RADLEY COLLEGE
Entrance Scholarships

SCIENCE AND TECHNOLOGY

March 2011

Time allowed: 2 hours

*Answer **all** questions.*

Write the answers to each section on a separate sheet of paper.

CALCULATORS ARE NOT TO BE USED

Biology **[25 marks]**

Read the following passage:

Dehydration

Sweating helps the body **maintain** its **core temperature** at 37 degrees centigrade. Sweating results in the loss of body fluid and electrolytes (minerals such as chloride, calcium, magnesium, sodium and potassium) and if unchecked will lead to **dehydration** and eventually circulatory collapse and heat stroke. The effect of fluid loss on the body is as follows:
% body weight lost as sweat

% body weight lost as sweat	Physiological Effect
2%	**Impaired** performance
4%	Capacity for muscular work declines
5%	Heat exhaustion
7%	Hallucinations
10%	Circulatory collapse and heat stroke

Hydration

Fluid absorption

Two main factors affect the speed at which fluid from a drink gets into the body:

1. the speed at which it is **emptied** from the stomach
2. the rate at which it is **absorbed** through the walls of the small intestine

The higher the carbohydrate levels in a drink the slower the rate of stomach emptying. **Isotonic** drinks with a carbohydrate level of between 6 and 8% are emptied from the stomach at a rate similar to water. Electrolytes, especially sodium and potassium, in a drink will reduce urine output, enable the fluid to empty quickly from the stomach, promote absorption from the intestine and encourage fluid retention.

Adapted from: *http://www.brianmac.co.uk/drinks.htm* 01.03.11 17.26

Using information in the passage and your own knowledge, answer the following questions.

1. What is meant in the passage by the words indicated in bold as follows:

(i) **maintain**
(ii) **core temperature**
(iii) **dehydration**
(iv) **impaired**
(v) **emptied**
(vi) **absorbed**
(vii) **isotonic** [7]

2. How does sweating help 'maintain' an organism's core temperature? [3]

3. What is the purpose of organisms keeping their body temperature constant? [2]

4. Reptiles adapt their behaviour to help keep their body temperature as constant as possible. Explain how they do this. [2]

5. What adaptations does the small intestine have to increase the rate at which the sports drinks are absorbed. [2]

6. If an athlete has been running hard on a hot day and has not drunk enough what changes might you expect to see in their urine output. [2]

7. What happens to the carbohydrates in the drink when they are in the stomach. [1]

8. A lot of commercial 'sports drinks' are not isotonic, but hypertonic. What does hypertonic mean? [1]

9. Apart from sweating, what other changes would you expect to happen automatically in the body of an athlete who is exercising hard. Explain why each change occurs. [5]

Chemistry **[25 marks]**

1. This question is about carbon dioxide.

a. The gases in air boil at different temperatures. What separation method could be used to separate them? Explain your answer [3]

b. When carbon dioxide is one of the gases which contributes towards acid rain.

i. Describe how acid rain is formed. [2]

ii. Name two other gases which can cause acid rain. [2]

iii. What pH number will acid rain have? [1]

iv. Give an example of an unwanted effect of acid rain. [1]

v. Name one substance which can neutralise acid rain. [1]

Question 1 total marks [10]

2. Copper is often used as a building material.

a. What properties of copper make is suitable for

i. Water pipes. Explain your answer. [2]

ii. Electrical cables. Explain your answer [2]

b. Why would pipes made of magnesium be unsuitable for carrying water? [3]

Question 2 total marks [7]

3. This question is about an alternative to the salt you put on food called LO SALT. It contains potassium chloride as well as sodium chloride.



Describe how you could make potassium chloride crystals in the laboratory starting from an acid and potassium carbonate. Include in your answer the word equation for any chemical reaction. You may use a diagram in your answer to show how the experiment is carried out. Marks are also given for correct use of scientific terms.

Question 3 total marks [8]

Physics **[25 marks]**

Following the recent historic Ashes victory in Australia, this question is based around cricket.

You must show your working out at all stages and clearly state any assumptions that you are making.

MOST OF THE MARKS IN THIS QUESTION ARE FOR SHOWING HOW WELL YOU CAN THINK. THE FINAL ANSWERS ARE LESS IMPORTANT THAN SHOWING THAT YOU CAN THINK AND WORK LOGICALLY.

CALCULATORS ARE NOT TO BE USED

1. When a cricket ball is hit to the boundary by a good cricketer, it leaves the bat at approximately 90 km/h. Convert 90 km/h into metres per second (m/s). [2]

2. Estimate the distance in metres to the boundary in a cricket ground. Then, assuming that the ball does not slow down during its journey, use this estimate and the answer to question 1 to calculate the time the ball would take to reach the boundary. [3]

3. In the Melbourne Cricket Ground it is approximately 130 metres from the players in the middle to the back row of the stadium.

Sound travels at 330 m/s.
Calculate how long it would take for the sound of the ball hitting the bat to reach a person sitting in the back row of the stadium. [3]
Give your answer to 2 significant figures.

4. The TV signal that relays the cricket to England is transmitted up to the Sky satellite at the speed of light and then down to England at the same speed.
Speed of light = 3.0×10^8 m/s
Distance from Earth to Sky satellite = 4.2×10^3 km
Calculate how long it takes for the TV signal to travel from Australia to England via the Sky satellite.
Give your answer to 2 significant figures. [4]

5. Comment on your answers to questions 4 & 5. [2]

6. After watching the cricket, Fergus decides to carry out an experiment to measure the effect of air resistance on a cricket ball. Using a radar gun that he made in his spare time, he measures the speed that a cricket ball leaves a bowler's hand. Using another radar gun made by his sister, he also measures the speed of the same ball when it reaches the batsman. The results are shown below.

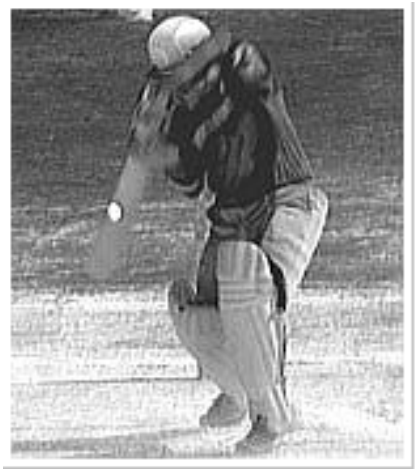
Bowling speed (m/s)	Speed at batsman (m/s)
50	40
44	35
35	28
29	23
23	18
14	11

a) On the graph paper provided, plot a graph of bowling speed (on the y axis) against speed at the batsman (on the x-axis). [4]

b) Measure the gradient/slope of your line. [1]

c) Use your answer to part b) to predict the speed at the batsman of a ball fired out of a gun at 200 m/s. [3]

7. Look at the picture below



It shows a 'hot spot' on the bat where the batsman has hit the ball.

Explain how this technology works with reference to the <u>energy changes</u> that take place. [3]