



Rewarding Learning

ADVANCED
General Certificate of Education
2023

**Sports Science and the
Active Leisure Industry**

Unit A2 2

The Application of Science
to Sports Performance

[AAL21]

WEDNESDAY 24 MAY, AFTERNOON

**MARK
SCHEME**

General Marking Instructions

Introduction

Mark schemes are intended to ensure that the GCE examinations are marked consistently and fairly. The mark schemes provide markers with an indication of the nature and range of candidates' responses likely to be worthy of credit. They also set out the criteria which they should apply in allocating marks to candidates' responses.

Assessment objectives

Below are the assessment objectives for GCE Sports Science and the Active Leisure Industry.

Candidates must:

- demonstrate knowledge and understanding of sports science and the active leisure industry (AO1);
- apply knowledge, understanding and skills through different contexts appropriate to the sports science and the active leisure industry (AO2); and
- analyse and evaluate evidence to make reasoned and valid judgements about sports science and the active leisure industry (AO3).

Quality of candidates' responses

In marking the examination papers, examiners should be looking for a quality of response reflecting the level of maturity which may reasonably be expected of a 17-year-old or 18-year-old which is the age at which the majority of candidates sit their GCE examinations.

Flexibility in marking

Mark schemes are not intended to be totally prescriptive. No mark scheme can cover all the responses which candidates may produce. In the event of unanticipated answers, examiners are expected to use their professional judgement to assess the validity of answers. If an answer is particularly problematic, then examiners should seek the guidance of the Supervising Examiner.

Positive marking

Examiners are encouraged to be positive in their marking, giving appropriate credit for what candidates know, understand and can do rather than penalising candidates for errors or omissions. Examiners should make use of the whole of the available mark range for any particular question and be prepared to award full marks for a response which is as good as might reasonably be expected of a 17-year-old or 18-year-old GCE candidate.

Awarding zero marks

Marks should only be awarded for valid responses and no marks should be awarded for an answer which is completely incorrect or inappropriate.

Types of mark schemes

Mark schemes for tasks or questions which require candidates to respond in extended written form are marked on the basis of levels of response which take account of the quality of written communication.

Other questions which require only short answers are marked on a point for point basis with marks awarded for each valid piece of information provided.

Levels of response

Tasks and questions requiring candidates to respond in extended writing are marked in terms of levels of response. In deciding which level of response to award, examiners should look for 'best fit' bearing in mind that weakness in one area may be compensated by strength in another. In deciding which mark within a particular level to award to any response, examiners are expected to use their professional judgement.

Quality of written communication

Quality of written communication is taken into account in assessing candidates' responses to all tasks and questions that require them to respond in extended written form. These tasks and questions are marked on the basis of levels of response. The description for each level of response includes reference to the quality of written communication.

For conciseness, quality of written communication is distinguished within levels of response. An example follows:

Level 1: Quality of written communication is basic.

Level 2: Quality of written communication is good.

Level 3: Quality of written communication is excellent.

In interpreting these level descriptions, an example is provided below. Examiners should refer to the specific guidance given within the mark scheme for each question:

Band 1 (Basic): The candidate makes only a limited selection and use of an appropriate form and style of writing. The organisation of material will lack clarity and coherence. There is little use of appropriate specialist vocabulary. Presentation, spelling, punctuation and grammar may be such that intended meaning is not clear.

Band 2 (Good): The candidate makes a reasonable selection and use of an appropriate form and style of writing. Relevant material is organised with clarity and coherence. There is some use of appropriate specialist vocabulary. Presentation, spelling, punctuation and grammar are sufficiently competent to make meaning clear.

Band 3 (Excellent): The candidate successfully selects and uses the most appropriate form and style of writing. Relevant material is organised with a high degree of clarity and coherence. There is widespread and accurate use of appropriate specialist vocabulary. Presentation, spelling, punctuation and grammar are of a sufficiently high standard to make meaning clear.

