NATIONAL SENIOR CERTIFICATE EXAMINATION
NOVEMBER 2012

SPORT AND EXERCISE SCIENCE: PAPER I

MARKING GUIDELINES

Time: 2 hours | 150 marks

These marking guidelines are prepared for use by examiners and sub-examiners, all of whom are required to attend a standardisation meeting to ensure that the guidelines are consistently interpreted and applied in the marking of candidates' scripts.

The IEB will not enter into any discussions or correspondence about any marking guidelines. It is acknowledged that there may be different views about some matters of emphasis or detail in the guidelines. It is also recognised that, without the benefit of attendance at a standardisation meeting, there may be different interpretations of the application of the marking guidelines.

QUESTION 1

1.1 C – B – E – A – D (5)

1.2 Marathon runners need to use fats early in the race (glycogen sparing) to delay the depletion of carbs. Runners need to use fats early to delay 'hitting the wall' when the carbs get depleted and the heart has to work harder because more oxygen is needed. (2)

1.3 1.3.1 ATP-PC
1.3.2 Aerobic
1.3.3 Anaerobic (3)

1.4 ANY FOUR OF THE FOLLOWING:
- Delay the intake of carbs after exercise
- Not enough carbs
- High intensity exercise during recovery
- Muscle damage
- Insufficient rest
- Not enough protein with the carbs
- Reliance on carb-rich foods with a low glycaemic index
- Drinking water instead of a sports drink (4)

1.5 C – longer duration, continuous training/A and D – short duration, intense
B and E – mix of long duration, continuous training plus short duration, intense (5)

1.6 Y Higher energy expenditure. Work output is high so a high percentage of energy will come from glycogen (2)

1.7 Banana, sweets, pasta, fruit juice, soft drink (2)
[23]

QUESTION 2

2.1 ANY OF THE FOLLOWING:
Long arms = lever length
Large hands and/or feet
Greater percentage fast twitch muscles (1)

2.2 ANY **TWO** OF THE FOLLOWING:
Increased anaerobic capacity
Increased capacity of the LA system
Higher LA tolerance (1)

2.3

Technology
– Use of video/dvd camera → provides feedback/technique/improve coaching – Biomechanical analysis – Full length swimsuits → decrease drag – Lycra → decrease drag – 'sharkskin' costumes → decrease drag – Deeper pools → decrease friction between swimmer and bottom of pool – Lane ropes → decrease resistance from waves – 10 lane pools use 8 lanes → decrease resistance – Shaving down → decrease resistance, psychological factors – Starting block changes – Timing systems have improved

(3)

2.4 2.4.1 ANY **TWO** OF THE FOLLOWING:
Apartheid system ensured that physical education was not available in 'Bantu Education'
Money was not allocated to black facilities
No coaches to teach non-whites how to swim
No black role models
No money to buy unnecessary items such as costumes or pay for coaching or pay entrance fee to pools (2)

2.4.2 Improved local scientific approach to training and more frequent exposure to International competition. (1)

2.4.3 ANY OF THE FOLLOWING:
Success/sense of achievement
Enjoyment
Opportunities on offer
Friendships formed
Aquatic facilities in schools and community recreation facilities
Trained teachers and coaches
Role models representing all cultures in South Africa (1)
[9]

QUESTION 3

3.1 Brothers, L.O./P.E. teacher, family support, access to these opportunities, friends involved, parental pressure, finance, male-headed household. (2)

3.2 Changing body shape/self image
Gender stereotypes
Peer pressure
Increased commitment – school, home, boyfriend
Sports on offer at high school (3)

3.3 She will have decreased aerobic capacity due to:
Decreased size and number of skeletal muscle mitochondria
Decreased heart volume
Possibility of obesity (2)

3.4 Sport needs to be made compulsory at school so that girls are exposed to it; role models encourage participation; introduce more female leagues; more money needs to be spent on female sports, including prize money. ACCEPT OTHER FEASIBLE SUGGESTIONS (2)

