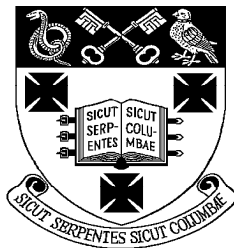**RADLEY COLLEGE**
Entrance Scholarships

SCIENCE AND TECHNOLOGY I

Monday 21st February 2005

Time allowed: 2 hours

*Answer **all** questions.*

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

Biology

Read the following passage:

The oak's acorns, so rich in nutriment, provide meals for another whole range of diners. There is a lot for them to feed on, for a mature oak may produce 90,000 acorns a year - several million in its lifetime. Since only one acorn from each tree need grow to maturity each century to maintain the oak population, there is a vast surplus. Animals of all kinds make sure that it is not wasted. Rooks and jays rip the acorns from the branches as they mature. Wood pigeons are particularly **gluttonous.** One of them can hold seventy in its **crop** at any one time and consume a hundred and twenty in a day. Weevils bore holes into them with their long snouts and lay their eggs there. And when those acorns that survive this **toll** fall to the ground, they are greedily collected by mice, squirrels, deer and, in mainland Europe, by wild pig.

The consumers of the oak's tissues, in their turn, serve as food for another set of animals. Wasps, spiders and ladybird **larvae** hunt for the caterpillars. Native birds are now beginning to nest and the females need to feed intensively in order to produce their eggs. Spotted woodpeckers and tree creepers clamber over the oak's bark, picking out insects hidden in the crevices. Great tits time the production of their families to coincide with that when the caterpillars are most abundant on the oak leaves and a parent bird, with nestlings to feed, may collect at least three hundred caterpillars a day. Many **migrants** including warblers and nightingales fly to share in the feast. And these small birds themselves become the food of bigger birds - magpies and jays - which take not only eggs and nestlings but the adults of smaller species. As the oak ages and holes develop in its trunk, owls and bats may take up residence inside it; and down among its **gnarled** interlacing roots, badgers and foxes burrow out their homes.

Oaks are indeed the lords of the forest, and in the proper traditions of reigning monarchs, they provide a livelihood for a multitude of the smaller inhabitants of their kingdom.

(Adapted from: *ThePrivate Life of Plants*. David Attenborough)

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)   **gluttonous**
    (ii)   **crop**
    (iii)   **toll**
    (iv)   **larvae**
    (v)   **migrants**
    (vi)   **gnarled**   [6]

    Give an example from the passage of each of the following:

    (i)   a producer
    (ii)   a secondary consumer
    (iii)   a tertiary consumer
    (iv)   a parasite   [2]

2. Why does the oak tree need to produce so many acorns?   [2]

3. Are weevils herbivores, carnivores or omnivores?   [1]

4. To which Kingdom do oaks belong?   [1]

5. To which Phylum do tree creepers belong?   [1]

6. Give two distinguishing features of arachnids.   [2]

7. To which Phylum do bats belong?   [1]

8   Give three distinguishing features of mammals.   [3]

9. How does the behaviour of the great tit benefit its young?   [3]

10. Draw a food web using some of the organisms **named** in the passage.
                                                                   [3]

Chemistry

1. Some marble chips are reacted with hydrochloric acid in a divided flask connected to a gas syringe (Figure 1).
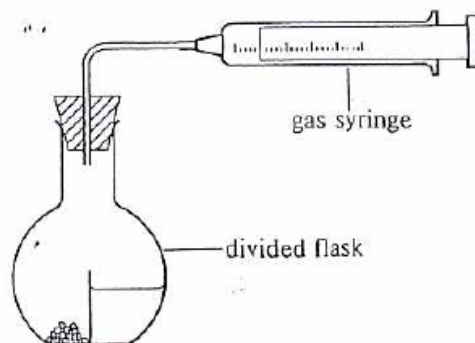

figure 1

To start the reaction, the flask is tipped up so the acid enters the side of the flask containing the marble chips. This is when the stopwatch is started and the volume of gas is recorded every 60 seconds for 10 minutes.