- 1 (a) (i)** Some examples of suitable points to be explained by the candidate:
- The amount of blood pumped by the heart in 1 minute, measured in L/min.
 - The amount of blood pumped out by the heart/left ventricle in one minute.
 - Cardiac output(Q) is the product of stroke volume and heart rate.
 $Q = SV \times HR$.
- Award [1] for brief definition. Award [2] for full definition.
All other valid points will be given credit.
(1 × [2])
(AO1) [2]
- (ii)** Some examples of suitable points to be explained by the candidate:
- Cardiac output will increase from 5L/min at rest to 20–30L/min.
 - Cardiac output increases to increase the supply of oxygenated blood to the working muscles.
 - Heart rate will increase during exercise to deliver more blood to the body.
 - Stroke volume will increase so more blood is pumped out of the heart each time it contracts.
 - Stroke volume and heart rate increases during exercise therefore cardiac output will also increase. $Q = SV \times HR$.
- Award [1] for key phrase and up to [2] for full description.
All other valid points will be given credit.
(1 × [2])
(AO1) [2]
- (b)** Some examples of suitable points to be explained by the candidate:
- (i)** Diastole:
- This is the relaxation phase in the atria and ventricles lasting 0.5 of a second.
 - Atria fill with blood and the atrioventricular valves (mitral & bicuspid) are closed.
 - Rising atrial pressure forces the atrioventricular valves open and the ventricles begin to fill.
 - The semi-lunar valves to the aorta and pulmonary artery remain closed.
- (ii)** Systole:
- This is the contraction phase of the atria and ventricles which lasts 0.3 of a second. The SA node initiates an impulse to the AV node to stimulate the wave of contraction of the atria and then the ventricles.
 - Atrial systole involves the contraction of the atria forcing the remaining blood to be pushed into ventricles. AV valves close after the passage of blood.
 - Ventricular systole involves the contraction of the ventricles to push blood out through the semi-lunar valves to the aorta and pulmonary artery.
- Award [1] for key phrase and up to [2] for full description.
All other valid points will be given credit.
(2 × [2])
(AO2) [4]

(c) Some examples of suitable points to be explained by the candidate:

- Increased vascularisation.
- Capillary density increases.
- Increased red blood cell count, improving the body's ability to transport oxygen to the muscles.
- Cardiac hypertrophy, resulting in thicker stronger walls and increases in heart volumes.
- Arteries and veins become more elastic.
- Increased blood volume and haemoglobin levels.
- Increase in haemoglobin.
- Increase in efficiency of vascular shunt mechanism due to improved vasodilation.

Award [1] for key phrase and up to [2] for full description.

All other valid points will be given credit.

(2 × [2])

(AO2)

[4]

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- 2 (a) Some examples of suitable points to be explained by the candidate:
- Motivation is the direction and intensity of one's effort. Motivation can be intrinsic (coming from sources within the individual) or extrinsic (coming from sources outside the individual).
 - A coach can aim to intrinsically motivate a young performer by developing stimulating, fun and enjoyable practice sessions to encourage an intrinsic love of sport.
 - A coach can aim to extrinsically motivate a young performer by giving tangible rewards such as trophies, medals and certificates.
 - A coach can aim to extrinsically motivate a young performer by giving intangible rewards such as praise, recognition and approval of effort.
 - Goal setting is a key strategy a coach can use to motivate a young performer. Using SMARTER targets a coach can set short term and long term goals to maintain motivation throughout the season.
 - Winning provides a positive motive for further participation. Coaches can create opportunities for success through challenge/friendly games to create a winning mentality that can boost confidence and enhance motivation.
 - Communication is key to maintaining motivation. Team selection and levels of performance may vary as the season progresses which will have an impact on the athlete's motivation. Coaches must use feedback to communicate clearly with players to continue their level of effort despite not being selected.
 - Drive reduction theory – A coach must continue to provide new opportunities for learning in order to motivate performers.
 - Inverted U theory – A coach must ensure the performer has reached their optimal level of arousal to produce their maximal performance.
 - Team building events/days.
 - Music in relation to motivating a young performer to train for their sport.
- Award [1] for identification of strategy and up to [2] for full description.
All other valid points will be given credit.
(2 × [3])
(AO1, AO2) [6]

