OCR
RECOGNISING ACHIEVEMENT

ADVANCED GCE UNIT **G628**

APPLIED SCIENCE

Unit 9: Sampling, testing and processing

FRIDAY 19 JANUARY 2007 Afternoon

Time: 1 hour 30 minutes

Additional materials: Electronic calculator
Ruler (cm/mm)
Candidates may not bring the Pre-released Case Study into the examination room. An Insert is provided.

Candidate Name

Centre Number | | | | | |

Candidate Number | | | | |

INSTRUCTIONS TO CANDIDATES

- Write your name, Centre Number and Candidate number in the boxes above.
- Answer **all** the questions.
- Use blue or black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure you know what you have to do before starting your answer.
- Do **not** write in the bar code.
- Do **not** write outside the box bordering each page.
- WRITE YOUR ANSWER TO EACH QUESTION IN THE SPACE PROVIDED. ANSWERS WRITTEN ELSEWHERE WILL NOT BE MARKED.

INFORMATION FOR CANDIDATES

- The number of marks for each question is given in brackets [ ] at the end of each question or part question.
- The total number of marks for this Paper is 90.
- You are advised to show all the steps in any calculations.
- You may use an electronic calculator.

For Examiner's Use		
Qu.	Max.	Mark
1	24	
2	40	
3	26	
Total	90	

This document consists of **16** printed pages and an Insert.

[Turn over

Section 1

Answer **all** the questions.

The questions in this section refer to the materials supplied to your Centre in the Pre-release Case Study. You are supplied with fresh copies in the insert.

1 This question is based on the article 'Osteoporosis – A challenge for modern medicine'.

(a) The population of the United States is 280 million. There are 31 million women over 55. There is a 20% risk of hip fracture for women over 55. Statistically women of this age are 5 times more likely to suffer from fractures than men.
Use these values to calculate

(i) the total number of women over 55 at risk of a fracture

..... million [1]

(ii) the total number of men over 55 at risk of a fracture, assuming that the number of men over 55 is the same as the number of women over 55.

..... million [1]

(b) State **one** function of oestrogen in the body, as described in the article.

.....[1]

(c) Suggest why 'other medical problems' may result from maintaining hormone levels artificially.

.....

.....[1]

(d) Fig. 1.2 shows the chemical structure of 'pyrophosphate' and 'bisphosphonate' groups.
Describe or sketch which part of the structure is likely to be attacked by controlling enzymes when the pyrophosphate group is decomposed during the dissolving of bone material.

.....[1]

(e) The first trial involving bisphosphonates used a compound containing the structure shown in Fig. 1.2. This trial involved 166 women aged over 50.
After 5 years those women receiving the bisphosphonates showed an increase in bone mineral density of around 2%. Those receiving a placebo had lost around 3% of their bone mineral density.

(i) Describe what is meant by the term placebo.

.....

.....[1]

(ii) Explain why, in this trial, it would not matter if the participants knew whether they were receiving a placebo or the bisphosphonate treatment.

.....

.....[1]

(iii) Apart from age and gender, give two ways in which **this** trial could have been extended to produce a wider range of conclusions.

1. .....

2. .....[2]

(iv) Use the article to state a possible problem with the long term use of bisphosphonates.

.....[1]

(f) Other bisphosphonates have since been developed that may also be effective in combating osteoporosis.

State **four** features that must be considered when a new development of a drug is to be trialled.

1. .....

2. .....

3. .....

4. .....[4]

(g) Fig.1.3 shows typical percentage changes in bone mineral density against treatment time for women over the age of 50 who underwent different treatments.

