Eton College King's Scholarship Examination 2011

SCIENCE (SECTION 2 - DATA ANALYSIS) (30 minutes)

*Candidate Number:*_____

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

Read the information and answer the questions only in the spaces provided.

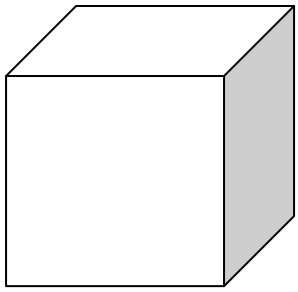
You are expected to answer all the questions.

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

For examiners' use only.

Total [40]	

1. Bruce is investigating the properties of a solid brass cube. The cube has a side-length of 3.0 cm and a mass of 230 g.



(a) Calculate the surface area of one face of the cube in cm^2.

_____ [1]

(b) Calculate the volume of the cube in cm^3.

_____ [1]

Bruce's teacher explains that the density of the cube can be calculated using the equation

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

(c) Calculate the density of the cube in g/cm^3. Show your working.

_____

_____ [2]

The cube has a weight due to the Earth's gravitational field; the Earth exerts a gravitational force of 10 newtons on each kilogram of mass (i.e. its field strength is 10 N/kg).

(d) Calculate the weight of the cube in newtons. Show your working.

_____

_____

_____ [2]

[Turn over]

Placed on a flat surface, the cube's weight causes it to exert a pressure on the surface. Bruce's teacher explains that the pressure can be calculated using the following equation:

$$\text{pressure} = \frac{\text{weight}}{\text{contact area}}$$

(e) Calculate the pressure exerted by this cube when it rests on a flat surface, in N/cm^2. Show your working.

_____

_____ [2]

Centimetres are not standard units; the metre is the standard unit of length used by scientists.

(f) Calculate the number of square centimetres in one square metre.

_____ [1]

(g) Calculate the number of cubic centimetres in one cubic metre.

_____ [1]

(h) Express the pressure exerted by the cube above in N/m^2.

_____

_____

_____ [2]

(i) Express the density of the cube above in kg/m^3.

_____

_____

_____ [2]

2. Bruce is given five different solid metal cubes. The cubes have been manufactured so th they all have exactly the same mass.

Bruce measures the pressure exerted by each cube when placed face down on a flat, horizontal surface. The table below contains his data and other relevant information.

Cube	Material	Density (g/cm^3)	Pressure Exerted (N/cm^2)
1	Lead	11.3	0.317
2	Iron	7.8	0.248
3	Osmium	22.6	0.504
4	Gold	19.3	0.453
5	Aluminium	2.7	0.122

(a) Explain why the five cubes will not be the same size.

_____

_____ [2]

(b) Which of the five cubes has the greatest side-length?

_____ [1]

(c) Cube 4 has a side-length of L cm. What is the side-length of cube 5, expressed as a multiple of L?

