RADLEY COLLEGE
Entrance Scholarships

SCIENCE AND TECHNOLOGY II

Wednesday 9th March 2005

Time allowed: 2 hours

*Answer **all** questions.*

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

Chemistry

1.a) Explain the following observations using your understanding and knowledge of Chemistry to help you. Wherever relevant, write word or symbol equations.

i) When a small piece of magnesium ribbon is added to copper sulphate solution, a colourless solution and a pink-brown solid are formed. [2]

ii) On heating a mixture of iron and sulphur in a test tube, it is observed that the mixture produces an orange glow that continues even when taken out of the bunsen flame. The compound formed is tested with a magnet and found not to be magnetic. [2]

iii) When a diamond is heated very strongly in air, a gas is formed that turns limewater milky. [2]

iv) A mixture of hydrogen and oxygen gas will explode only when an energy source is provided. [2]

v) When a solution of silver nitrate has electricity passed through it using graphite electrodes, a shiny metal forms at the negative electrode. However, when a solution of sodium nitrate solution is used, a shiny metal is not formed but a colourless gas is formed instead. [2]

1.b) Consider the following reaction scheme that is used to work out the elements present in a gas called 'salt gas'.

When concentrated sulphuric acid is added to rock salt, a colourless gas that fumes in moist air is formed – let us called this gas 'salt gas'.

When salt gas is passed over heated iron, a yellow crystalline solid, A, and also a gas, B, is formed that gives a squeaky pop with a lighted splint is produced.

When a solution of salt gas is made in water, a very strong acid, C, is formed. When solid potassium permanganate ($KMnO_4$) is added to this solution, a pale green gas, D, is formed that smells of swimming pools.

i) Suggest a symbol equation for the reaction between salt gas and heated iron. [2]

ii) Suggest names for the substances A, B, C and D. [4]

iii) Given the information above, which elements may be present in salt gas? [2]

iv) Describe an experiment that could be carried out next that would determine which elements are present in salt gas. Draw a diagram of the apparatus that you use and describe any chemical tests that you carry out. [4]

1.c) It is known that in 24 000 cm^3 of salt gas, measured at 25^0C and 1 atmosphere pressure, there are 600, 000, 000, 000, 000, 000, 000, 000 or 6 x 10^{23} particles present. In an experiment, 400 cm^3 of salt gas is added to 1000 cm^3 of water, and it is found that 99.2 % of the gas dissolves in the water.

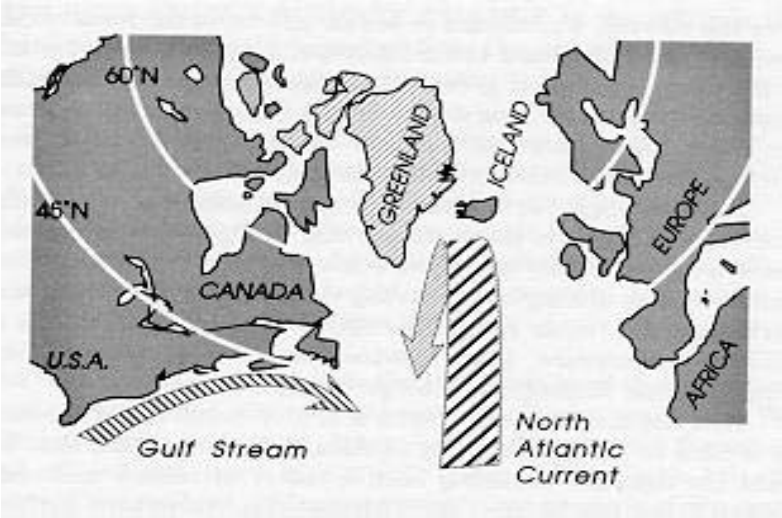
i) Calculate the volume of gas that dissolves in the water. [1]

ii) Calculate the number of particles of salt gas that do not dissolve in the water. [2]

Physics

Ocean currents play an important role in transferring heat from the warm tropics to the cold polar regions.

An example is the relatively mild climate of Norway that depends upon currents of warm water brought to the Norwegian coast. They can even grow strawberries in Norway despite its high latitude (60 to 70°N).



The "North Atlantic Current" takes warm water, heated by the Sun at the Equator, to the shores of all of northwestern Europe including Britain.

The North Atlantic Current moves very slowly - at most, 10cm per second - but it is some 300 Km wide and 1 Km deep. It moves an incredible 30 million cubic metres of water every second, which is about 100 times more than the Amazon river!

1. How many metres is 10cm? [1]

2. There are 1000 metres in 1 Kilometre. How many cubes of size 1 m x 1m x 1m would fit into a cube that was 1Km x 1Km x 1Km [1]

3. Show that there are approximately 32 million seconds in 1 year [2]

4. Show that there are 30 million cubic metres of water in a block of water 10 cm x 300 Km x 1 Km. [2]

All of this water, warmed at the equator, moves some 7000 Km North to high latitudes where the water is able to release its heat to the atmosphere. As a result, the water cools and sinks to the deep ocean.

5. How long will it take the water to move from the equator to these high latitudes? [2]

6. How does the water "release its heat [redacted] mosphere"? [2]

7. Why does cold water sink?

This water now returns South very slowly, in the depths of the ocean, until it is finally recycled to the surface some 1000 years later.

It turns out that the volume of the deep ocean is approximately 1000 million cubic kilometers and, since it takes a thousand years to recycle the water, this suggests that one million cubic kilometers of water are recycled each year.

8. Show that "one million cubic kilometers of water are recycled each year" is the same as 30 million cubic metres per second. [2]

One possible consequence of Global Warming is that the North Polar Cap of ice may melt. This in turn may disrupt the flow of the North Atlantic Current, which may "switch off" the heating system that allows strawberries to be grown in Norway. Calculations suggest the temperature may drop by as much as 5 degrees Celsius. It is possible that such change could happen very quickly - perhaps over the course of 10 or 20 years.

If water is heated it requires 4,200,000 Joules to heat 1 cubic metre by 1 degree Celsius. If you provided this amount of energy in the form of electricity it would cost about 10 pence.

9. How much energy is required to heat 30 million cubic metres of water by 5 degrees Celsius? [3]

10. How much would this energy have cost if it had been provided in the form of electricity? [2]

11. To warm the North Atlantic Current this amount of heat is needed every second. Where does all this heat actually come from? [2]

The atmosphere also carries energy from the Equator to more Northern latitudes.

Air only requires 1000 Joules to heat 1 cubic metre by 1 degree Celsius.

12. Why do you think air can be heated so much more easily than water? [2]

13. Do you think that the movement of air will have a greater or lesser effect than the movement of the "North Atlantic Current"? Explain your answer. [2]

Design & Technology

1. Design a see-saw for a playgroup of 3 to 4 year olds. The finished article must be able to be taken outside.

   One important measurement (dimension) is the length of the see-saw which is 2000mm or 2 metres in total.

   Name two other important measurements (dimensions) that are necessary for the see-saw. [2]

2. Explain briefly why you chose the two measurements from the question above. [2]

3. You have to consider safety especially with young children. Name THREE areas of research that need to be considered before any idea is finalised. [3]

4. Using materials of your choice sketch ideas that would be suitable for a see-saw. Marks will be awarded for covering the following areas:

   Safe and secure sitting position [5]

   Stability of the finished article [4]

   Materials and finishes [4]

   Ideas for pivoting [5]

Biology

What is conservation, and why is it important? You may refer to specific problems, examples and methods.

[25]