3.5 Community recreation centre access, low cost participation, family support, personal motivation, health and wellness knowledge, intrinsic satisfaction, peer involvement, personal choice. (2)

3.6 Can watch her mother play – get more ideas and movement patterns
Wants to imitate her mother (role model)
Likely to get encouragement
Mother probably more keen to transport daughter to training as she is also interested
Tennis or other equipment is lying around the house
Probably watch sport on TV together and discuss tactics, etc.
Before & after the game she can practice with her mother
At the same time her mother can give her some tips and advice (2)

[13]

QUESTION 4

4.1 Performance has improved over time
Men are faster than women (1)

4.2 ANY **THREE** OF THE FOLLOWING:
Men have less fat and more muscle
Men have narrower hips
Men have larger hearts and greater blood volume
Males have higher VO2 max
Females have lower haemoglobin levels (3)

4.3 Improved technology, scientific testing, athlete selection, androgeny, advances in nutritional supplementation, extensive controls on competition-recovery strategies. (3)

4.4 Androgeny may account for close similarities in the physical capacity of male and female athletes, but equal opportunities for genders should be preserved. (2)

[9]

QUESTION 5

5.1 The foods in meal A have generally lower glycaemic index (GI) or slow release energy (4)

5.2 Meal C: (2)

5.3 Lactic acid is produced:
As a by-product of anaerobic exercise
When muscles are depleted of oxygen during intense exercise
From glucose in the blood or glycogen in the muscles after being used as an energy source or from pyruvic acid
Only in skeletal muscles during intense exercise
OR
LA is produced as a waste product in the muscles during strenuous exercise

Contracting muscles obtain ATP from glucose stored in the blood, also from the breakdown of glucose
Pyruvic acid & ATP are generated from this breakdown
Pyruvic acid mixes with oxygen and is converted to carbon dioxide, water and ATP
When long periods of exercise occur the circulatory system begins to lose ground in the delivery of oxygen. Pyruvic acid gets converted into lactic acid. This leaks into the blood system and is carried around the body. LA is removed by breathing in more oxygen (5)

5.4 24 – 48 hours but up to 5 days (1)

5.5 Fast twitch, white or type 2 (1)

5.6 A (1)

5.7 Athlete A has the least amount of fast twitch muscle. A marathon runner has predominant slow twitch muscle. (2)

[16]

QUESTION 6

6.1 Some LA is being oxidised during exercise (1)

6.2 6.2.1 Training has produced a greater LA tolerance or ability to tolerate greater acidity. Buffering (1)

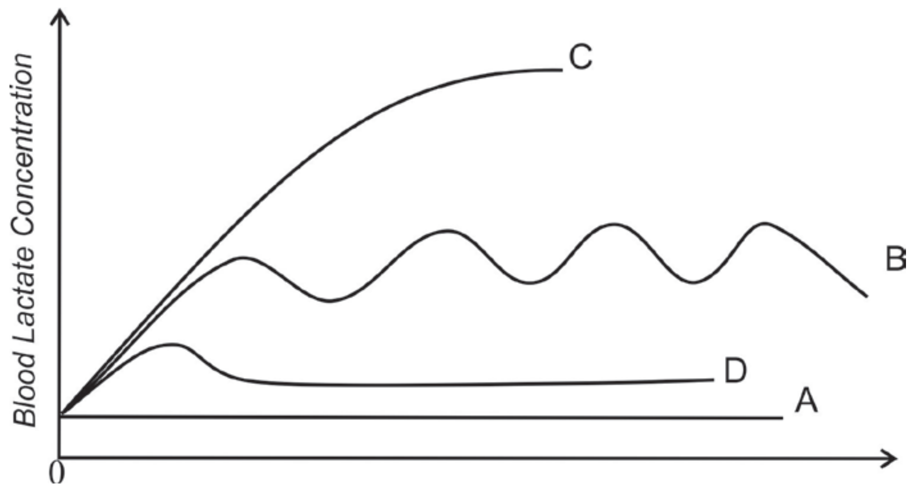
6.2.2 LA tolerance training, interval training (1)

