR*** a change in acidity of the blood is detected by chemoreceptors which send nerve impulses to the respiratory muscles which increase the rate of ventilation ‹faster/deeper›✓ peripheral chemoreceptors are in the carotid and aorta ‹O_2, pH, CO_2›✓ central chemoreceptors ‹pH, CO_2›✓		

	c		*cognitive/verbal (early phase):* learning occurs through verbal labels/physical demonstrations, videos, films, reading information or listening to a description of the skill ***OR*** to aid memory learning occurs through trial and error✓ *associative/motor phase (intermediate phase):* a performer practices the task and can associate their movements with the mental image of the skill✓ a performer begins to "feel" what a good performance is like kinaesthetically ***OR*** a performer begins to detect and correct errors in their performance✓ *autonomous phase (final phase):* reaction time is shorter as motor programmes are well learnt ‹stored in long-term memory›✓ skills appear automatic as attention is focused elsewhere ‹for example on tactics, the move or pass or shot and on using fakes›✓ a performer judges his/her own performance and make changes without external feedback from a coach✓ a novice performance will typically occur during the ‹early› cognitive and associative phase✓ a performer will gradually get more skilled in their performance as they get closer to the autonomous phase✓	*Award **[1]** if the three phases are stated and not explained.* *Award **[1 max]** for a description of the cognitive/verbal (early phase).* *Award **[1 max]** for correctly relating novice and/or skilled performance to the cognitive phase.* *Award **[1 max]** for a description of the associative/motor phase (intermediate phase).* *Award **[1 max]** for correctly relating novice and/or skilled performance to the associative phase.* *Award **[1 max]** for a description of the autonomous phase (final phase).* *Award **[1 max]** for correctly relating novice and/or skilled performance to the autonomous phase.*	**6 max**

	d		the PRP is the increase in RT to a second stimulus caused when the second stimulus has been delivered while the performer is responding to the first stimulus ***OR*** time delay in RT caused by the arrival of a second stimulus before the first is processed ***OR*** when a second stimulus arrives before the first response is completed ***OR*** reaction to the second stimulus is longer as first response is still being processed✓ player has to sort out new and correct stimulus, but first they have to disregard the old and now useless stimulus and this causes the delay✓ brain processes one action at a time causing a time delay in responding to the second stimulus ***OR*** the performer might "freeze" completely for the second it takes to sort out the conflicting information✓	*Award **[3 max]** for an explanation of how players can use the PRP to their advantage.* *Award **[2 max]** for an explanation of the PRP including a schematic representation, for example:*   [Source: adapted from C Atherton, (2003), *Skills Acquisition and Sports Psychology Teacher Resource Pack*, page 45]	**5 max**

continued …

			for example a rugby player pretends to pass the ball *ie* dummy ‹stimulus 1› ✓ but then keeps hold of it and attempts to run past the defender ‹stimulus 2›, ✓ hoping the defender has been distracted by the fake pass as they cannot respond until the full reaction/response 1 has been processed by the brain ***OWTTE***✓ the single channel hypothesis states that each stimulus can only be processed one at a time ***OR*** a second stimulus must wait until the first has been processed ***OR*** each stimulus we process has to progress through a single track ***OR*** any subsequent stimulus must wait for the one before it to be processed before it can be dealt with✓		

6.	**a**		*contractility:* the ability of muscle cells to actively generate force/to undergo shortening for movements to bring about dynamic movements✓ *elasticity:* the ability of muscle tissue to return to its original shape after contraction/extension ***OR*** helps store energy for movement✓ *extensibility:* ability of muscle to stretch without damage ‹within the permitted range of movement› ***OR*** allows quick changes in range of movement (ROM)✓ *controlled by nerve stimuli:* the ability of the muscle tissue to be stimulated by electrical impulses/excitability/conductivity✓ muscles work in pairs through reciprocal inhibition✓ *fed by capillaries:* capillaries supply muscles with oxygen and nutrients/remove waste products✓ there may be a small amount of hypertrophy ‹due to blood moving into muscle›✓	*Award **[1 max]** for each characteristic.*	**5 max**

