OCR
RECOGNISING ACHIEVEMENT

GCE ADVANCED UNIT **G628**

APPLIED SCIENCE

Unit 9: Sampling, testing and processing

THURSDAY 7 JUNE 2007 Afternoon

Time: 1 hour 30 minutes

Candidates answer on the question paper.
Additional materials: Electronic calculator
Ruler (cm/mm)
Candidates may not bring the Pre-release Case Study into the examination room. An insert is provided.

CUP/T28030

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.
- You will be awarded marks for the quality of written communication where this is indicated in the question.
- You are advised to show all steps in any calculations.
- You may use an electronic calculator.
- The total number of marks for this paper is 90.

FOR EXAMINER'S USE		
Qu.	**Max.**	**Mark**
1	**38**	
2	**30**	
3	**22**	
TOTAL	**90**	

This document consists of **17** printed pages, **3** blank pages and an insert.

[Turn over

Answer **all** the questions.

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

This question is based on the article 'The manufacture and uses of cement products'.

1 **(a)** The article states that small balls of clinker are made from the fused mixture. Suggest a temperature for the 'melting point ' of the cement made in this way.

…… ^{o}C [1]

(b) Technicians at a cement factory regularly analyse samples of cement produced in the kiln. Why is it necessary to analyse several samples from the same batch of cement?

.....

.....[1]

(c) If the samples are to be stored before analysis, state

(i) how they should be stored, giving a reason for your answer

.....

.....

.....[2]

(ii) what else apart from 'cement' should be written on the label.

.....[1]

(d) The calcium content of the cement is measured using flame emission spectroscopy. In flame emission spectroscopy a number of samples containing a known concentration of calcium (standard solutions) are used. Each standard solution is placed in a flame and the intensity of the orange-red flame colour produced is measured and related to the concentration of calcium.

The intensity of the flame produced by the cement sample is then measured and the concentration of calcium in the cement calculated.

Give **two** reasons why this technique is used.

1. .....

2. ..... [2]

(e) A technician used flame emission spectroscopy to find the percentage of calcium in a sample of cement. He prepared a number of standard solutions and measured the intensity of the resulting orange-red colour. These results are shown in Table 1.1.

Table 1.1

concentration of calcium / mg dm^{-3}	emission reading	$\frac{\text{concentration of calcium / mg dm}^{-3}}{\text{emission reading}}$
5.0	17	0.29
10.0	32	
15.0	52	

(i) Complete the third column, giving your answers to **two** decimal places. [2]

(ii) **Calculate the mean value for the third column** in Table 1.1.

…… mg dm^{-3} [1]

(iii) A cement sample of mass 2.00 g was treated so that all the calcium in the cement was in 1 dm^3 of solution. 10 cm^3 of this solution was then diluted **100** times with water to give a total volume of 1 dm^3.

This diluted solution gave an emission reading of 43.

Use the formula below to calculate the concentration of calcium in this diluted solution.

concentration of calcium / mg dm^{-3} = mean value from **(ii)** x 43

concentration of calcium …… mg dm^{-3} [1]

(iv) Calculate the mass of calcium in the **undiluted** sample.

mass of calcium …… mg [1]

(v) Use the answer to **(iv)** to find the percentage of calcium in the sample of cement of mass 2.00 g.

percentage of calcium ……[2]

(f) The percentage of silicon in the sample was found using a weighing method.
A sample of cement of mass 2.56 g was treated so that all the silicon present in the sample was in solution.
A reagent was then added to the solution until all the silicon in the solution had combined to give a yellow solid.

(i) The instructions then stated that the yellow solid precipitate should be separated by filtration.

State why it is essential that **all** the yellow solid was transferred to the filter paper.

.....[1]

(ii) The instructions then said that the yellow precipitate in the filter paper should be washed several times with water.

State why this was done.

..... [1]

(iii) After filtering and washing the yellow solid was then dried for two hours before weighing.
The solid was then dried for a further hour and reweighed.