_____

_____

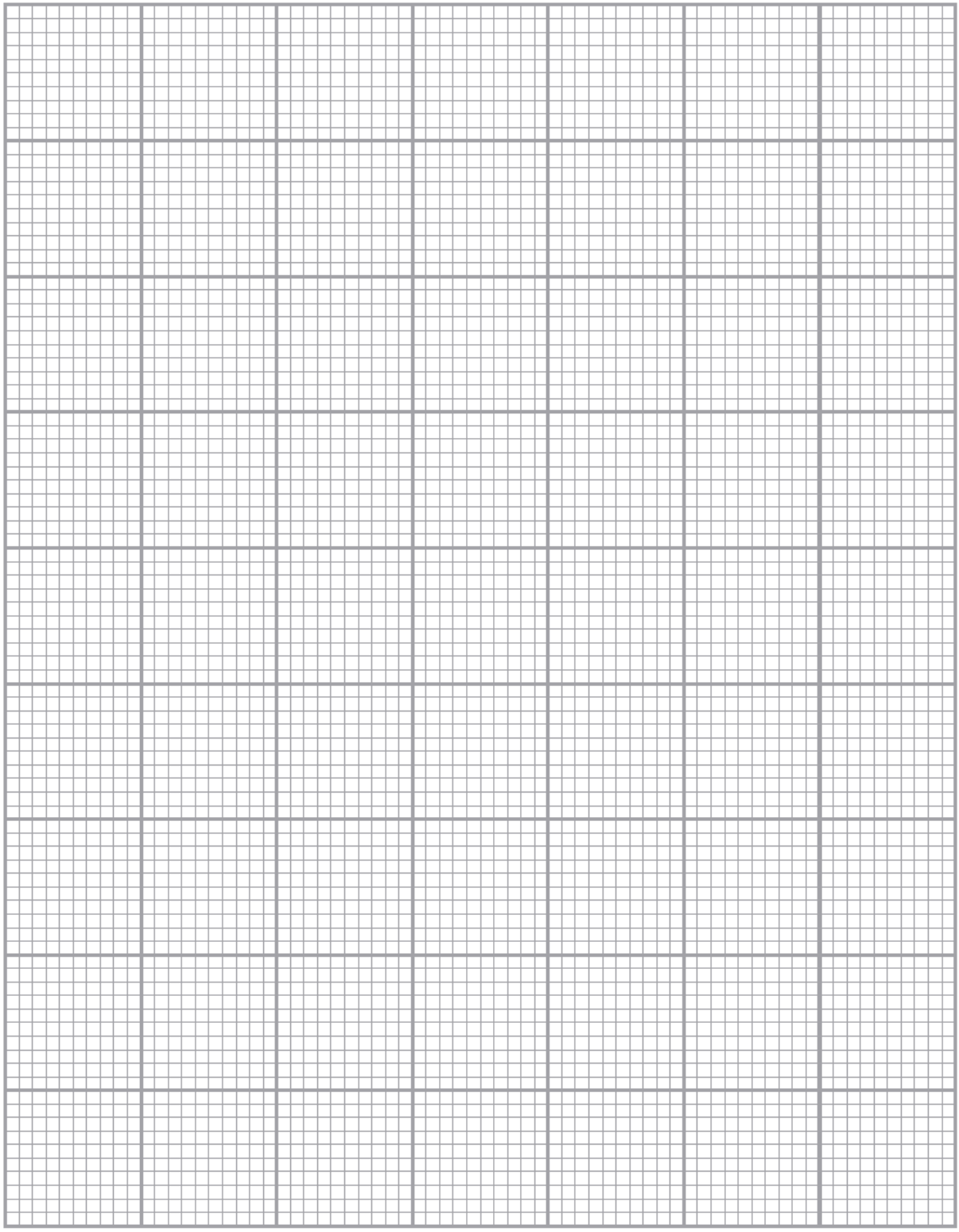
_____

_____ [2]

[Turn over]

(d) On the grid provided below, plot a graph with Density on the *x*-axis and Pressu
Exerted on the *y*-axis. Include a line of best fit.

[5]



Bruce's teacher informs him that the pressure exerted is not proportional to the density of th block.

(e) Suggest a feature of your graph that confirms this.

_____

_____ [1]

In order to obtain a graph showing proportional behaviour, Bruce's teacher suggests that he plots Density^2 (density squared) on the *x*-axis and Pressure^3 (pressure cubed) on the *y*-axis.

(f) Complete the table below with values of Density^2 and Pressure^3. The first set of values has been calculated for you.

[4]

Density (g/cm^3)	Density^2	Pressure (N/cm^2)	Pressure^3
11.3	128	0.317	0.0319
7.8		0.248	
22.6		0.504	
19.3		0.453	
2.7		0.122	

(g) On the grid provided on the next page, plot a graph with Density^2 on the *x*-axis and Pressure^3 on the *y*-axis. Include a line of best fit.

[5]

(h) Using your graph, or otherwise, determine the mass of the cubes.