- (b) Some examples of suitable points to be explained by the candidate:
- (i) Open skills:
- Open skills are affected by the environment or performed in a dynamic changing environment.
 - There is a high level of decision making due to range of factors being considered for e.g. changing terrain, position of other players, weather conditions, flight of a ball.
 - Open skills are usually externally paced.
 - Suitable sporting examples include a forward delivering a cross in soccer or a netball player adapting movement to get free according to position of defender.
- (ii) Gross skills:
- Gross skills involve large muscle movements.
 - These movements are performed by large muscle groups and are often not precise.
 - They include fundamental movement patterns such as running, jumping and throwing

- Suitable sporting examples include a rugby tackle or performing the shot put.

(iii) Self-paced skills:

- The timing of self-paced skills is determined by the performer for e.g. the timing of a serve in tennis is controlled by the performer.
- The rate of movement is controlled by the performer for e.g. a gymnast controls the speed of movement in a tumbling sequence.
- These skills tend to be towards the closed end of the environmental continuum.

Award [1] for key phrase and [1] for sporting example.

All other valid points will be given credit.

(3 × [2])

(AO2)

[6]

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**AVAILABLE
MARKS**

3 (a) Some examples of suitable points to be explained by the candidate:

- Cognitive stage.
- Associative stage.
- Autonomous stage.

Award [1] for the identification of a stage.

All other valid points will be given credit.

(2 × [1])

(AO1)

[2]

(b) Some examples of suitable points to be explained by the candidate:

Command style

- This is a didactic style where the coach makes all the decisions.
- Instructions and objectives are clear.
- Control and discipline are maintained.
- Information can be given quickly if time is limited.
- Large groups can be catered for easily.
- No decision making or input from the learner.
- Possible lack of understanding.
- Limited social interaction with coaches or other learners.
- Limited individual feedback is given.

Reciprocal style

- Performers work in pairs and take turns observing and giving feedback to each other based on established performance criteria.
- Encourages active involvement and interaction of performers.
- Develops communication and decision making skills.
- Coach has less control than command styles.
- Relies on learner's standard of knowledge and ability to communicate.
- This style can be more time consuming to plan and manage effectively.
- Promotes listening skills.

Problem solving

- Coach sets a problem/challenge and the learner devises a suitable solution.
- It is an open-ended approach, encouraging creativity while developing the cognitive and performance element of the learner.
- There is no correct outcome, time is not a restriction and the performers are experienced.
- Performers draw on their acquired knowledge.
- Encourages creativity and decision making skills.
- Development of the learner's responsibility for their own learning.
- Increased motivation and self-confidence.
- Trial and error accepted.

- **Discovery Style/Guided Discovery Style.**

- **Practice Style.**

- **Self-check Style.**

- **Inclusion Style.**

- **Divergent Style.**

- **Individual Style.**

- **Learner Initiated Style.**

- **Self teach Style.**

Award [1] for identification of teaching style and up to [2] for description.

All other valid points will be given credit.

(2 × [3])

(AO1, AO3)

[6]

(c) The quality of written communication is assessed in this question.

AVAILABLE
MARKS

Indicative Content:

Transfer of learning means the influence one skill has on the learning and performance of another. The process is extremely important in the acquisition of movement skills because practically all learning is based on some form of transfer.

Positive transfer:

- Positive transfer occurs when the knowledge and performance of one skill will help the learning of a new skill.
- Positive transfer tends to occur when the skills have a similar shape or form, e.g. overarm throwing technique for javelin and shoulder pass in netball.
- There must be similarity in the structure of the skill components.
- Positive transfer can be enhanced if these similar elements are shown to learners. Learning situations need to allow for positive transfer
- Variability of practice, such as two-touch football, would create the conditions experienced in a real game and help improve passing skills.
- The environmental conditions need to be similar to the real situation. For example, passing skills in hockey should for the most part be practiced in a changing environment.