	b		depolarization of the motor end plate travels throughout the muscle via the transverse tubules/neural impulse action potential/muscle action potential✓ calcium ions are released from the sarcoplasmic reticulum✓ calcium binds to troponin, changing its shape/moving tropomyosin from the active site of the actin/exposes active sites on actin✓ actin and myosin bind together forming a cross-bridge✓ myosin head tilts toward the arm of the cross-bridge✓ the breakdown of ATP releases energy✓ myosin head drags actin and myosin filaments in opposite directions/performs a power stroke✓ pulling of the actin filament past the myosin results in muscle shortening/sarcomere shortening/Z line shortens✓ shortening of the sarcomere occurs along the entire length of every myofibril in the muscle cell✓ pulling of the myosin head results in the generation of force✓ immediately after the myosin head tilts, it breaks away from the active site, rotates back to its original position, and attaches to a new active site further along the actin filament✓ the myosin head detaches from the actin when an ATP molecule binds to the myosin head✓ the ATP is then broken down and the myosin head can again attach to an actin binding site further along the actin filament✓		**7 max**

continued …

			repeated attachments and power strokes cause the filaments to slide/contract past one another✓ process continues until the ends of the myosin filaments reach the Z disks✓ H-zone disappears ‹and thus shortens›✓ at rest, troponin holds the tropomyosin in position to block the myosin-binding sites on actin filaments✓		
	c		during the upward motion/preparation phase/hamstring curl the joint action is flexion✓ during the downward motion/action phase the joint action is extension✓ during the upward motion/preparation phase/hamstring curl the hamstring contracts concentrically/is the agonist/the quadriceps relaxes/is the antagonist/eccentrically✓ ***OR*** during the upward motion/preparation phase/hamstring curl the quadriceps relaxes/is the antagonist/eccentrically✓ during the downward motion/action phase quadriceps contracts concentrically/is the agonist while the hamstring relaxes/is the antagonist/eccentrically✓ motion occurs as a result of reciprocal inhibition of muscle pairs✓		**4 max**

	d		variations in VO_2 max during different modes of exercise reflect the quantity of activated muscle mass✓ there is more muscle mass activated during treadmill running compared to either cycling or arm ergometry ***OR*** there is more muscle tissue activated during cycling than arm ergometry✓ treadmill running produces the highest VO_2 max values compared to either cycling or arm ergometry✓ cycling produces higher VO_2 max values compared to arm ergometry✓ arm-crank exercise test achieves only approximately 70 % of treadmill VO_2 max scores✓ competitive cyclists pedalling at their fastest rate achieve scores equal to their treadmill VO_2 max scores ***OR*** trained status in an exercise mode can influence VO_2 achieved ‹for example a sailor who grinds may actually have a very high VO_2 max with arm ergometry› ✓	*Accept other relevant responses.*	**4 max**

7.	**a**		catabolic reactions release the chemical energy stored in organic modules ***OR*** catabolic reactions are usually exergonic/exothermic ‹because they release more energy than they absorb› *OWTTE*✓ catabolic reactions involve chemical reactions that break down complex organic compounds into simple ones *OWTTE*✓ anaerobic catabolism involves chemical reactions that break down complex organic compounds into simple ones without oxygen *OWTTE*✓ anaerobic glycolysis is the breakdown of glucose to lactic acid when limited amounts of oxygen are available *OWTTE* ***OR*** glycolysis plays a role in anaerobic ATP production ***OR*** glycolysis does not require oxygen✓ the NADH molecules cannot be converted to ATP without oxygen, and the pyruvate is reduced to lactic acid✓ during anaerobic catabolism of glucose, 1 glucose molecule can make 2 ATP/ produce a small amount of energy✓ anaerobic catabolism of glucose occurs in the cytoplasm of the cell✓		**3 max**