_____

_____

_____

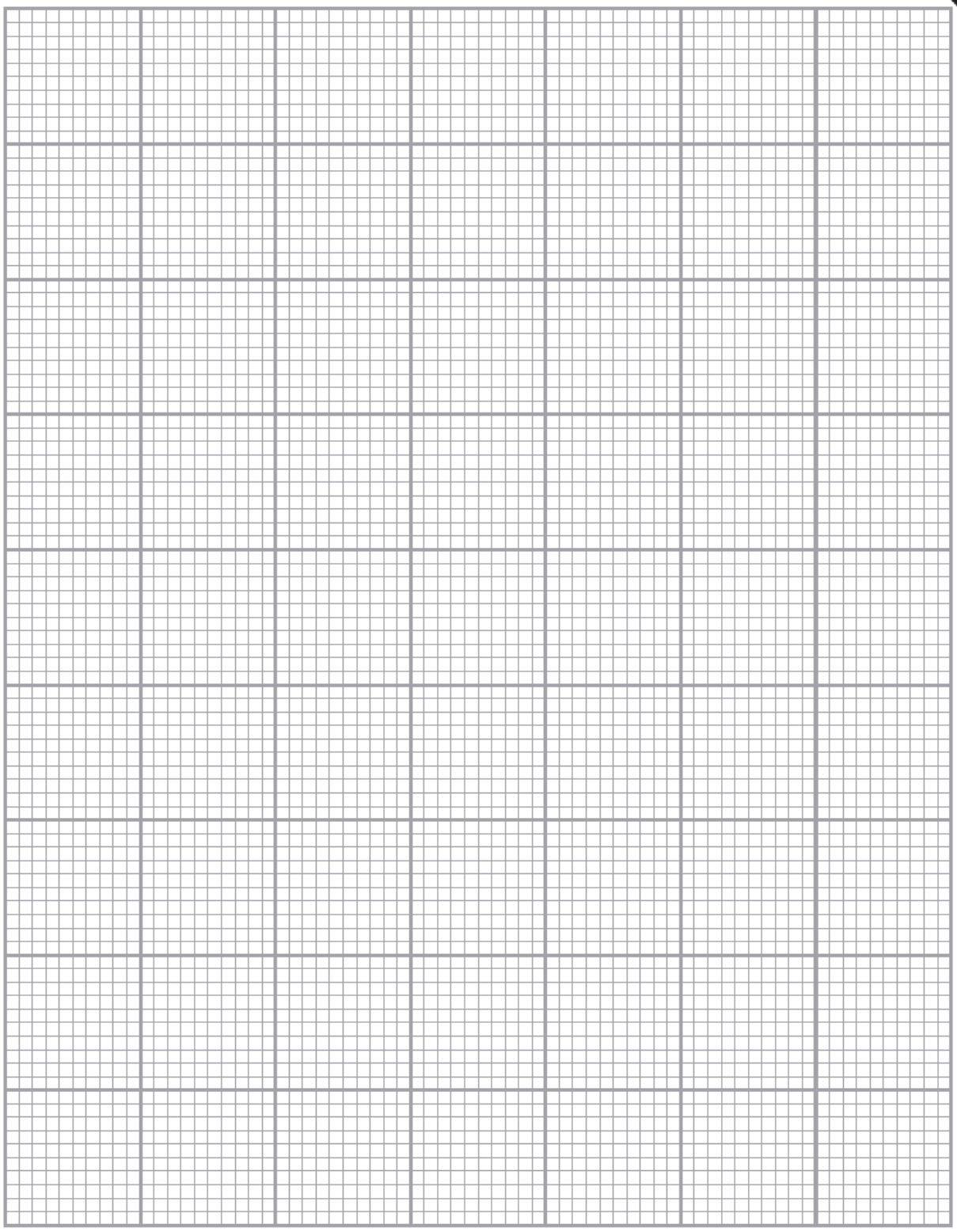
_____

_____

_____

_____ [3]

[Turn over]



[Turn over]

A solid piece of pure copper and a solid piece of pure lead (not necessarily of the same size) are stuck together. The composite object is found to have an average density of 9.5 g/cm^3.

The mass of an individual lead atom is three times that of a copper atom and the density of copper is 9.0 g/cm^3.

(i) What percentage of all of the atoms within the composite object are copper atoms?

_____

_____

_____

_____

_____

_____

_____ [3]

[END OF PAPER]