State why it may be necessary to repeat this procedure several times.

.....[1]

(iv) In the experiment the following results were obtained

mass of cement sample taken = 2.56 g

mass of yellow precipitate = 43.71g

The yellow precipitate contained 1.23% of silicon by mass.

Use these results to calculate the percentage of silicon in the cement sample.

% of silicon …..…….. [2]

(g) (i) The fineness of the cement cannot be measured by simply sieving the cement as the particles are too small.

Suggest **two** sources of information where a technician could find details of a suitable fineness test.

1. .....

2. .....[2]

(ii) Experiments have shown that the finer the particles of cement the more effective they are when making mortar or concrete.

Suggest a reason for this fact.

.....

.....[1]

(h) (i) The setting time of cement is very important as different setting times may be required for particular tasks in the construction industry.

You have been given a cement sample and are asked to devise an experiment to measure its setting time when added to water.
Your answer should include a description of the apparatus needed and how you will decide when the mixture has set. Exact quantities of cement and water are not required.

In this section 1 mark is available for spelling, punctuation and grammar and 1 mark is available for a clear ordered answer.

.....

.....

.....

.....

.....

.....

.....[4]

[QWC 2]

(ii) State **one** way in which your test could be extended to give a wider range of conclusions.

.....

.....[1]

(i) The manufacturers of ground granulated blast furnace slag (GGBS) state that 'no carbon dioxide is produced in the process'.
This statement is strictly correct.
Explain why it is misleading.

.....

.....[1]

(j) A technician analysed samples of a batch of GGBS and ordinary Portland cement and presented the results as a bar chart, Fig. 1.2. For simplicity the component elements are shown as their oxides.

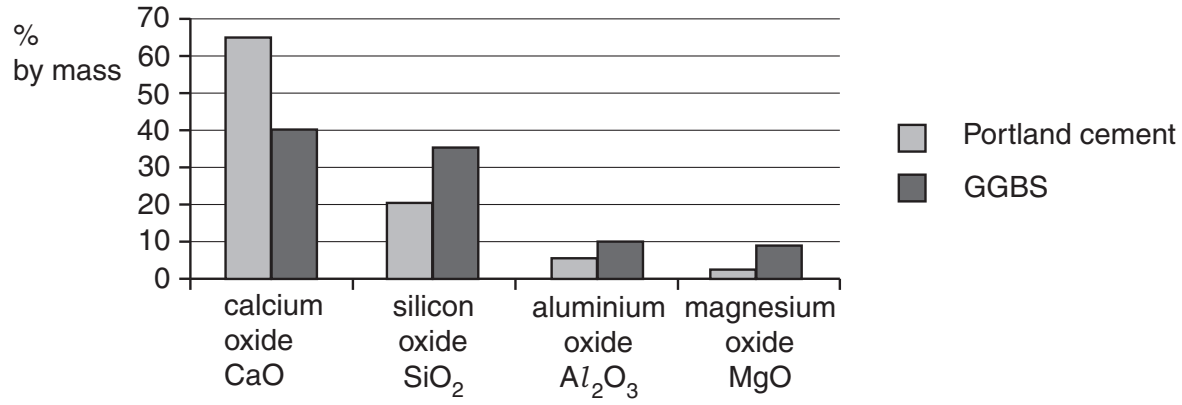


Fig. 1.2

Present these results in a table.

[2]

(k) The article describes one method of making a geopolymer cement.
State **one** advantage and **one** safety consideration in the manufacture of geopolymer cement compared to ordinary Portland cement.

advantage of geopolymer cement .....

.....[1]

safety consideration in making geopolymer cement .....

.....[1]

(l) Technicians have tested three types of cement for their stability in containing acidic waste products. The results are displayed in Fig. 1.3.

A graph has been removed due to third party copyright restrictions

Details:

A graph showing results of the Technicians experiment

Fig. 1.3

Using the chart make two comparative statements on the stability of these three cements in the two acidic conditions.

