General Certificate of Education
Advanced Subsidiary Examination
January 2010

General Studies (Specification A) GENA2

Unit 2 AS Science and Society

Source Booklet

Source for use with **Questions 1.1** to **1.30**.

Source for Questions 1.1 to 1.30

Consider the following passage, including **Figures 1** and **2**, and then answer **Questions 1.1** to **1.30**.

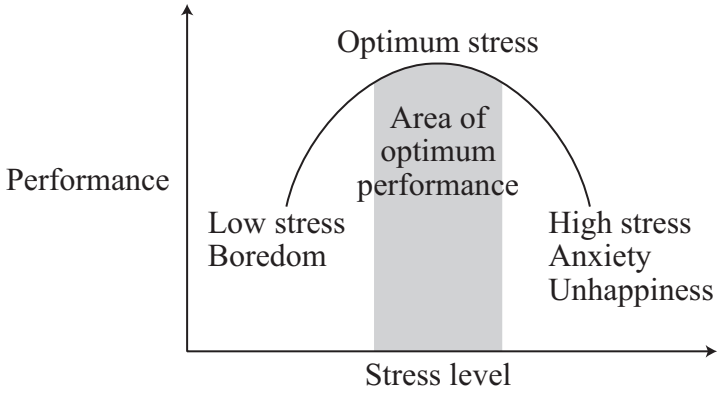
Science and Sport

(1) There has recently been an explosion in papers and conferences dedicated to the science of sport. Read any of the literature or attend any of the international meetings and you will find not only maths and physics being discussed but also psychology, computer modelling, biomechanics and physiology. All have been utilised to improve performance in sport.

(2) The role of psychologists in sport is ever increasing. They provide input on tactics, preparation and motivation and offer remedies for stress. No respected trainer today can afford to ignore the psychological dimension of success. Some sportspeople fail or 'choke' during stressful encounters. This may be because psychological arousal can be either too strong or too weak. When it is not at the required pitch to overcome the debilitating effects of performance-induced anxiety, optimum performance may not be achieved.

(3) The graph below shows how some psychologists perceive the link between stress and quality of performance.

Figure 1: The relationship between stress and performance



(4) Other psychologists explain the link between stress and performance differently. Walter Cannon's research in biological psychology led him to describe the 'fight or flight' response to threat by the Sympathetic Nervous System (SNS). Cannon found that SNS arousal in response to a perceived threat involves several elements which prepare the body physiologically either to take a stand and fight off an attacker or to flee from the danger. These include:

- heart rate and blood pressure increase
- perspiration increases
- more acute hearing and vision
- release of adrenaline
- colder hands and feet as blood moves from the extremities to the large muscles in preparation for fighting or fleeing.

(5) A process called ‘imaging’ which psychologists employ aims to reduce the pre-match anxiety that can inhibit performance. Players visualise experiences associated with a major sports event, for example appearing before a large hostile crowd. This generates the stress and anxiety that they would expect to experience, thereby allowing them to practise their stress management skills. This should help with their performance on the big day. Imagery could also be used to rehearse and perfect strategies that will be used during a real performance or to keep technique good when limbs feel exhausted.

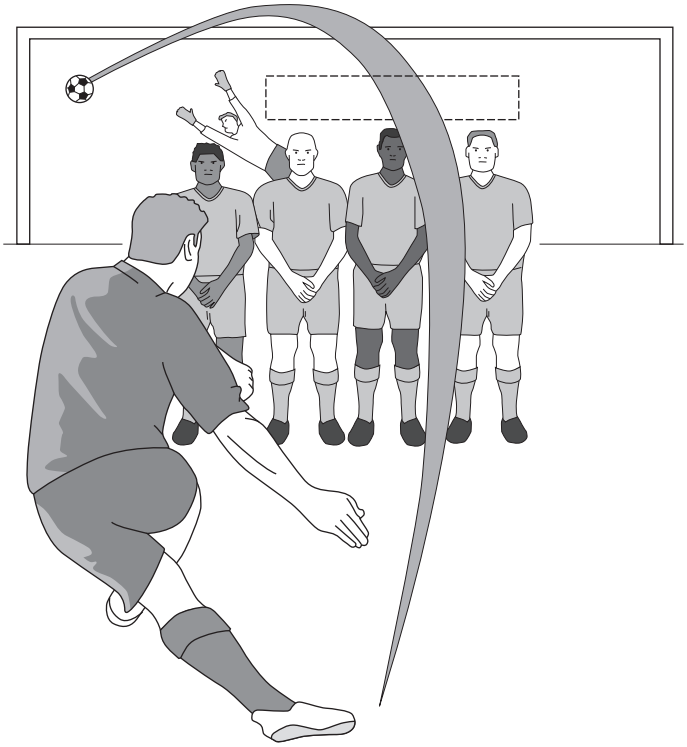
(6) Fundamental physics can also play a part in preparing for some sporting events, for example by explaining why balls swerve in tennis, football and volleyball. The vital ingredient in applying swerve is controlled spin. Without spin the airflow breaks away from the ball’s surface symmetrically and there is no deflecting force. When the ball rotates, however, the air flow pattern is disturbed. It breaks away earlier on the side rotating against the air stream and later on the side rotating in the same direction as the air stream. This results in a pressure differential and deflecting force such that a ball with clockwise spin will move from left to right.

