RADLEY COLLEGE
Entrance Scholarships

SCIENCE AND TECHNOLOGY

March 2010

Time allowed: 2 hours

*Answer **all** questions*.

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

CALCULATORS ARE NOT TO BE USED

Design and Technology **[25 Marks]**

You have been asked to by an ecotourism company to design a 'rainforest walkway'. Visitors will climb up Tower A through the rainforest canopy and then walk on a suspended walkway to Tower B some distance away to observe the flora and fauna.

The following design criteria have been set out by the ecotourism company:

- A maximum of 30 people can be on the rainforest walkway at any one time.
- NO specialist climbing equipment / experience are required – stairs will be used to ascend and descend the towers.
- Suitable for any age.



You have been asked to help them develop the walkway system.

1. What specific materials would you choose to build the system from, considering the environment in which it is to be used? [3]

2. What would be your '**top 8**' most important design features when designing a system like this?

[4]

3. Sketch **AND** label 2 different diagrams to show 2 different alternative solutions to this problem. (**Keep your favourite idea to use in the next question**). [6]

4. Sketch **AND** label your favourite idea, provide as much detail as possible. [6]

5. How would you minimise the impact on the delicate environment? Sketch **AND** label a diagram, giving reasons why you have designed the system in this way. [3]

6. High winds, humidity and rain can be a problem above the canopy in a rainforest. Using notes **AND** sketches, how would your chosen system be able to withstand this type of environment? [3]

Biology **[25 marks]**

Read the following passage:

Among the **vertebrates**, the most successful group in exploiting the desert environments must be the **reptiles**. They are found in every one of the world's deserts, and in the Sahara alone there are nearly a hundred **species**. Their key advantage is their thick **impermeable** skin, which helps retain water. They are **cold-blooded** and so do not need to rely on food intake to maintain their body temperature and can easily survive on the **sparse** supplies available in most deserts. Needing the heat of the sun to warm their bodies, many reptiles reverse the normal pattern of desert animals and hunt during the day. But even they have problems in extreme temperatures. The shovel-snouted lizard of the Namib Desert only ever keeps two of its legs on the ground at the same time – one in front and one on the opposite side at the back. By reversing the two legs at regular intervals, the lizard never …….

(Adapted from: Planet Earth, Alastair Fothergill)

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) **vertebrates**
(ii) **reptiles**
(iii) **species**
(iv) **impermeable**
(v) **cold-blooded**
(vi) **sparse** [6]

2. Reptiles and mammals are both subdivisions of the vertebrates. Name three other subdivisions (also known as Classes) of the vertebrates? [3]

3. Explain why 'their thick **impermeable** skin, which helps retain water' is an advantage to the reptiles. [1]

4. Explain why they 'do not need to rely on food intake to maintain their body temperature', whereas mammals would do. [1]

5. What behavioural patterns might the reptiles have to allow them to use the 'heat of the sun to warm their bodies', but not get too hot? [2]

6. Suggest some anatomical (body shape and structure) adaptations that the reptiles might have (or evolve) to help them to use the 'heat of the sun to warm their bodies'? [2]

7. Give some suggestions as to which colour skin different species of lizards might evolve, explain you reasoning for each. [3]

8.

(a) Complete the last sentence of the passage (in fewer than five words) [1]

(b) Explain why the shovel-snouted lizard's two-footed standing helps it survive in the desert. [2]

9. Suggest some adaptations that xerophytes (e.g. cacti) might have to survive under water-stress in the desert. [4]

Chemistry **[25 marks]**

1. Perfumes, aftershaves and deodorants contain a number of different chemicals and exist as a mixture of liquids.

(a) What is the name give to the movement of particles from a region of higher concentration to a region of lower concentration? [1]

(b) When you remove the stopper from a bottle of a perfume you can smell the perfume even if you are some distance away from the bottle. Explain this in terms of particle movement. [3]

(c) If we assume that a particular perfume is a mixture of several liquids, what technique could be used to separate the liquids from each other? What physical property of the liquids is being exploited? [2]

(d) (i) Deodorant sprays make use of a gas molecule known as a propellant to dispense the mixture of liquids as a fine mist, or aerosol. The propellant helps to pressurise the contents of the container. Imagine a container that was filled ONLY with gas molecules. How would you describe the movement of the gas molecules inside the container? [2]

(ii) It is highly dangerous to dispose of 'empty' deodorant containers in fires, mainly because the propellants used are highly flammable. If we assume that a particular deodorant container contained only non-flammable components, why would it still be dangerous to dispose of it in a fire – give a reason for your answer. [2]

2.

(a) In chemistry, changes can be classified as either physical or chemical. Explain what you understand by the terms physical change and chemical change, and give an example of each. [4]

(b) After a rain shower any puddles that may have formed will eventually disappear.

(i) Name the process responsible for this phenomenon and state what is happening to the water molecules. [2]

(ii) The above process is very different to boiling a beaker of water - explain why. [2]

(iii) Will a puddle of water disappear more quickly on a hot day or a cold day? Explain why, making reference to the individual water molecules. [2]

3. When an electric current is passed through water, hydrogen and oxygen are produced. The chemical equation for the reaction taking place is given below…

$$\ldots H_2O \rightarrow \ldots H_2 + \ldots O_2$$

(a) Balance the above equation by filling in the blanks (…). [2]

(b) From your balanced chemical equation, what can you say about the relative amounts of hydrogen and oxygen produced during the reaction? [1]

(c) Give a major use for one of the products and state why this use is so important. [2]

Physics **[25 marks]**



This question is based around one of the most famous buildings in the world, the Empire State building in New York.

You must show your working out at all stages and clearly state any assumptions that you are making.

<u>When making estimates, you should try to choose numbers that will make the sums easy to do without a calculator.</u>

Where you can, use powers of ten to show very big or very small numbers. For example 1,000,000 = 1.0×10^6

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.

1. The Empire State Building has 102 floors. Estimate the height of one floor and use this to estimate an approximate value for the height of the building in metres. [2]

2. The base of the Empire State building is 120 m wide and 50 m deep . Calculate:

(a) The area of the base of the building. [1]

(b) Use your answer to question 1 to calculate the volume of the building. State any assumptions that you make. [3]

3. The mass of the Empire State building is approximately 400,000 tonnes, where 1 tonne = 1000 kg.

(a) Write down the mass of the building in kg using powers of ten [2]

(b) Use your answer for the volume of the building to in question 2 to calculate the average density of the building. [4]

4. You might have heard that a small coin dropped off a tall building such as the Empire State building could kill someone at the bottom if it hit them on the head.

It's a good story, but isn't actually true. Below is a table of results showing the speed of a coin as it falls under gravity.

Speed (m/s)	Distance fallen (m)
0	0
20	20
39	80
59	180
78	310
98	490
118	710
137	960

(a) Plot a graph of speed against distance fallen and join the points with a suitable best fit line. Graph paper will be provided. [5]

(b) Using your value for the height of the building, use the graph to estimate the speed at which a coin dropped from the top would hit the ground. [1]

(c) Your answer for speed is in m/s. Convert this into miles per hour Assume that 1 mile = 1600m [4]

(d) The data above assumes that there is no air resistance. How would you expect the data to change if air resistance was taken into account? Explain your answer with reference to a small coin being dropped off a tall building. [3]