Bilateral transfer:

- Bilateral transfer occurs when learning and performance is transferred from one side of the body to the other. For example, when a basketball player who can do a lay up with the right hand learns to do it with the left hand.
- Bilateral transfer will enhance performance as it makes performers more versatile, e.g. a soccer player learns to strike with their right and then their left foot.

Retroactive transfer

- Retroactive transfer occurs when a newly learned skill influences a previously learned skill.
- This can be positive as skills overlap in many sports, e.g. jump to catch a high ball in gaelic football enhances rebound skills in basketball.

- **Proactive transfer.**
- **Near transfer.**
- **Far transfer.**

All other valid points will be given credit.

Level 1 ([1]–[3])

Overall impression: Basic

- Basic knowledge and understanding of how a coach could utilise a range of transfer methods to enhance learning and performance in sport. The candidate may provide basic examples.
- Demonstrates a basic ability to discuss the range of transfer methods used to enhance athlete performance. The candidate may provide limited relevant examples relating to how a coach can use methods to enhance learning and performance in sport.
- Quality of written communication is basic. The candidates make a limited selection and use of an appropriate form and style of writing. The

organisation of material may lack clarity and coherence. There is little use of specialist vocabulary. Presentation, spelling, punctuation and grammar may be such that intended meaning is not clear.

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Level 2 ([4]–[6])

Overall impression: Good

- Good knowledge and understanding of how a coach could utilise a range of transfer methods to enhance learning and performance in sport. The candidates will give some relevant examples.
- Demonstrates a good ability to discuss the range of transfer methods to enhance athlete performance. Candidates will provide some relevant explanations of the transfer methods used by the coach to enhance athletic performance.
- Quality of written communication is good. The candidate makes a reasonable selection and use of an appropriate form and style of writing. Relevant material is organised with some clarity and coherence. There is appropriate use of specialist vocabulary. Presentation, spelling, punctuation and grammar are sufficiently competent to make meaning evident.

Level 3 ([7]–[8])

Overall impression: Excellent

- Excellent knowledge and understanding of how a coach could utilise a range of transfer methods to enhance athlete performance. The candidate will provide fully developed examples and show excellent understanding of each one.
- Demonstrates an excellent ability to discuss the range of transfer methods used to enhance athlete performance. Candidates will be able to discuss to an excellent level and elaborate with thorough explanation.
- Quality of written communication is excellent. The candidate successfully selects and uses an appropriate form and style of writing. Relevant material is organised with a high degree of clarity and coherence. There is an extensive and accurate use of specialist vocabulary. Presentation, spelling, punctuation and grammar are of a high standard and ensure that the meaning is clear.

([0]) is awarded for a response not worthy of credit.

(AO1, AO3)

[8]

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4 (a) Some examples of suitable points to be explained by the candidate:

Hinge joint:

- Location: Elbow, knee and ankle.
- Articulating bones in elbow: humerus, radius & ulna.
- Movement: flexion & extension.
- Sporting example: bicep curl.
- Flexion: Upward phase of bicep curl.
- Extension: Downward phase of bicep curl.

Ball and Socket joint:

- Location: Shoulder & hip joints
- Articulating bones in shoulder: scapula & humerus
- Movement: flexion, extension, abduction, adduction, rotation, circumduction.
- Sporting example: circumduction of the shoulder during backstroke arm action in swimming.

Condyloid joint:

- Location: wrist
- Articulating bones: carpals, radius & ulna
- Movement: Flexion, extension, abduction, adduction.
- Sporting example: use of wrist flexion in netball shooting action

- **Saddle joint**
- **Plane joint**
- **Gliding joint**

Award ([1] for the identification of each joint and up to [3] for the description of movement of each synovial joint in specific sporting actions.

All other valid points will be given credit.

(3 × [4])

(AO1, AO2)

[12]

(b) (i) Some examples of suitable points to be explained by the candidate:

- Isometric.
- Isotonic.
- Concentric.
- Eccentric.

Award (1) for identification of each contraction.

All other valid points will be given credit.

