

Eton College King’s Scholarship Examination 2009

SCIENCE (SECTION 1)

(60 minutes)

Candidate Number: _____

INSTRUCTIONS

Write your candidate number, not your name, in the space provided above.

You should attempt ALL the questions. Write your answers in the spaces provided: continue on a separate sheet of paper if you need more space to complete your answer to any question.

Allow yourself about 12 minutes for each question.

The maximum mark for each question or part of a question is shown in square brackets.

In questions involving calculations, all your working must be shown.

For examiners’ use only.

1	2	3	4	5	TOTAL

1. (a) Describe briefly how the amplitude of a sound wave affects the sound that we hear.

[1]

- (b) Describe briefly how the frequency of a sound wave affects the sound that we hear.

[1]

The table below explains how the properties of sound and light can be compared, despite their fundamental differences.

Property of Sound	Equivalent Property of Light
Loudness	Brightness
Pitch	Colour

Two wave speeds are given below. One is the approximate speed of sound in air; the other is the approximate speed of light in air.

Speed A = 300 000 km/s

Speed B = 0.3 km/s

- (c) Light and sound travel at very different speeds. Briefly describe one example from everyday life in which this fact is apparent.

[1]

[Turn over]

Stars are luminous objects; we can see them from Earth because they emit light. The table below compares the properties of different types of star.

Star Colour/Type	Relative Brightness*
Blue Giant	1
Red Giant	2
‘Normal’ Star (e.g. The Sun)	3
Red Dwarf	4=
White Dwarf	4=

*1 = most bright; 4 = least bright.

In answering questions (d) and (e) below, you should refer specifically to the amplitude and/or frequency of light waves.

(d) What is the difference between the light waves emitted by a Red Giant and a Red Dwarf?

[1]

(e) What is the difference between the light waves emitted by a Red Dwarf and a White Dwarf?

[2]

(f) The Moon is 0.38 million km from Earth. Scientists have successfully fired a laser beam at mirrors left on the Moon by the Apollo astronauts and detected the subsequent reflection.

Calculate the time interval between the firing of the laser beam and the detection of the reflection.

[3]

[Turn over]

During a total solar eclipse, the Moon moves between the Sun and the Earth. As viewed from earth, the Moon appears to be *exactly* the same size as the Sun. As a result, the Moon *just* blocks out the Sun as viewed from Earth.



<http://bloggingabout.net/>

Object	Diameter
Sun	1 400 million km
Earth	13 million km
Moon	3.5 million km

(g) Using a suitable diagram and the information above, calculate the distance between the Sun and Earth. Express your answer in millions of km.

[3]

2. (a) Given that an object with mass 1 kg has a weight of 10 N on Earth, calculate the weight of a 500 g box on Earth.

[1]

(b) A particular spring has an unstretched length of 10 cm. The spring obeys Hooke's law and extends by 1 cm when a force of 3 N acts upon it. If the box from part (a) is hung from the spring, calculate the new length of the spring, shown by distance l_1 in Figure 1.

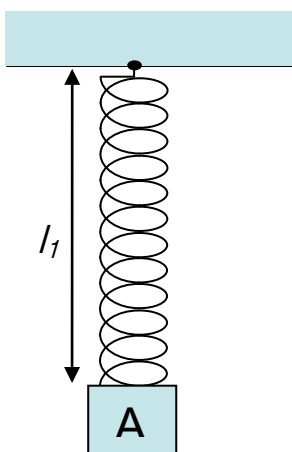
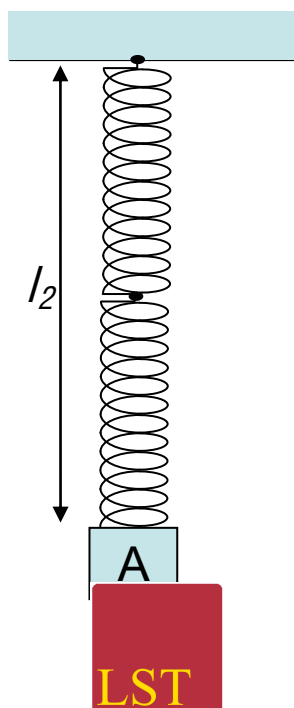


Figure 1

[2]

The same box is now hung from two such springs which are identical and arranged as in Figure 2.



(c) Calculate the new length, l_2 .

[2]

(d) Three such springs are now arranged differently, as shown in Figure 3. Calculate the new length, l_3 .