1. .....

.....

2. .....

.....[2]

(m) Magnesium phosphate cements can be made at room temperature by mixing solid magnesium oxide with ammonium dihydrogenphosphate in the presence of water. The magnesium phosphate cement is produced as a white solid which slowly hardens. A group of students decided to carry out this reaction.
State two important details, apart from health and safety aspects, they need to find out before they can carry it out successfully.

1. .....

2. .....[2]

[Total: 38]

This question is based on the article 'Bamboo – an essential plant for life'.

2 **(a)** Bamboo needs large quantities of fertiliser for successful growth.
Suggest a reason for this.

.....[1]

(b) You are given some bamboo plants in pots. They are all of the same variety.
A range of different fertilisers is also supplied.
Your task is to carry out tests to find the best fertiliser for the successful growth of these plants.

(i) State **four** factors that you will keep constant so that the results are scientifically meaningful.

1. .....

2. .....

3. .....

4. .....[4]

(ii) State **two** ways in which the progress of your tests can be followed.

1. .....

2. .....[2]

(iii) What needs to be written on the label of each pot?

.....[1]

(iv) Give **two** reasons why the results of your tests may not be applicable to all varieties of bamboo.

1. .....

2. .....[2]

(c) Some bamboo for construction purposes is to be harvested when it is about 20 m tall.
It is difficult to reach the top of the bamboo to measure its height.
Instead, the approximate height of the bamboo is found by measuring the distance between the observer and the bamboo and by finding the angle θ, Fig. 2.3.

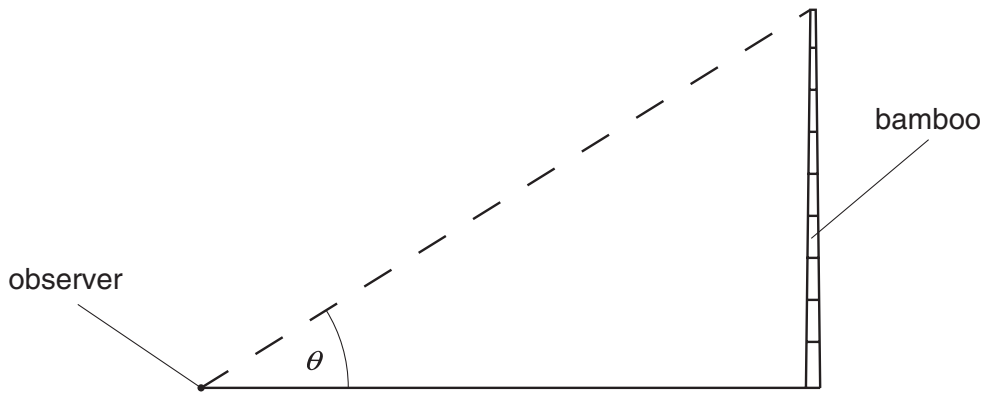


Fig. 2.3

The height of the bamboo is then found using the formula

height = tan θ x distance from observer to the bamboo

In an observation the value of the angle θ is 31°, tan 31° = 0.6 and the distance to the bamboo is 30 m.

(i) Use the formula to calculate the height of the bamboo plant.

height of bamboo plant = ...m [1]

(ii) The observer then stands further away so that the distance to the bamboo plant is greater and the angle measured is less. He takes another set of readings.

Suggest, giving a reason, whether this result will be more, or less, accurate than the first set of readings.

.....

.....[1]

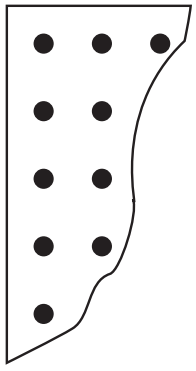
(iii) Workers in the bamboo plantation find that a simpler method for finding the height of the bamboo is to use the formula

height = circumference of the bamboo at the base x 58

Calculate the circumference at the base, if the bamboo is ready to be cut down, at a height of 20 m.

circumference ……..m [2]

(d) In a bamboo plantation of size 1 hectare (100 m x 100 m) there are 40 000 equally spaced bamboo culms (poles).
A section of the plantation is shown below.