(2 × [1])

(AO1)

[2]

(ii) **The quality of written communication is assessed in this question.**

Indicative Content

Positive Impact:

- Impact exercise will result in increased bone density. Stronger bones are less prone to fracture or injury.
- Increased stability of joints to prevent dislocations through strengthened ligaments, tendons and muscles.
- Greater ability to absorb shocks on landing or falling.
- Increased muscle tone improves posture.
- Hypertrophy of muscle increases maximal and dynamic muscle strength.

- Increased speed and power of muscular contraction as a result of high intensity training.
- A stronger, leaner body (mesomorph) can perform more efficiently in contact sports than an untrained participant.
- Increase lactic acid tolerance.
- Increase myoglobin.
- Increase mitochondria.
- Increase calcium deposits.
- Increase secretion of synovial fluid.

Negative Impact:

- Overuse injuries can occur from repetitive training, e.g. shin splints
- Increased likelihood of damage to ligaments for e.g. an anterior cruciate ligament tear is a common sporting injury.
- Increased likelihood of damage to tendons for e.g. ruptured achilles tendon injuries have ended some sporting careers.
- Wear and tear of cartilage is common in many sports
- Muscular injuries such as pulls and tears often occur in sport, e.g. hamstring tear in soccer.
- Increase fatigue/burnout.
- Impact on menstruation cycle.

Practices to manage the physical demands of training:

- Ensure sufficient warm-up and cool down time is incorporated into training.
- Apply appropriate progression and overload to training.
- Incorporate rest and recovery practices into training programmes for e.g. light activity sessions based on flexibility, foam rolling, massage, ice baths.
- Ensure recovery after injury is managed well through use of physiotherapists and that the athlete gradually returns to training when fully fit.
- Nutritional strategies.
- Creatine.

All other valid points will be given credit.

Level 1 ([1]–[4])**Overall impression: Basic**

- Basic knowledge and understanding of the impact of training on the musculoskeletal system. The candidate may provide basic examples.
- Demonstrates a basic ability to assess the impact of exercise on the musculoskeletal system. The candidate may provide basic explanations but does not examine in detail. Limited practices are outlined.
- Quality of written communication is basic. The candidate makes a limited selection and use of an appropriate form and style of writing. The organisation of material may lack clarity and coherence. There is little use of specialist vocabulary. Presentation, spelling, punctuation and grammar may be such that intended meaning is not clear.

Level 2 ([5]–[7])**Overall impression: Good**

- Good knowledge and understanding of the impact of training on the musculoskeletal system. The candidate will give some relevant examples.
- Demonstrates a good ability to assess the impact of exercise on the musculoskeletal system. The candidate will provide some explanations of the risks involved. Some practices are outlined.
- Quality of written communication is good. The candidate makes a reasonable selection and use of an appropriate form and style of writing. Relevant material is organised with some clarity and coherence. There is appropriate use of specialist vocabulary. Presentation, spelling, punctuation and grammar are sufficiently competent to make meaning evident.

Level 3 ([8]–[10])

Overall impression: Excellent

- Excellent knowledge and understanding of the impact of training on the musculoskeletal system. The candidate will provide fully developed examples and shows excellent understanding.
- Demonstrates an excellent ability to assess the impact of training on the musculoskeletal system. The candidate will provide thorough explanation and will use a variety of relevant examples. A number of practices are outlined.
- Quality of written communication is excellent. The candidate successfully selects and uses an appropriate form and style of writing. Relevant material is organised with a high degree of clarity and coherence. There is an extensive and accurate use of specialist vocabulary. Presentation, spelling, punctuation and grammar are of a high standard and ensure that the meaning is clear.

[0] Is awarded for a response not worthy of credit.

(AO1, AO3)

[10]

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5 (a) Some examples of suitable points to be explained by the candidate:

(i) Illegal method:

Blood doping

- Blood doping is an artificial way of increasing the number of red blood cells in the body in order to enhance athletic performance.
- A higher concentration of blood cells increases haemoglobin levels and can improve an athlete's aerobic capacity (VO_{2max}).
- It is carried out by blood transfusion, using either the athlete's blood (autologous) or matched blood type from another person (homologous).
- The benefits are increased energy delivery and delayed fatigue for aerobic performance.

