RADLEY COLLEGE

Entrance Scholarships

SCIENCE AND TECHNOLOGY II

Wednesday 6th March 2002

Time allowed - 2 hours

*Answer **all** 4 sections.*
Each section carries the same number of marks.
Illustrate your answers with sketches where necessary.

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

You may use a calculator

Biology

What do you understand by "The Balance of Nature".

[25 Marks]

Chemistry

1.   Methane is a gas that is the main component of natural gas, the gas that undergoes combustion within homes in order to provide heat energy. When methane gas burns, it produces carbon dioxide and water vapour.

        Describe an experiment, with the aid of a fully labelled diagram, which proves that when methane burns, carbon dioxide and water vapour are formed.   [5]

2.   A piece of magnesium has its mass recorded and then it is ignited in air. The mass of the white ash formed in the reaction is also measured.

        i) What is the name of the white ash?   [1]

   ii) How would you expect the mass of the magnesium to change on forming the white ash? Explain your answer.   [2]

3.   Many years a go, scientists believed that when substances burn, they produce a substance called 'phlogiston'. The following scientific situations are described using the 'Phlogiston Theory of Matter'.

Case 1:
When a lighted splint is placed into a container, the splint is eventually extinguished. Explanation: the air in the container is now saturated with phlogiston and cannot hold anymore so the flame goes out.

Case 2:
When iron rusts, it loses its phlogiston to form dephlogisticated iron. If a piece of coal is added to the dephlogisticated iron and heated, the iron metal reappears. Explanation: coal still has its phlogiston and as it is heated with the dephlogisticated iron, the phlogiston is passed from the coal to the dephlogisticated iron therefore turning the dephlogisticated iron into iron.

dephlogisticated iron + phlogiston ⇒ iron
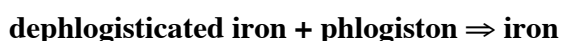
        i) Explain what is really happening in the two cases above using your understanding of modern chemical science to help you.   [4]

        ii) Suggest a way in which you could prove that the phlogiston theory is false and that your explanation to the previous question is correct.   [4]

4   Explain the following observations.

        i) When ice melts, energy is required but when liquid water freezes, energy is released.
                                                                                                      [3]
        ii) When aluminium reacts with iodine, it is found that the ratio of the masses of aluminium to iodine is always the same.   [3]

        iii) When copper carbonate is added to dilute h■■■■ic acid, a gas is produced whereas when copper oxide is added to the same acid, no gas■■■■■.   [3]

Design &Technology

You are shipwrecked on a desert island.

Washed up on the beach are:

    A.   plastic bottles
    B.   tins
    C.   polystyrene packaging
    D.   a pullover made from strong nylon thread.
    E.   other discarded objects.

1.   How would you use these items to survive and make your life more comfortable? Use drawings to help explain your ideas and consider the following:

    i)   collecting and storing food and water.
    ii)   shelter from storms.
    iii)   attracting rescuers.

            [15 Marks - 5 marks each]

2.   You would need to work with many different materials, both natural and man made. What five tools would you find most useful? Give reasons for your choice.

            [5 marks]

3.   You need to cross a deep crevice in the rock. Two planks have been washed ashore. They are long enough to bridge the gap but not strong enough when laid flat. **Use drawings** to explain how you could adapt them to reach the other side.

            [5 marks]

circumference of sphere = 2πr
X-section area of sphere = 2πr²
surface area of sphere = 4πr²
volume of sphere = ⁴/₃πr³
North Pole to Equator = 10,000, 000m = 10⁷m
Density of Rock = 5000 kg/m³
Density of Water = 1000 kg/m³
Density of Air = 1 kg/m³

Use the information above to show that the **Radius** of the Earth is about $6,400,000$ metres. [3]

Use this answer to calculate

The **Surface Area of the Earth**   [2]
The **Volume of the Earth**   [2]
The **Mass of the Earth** (assume it is all made of rock)   [2]

Approximately 75% of the earth is covered in water of some description. Suppose that it has an average depth of 1000 metres. Calculate:

The **Volume of water** on Earth.   [2]
The **Mass of water** on Earth.   [2]
The **Weight of water** on Earth.   [1]

We have an atmosphere all around the Earth with an approximate depth of 10 km. (watch the units…)

Calculate the weight of air on Earth.   [4]

Actually the atmosphere carries on up to about 35km or so, but it doesn't make much difference to your calculation. Why not?   [2]

Suppose you had some amazing jet-powered back-pack and could launch yourself upwards like a rocket.

What physical effects would you notice as you climbed away from planet Earth.   [5]