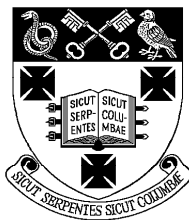


RADLEY COLLEGE

Entrance Scholarships



SCIENCE AND TECHNOLOGY I

Thursday 22nd February 2001

Time allowed - 2 hours

Answer all questions.

Write the answers to each section

on a separate sheet of paper.

Biology

Read the following passage:

Neither the reptiles nor the amphibians generate their heat internally; they draw it directly from their environment. As amphibians cannot expose themselves directly to the sun, because of the permeability of their skins, they must remain relatively cold and sluggish. But the reptiles have no such problems. The marine iguanas follow a daily routine that maintains their bodies at the most efficient temperature. At dawn they assemble on the tops of lava ridges or clamber onto the eastern faces of boulders, lying with their flanks broadside to the rising sun and absorbing as much heat as possible. Within an hour or so their temperature reaches its **optimum** level and they turn to face the sun. Now their flanks are almost in shadow and the rays strike only their chests. As the sun climbs higher and higher, the risk of overheating grows. Although reptile skin has the crucial quality of relative **impermeability**, it does not possess sweat **glands**, so the iguanas cannot cool themselves by allowing sweat to evaporate. Indeed even if they could, this might not be a practical technique in an environment where water is so scarce. But they have to find some way of preventing themselves from simmering inside their skins.

Relief is hard to find. They stiffen their legs and hold their bodies off the baking black rock so that they absorb as little heat as possible from it, while what wind there is blows over their undersides as well as their backs. They pack themselves tightly into the few places where there is shade - in crevices beneath boulders or, better still, in the deep narrow gullies that are kept cool by the surging waves. The sea itself is too cold for comfort, for the Humboldt Current in which the Galapagos lie sweeps straight up from the Antarctic. The marine iguanas are compelled, however, to venture into it at some time every day to feed. Like many of their relations on the mainland of South America, they are **herbivores**. No edible plants grow on the **lava**, but in the sea, just below high water mark, there are thick pastures of green algae. So, at some time during the middle of the day when their blood is almost as hot as they can stand and they are in danger of sunstroke, they risk a swim. They plunge into the surf, swimming strongly, beating their tails like giant newts. Some hang on the rocks near the sea's edge, gnawing the seaweed with the sides of their mouths. Others swim farther out and dive to forage along the sea bottom.

(Adapted from: *Life on Earth*. 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) optimum
(ii) impermeability
(iii) glands
(iv) herbivore
(v) lava [5]
2. Give an example from the passage of each of the following:
(i) an amphibian
(ii) a reptile
(iii) a producer
(iv) a consumer [4]
3. What are the distinguishing features of amphibians? [2]
4. What are the distinguishing features of reptiles? [2]
5. Name three other classes of vertebrate. [1]
6. Why would sweating possibly be disadvantageous for iguanas? [2]
7. How do iguanas increase their body temperature? [1]
8. How do iguanas lose heat? [2]

Humans are mammals and able to keep their body temperature constant.

9. From your own experience, describe **three** responses your body has to overheating. [2]
10. From your own experience, describe **three** responses your body has to cooling. [2]
11. Many small rodents hibernate in winter and allow their body temperature to drop.
Why might dropping their temperature help them survive this long sleep? [2]

Chemistry

Explain the following:

1. When a kettle containing water is boiled, the temperature of the water initially rises until the water starts to boil and then the temperature remains constant.

[2]

2. When zinc metal is placed into a solution of copper sulphate, a pinky brown metal is formed but when a piece of silver metal is placed into another solution containing copper sulphate, no change is observed.

[2]

3. A mixture of copper and sulphur may be separated relatively easily but, after heating the mixture strongly, separation is significantly more difficult.

[2]

4. When a sample of calcium metal is placed into some dilute hydrochloric acid, a gas that is lighter than air is produced but when calcium carbonate is placed into a solution of hydrochloric acid, a gas heavier than air is formed.

[2]

5. A balloon containing a mixture of hydrogen and chlorine gas will remain unchanged for a long time but when the mixture is heated, an explosion may occur.

[2]

A mixture of the metals copper and zinc was prepared. 1.00 g of this mixture was added to an excess of a solution of dilute sulphuric acid and the volume of gas produced was measured against time. The results are shown in the table below.

Time/s	0	10	20	30	40	50	60	70	80	90	100
Gas volume cm ³	0	45	84	118	145	162	174	182	188	190	190

6. Plot a graph, on the graph paper provided of volume of gas on the y-axis against time on the x-axis.

[4]

7. Indicate appropriate units for the volume of gas.

[1]

8. What is the name of the gas produced in this reaction?

[1]

9. At which point in the above experiment was the reaction proceeding with the

greatest rate of reaction? Explain your answer using particles.

[2]

10. Another 1.00 g sample of the mixture is then separated into the individual metals and then each metal, in turn, is added to **separate** solutions of dilute sulphuric acid.

How would you expect the volume of gas to vary with time in each of these two experiments?

Explain your answer.

[4]

11. Another 1.00 g mixture of the two metals is heated strongly, for an hour, in pure oxygen gas before each is added to the sulphuric acid, again as two separate experiments.