EPO/Peptide hormone

- Erythropoietin (EPO) is a hormone that stimulates the production of red blood cells in the bone marrow. It is a blood protein naturally produced in the kidneys during periods of hypoxia, where there is an insufficient supply of oxygen in the respiring muscles.
- EPO can be injected to stimulate the production of red blood cells.
- EPO can increase red blood cell volume from 45% to 65%. Athletes use EPO as it builds and repairs muscle and increases oxygen transportation.

- Stimulant if explained in relation to recovery.

Award [1] for key phrase and up to [3] for full description.

All other valid points will be given credit.

(1 × [4])

(AO2)

[4]

(ii) Risks:

- Increasing the number of red blood cells causes blood to thicken. The heart has to work harder than normal to pump blood throughout the body.
- Blood doping raises the risk of: blood clot, heart attack, stroke.
- Blood doping via transfusion carries additional risks: HIV, Hepatitis B, Hepatitis C, allergic reactions, fever and rash.
- EPO injections can cause high blood pressure.
- Damage to athlete's reputation.
- Damage reputation of sport.
- Ban from sport.
- Strip of medals/titles.
- Death.
- Infection.

Award [1] for basic description or [2] for full description.

All other valid points will be given credit.

(2 × [2])

(AO2)

[4]

(b) The quality of written communication is assessed in this question.

Indicative Content:

- Altitude is the measurement of elevation, altitude training takes place around 2000m/8000 feet above sea level.
- Atmospheric pressure decreases as altitude increases. This has

significant implications for athletes because a fall in partial pressure can lead to a shortage of oxygen (hypoxia). Every breath taken at high altitude delivers less of what working muscles require.

- To compensate for the decrease in oxygen, the athlete's body produces erythropoietin/EPO naturally. EPO triggers the production of more red blood cells.
- There is an increased concentration of haemoglobin and myoglobin therefore the body is more efficient at carrying oxygen.
- Increased mitochondria and capillarisation increases the efficiency of the aerobic energy system.
- Enhanced oxygen transport to overcome oxygen debt.
- Increased tolerance to lactic acid/delayed OBLA.
- Spending time at altitude (or hypoxic environments) results in physiological adaptations that may enhance the performance of endurance athletes.
- High altitude training will increase $VO_2\text{max}$.
- Altitude training can give athlete advantages over their competitors.

Altitude training strategies

- Live High, Train Low (LHTL)- An athlete 'lives high', either at altitude or with the help of an altitude/hypoxic tent, but does their training at a lower altitude. Common strategy employed by athletes as more oxygen carrying red blood cells are produced and the athlete is able to keep the training sessions high in intensity/quality as there is no restriction to oxygen uptake.
- Live High, Train High (LHTH) – An athlete 'lives high' but also trains high. Not as common, may be an appropriate strategy for those competing at high altitude.
- Live Low, Train High (LLTH) – An athlete lives at normal altitude but trains at high altitude. Not as common, may be an appropriate strategy for those competing at high altitude.

Simulation of altitude conditions using hypoxic tents

- The amount of oxygen in the atmosphere in the tent can be controlled. Athletes can live or in some cases train in hypoxic tents to simulate the effects of living or training at high altitude.
- The tents facilitate the LHTL (Live high, Train Low) method allowing athletes the opportunity to sleep in a hypoxic tent and train locally. This is more cost effective as the athlete does not have to incur travel/accommodation costs going to a high altitude training camp.

Disadvantages of Altitude training

- Athletes may experience altitude sickness, dizziness, headaches, nausea.
- It takes time to acclimatise and breathing rate may increase on arrival at altitude causing hyperventilation.
- Detraining is possible, where the decreased availability of oxygen makes training harder, it may be difficult to train at the same intensity, which could lead to loss of fitness level.
- Altitude training is an expensive method of training for some athletes.
- Benefits may be lost quicker than anticipated when the athlete returns back to sea level (2 – 3 week benefits).
- Altitude training can be isolating and athlete can be lonely.

All other valid points will be given credit.