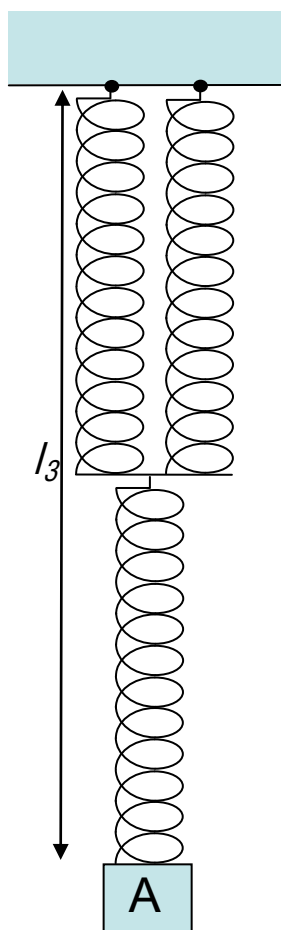


Figure 3

[3]

(e) If the box is now filled with 1 kg of sugar, by what factor will all the extensions in figures 1, 2 and 3 increase?

[1]

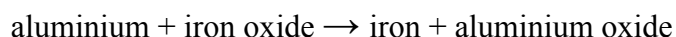
(f) A spring can be used as an instrument to measure the weight of any object hung on it. What is the normal name given to this instrument?

[1]

(g) If somebody now pulls down on the box and then lets go, the box will bounce up and down on the spring. Eventually, the box will come to rest again. Why does the box not continue bouncing up and down forever?

[2]

3. Metallic iron can be produced by heating iron oxide powder with aluminium powder. The word equation for the reaction is shown below:



(a) What does this reaction tell you about the positions of iron and aluminium in the reactivity series of metals?

[1]

(b) Which substance is being reduced during the reaction?

[1]

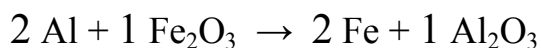
(c) Explain why the two starting materials should both be powdered.

[2]

(d) Would you expect the mass of iron produced to be more, or less, than the mass of iron oxide which reacted with the aluminium? Explain your answer.

[2]

The equation below shows the balanced chemical equation for the same reaction. It shows the ratio in which the chemicals are needed for the reaction.



(e) Masses of atoms are measured in atomic mass units (amu). Each atom of aluminium has an atomic mass of 27 amu, while each atom of iron has an atomic mass of 56 amu. Using this information, calculate the mass of iron which would be produced if 1.8 grams of aluminium reacted with iron oxide. Be sure to show your working.

[3]

(f) A student performed the reaction with 1.8 grams of aluminium. Using the atomic masses he correctly calculated the mass of iron he would expect, but after the experiment he found that he had obtained less than this amount. Other than human error suggest two other possible scientific explanations for this.

[2]

(g) Although this reaction produces a lot of heat, it will not start until the powdered iron oxide and aluminium are at a high temperature. Suggest a reason for this.

[1]

[Turn over]

4. Copper carbonate is a green solid, insoluble in water, with formula CuCO_3 . Many of its reactions produce carbon dioxide gas. When it is heated, carbon dioxide is given off and a black solid remains.

(a) Identify this black solid.

[1]

(b) Describe how you would confirm that the gas produced is carbon dioxide.

[1]

One student doing this experiment was told to bubble his carbon dioxide gas through water with a little Universal Indicator dissolved in it.

(c) Describe and explain the colour changes he would expect to see.

[3]

(d) The student took the coloured mixture from part (c) and warmed it gently until it was almost boiling. He found that the Universal Indicator returned to its original colour. Suggest an explanation for this.

[2]

[Turn over]

In another experiment, a student was told to prepare a solution of copper sulphate by adding copper carbonate to a beaker of warm, dilute sulphuric acid.

(e) State two things the student would expect to see which would show him that a reaction was happening.

[2]

(f) How would the student know when he had added enough copper carbonate to react with all the sulphuric acid?

[1]

(g) Briefly state what further steps would be needed to obtain some pure crystals of copper sulphate.

[2]

[Turn over]

5. One of the first people to do experimental studies of plant growth was the Flemish physician Jan van Helmont, early in the 17th century. A famous experiment that he performed was to plant a small, young willow tree weighing 2 kg in a pot containing 90 kg of dry soil. He did nothing other than provide the tree with water for five years, at the end of which time it weighed 76 kg and the dried mass of the soil was 2g lower than at the start. He assumed that the increase in mass (biomass) of the tree was formed entirely from water.

(a) By what process had the plant manufactured the additional biomass?

[1]

(b) van Helmont was wrong in concluding that the only source of the increased biomass was water. What was the other main source?

[1]

(c) Suggest three possible reasons why the mass of the dry soil decreased during his experiment.

[3]

[Turn over]

A student wanted to carry out a controlled experiment to show that light is also needed for a plant to manufacture biomass.

(d) What does the term “controlled experiment” mean?

[2]

(e) Before carrying out this controlled experiment, the student placed his experimental plant in the dark for 24 hours in order to remove any stored starch from its cells. This is known as ‘**de-starching**’ a plant. Explain why a plant becomes de-starched if left in the dark for 24 hours.

[3]

(f) Why did the student need to de-starch the plant before carrying out the experiment?

[2]

[End of Paper]