6.3

Activity	Line on graph
Person at rest	A
A 200 m sprint runner	C
A mid-field soccer or hockey player	B

(3)

6.4



(1)
[7]

QUESTION 7

7.1 192 bpm (1)

7.2 Flexibility (1)

7.3 Young **or** female **or** due to the type of training that a gymnast does (1)

7.4 Muscle fibre type
Does mainly aerobic training
Female so lower power to weight ratio
Age (she's older) (2)

7.5 A coach can prepare proper training programmes
Can correct an athlete's weakness
Coach can choose a sport most suited to the athlete
Can investigate incorrect training methods
Coach can look for overtraining or fatigue
To compare athletes
Use as an incentive (4)

7.6 In order to discover their weaknesses and make improvements in training
Improve performance
To discover if they are suited to their chosen sport or not
To compare to others
Motivate themselves (2)
[11]

QUESTION 8

8.1 Short interval training or sprint interval training (1)

8.2 Answers similar to:

8.2.1 Ensure speed is high enough to elevate the heart rate to target levels use this to set target times and keep to them. (2)

8.2.2 Answers similar to: Do a minimum of 3 sessions per week on alternate days. (2)

8.2.3 Answers similar to: perform near maximum sprints, e.g. 6 – 15 reps × 40 – 60 metres. Increase the intensity by dragging a load or carrying a weight, running up an incline, applying resistance Include another training session for the week. (2)

8.3

Training focused on improving:	**Cardiovascular adaptation**	**Muscular adaptation**
Anaerobic capacity	Size of left ventricle wall – hypertrophy	Muscle hypertrophy – increased glycolytic enzymes Increased glycogen stores Increased contraction force Increased ATP and PC stores
Aerobic capacity	Increased volume of left ventricle = decreased resting heart rate Increased stroke volume Increased haemoglobin count Increased blood volume Increased cardiac output (Q)	Increased capillarisation Increased size & number of mitochondria Increased myoglobin Increased oxidative enzymes Increased lactic acid tolerance Increased glycogen and triglyceride stores Increased size of ST fibres

(4)
[11]