(7) Sportspeople who specialise in putting spin on a ball use sidespin to deflect a ball horizontally. They can also put topspin on the ball where the ball spins forward as it flies through the air. Backspin can also be applied so the ball spins backwards whilst being propelled forwards. Applying backspin can be a problem in some situations, however, as the force is vertical and the ball is likely to balloon into the air.

(8) Some sports scientists have studied the movement of balls using fast digital video cameras. A ball’s trajectory can be measured very accurately in 3D and, by building a mathematical model incorporating all the aerodynamic forces, scientists can arrive at a complete description of the technique. In football, for example, it is possible to show how precise a player’s technique must be. When a free kick is struck, the ball’s elevation, direction, speed and spin must all be carefully controlled in order to hit the undefended part of the goal.

Figure 2: The perfect free kick

The perfect free kick
Not much to aim for when there’s a ‘wall’ in the way.



Sideways deflection in a 25-metre kick can be as great as 3.5 metres, depending upon angle, speed and spin rate.

A launch angle of just over 16 degrees, speed between 25–30 metres per second and spin rate between 5–10 revolutions per second will allow a ball to be ‘slotted’ through a ‘letterbox’ above the wall of players, roughly one ball high and six balls wide.

(9) Science also plays its part in helping us to understand the specialist needs of different sportspeople. In athletics, for example, distance runners who cover from 5 km to full marathons will convert chemical energy into mechanical energy by 'burning' glycogen and fats in aerobic combination with oxygen. However, for explosive events like sprinting, aerobic conversion is not rapid enough and energy stores in muscle groups themselves must be plundered, using anaerobic mechanisms. This explains why distance runners are usually lean but sprinters have well-developed musculature.

10) A range of other scientists and scientific techniques are also employed by the professional sports industry to maximise performance. Nutritional scientists recommend that rugby players have a high carbohydrate intake the day before a game to boost liver and muscle reserves, but that they should only eat a light snack on the day. The hard physical exertion of a match requires a continuous supply of energy. A player may lose up to 2.5 kg during a game, through sweating. Consequently, fluid intake should be controlled.

(11) Science has not been alone in its application to professional sport. Mathematics has also been employed. For example, the system ProZone has been developed to produce a minutely detailed analysis of a complete match, including every movement of each player every tenth of a second.

(12) This then allows a coach to analyse individual performances and the tactical effectiveness of different playing formations. The process of capturing and delivering this raw data into a useable format begins with the live capture of player movements by between 8 and 12 camera sensors, located within the stadium. Images are digitally captured and all data is transferred as the x and y co-ordinates of every player and official on the field of play. It is also possible to record and analyse passes, or attempted passes, between players in team ball games. An analysis of these has shown that only about 60% of attempted passes are successful and that a sequence of six or more successful passes is rare.

(13) Science not only applies itself to people in order to enhance performance, but also to sports equipment. The technology behind a basketball and football today is staggering. A German consortium is developing a 'smart ball' that carries a chip which transmits a radio frequency to reveal its position with very high accuracy. If successful, such technology will reduce discussions as to whether a football did or did not 'cross the goal line'. Already electronic technology is being used in other sports, such as Hawkeye letting the players and the umpire know whether a ball was in or out in tennis, and letting the television viewer know whether a batsman should have been 'out' in cricket.

Source: adapted from article in *BBC Focus* by KEN BRAY,
author 'How to Score' – Science and the Beautiful Game (Granta Books, 2006)

END OF SOURCE