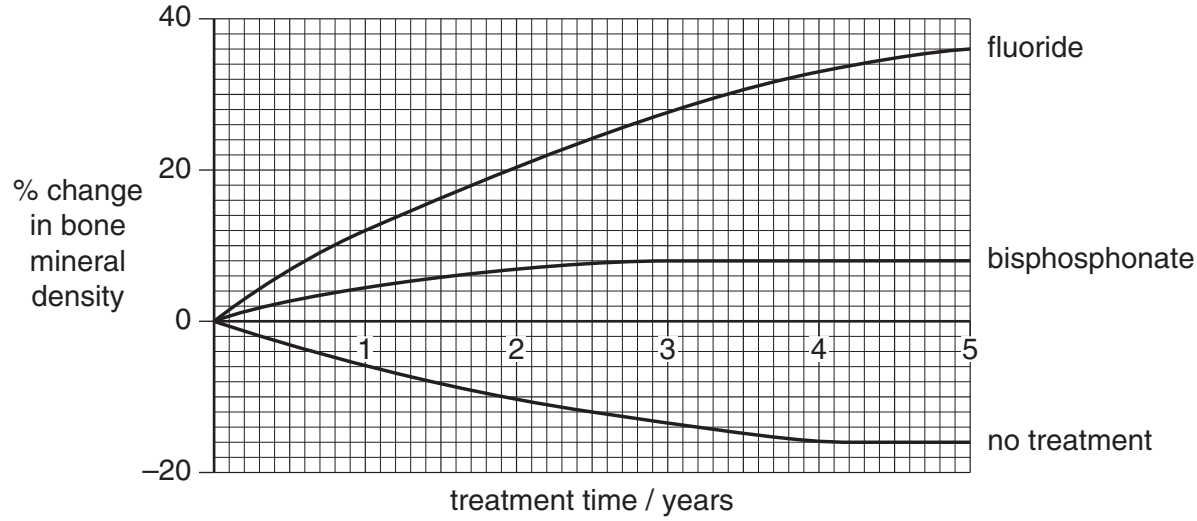

Fig. 1.3

(i) Medicine containing fluoride, which would not be expensive, is not approved for use in the United States, even though the graph shows its advantages.
Suggest a reason why this medicine is not approved.

.....[1]

(ii) Describe how using bisphosphonates affects changes in bone mineral density.

.....

.....

.....[2]

(iii) After four years of 'no treatment' the graph reaches a plateau.
Describe what this means in terms of bone formation and dissolving (resorption).

.....[1]

(h) Recent advances suggest the use of a particular antibiotic in the treatment of osteoporosis.
State what scientists should do next to advance research further in this area.

.....

.....

.....[2]

(i) A health food shop sells 'Chewable calcium' tablets.
Each tablet contains 120 mg of calcium in the form of calcium carbonate and **one** is taken each day.

(i) Absorption of calcium by this method is poor, with 15% of the calcium being absorbed by the body.
Calculate how much calcium is absorbed by the body **each week**, assuming that this is the only source of dietary calcium.

..... mg [1]

(ii) Quality control technicians test 'Chewable calcium' tablets for their calcium content using flame emission spectroscopy.
A tablet is dissolved in acid and the solution made up with water to a volume of 250 cm^3.
The solution was analysed for calcium and it gave a flame emission reading of 30.0.

1. Use the formula below to find the concentration of calcium in mg dm^{-3}.

$$\text{concentration of calcium / mg dm}^{-3} = \frac{\text{emission reading}}{0.063}$$

..... mg dm^{-3} [1]

2. Show that the mass of calcium present in this tablet is 119 mg.

[1]

(iii) Suggest **one** reason why simple treatment with calcium supplements may not be a successful course of treatment.

.....

.....[1]

[Total: 24]

2 This question is based on the article 'Bituminous materials'.

(a) A new deposit of rock asphalt has been discovered by a geologist.

(i) Explain why it is necessary to take **representative** samples when finding its bitumen content.

.....

.....[1]

(ii) State **two** things that the geologist must tell his colleagues before he leaves to collect his samples from the rock asphalt deposit.

1. .....

2. .....[2]

(iii) The rock asphalt outcrops as a deposit 50 m long and 6 m high.
Several samples are to be collected.
Describe from where in the outcrop these samples should be collected, giving a reason for your answer.

.....

.....

.....[3]

(iv) Before the samples in **(iii)** are collected, the geologist needs to assess the risks of his collecting procedure.
State **one** hazard that he should be aware of when collecting these samples.

.....

.....[1]

(v) The geologist has collected the samples and stores them in the laboratory before working with them.
What should be written on the label for each sample?

.....[1]

(vi) The geologist finds that the finer the limestone particles the greater the percentage of bitumen they contain.
Suggest a reason for this.

.....[1]

(vii) A group of students were given some samples of rock asphalt and asked to analyse them for their bitumen content. They were told that the solvents carbon disulphide and methylbenzene were unsuitable for student use.
Suggest where they would find details about suitable solvents that were safer to use.

..... [1]

(viii) The students then analysed the rock in **(vii)** for the bitumen content.
They weighed a rock asphalt sample and, after crushing, they added 25.0 cm^3 of their chosen solvent and stirred the mixture. They then filtered the solution from the crushed rock and washed the crushed rock in the filter paper with a little more fresh solvent.
The solution samples were then evaporated and the bitumen residue weighed.
The procedure was repeated for all samples.

1. Suggest how the rock was crushed.

.....[1]

2. Suggest why it would have been a better idea to crush some rock asphalt first before weighing a sample.

.....

.....[1]

3. State why the crushed mixture and solvent were stirred.

.....

.....[1]

4. State why the crushed rock in the filter paper was washed with fresh solvent.

.....