Level 1 ([1]–[4])**Overall impression: Basic**

- Basic knowledge and understanding of the effectiveness of altitude training as a way to improve performance in endurance events. The candidate may provide basic examples.
- Demonstrates a basic ability to discuss the effectiveness of altitude training as a way to improve the performance in endurance events. The candidate may provide basic explanations but does not examine in detail.
- Quality of written communication is basic. The candidate makes a limited selection and use of an appropriate form and style of writing. The organisation of material may lack clarity and coherence. There is little use of specialist vocabulary. Presentation, spelling, punctuation and grammar may be such that intended meaning is not clear.

Level 2 ([5]–[8])**Overall impression: Good**

- Good knowledge and understanding of the effectiveness of altitude training as a way to improve the performance in endurance events. The candidate will give some relevant examples.
- Demonstrates a good ability to discuss the effectiveness of altitude training as a way to improve performance in endurance events. The candidate will provide some explanations.
- Quality of written communication is good. The candidate makes a reasonable selection and use of an appropriate form and style of writing. Relevant material is organised with some clarity and coherence. There is appropriate use of specialist vocabulary. Presentation, spelling, punctuation and grammar are sufficiently competent to make meaning evident.

Level 3 ([9]–[12])**Overall impression: Excellent**

- Excellent knowledge and understanding of the effectiveness of altitude training as a way to improve the performance in endurance events. The candidate will provide fully developed examples and shows excellent understanding.
- Demonstrates an excellent ability to discuss the effectiveness of altitude training as a way to improve performance in endurance events. The candidate will provide thorough explanation and will use a variety of relevant examples.
- Quality of written communication is excellent. The candidate successfully selects and uses an appropriate form and style of writing. Relevant material is organised with a high degree of clarity and coherence. There is an extensive and accurate use of specialist vocabulary. Presentation, spelling, punctuation and grammar are of a high standard and ensure that the meaning is clear.

[0] is awarded for a response not worthy of credit.

(AO1, AO3)

[12]

(c) The quality of written communication is assessed in this question.**Indicative Content:****Assessing and tracking performance**

- Technology can be used to assess fitness levels for e.g. use of timing gates to assess speed and the laboratory VO₂ max tests to assess level of cardiovascular endurance.
- Using sensors placed on the body or in smart clothing, athletes and coaches can measure and track performance in real time. Breathing, heart rate, hydration and temperature can all be monitored live.
- Blood lactate levels can be monitored during laboratory multi-stage fitness test to assess OBLA. Lactate threshold testing results can be used to create more targeted training zones and induce greater physiological adaptations.
- Global positioning systems (GPS) such as STATSports provide player data using GPS device located on player's clothing. Max speed, total distance, sprint distance and fatigue are just some of the indicators assessed using this technology.
- VAR/Hawkeye accepted in relation to performer.

Perfecting athletic movements

- Athletes can use technology to assist performance of the perfect technical model, Cyclists can wear heads-up display glasses (HUD) that deliver heart rate, speed, incline and other relevant data to the cyclist live.
- Swimmers and divers can wear sensors to map rotational speed, dive angle, leg movement and hydrodynamics. Observing movements like this allow the divers to perfect their technical dives.
- Sports motion analysis looks at the biomechanics of athletes using motion capture software, cameras and markers. This detailed analysis can be used to correct technique in sports such as golf, tennis and cricket. Athletes can improve technique and movement efficiency.
- Observing running and walking action during a gait analysis can pinpoint problems in the gait cycle. Assessing and improving gait can enhance efficiency of movement and minimise injuries.
- Digitally recording performances on camera provides athletes and coaches with information that can be used to analyse the performance of the athlete.
- Use of social media.

Alter training environments/use of ergogenic aids

- Use of technology to alter training environment e.g. hypoxic chambers to gain aerobic adaptations of living at high altitude.
- Heat chambers can be used to simulate training in a hot environment. This training can accelerate acclimatisation on arrival at training/competition venue.
- Use of ergogenic aids to gain a winning edge or to aid the recovery/injury process.