	b		glucagon is a hormone released by the pancreas when blood sugar levels are low✓ fasting reduces blood glucose which stimulates the release of glucagon✓ glucagon increases the blood glucose level when it falls below normal levels ***OR*** glucagon accelerates the conversion of glucagon in the liver into glucose ***OR*** glucagon promotes glycogenolysis✓ adrenaline stimulates the liver/skeletal muscle to convert stored glycogen into glucose ‹same as glucagon›✓ adrenaline is released during fasting✓ when glycogen stores are depleted during extreme fasting, this stimulates the conversion of amino acids into glucose ***OR*** when glycogen stores are depleted during extreme fasting, this stimulates gluconeogenesis✓	*Award **[2 max]** for glucagon.* *Award **[2 max]** for adrenaline.*	**3 max**

	c		occurs mainly within the mitochondria✓ the initial phase is the same as anaerobic system and occurs in the sarcoplasm ✓ fuel source is glycogen/glucose and fats/lipids ‹proteins/amino acids›✓ ‹three processes› aerobic glycolysis, Krebs cycle, electron transport chain✓ electron transport chain produces the most ATP ✓ in the presence of oxygen, pyruvate is processed by the Krebs cycle which liberates electrons that are passed through the electron transport chain producing energy/ATP✓ 36-38 molecules of ATP from one molecule of glycogen/glucose✓ more electrons thus more ATP is produced from fatty acids than from glucose ***OR*** with beta oxidation, approximately three times/129 molecules of ATP from one molecule of free fatty acid✓ the oxidative cost of ATP from glucose sources is more efficient than from fat sources✓ some amino acids can be converted into glucose/pyruvate✓ controlling enzymes/pyruvate dehydrogenase✓ by-products are carbon dioxide/CO_2, water/H_2O and heat/energy✓		**4 max**

	d		for example multistage fitness test (MST)/bleep test/beep test/Leger test/treadmill: *advantages:* able to cater for large numbers at the same time✓ requires limited space, staff and equipment✓ inexpensive✓ appropriate for sports players ***OR*** targeted at repeated sprint sports and this adds to the validity✓ can be used to predict VO_2 max ***OR*** indirect✓ pacing strategy is pre-determined✓ reliability/accuracy can be improved by employing a standardized protocol✓ different predictive tables are available for young people compared to adults✓ method ‹treadmill› has a high level of accuracy/reliable✓ *disadvantages:* MST is purely a prediction/indirect determination of maximal oxygen uptake✓ reliability/accuracy can be improved by use of technology/direct test *eg* Douglas bag ***OR*** gas analyzer ***OR*** treadmill test✓	*Accept other suitable examples (Cooper's 12 minute run, Harvard Step test, Yo Yo test).* *Award **[2 max]** for advantages.* *Award **[2 max]** for disadvantages.*	**4 max**

continued …

			may be invalid for some due to motivation ***OR*** comparison can be demotivating for some performers✓ environmental conditions can vary (for example running surface/ wind speed/ambient temperature)✓ unsafe for unhealthy individuals ***OR*** requires medical screening✓ reference to issue of runners/sports players underperforming at pre-season training so that a re-test score looks impressive✓ ‹for treadmill› cost of equipment ✓ time consuming✓		

	e		identification of the research question ‹for example has a specific problem identified›✓ control groups✓ identification of the variables/independent variable/dependent variable✓ identification and management of control variables✓ identification of confounding variables and minimizing their impact if possible✓ selection of suitable/appropriate statistical tests✓ selection of suitable/appropriate methods for data collection✓ pre-test standardization of nutritional status and activity profile of subjects✓ appropriate recording of the data✓ appropriate amount of data is recorded ***OR*** appropriate number of trials✓ use of randomization✓ use of placebos✓ use of blinding ***OR*** double-blinding✓ ecological/external validity ***OR*** acknowledgment of the limitations of the study✓	*Aspects need to be explained ie give reasons why these aspects are important to award the mark.* *Award **[1 max]** for a list of study design considerations.*	**6 max**