

**MAGDALEN COLLEGE SCHOOL**  
**OXFORD**



**SAMPLE SCHOLARSHIP PAPER**

**SCIENCE**

**1 HOUR**

You should answer one question from each section of the paper.  
That is, one question on Biology, one on Chemistry and one on Physics.

Please begin each question on a separate sheet of paper and  
remember to write your name on each sheet. Graph paper is available.

You should explain your answers as fully as possible and show your  
working when attempting calculations. All questions carry equal weight.

# Biology Scholarship Questions 2011

## Answer Question 1 or Question 2

### Biology Question 1

- a) i. Plant and animal cells differ in a number of ways. Sketch one animal and one plant cell. Label the nucleus, the cytoplasm and the cell membrane in each. **(2)**
- ii. Now label three features which you could find in a plant cell, but not in an animal cell and briefly describe their roles. **(3)**
- b) i. Plants carry out a process known as photosynthesis. Write the word equation which summarises this process. **(2)**
- ii. Describe how a plant uses the products of photosynthesis. **(3)**
- c) Look at the picture below.



- i. What differences would you expect to see when shown a picture of the same tree in July? **(1)**
- ii. Explain why trees grow very slowly during the winter but far more quickly during the summer. **(4)**

*A Weeping Ash tree in January.*  
© C.Pearson 2010

- d) During the day plants photosynthesise and respire, whilst at night they only respire. Sketch a graph to show how this will affect the amount of oxygen and carbon dioxide released at different times of the day and night. **(3)**
- e) The Amazonian rain forest is sometimes described as the 'lungs of the planet'. Suggest why this is actually a misleading statement, based on your understanding of photosynthesis and the human lungs. **(2)**

**Total: 20 marks**

## Biology Question 2

The following information is taken from the UK government statistics website:

- *Smoking fell to its lowest recorded level in 2007 – 21 per cent of the population of Great Britain aged 16 and over.*
- *66 per cent of smokers said they wanted to give up.*
- *17 per cent of smokers said they lit up within five minutes of waking. Heavy smokers are more likely to light up immediately and 35 per cent of those smoking 20 or more a day do so, compared with 3 per cent of those smoking fewer than 10 a day*
- *Heavier smokers are less likely to want to give up. The proportion wanting to give up in 2007 was highest among those smoking, on average, fewer than 20 cigarettes a day.*
- *Health concerns are the most commonly mentioned reason for quitting, with 86 per cent of people who want to give up mentioning at least one health reason. After health, the next most commonly mentioned reasons are costs (27 per cent), family pressure (20 per cent) and the effect on children (15 per cent).*
- *Married or cohabiting people smoke less (18 per cent) than singles (28 per cent).*
- *Cigarette smoking is lower among households classified as professional and managerial (15 per cent) than among those classified as routine and manual (26 per cent).*
- *Smoking is highest in the 20-24 age group (31 per cent) and lowest among those aged 60 and over (12 per cent).*

<http://www.statistics.gov.uk/cci/nugget.asp?id=313>

Use the information above and your own knowledge to answer the following question:

- a)
- If there were 50 million people over the age of 16 in Britain in 2007, how many were smokers? Show your working (2)
  - What part of the cigarette smoke is likely to help people feel more awake and alert in the morning? (1)
  - What is the main reason given by people for quitting smoking? (1)
  - Despite two thirds of all smokers indicating that they would like to give up suggest why people continue to smoke in large numbers. (1)
- b) Which is the main organ of the body damaged by smoking? (1)

- c) Cigarette smoke contains carbon monoxide. Carbon monoxide binds irreversibly to haemoglobin in red blood cells meaning that haemoglobin transports less oxygen around the body. How might smoking affect someone's ability to exercise? (4)
- d) Smoking can also lead to the onset of lung cancer. Cancers occur when cells in a tissue begin to divide in an uncontrolled way. Damage to what part of the cell can lead to cancer? (1)
- e) Smoking whilst pregnant can harm the developing foetus, suggest how this might happen. (2)
- f) Most cancers have a genetic component which means that you can inherit genes from your parents which may put you at risk.
- i. What is meant by the term 'gene'? (1)
- ii. Outline the process of human fertilisation and explain how it is possible for genetic information to be passed on to the offspring from both the mother and the father. (4)
- A diagram may be used to support your answer.*
- g) Suggest how waste products produced by the developing foetus are got rid of. (2)