Calculate the distance apart of these culms.

……..m [2]

(e) **(i)** The article uses the word *systemic* insecticide in eradicating mites from bamboo.
State the meaning of the word *systemic* as used in the article.

.....

.....[1]

(ii) Give **two** reasons why a systemic insecticide is more effective at eradicating mites than a contact insecticide.

1. .....

2. .....[2]

(iii) A simple way of eradicating mites is to use a mixture of liquid detergent, vegetable cooking oil and water.
Give **three advantages** of this home-made product compared with commercial insecticides.

1. .....

2. .....

3. .....[3]

(f) Some types of bamboo spread by underground rhizomes and can double in area in one year.
The owner of a plantation with this type of bamboo wishes to limit the area in which it grows.
Suggest what the owner could do to prevent this bamboo spreading.

.....

.....[1]

(g) Bamboo, which has spread out of control, can be treated with a water solution of a herbicide such as sodium trifluoroethanoate.

What should the owner do before he uses this material?

.....[1]

(h) A group of students read that bamboo is strong in **tension.**
Bamboo is hollow but every so often there is a node where the bamboo is jointed and this area is stronger than the hollow sections between nodes. At a node the bamboo is solid for a very short distance.
They devised an experiment where they supported a bamboo pole and hung masses in the middle until the bamboo cracked, Fig. 2.4.

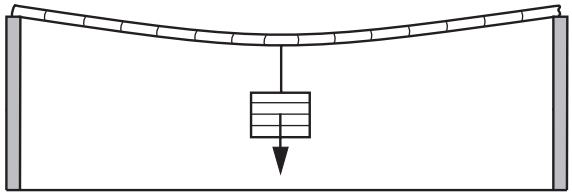


Fig. 2.4

State **two** features that they should keep constant when comparing the strength of bamboo poles.

1. .....

2. ..... [2]

(i) The students then burnt a known mass of bamboo to find the percentage of silica present in the bamboo.
When all the carbon had been burnt away, a white ash remained.
Water was added to the ash, the mixture stirred, filtered and the solid in the filter paper dried.

(i) The washed ash was then analysed for silica.
The figures showed that the percentage of silica was only 1.2%.
Explain why this percentage differs from the figure obtained stated in the article.

.....

.....[1]

(ii) The filtrate from the ash was heated carefully so that all the water was evaporated.
A white solid remained which gave a positive test for carbonate and potassium ions.
A student reported that this white solid was potassium carbonate.
What is wrong with this conclusion?

.....

.....[1]

(j) Bamboo has been used for hundreds of years to make simple musical instruments such as flutes, Fig. 2.5.

Fig. 2.5

During a project on traditional instruments a student devised a formula to relate the length of the bamboo pipe and the frequency of the note obtained.

$$\text{frequency (in Hz)} = \frac{15000}{\text{length of pipe in centimetres}}$$

(i) Calculate the length of a bamboo pipe necessary to give a note of frequency 256 Hz.

……cm [1]

(ii) What, if anything, would be the effect on the frequency if the pipe in **(i)** was shortened?

.....[1]

[Total: 30]

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QUESTION 3 STARTS ON THE NEXT PAGE.

3 Soap has been made since Roman times by treating animal or vegetable fats and oils with an alkali.
A college tutor asked a group of students to investigate soap manufacture. They were asked to prepare samples of soap in the laboratory starting from oil palm fruits which had been obtained from a supplier. They found a method and then adapted it to suit their investigation.

(a) Palm oil is contained in the flesh of the fruit and needs to be separated from the stones.

- The stones are removed from the fruit.
- The flesh containing the palm oil is crushed and squeezed.
- The palm oil extracted still contains some solid particles.