Equipment design

- Equipment design has developed from a greater understanding of the biomechanics of sporting movement and advances in material science.

- New materials have contributed to advances in sport equipment. Lighter materials used in equipment have improved performance for e.g. carbon fibre bikes, graphite tennis racquets and golf clubs.
- Aerodynamic design of equipment has aided performance. The design of cycle helmets, Formula 1 cars and skis have attributed to faster times.
- Technological improvements in equipment have made some sports safer. More robust landing mats used in pole vaulting, high jump and gymnastics. Headgear in boxing was adopted to provide protection from head injuries. Helmets in cycling are now lighter but designed to a higher safety specification.
- Advances in technology have enabled Paralympic athletes to wear carbon fibre prosthetics specifically designed for their event.

Clothing and footwear design

- Improvement in design and manufacturing of clothing for sport. Availability of sport clothing to suit numerous sports.
- Clothing can now be designed to reduce friction (air, water). Tech swimsuits/running suits use a range of technologies to help cut down on drag and improve oxygen efficiency.
- Compression clothing encourages blood circulation and can also aid recovery after injury.
- Research into fabrics has created sports clothing that are designed to be breathable, waterproof and can either prevent heat loss or prevent overheating.
- Footwear is constantly being developed to suit specific sports often lighter, cushioned reducing impact and adding support.

Prevention and rehabilitation injuries

- Using technology to track movement, perfect movement and enhance communication can create less injury prone environments. Training can be tailored to suit the athlete's state of health, e.g. energy, diet, sleep preventing fatigue and burnout.
- Physiotherapists can use technology to enhance athlete's rehabilitation from injury, e.g. anti-gravity treadmill or use of ice/compression vests.

Discussion points

- The use of technology can be seen as an unfair advantage for those that can afford it, for e.g. the specialised staff and the costly equipment. Athletes from developing countries do not have access to the high tech equipment or specialist coaching, due to financial constraints.
- Nature v nurture argument. Is it the ability of the athlete or the availability of technological support that determines the result?
- Some sport technology has raised questions on the validity of results, e.g. shark suits, which have been banned in swimming competitions.
- Athletes become over-reliant on technology.

All other valid points will be given credit.

Level 1 ([1]–[5])

Overall impression: Basic

- Basic knowledge and understanding of the use of technology by elite athletes to maximise their performance. The candidate may provide basic examples.
- Demonstrates a basic ability to discuss the use of technology by elite athletes to maximise their performance. The candidate may provide basic explanations but does not examine in detail.
- Quality of written communication is basic. The candidate makes a limited selection and use of an appropriate form and style of writing. The organisation of material may lack clarity and coherence. There is little use of specialist vocabulary. Presentation, spelling, punctuation and grammar may be such that intended meaning is not clear.

Level 2 ([6]–[11])

Overall impression: Good

- Good knowledge and understanding of the use of technology by elite athletes to maximise their performance. The candidate will give some relevant examples.
- Demonstrates a good ability to discuss the use of technology by elite athletes to maximise their performance. The candidate will provide some examples and explain in some detail.
- Quality of written communication is good. The candidate makes a reasonable selection and use of an appropriate form and style of writing. Relevant material is organised with some clarity and coherence. There is appropriate use of specialist vocabulary. Presentation, spelling, punctuation and grammar are sufficiently competent to make meaning evident.

Level 3 ([12]–[16])

Overall impression: Excellent

- Excellent knowledge and understanding of the use of technology by elite athletes to maximise their performance. The candidate will provide fully developed examples and shows excellent understanding.
- Demonstrates an excellent ability to discuss the use of technology by elite athletes to maximise their performance. The candidate will provide thorough explanation and will use a variety of relevant examples.
- Quality of written communication is excellent. The candidate successfully selects and uses an appropriate form and style of writing. Relevant material is organised with a high degree of clarity and coherence. There is an extensive and accurate use of specialist vocabulary. Presentation, spelling, punctuation and grammar are of a high standard and ensure that the meaning is clear.

[0] is awarded for a response not worthy of credit.

(AO1, AO3)

[16]

36

Total

100