Explain how the volume of gas would vary, if at all, with time in these two cases.

[3]

Physics

You find an injured Sparrow in your back garden.

It seems to have problems flying, perhaps because its wings aren't strong enough to lift its own weight.

1. How would you measure the volume of the bird ? [2]

2. How would you measure the area of its wings ? [2]

To make things easy let us assume that a bird is basically a cube with thin rectangular wings stuck on each side.

3. Suppose our bird is just a cube with sides of 10 cm (ie 0.1 m).

What is the volume of the bird ? [1]

4. The density of most birds is about 2000 kg per m³.

Calculate the mass of this Sparrow. [1]

5. Gravity produces a downwards force of 10 N per kilogram.

What is the weight of this Sparrow ? [1]

6. How much force must be produced by **each** of its wings to keep the bird airborne ?

[1]

The upwards force on a bird's wing is caused by the pressure below the wing being greater than the pressure above.

7. Suppose each wing is a rectangle of 10 cm x 10 cm.

What is the area of each wing in m^2 ? [1]

8. If the pressure below the wing is 100,000 N per m^2 .

What is the upward force on each wing? [2]

9. If the pressure above the wing is 99,900 N per m^2 .

What is the downward force on each wing? [1]

10. Is the pressure difference on these wings sufficient to keep the Sparrow airborne?

[2]

11. Is the pressure difference on these wings sufficient to allow the bird to take off?

[2]

The Dodo was a bird that had dimensions 5 times greater than a Sparrow. In other words it was 5 times taller, 5 times wider (left to right) and 5 times "fatter" (front to back).

12. What is the weight of a Dodo?

[3]

13. Suppose that a Dodo has wings that are 50 cm x 50 cm.

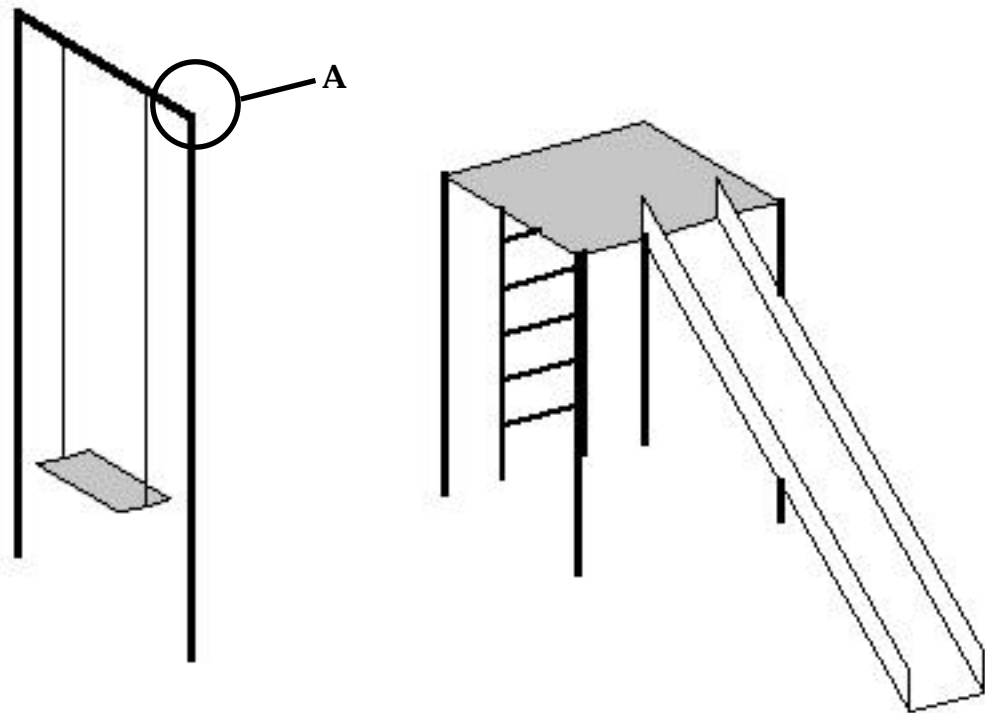
Suggest why the Dodo might have become extinct... [3]

14. How would a Dodo need to be "redesigned" if it were to avoid extinction?

[3]

Design & Technology

The swing and slide (with step ladder) shown below are initial ideas by a boy for playground equipment and are to be manufactured in a school workshop.



1. Suggest a suitable material from which the **swing** seat could be made. Give one reason why the material you have chosen would be suitable for this application.

[2]

2. Suggest a suitable material from which the **slide** seat could be made. Give one reason why the material you have chosen would be suitable for this application.

[2]

3. Give **six** design requirements for this kind of playground equipment.

[6]

4. Using diagrams suggest ways of improving the strength and stability of the structures above.

[5]

5. Suggest **two** ways in which the swing's frame at 'A' could be joined.

[2]

6. Suggest a suitable finish for the swing's frame. Explain your answer.

[2]

7. How could the designer of the playground equipment make the slide safer?

[3]

8. The company that will produce the design want a name for the new range of equipment that they are to sell. Suggest a name and explain your choice.

[3]