The students tried to remove these solid particles by filtering but the oil did not easily pass through the filter paper.

Suggest another method to remove these solid particles.

.....[1]

(b) **(i)** The palm oil obtained was yellow in colour. The next stage was to remove the colour from the oil using acidified potassium dichromate solution which is toxic and corrosive.
State one safety procedure that they should take in handling this material, apart from the use of laboratory coats and goggles.

.....[1]

(ii) The students shook the two liquids together and allowed the mixture to stand.
The oil formed an insoluble layer above the acid layer.

State why the oil formed an insoluble layer **above** the acid layer.

.....[1]

(iii) **1** Draw apparatus that can be used to separate the two liquids in **(ii)**.

2 Describe how this apparatus is used.

.....

.....

.....

.....

.....

.....

.....

.....[2]

(c) The method followed by the students stated that the percentage of palm oil obtained from the flesh after removal of the colour should be 20% but the students only obtained 12%.
Suggest how the students could have improved on their method to obtain more oil.

.....

.....[1]

(d) The next stage of making soap was to heat the colourless palm oil with concentrated sodium hydroxide solution, using the equipment below, Fig. 3.1.
Concentrated sodium hydroxide is a very corrosive alkali.

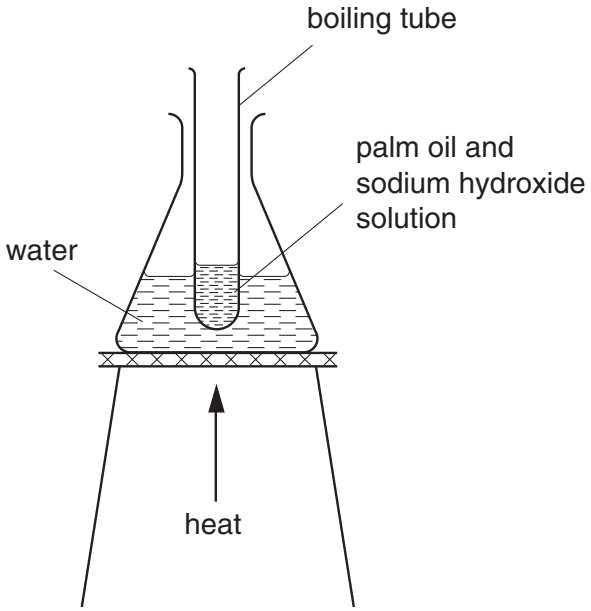

Fig. 3.1

(i) The method stated that there was a risk of hot alkali being lost from the tube by sudden boiling.
Using the same reagents, suggest what the students could do to keep this risk to a minimum.

.....

..... [1]

(ii) One of the students suggested that the method would be safer if the alkali solution was less concentrated.
Although this is true, suggest a reason why this is not generally done.

.....

.....[1]

(e) After boiling, the mixture was allowed to cool and when common salt was added, soap was precipitated.
The soap was removed and then washed twice with fresh salt water.

(i) State the meaning of the word *precipitated*.

.....[1]

(ii) Suggest a test, giving observation(s), to check if the soap still contained sodium hydroxide.

.....

.....[2]

(f) The students pressed the precipitated soap together to obtain a 'cake' of white soap.
Most soaps contain a fragrance. The students decided to produce lavender scented soap.
They consulted a science book and found a drawing of the equipment to extract lavender oil on a laboratory scale, Fig. 3.2.