Time (mins)	0	1	2	3	4	5	6	7	8	9	10
Volume (cm^3)	0	12	20	26	30	33	35	36	37	38	38

a)   What is the formula of hydrochloric acid?   [1]

b)   What is the chemical name of marble ($CaCO_3$)?   [1]

c)   Write a word equation for the reaction   [2]

d)   Write a balanced symbol (formula) equation for the reaction   [2]

e)   Describe what you would observe during the reaction   [1]

f)   How would you test for the gas given off in the reaction?   [1]

g)   On a piece of graph paper plot the results as a line graph   [5]
     Hint: gas volume (y axis) & time (x axis)

h) When was the reaction fastest?   [1]

i) What was the rate (in cm^3/min) of the reaction in part (h)?   [2]

j) When did the reaction stop?   [1]

k) How much gas was produced?   [1]

l) Why was the flask divided?   [1]

m) Why was the gas syringe connected before the reaction started? [1]

n) Give <u>two</u> uses for the gas made in this reaction   [2]

o) Where in the human body would you find the acid used in this
    reaction?   [1]

p) Name the <u>two</u> elements which can be used to make the acid   [2]

Physics

Data (Approximate Values):

Radius of Earth	6, 400 km
Height of Sky Satellite	40,000 km
Height of Moon	360,000 km
Distance to Sun	150 million km
Fast Walking Speed	3 m/s
Fast Driving Speed	30 m/s
Speed of Sound	300 m/s
Speed of Light	300 million m/s
Density of Air	1 kg/m^3
Density of Water	1000 kg /m^3
Density of Rock	5000 kg/m^3

1.   **Calculate** how long it would take a beam of light to go from the Sun to the Earth.   [1]

2.   **Calculate** how long it would take a radio signal to go from the Earth to the Sky Satellite.   [2]

3.   Using your previous answer and no calculator, write down **roughly** how long it will take a radio signal to get to the Moon, stating your reasoning.   [2]

4.   If a string were stretched to the Sky Satellite from the Earth, then this length of string wrapped around the Earth, **roughly how many times round** would it go?   [3]

5.   What do you think the **radius** of the Moon might be? Explain your answer.   [3]

6. How **fast** can you cycle? Explain your answer. [2]

7a. **Estimate** the volume of water in a reasonably deep bath. Show your working. [2]

7b. So, what would the **mass** of water in that bath be? [2]

8. **Estimate** the **density** of wood? Explain your answer. [2]

9. **Estimate** the **density** of Lead? Explain your answer. [2]

10. Rugby regulation 12 on shoulder pads states that "**no part of the pads may have a density of more than 45 kg/m³**". Write a detailed **method** to describe how you would **test** some shoulder pads to see if they are legal. [4]

Design & Technology

1. Using words from the list below, pick out the most appropriate word for each sentence.

Tensile strength, compressive strength, density, brittleness, and conductivity

a) Mercury is heavy because of its high_____

b) Steel cable is used to pull heavy boats because of its excellent_____

c) Copper is used in household electricity cables because of its excellent_____

d) Concrete is used in columns that support bridges because of its excellent_____

e) Great care has to be taken when transporting fine china because of its_____
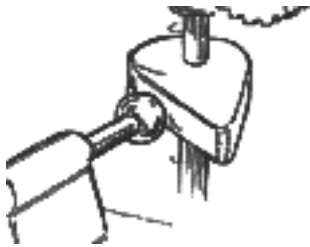
[5]

2. Structures play a very important part in our every day life and the life of the world around us.

a) Give three everyday examples of natural structures. [1]

b) Give three everyday examples of man-made structures. [1]

3.   Name the four mechanical components shown in the drawings below.
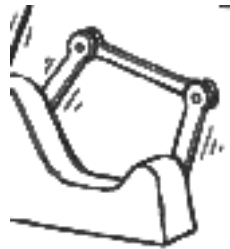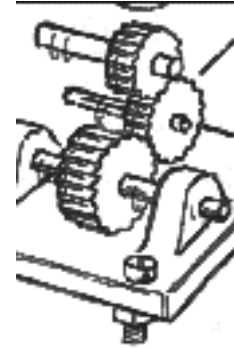   [4]

Component **A**   Component **B**   Component **C**   Component **D**

4.   There are four basic types of motion, one example being rotary
      motion.

a)   What are the other three types of motion?   [3]

b)   An example of rotary motion would be a spinning bicycle wheel.
      Give examples of the other three forms of motion.   [3]

c)   Explain the major problem which prevents us from achieving
      perpetual motion in a machine.   [2]

5.   The diagram below shows a design for a steady hand game. The
      object of the game is to manoeuvre a ring along a bent wire without
      bringing the two in contact. If the ring touches the wire it creates a
      circuit which activates a buzzer.

      Suggest suitable materials for three of the labelled components.   [6]