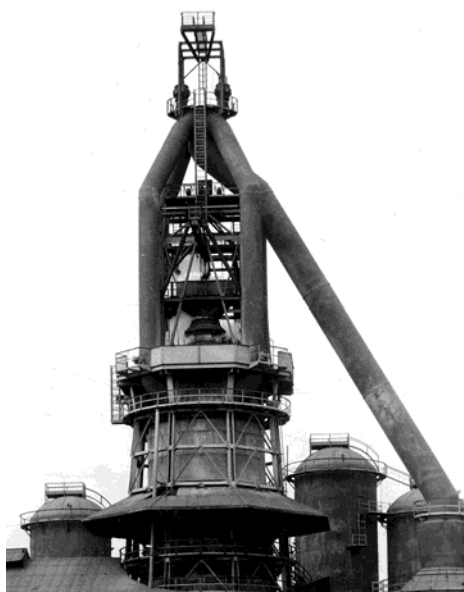
**Total: 20 marks**

## Chemistry Scholarship Questions 2011

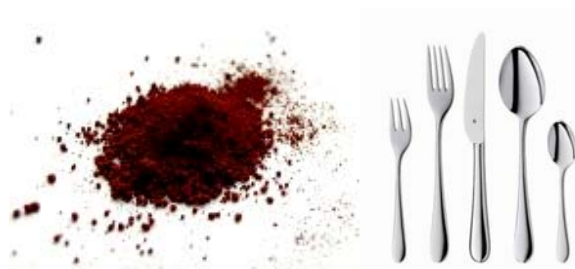
Answer Question 3 or Question 4 ON A SEPARATE SHEET OF PAPER

### Chemistry Question 3

More iron is produced worldwide than any other metal. Much of this iron is converted into steel. Steel consists of iron mixed with small quantities of carbon and possibly other elements, depending on the physical and chemical properties that are desired. Iron is extracted industrially from various iron ores in huge furnaces known as 'blast furnaces'. Common iron ores contain minerals such as Haematite ( $\text{Fe}_2\text{O}_3$ ), Magnetite ( $\text{Fe}_3\text{O}_4$ ) and Siderite ( $\text{FeCO}_3$ ).



Element	'Relative Mass' of Atom
Iron (Fe)	56
Carbon (C)	12
Oxygen (O)	16



- (a) Give the chemical name for the mineral Siderite. **(1)**
- (b) Explain what you understand by the term 'chemical properties'. Illustrate your answer with at least one example. **(2)**
- (c) Haematite (pictured above) is a reddish-brown solid at room temperature with a melting point of  $1565^\circ\text{C}$ .
- (i) Explain what the chemical formula of haematite tells you about its composition. **(1)**
- (ii) Suggest why haematite has such a high melting temperature. **(2)**
- (iii) In the blast furnace, haematite reacts with carbon monoxide (CO) at very high temperatures, producing iron metal and another product. Write a chemical equation for this process. Full credit will be awarded for a balanced symbol equation; partial credit can be gained for a correct word equation. **(2)**

(d) Using the 'relative mass' values given in the table at the start of the question, calculate a value for the 'relative mass' of the following compounds: **(2)**



(e) Iron metal is a shiny, silver solid at room temperature. It reacts slowly with dilute hydrochloric acid to produce hydrogen gas.

(i) Draw a fully labelled diagram to show the apparatus you would use in the laboratory to perform this reaction and collect the gas produced. **(3)**

(ii) Describe briefly how you would test the gas produced to prove that it was hydrogen. **(2)**

(iii) Describe the arrangement and motion of iron atoms at room temperature. Use a diagram if it helps your answer. **(2)**

(f) Iron and steel are traditionally used to make a huge variety of objects, ranging from kitchen cutlery to bicycle frames.

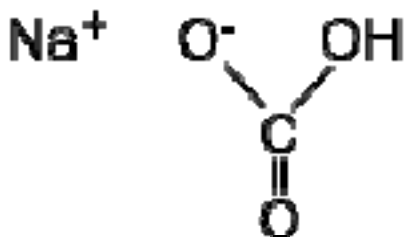
Briefly discuss the advantages and disadvantages of making a bicycle frame from steel rather than a more modern material such as carbon fibre. **(3)**



**Total: 20 marks**

#### Chemistry Question 4

This question is about bicarbonate of soda (sodium bicarbonate), a compound used widely in baking to help bread and cakes rise. Sodium bicarbonate is a white powder at room temperature. An aqueous solution of sodium bicarbonate acts as a very weak alkali. The chemical structure of sodium bicarbonate is shown below:



- (a) Explain what you understand by the following terms: **(4)**
- Aqueous solution
  - Alkali
- (b) Suggest a chemical formula for sodium bicarbonate. **(1)**
- (c) What would you expect to observe when universal indicator is added to a solution of sodium bicarbonate? **(1)**
- (d) If sodium bicarbonate is heated strongly, the following reaction occurs:
- sodium bicarbonate  $\rightarrow$  sodium carbonate + water + carbon dioxide gas
- What type of chemical reaction is this? **(1)**
  - Draw a fully labelled diagram to show the apparatus you would use in the laboratory to perform this reaction and collect the gas produced. **(3)**
  - Describe briefly how you would test the gas produced to prove that it was carbon dioxide. **(2)**
  - Carbon dioxide is a colourless gas at room temperature. Describe the arrangement and motion of carbon dioxide molecules in the gaseous state. Use a diagram if it helps your answer. **(2)**
  - Carbon dioxide can also be produced by burning carbon. Write a balanced chemical equation for this reaction. **(2)**

- (e) You are eager to bake a delicious cake for a friend's birthday. You find four jars in the kitchen that contain white solids. Unfortunately they have not been effectively labelled. You are told that one contains sodium bicarbonate, one contains table salt, one contains icing sugar and one contains flour.



Explain, as fully as you can, how you would distinguish between these four white solids using simple laboratory tests, allowing you to re-label the bottles correctly. (4)

**Total: 20 marks**



## Physics Scholarship Questions 2011

**Answer Question 5 or Question 6 ON A SEPARATE SHEET OF PAPER.  
Graph paper is available.**

### Physics Question 5

The table below shows the information given in the Highway Code about the shortest stopping distances which can be expected for cars travelling at different speeds. The *total stopping distance* is made up of two parts: the *thinking distance* and the *braking distance*.

speed (m/s)	thinking distance (m)	braking distance (m)	total stopping distance (m)
10	7	8	15
20	14	32	46
30	21	72	93

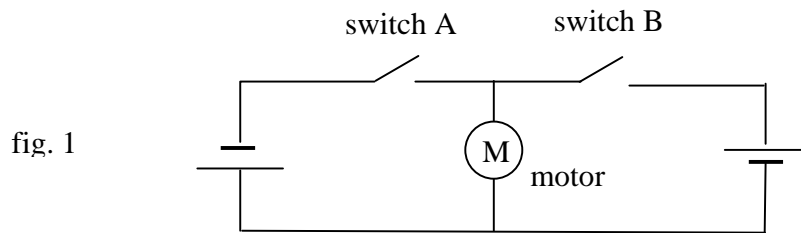
- (a) Explain what you think is meant by:
- (i) the *thinking distance*
  - (ii) the *braking distance*. [4]
- (b) Plot a graph of *thinking distance* against *speed*. [3]
- (c) How does the thinking distance change as the speed increases? [2]
- (d) Plot a graph of *braking distance* against *speed*. [3]
- (e) How does the braking distance change as the speed increases? [2]
- (f) Why do you think that the thinking distance changes as it does? [2]
- (g) Why do you think that the braking distance changes as it does? [2]
- (h) Name one factor that would increase (i) *thinking distance* (ii) *braking distance*. [2]

**Total: 20 marks**

### Physics Question 6

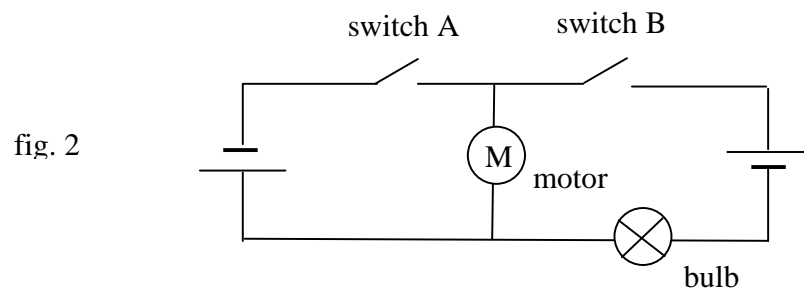
This question is about electrical circuits.

- (a) Draw a circuit diagram to show how you would make three 6 volt bulbs light at normal brightness using a single 6 volt battery. [2]
- (b) What would happen if the filament of one of the bulbs broke? [1]
- (c) Now redraw your circuit with switches added so that each of the bulbs can be switched off separately. [2]
- (d) Draw a circuit diagram to show how you would make three 2 volt bulbs light at normal brightness using a single 6 volt battery. [2]
- (e) What would happen if the filament of one of the bulbs broke? [1]
- (f) Look carefully at figure 1. What happens if switch A is closed? [1]



- (g) What happens if switch A is opened and then switch B is closed? [1]
- (h) Why would it be unwise to close both switches at the same time? [2]

- (i) A bulb is added to the circuit as shown in figure 2. Switch A remains open and switch B is closed. How does the performance of the motor now compare to that in question (g)? [2]



- (j) Draw a circuit which would enable you to vary the speed of a motor and explain how the circuit works. [3]
- (k) When a battery is used to light a bulb or drive a motor, the battery eventually runs down. Explain what happens to the energy of the battery in each case. [3]

**Total: 20 marks**