Eton College King's Scholarship Examination 2012

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 in the spaces and on the graph paper provided as appropriate.

You are expected to answer all the questions.

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

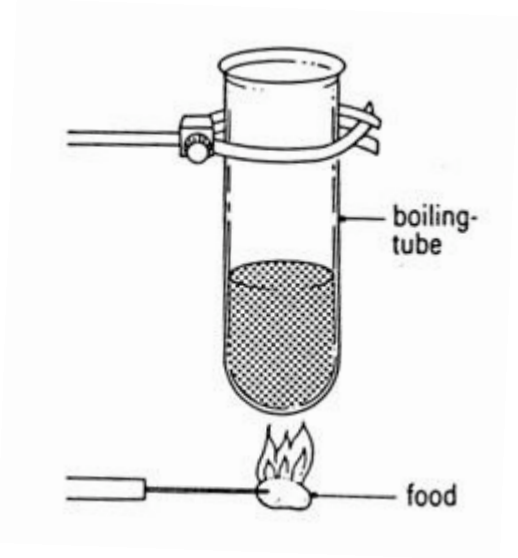
[Additional materials required: graph paper]

For examiners' use only.

Total [40]	

1. The energy content of foods can be measured in units called calories. One calorie is the heat energy required to raise the temperature of 1g of water through 1°C.

   Nine students were asked by their teacher to carry out the following experiment in order to estimate the energy content of a common snack called 'Monster Munch'. Each student had to add 30cm^3 of distilled water to a boiling tube and measure its temperature. Next, they had to weigh one 'Monster Munch' from the packet, ignite it using a Bunsen flame, before quickly holding it beneath the boiling tube in order to heat the water inside (see below). Once the food sample had burned away, the student had to measure the temperature of the water again.



   Here are the results obtained by one student:

   Temperature at start: 21°C
   Mass of Monster Munch: 0.91g
   Temperature at end: 68°C

   a) Remembering that 1g of water has a volume of 1cm^3, how many calories of energy were transferred from this student's food sample to the water? [2]

The joule (J) is the unit of energy used in the International System (SI) of units. One calorie is equivalent to 4.2 joules. Because the Monster Munch pieces used by the nine students were different sizes the teacher asked them to calculate the energy content of the food in joules per gram (J/g).

b) Using the student's data above, calculate the energy content of Monster Munch in joules per gram. [3]

Here are the results obtained by the other eight students:

Student	Energy content (J/g)
1	4355
2	4870
3	3100
4	4553
5	7208
6	4350
7	3960
8	4255
9	
Mean	

c) Add the result you calculated in part (b) to the table alongside 'student 9' and calculate the mean. [1]

d) Suggest reasons for the wide range of results collected by the students. [3]

The teacher then showed the students the nutritional information label on the bag of Monster Munch. This is what it showed:

TYPICAL NUTRITIONAL VALUES		
	Per Pack	Per 100g
ENERGY	456 kJ	2064 kJ
PROTEIN	1.3 g	6.0 g
CARBOHYDRATE	13.2 g	60.0 g
of which sugars	0.7 g	3.0 g
FAT	5.5 g	25.0 g
of which saturates	0.5 g	2.1 g
FIBRE	0.4 g	1.7 g
SODIUM*	0.13 g	0.6 g
**EQUIVALENT AS SALT*	*0.34 g*	*1.6 g*

e) Compare the energy content displayed on the label with the mean value calculated above in part (c). (Note that 1kJ = 1000J). Explain why you think the value for energy content, as calculated by the manufacturers, was so different from that calculated by the students. [3]

f) Describe, with reasons, how you would modify or change the apparatus used by the students in order to improve the accuracy of their findings. [4]

The figures below show the amount of energy that is required by different types of people over a 24 hour period.

Individual	Daily energy requirements (kJ/day)
Newborn baby	1900
Child, 1 year	3350
Child, 2-3 years	5850
Child, 5-7 years	7550
Girl, 12-15 years	9650
Boy, 12-15 years	11750
Average woman	9200
Average man	13000
Pregnant woman	10050
Breastfeeding woman	11300

g) How many grams of Monster Munch would a typical 13-year old boy need to eat in order to meet his daily energy requirement if there was no other source of food available to him? [2]

_____

_____

h) It is perhaps interesting that a woman who is breastfeeding her baby should require so much more energy than a woman who is pregnant. Suggest reasons for this. [2]

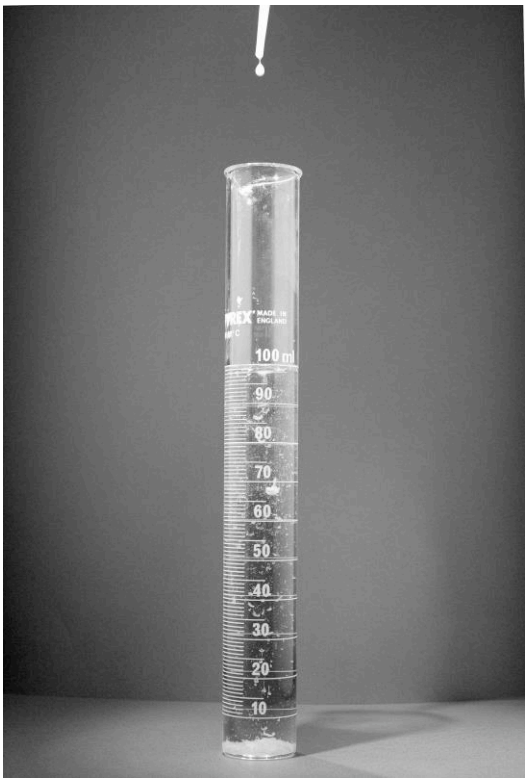
_____

_____

_____

_____

2. In the next lesson the teacher asked the nine students to carry out an experiment to investigate the fat content of three different types of milk: full fat, semi-skimmed and skimmed. Each student was asked to fill a measuring cylinder with 100cm^3 of a solution of copper sulphate and measure the time taken for a drop of milk to sink to the bottom of the cylinder, having been dropped from a pipette as shown in the picture below.



Each student was asked to do this once for each milk type. The mean results for the class are shown in the table below:

Milk type	Mean time taken for drop to sink (seconds)
Full fat	19
Semi-skimmed	16
Skimmed	12

a) Suggest reasons why copper sulphate solution was used instead of water. [3]

b) State the factors that the students should have kept constant in order to make the test fair. [3]

The teacher then showed the students the nutritional information labels on the side of the milk cartons. The table below shows the percentage fat content for the three types of milk.

Milk type	Percentage fat content (%)
Full fat	3.6
Semi-skimmed	2.0
Skimmed	0.5

c) Plot percentage fat content for each milk type against the mean time taken for a drop to sink on an appropriate graph, using the graph paper provided. [5]

d) Describe the relationship between the time taken for the milk drop to sink and the percentage fat content of milk. [2]

A goat farmer claims that the milk which his goats produce has a fat content of 4%. The students decide to test the farmer's claim and repeat their experiment above using the goats' milk. They calculate a mean time for a drop to sink is 22 seconds.

e) Estimate the percentage fat content of the goats' milk explaining clearly how you arrived at your answer. [3]

f) Do you think this is an accurate and reliable way to estimate the fat content of the goats' milk? Explain your answer fully. [4]

[End of Paper]