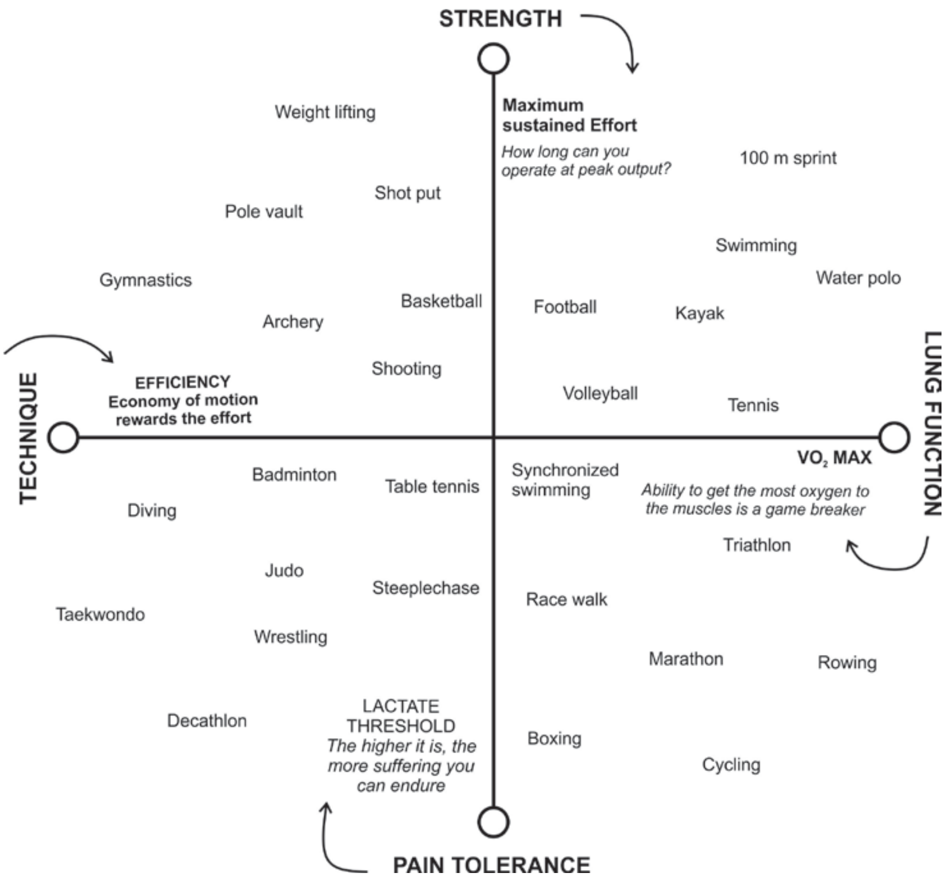
QUESTION 9

Overtraining occurs when the repetitive stress of exercise becomes too great for the body to cope with. It causes tiredness, injury and a decrease in performance. Not having a properly planned training programme, including rest and recovery periods, could result in overload. A balanced diet and sufficient rest periods allow the body to recover properly before the next session. Pupils must refer to the diagram – through repeated overload the initial fitness level has dropped (5)
[5]

QUESTION 10

10.1 10.1.1 Marathon running endurance, tall & slender body shape
10.1.2 Shot put strength & power; short, well built
10.1.3 Squash endurance, power, speed; low fat body shape
10.1.4 Rowing endurance, strength; tall, muscular shape (4)

10.2



(9)
[13]

QUESTION 11

11.1 A
Lower RHR
Heart rate increases at a slower rate
Lower working heart rate
Heart rate returns to normal quicker (5)

11.2 Heart increases in size
Heart can hold more blood
Contract more strongly
Increase in red blood cells
Reduced bp
Lower RHR (5)

11.3 Aerobic – anaerobic – oxygen debt
At 1st respiration will be aerobic. Breathing will be shallow and controlled. Stored fats will be used instead of carbs. Energy will be produced by oxygen combining with glucose. The energy gets used by muscle contractions. CO2 is carried away by blood. Waste is excreted through lungs.
The athlete starts to work with maximum effort in the 2nd part of the race.
Aerobic system is used because the athlete needs energy & it can't reach the muscles quickly enough. Breathing becomes deeper. Some of the energy is turned into heat.
LA gets produced and this makes the muscles get tired. It gets removed by breathing in more oxygen.

The final part – extra oxygen is needed to remove the LA and oxygen debt is caused. Oxygen gets gulped into the lungs. (5)

[15]

QUESTION 12

12.1 Significantly high sedentary behaviours observed (TV watching by 45%) Low (5%) involvement in organized and informal activities. Australian children (40%) appear to be active (physically) for 2 hours within the fortnight period. Implications: health compromise. (3)

12.2 Expose them to more sport.
Make physical education compulsory.
Train more physed teachers
Find sponsors who will provide equipment
Create more festivals, tournaments, etc.
ACCEPT FEASIBLE ANSWERS (3)

[6]

QUESTION 13

Pupils need to provide both sides of the argument and then reach a decision.

Below are some random facts from sports scientists:

- Prosthetics worn by disabled sprinters confer no speed advantage, scientists have found. If anything, they may reduce the top speed a runner can achieve.
- Simon Choppin, a sports engineer at Sheffield Hallam University, said the Pistorius controversy rested on whether his prosthetics increased the efficiency of his limbs, allowing him to achieve higher speeds for less effort. 'So, simply, you can move the prosthetic quicker and you're ready for the next step faster than someone who has a leg'.
- The design of the limbs – the limb is specifically designed to store and then return as much energy as possible. This statement is effectively saying that the prosthetic limb is able to take the forces that are generated DURING LANDING, store them and then translate this into FORWARD movement. In effect, the limb is able to propel the athlete forward. A human limb is similar in respect to being able to store energy. However, there are two critical differences between the human limb and the Cheetah Prosthesis. Firstly, the human limb is unable to translate the energy into FORWARD MOTION. The Cheetahs, can do this because they have their unique shape. A human limb cannot take a force in one direction and convert it to another without requiring muscle contraction.
- The human limb is not able to return energy PASSIVELY. In other words, if you jump off a box and land on the floor, you do not bounce up, and almost all the energy that might have been stored is lost. This means that if you want to use that energy, a human limb must ACTIVELY contract. There are many studies that have shown that if a landing phase is followed by an active contraction, then at most 70% of the energy can be recovered. Some studies have found energy return of only 30%, much less than the Cheetahs, and this is ACTIVE return. The point is that this recovery of energy is ACTIVE – it requires muscle contraction and therefore requires energy. Pistorius does not require energy, and so the metabolic

- cost of running will be lower and he has a potentially enormous advantage as a result.
- The implication of this physiological reality is that the energy cost of running may be reduced. During running, it is factors related to metabolism that are responsible for the fatigue experienced by athletes. These, and the oxygen demand from the muscles, will be reduced in Oscar Pistorius. This is, until proven otherwise, a clear advantage. At its core, sprinting is about accelerating mass. In other words, the athlete uses muscle, which applies force to a mass to cause it to accelerate. It is well known in coaching and in science, that two factors can influence how much acceleration can be achieved. The first is the force that is applied by the muscles. This is the reason that the sprinters you see on television are so extremely well-built and defined – a great deal of power is required to sprint.
- The second factor is mass. A smaller mass is easier to accelerate. Now an athlete's lower limb would usually weight between 5 and 8 kg. In Pistorius' case, the limb is massively reduced by ultralight carbon fibre blades that weigh no more than 1kg. This means that he is saving approximately 6 kg on each leg when he runs. The reduction in mass is thus a massive advantage.
- Now, the counter-argument to this is that Oscar does not have calf muscles to assist with this force generation. This is of course true, and so the scientific response is to look at just HOW MUCH DO CALF MUSCLES ACTUALLY CONTRIBUTE TO PROPULSION DURING RUNNING? And the answer is surprisingly little. In fact, studies have estimated that during walking, only 6% of the total energy comes from the Achilles tendon and calf, and during hopping, it rises to about 16%. Therefore, for sprinting, we might assume it is between 10 and 15%. This is a remarkably small amount, when you consider that the reduction in mass is probably 90%. So he is losing maybe 15% of his ability to push forward, but he also loses 90% of the weight of the lower limb, and about 40% of the total weight of the limb. In the initial stages of the bid to be allowed to compete, one of the key factors put forward by the IAAF was the possibility that the prosthetic limbs would provide a longer stride than for an able-bodied athlete of the same height. There are two reasons why this might be so: and the fact remains that the limbs are designed specifically to PASSIVELY return energy to the runner. An able-bodied athlete must ACTIVELY contract the muscle to capture and use this energy.
- The fact that the prosthetics are designed to simulate the ability of the runner to run on his toes. In sprinting, runners usually land on the ball of the foot, but the problem is that the ankle, which is a hinge joint, 'Collapses' and causes a great deal of inefficiency. If the ankle could be locked in place, it would increase stride length and mechanical efficiency substantially. Now Pistorius has this advantage automatically.
- At this stage, it is important to identify the single factor that is without doubt a disadvantage to Pistorius. And that is from the starting blocks. Because of the double amputation, and the fact that Pistorius is running on legs that have a very small contact area with the ground, his balance from the blocks is compromised. It is for this reason that he starts so slowly and then has to catch up distance on his rivals. However, in the 400 m event this disadvantage is greatly reduced, and is almost minimised.
- They have since concluded – and published their findings in the Journal of Applied Physiology – that Pistorius' prosthetics provide a significant advantage. They calculate the artificial limbs take as much as 10 seconds off the 400 m time he could have run had he been born with lower legs. (12)

[12]

Total: 150 marks