.....[1]

5. The solvent chosen by the students boiled at about 80°C and is very flammable.
Describe how this solvent should be evaporated in the college laboratory.
A diagram can be used in your answer if you wish.

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.....[3]

(ix) The rock asphalt samples were analysed for their bitumen content and the results recorded in Table 2.2.

Table 2.2

	mass of sample / g	mass of bitumen / g	% of bitumen
1	12.50	1.00	8.00
2	10.58	0.82	
3	11.54		7.80

Complete Table 2.2. [2]

(x) Use your answers in **(ix)** to calculate the mean value for the percentage of bitumen in the rock asphalt.

mean value ..... % [1]

(b) Fig. 2.1 shows the equipment used to measure the relative softness of bituminous materials.

(i) Explain why it is important to use the same force and time for each measurement.

.....[1]

(ii) For one sample of bitumen the penetration of the needle was 0.4 mm.
State and explain how this value would change (if at all) if the test was run at 35°C rather than at 25°C.

.....

.....[2]

(c) A tar viscometer (Fig. 2.2) can be used with a 10 mm or 4 mm orifice.
Explain which one should be used when using a low viscosity tar sample.

.....

.....[1]

(d) When finding the **composition** of bitumen samples, method 2 (a) is used to find the percentage of **volatile** material in the bitumen.
Describe how you would choose a temperature for this experiment so that volatile decane is evaporated from the bitumen but high boiling point black material remains.

.....

.....[2]

(e) Method 2 (b) is used to find the percentage of ash remaining after burning off carbon containing compounds in the bitumen.
In an experiment the percentage of ash in the bitumen was found to be 0.2%.
Explain why the technician felt it better to use a sample of mass 10 g for the experiment rather than a sample of mass 1 g.

.....

.....[1]

(f) **(i)** Method 2 (c) is used to find the percentage of insoluble material in the bitumen.
The solvents used are carbon disulphide and methylbenzene.
State what should be done before these solvents are used by trained technicians.

.....[1]

(ii) Briefly describe how you would advise a trained technician to carry out method 2 (c) starting from a known mass of asphalt, to find the mass of insoluble material in this sample.

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.....[6]

(g) **(i)** 'Orimulsion' is an **emulsion** of oil and water.
Describe what is meant by an emulsion.

.....

.....[1]

(ii) 'Orimulsion' has great potential as a replacement fuel for coal and gas in power stations.
State **one** advantage of transporting 'Orimulsion' compared with natural gas or crude oil.

.....[1]

(iii) Give a reason why 'Orimulsion' is suitable as a fuel in power stations but bitumen itself is not.

.....[1]

(iv) At many power stations in Britain large supplies of coal are stored in the open air ready for use.
Suggest a reason why this method of storage would be unsuitable for 'Orimulsion.'

.....[1]

(v) Describe one **advantage** and one **disadvantage** of using 'Orimulsion' as a power station fuel compared with coal.

Advantage .....

.....[1]

Disadvantage .....

.....[1]

[Total: 40]

Section 2

Answer **all** the questions.

3 On a trip to Derbyshire, a group of students collected some zinc ore and decided to see if they could make zinc metal from it in the laboratory and find out about some of the uses of zinc.

(a) One of the chemicals used for making zinc was no longer available from the suppliers. Suggest what they should do about this problem.

.....

.....[1]

(b) They found that the method was described in stages. Stage 1 stated 'crush the ore and roast in air to produce impure solid zinc oxide and toxic sulphur dioxide gas'.

Devise a procedure for this stage, including the apparatus needed to deal with 20 g of ore.

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.....

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.....[5]

(c) Stage 2 stated 'crush the impure solid zinc oxide product and react it with dilute sulphuric acid to give a solution containing zinc sulphate'.
The students followed these instructions but the powder was slow to react and a cloudy mixture was formed.

What **two** methods could they use to overcome these problems?

1. .....

2. .....[2]

(d) Stage 3 stated 'add zinc powder to the solution containing zinc sulphate so that the valuable metal cadmium, present as an impurity, precipitates'.

Complete Fig. 3.1, to show how pure dry cadmium powder is produced.
Your answer should include labelled diagrams.

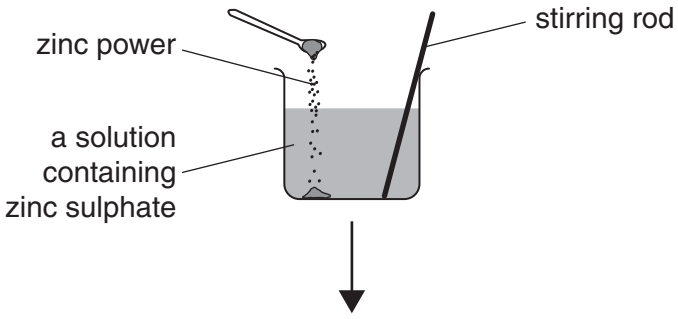

Fig. 3.1

[3]

(e) The students obtained a small quantity of toxic cadmium powder.

