RADLEY COLLEGE
Entrance Scholarships

SCIENCE AND TECHNOLOGY

March 2009

Time allowed: 2 hours

*Answer **all** questions.*

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

Biology **[25 marks]**

Read the following passage:

Pond-living snails are **hermaphroditic**. Some species fertilize their own eggs while, for others, **cross fertilization** is the rule. Another variant is for the male and female reproductive systems to **mature** at different times so that, at any given moment, the snail is either an active male or female but not both.

Some freshwater snails are of great medical or economic importance as **intermediate hosts** to flukes that infect man and his stock. Bilharzia disease in humans is caused by a parasite that spends part of its life cycle in an African pond snail. The oriental liver fluke passes from pond snail to fish to man where it **migrates** from the gut along the bile duct to the liver. Because the Japanese eat a lot of raw fish the **infection level** may reach 35 per cent in certain districts.

(Adapted from: *The Pond*, Thompson, Coldrey & Bernard)

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) **hermaphroditic**
(ii) **cross fertilization**
(iii) **mature**
(iv) **inter-mediate hosts**
(v) **migrates**
(vi) **infection level** [6]

2. To which phylum do the snails belong? [1]

3. Give an advantage of cross-fertilization over self-fertilization. [1]

4. Give an advantage of self-fertilization over cross-fertilization. [1]

5. Explain the 'medical importance' of the snails [2]

6. Explain the 'economic importance' of the snails on 'his stock'? [2]

7. What benefits might the fluke get when inside the gut of the host? [2]

8. a. For an 'average' Japanese community of 200 people, what maximum number would you expect to be infected. Show your workings. [2]

b. For most parts of Japan the average would be less than your answer to 8.a. Explain, in detail, why. [3]

9. Snails live in shells - discuss some of the advantages and disadvantages of this body design [5]

Chemistry **[25 marks]**

This question relates to the chemistry of materials in the kitchen.






1. i) Using the terms physical change and chemical change, explain the difference between baking a cake and boiling the kettle. [4]

ii) Describe what happens to the water particles as the kettle reaches boiling point. Include a diagram in your answer. [3]

iii) To turn all the water to steam would require more energy to be put in. Using the term bonds, explain where the energy goes. [2]

2. To make a cake, it is necessary to add a raising agent such as baking powder, which contains sodium bicarbonate. When sodium bicarbonate is heated, carbon dioxide gas is given off.

i) How would you test that the gas was carbon dioxide and what would you expect to see? [2]

ii) How does the baking powder help the cake to rise? [2]

iii) A cake weighs rather less after baking than the runny mixture did before. Suggest TWO ways in which this might have happened. [2]

3. Kitchen pans are often made from metals such as copper or steel.

i) What three properties of these metals make them particularly useful in the kitchen? [3]

ii) Why isn't sodium used for kitchen pans? [2]

4. A cook accidentally puts the cake mixture into a plastic container before placing this in a hot oven, and the container burns.
The plastic, called polypropene, contains carbon and hydrogen.

i) What are the two main products formed from the burning container? [2]

ii) A lot of smoke is also produced, and a choking smell. What caused the smoke and smell? [1]

ii) One way to reduce the amount of household waste which goes into land-fills is to burn the waste to generate electricity. Given domestic waste often contains a lot of plastics like polypropene, what two specific environmental concerns would have to be considered when doing this? [2]

Physics **[25 marks]**

This question is about electricity generation and you will be carrying out a number of calculations to compare a coal-fired power station with a wind turbine.

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.

The number of marks for each question is shown in [ ] after the question

CALCULATORS ARE NOT ALLOWED

The number of marks available for each part of the question is shown in brackets.