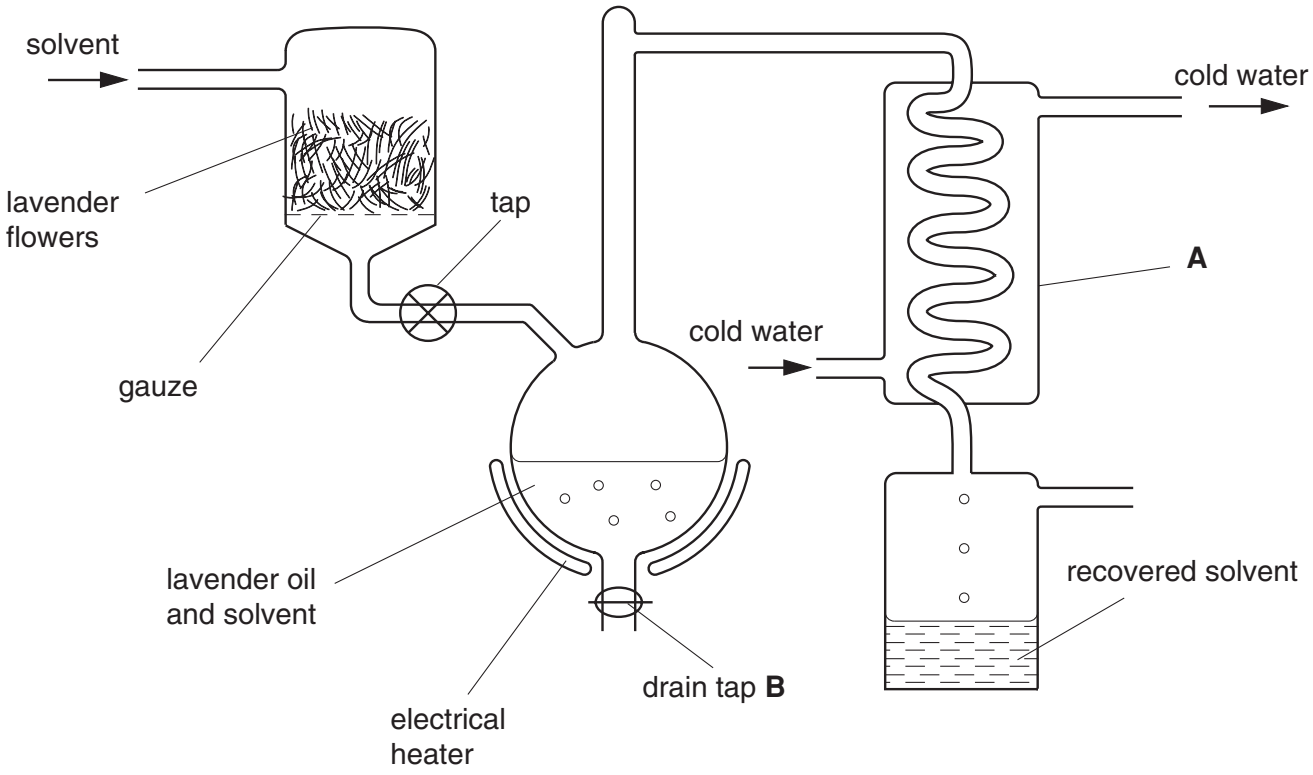

Fig. 3.2

(i) State **two** advantages of using electrical heating, rather than gas heating, for this method.

1. .....

2. .....[2]

(ii) State the purpose of the equipment labelled **A**.

.....[1]

(iii) State the purpose of the drain tap **B**.

.....[1]

(iv) State why the lavender flowers are **not** placed directly in the flask being heated, apart from the risk of them being charred by the heat.

.....

.....[1]

(v) State **two** modifications to this equipment that would be needed if this method was used on a much larger scale, apart from the use of larger equipment.

1. .....

2. .....[2]

(g) Soap sold by shops tends to be coloured and scented.
There are many coloured dyes available but not all of them are suitable for colouring soap.
Give **three** factors that should be considered when selecting a dye to use in soap.

1. .....

2. .....

3. .....[3]

(h) The students wished to check the percentage of water in their soap.
A science book suggested cutting a known mass of the soap into shavings, letting it stand for some time and then reweighing it to find he amount of water lost.
Suggest why this method will give a better result than leaving it as one block.

.....

.....[1]

[Total: 22]

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