What should be written on the label apart from the name of the material?

.....

.....

.....[1]

(f) Stage 4 is the electrolysis of the zinc sulphate solution using a lead anode (+) and an aluminium cathode (–). The students used the apparatus below, Fig. 3.2.

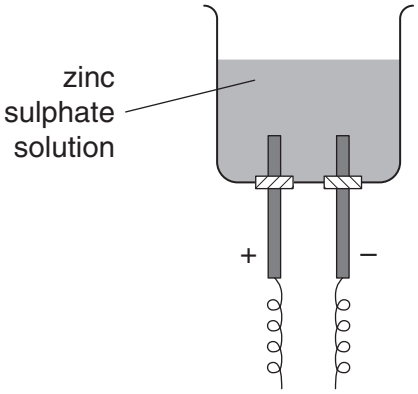

Fig. 3.2

(i) Zinc collected on the cathode and oxygen gas was given off from the anode.
The students needed to collect the oxygen for identification.

Draw a diagram to show the oxygen being collected.

[2]

(ii) Zinc was deposited on the aluminium cathode.
Describe what the students should do to find out how much zinc metal had been produced.

.....

.....

.....

.....[3]

(g) This method is used in industry to extract zinc from its ore.
The following modifications from the laboratory method are used.
Explain the importance of these modifications.

(i) The sulphur dioxide is collected.

.....[1]

(ii) The electrolysis vessel is sealed but vented.

.....

.....[1]

(iii) The process is made to be continuous rather than done in batches.

.....[1]

(h) The students found that one major use for zinc is in the making of the alloy brass which also contains copper. The percentage of copper in brass depends on the use for which it is required.

(i) The density of brass depends on the percentage of copper present, Table 3.1.

Table 3.1

percentage of copper	density of brass / g cm^{-3}
60.0	8.20
63.0	8.25
66.0	8.30
70.0	8.33
75.0	8.45

Plot these values on the graph opposite, Fig. 3.3, and draw a straight line of **best fit** through as many points as possible.

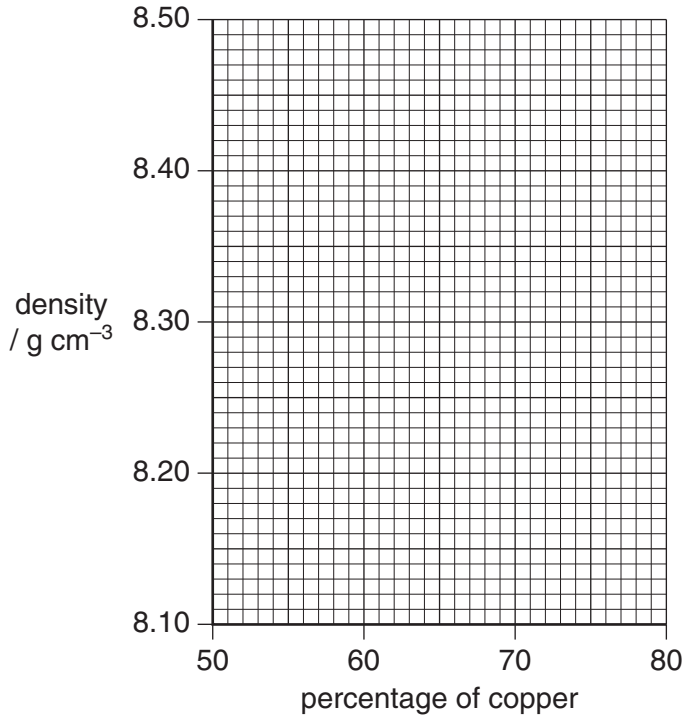

Fig. 3.3

[2]

(ii) The students used the graph, Fig. 3.3, to find the percentage of copper in a brass gas tap.
The mass of the tap was 92.4 g and its volume was 11 cm^3.

Calculate the density of this brass tap, in g cm^{-3}, using the formula below.

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

..... [1]

(iii) Use your graph, Fig. 3.3, and your result to **(ii)** to find the percentage of copper in the brass tap. You should show how you used the graph to obtain the answer.

.....

.....[2]

(iv) Explain why the value for the density, obtained in **(ii)**, is not accurate.

.....

.....[1]

[Total: 26]

END OF QUESTION PAPER

PLEASE DO NOT WRITE ON THIS PAGE