1. Didcot Power station is a coal-fired power station in Oxfordshire. It produces electricity at the rate of 2 billion Joules per second or 2×10^9 J/s.

a. Calculate how many Joules per year the power station produces. One year is approximately 3×10^7 seconds. [2]

b. The power station uses about 4×10^9 kg of coal per year. Calculate the volume that this coal would occupy. [3]

Density of coal = 2000 kg/m^3

c. The coal is brought to the power station in coal trucks. A picture of one of the trucks is below.



Estimate the volume of coal that a truck like this could carry. Clearly state any assumptions you make about the size of the truck. [3]

d. From your answer to part c) above, estimate

(i) How many trucks per year are needed to keep Didcot power station supplied with coal. [3]

(ii) How many is this per day? [2]

2. A large wind turbine can produce 1.5 million joules per second (1.5×10^6 J/s) of energy. Didcot power station produced 2×10^9 J/s.

a. How many wind turbines would be needed to produce the same power output as Didcot Power Station? [2]

b. 1.5×10^6 J/s is the maximum output of the wind turbine. The table overleaf shows the power output (in kilojoules per second) at different wind speeds.

1 kJ = 1000J

Plot a graph to show the power output for different windspeeds.
Plot wind speed on the x-axis and power output on the y-axis.
Join your points with a line of best fit. [4]

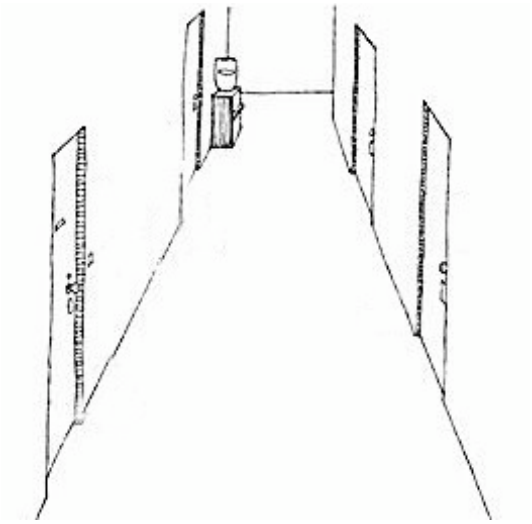
Wind speed m/s	Power kJ/s
0	0
2	0
4	0
6	200
8	580
10	1150
12	1450
14	1500
16	1500

c. With reference to your graph, explain how the power output varies with wind speed. [3]

d. A friend thinks that we should replace all the coal fired power stations with wind turbines. Why would this not be a good idea? [3]

Design and Technology **[25 Marks]**

Look at the below questions and follow the instructions carefully. Some questions ask for an **annotated sketch**, some questions ask for just **text only**. Some questions have a number of parts to them. These have been printed in **bold**.



Two brothers have decided to build a cable car system along a corridor between their bedroom doors. They want to pass small objects and notes backwards and forwards to each other without having to walk along the corridor and into each other's rooms, (things they might consider sending along the cable would be model soldiers / sweets and secret notes). The distance between the doors is 5 meters (see diagram above).

Before building a prototype, you are asked to list **8 of the most important specification points** that would be necessary to consider when designing it. [4]

Name **four reasonable, different methods** of making the container move. [2]

Explain, **for each system**, the way they might work. [2]

Explain, **for each system**, the problems that the system might encounter. [2]

Draw and label the container that goes along the line and by **using annotations and sketches**, explain:

a) **why it is shaped** the way you have designed it? [2]

b) **what materials** it would be made from **and why**? [2]

One brother decides he would like a system that signals the other brother that a container has arrived outside his door.

a) What 4 **reasonable - different methods** can you think of using? [2]

b) Draw a **detailed drawing** of **two** of the systems and **label them showing how they might work**.

Sketch with notes showing method 1 (2 marks for drawing, 2 for notes). [4]

Sketch with notes showing method 2 (2 marks for drawing, 2 for notes). [4]

A company becomes interested in marketing the product, and you are asked what you plan to call the system. Devise **two** exiting names for the product that would entice children to buy the product for their houses.

[1]