OXFORD CAMBRIDGE AND RSA EXAMINATIONS
A2 GCE

G628/01

APPLIED SCIENCE

Sampling, Testing and Processing

MONDAY 8 JUNE 2015: Afternoon
DURATION: 1 hour 30 minutes
plus your additional time allowance

MODIFIED ENLARGED

Candidate forename		Candidate surname	

Centre number						Candidate number				

Candidates answer on the Question Paper.

OCR SUPPLIED MATERIALS:

Insert (G628/01/I)

OTHER MATERIALS REQUIRED:

Electronic calculator
Ruler (cm/mm)

READ INSTRUCTIONS OVERLEAF

DC (KN/CGW) 5311490840 110258/1

INSTRUCTIONS TO CANDIDATES

The Insert will be provided with this document.

Write your name, centre number and candidate number in the boxes on the first page. Please write clearly and in capital letters.

Use black ink. HB pencil may be used for graphs and diagrams only.

Answer ALL the questions.

Read each question carefully. Make sure you know what you have to do before starting your answer.

Write your answer to each question in the space provided. If additional space is required, you should use the lined pages at the end of this booklet. The question number(s) must be clearly shown.

INFORMATION FOR CANDIDATES

Candidates may NOT bring the Pre-release Case Study into the examination room.

The number of marks is given in brackets [ ] at the end of each question or part question.

The total number of marks for this paper is 90.

Where you see this icon you will be awarded marks for the quality of written communication in your answer.

This means, for example, you should:

ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear;

organise information clearly and coherently, using specialist vocabulary when appropriate.

A calculator may be used for this paper.

You are advised to show all the steps in any calculations.

Any blank pages are indicated.

Answer ALL the questions.

Questions 1 and 2 refer to the materials supplied to your Centre in the Pre-release Case Study.
You are supplied with fresh copies of the Case Study in the Insert.

This question is based on the article 'CHESTNUT TREES'.

1 (a) The article states that horse chestnut trees are found in countries that have temperate climates.

State the meaning of the term 'temperate'.

_____

_____ **[1]**

(b) Conkers have been used as a source of starch, which is then fermented under anaerobic conditions.

(i) State the meaning of the term 'anaerobic'.

_____

_____ **[1]**

(ii) This fermentation process produces three major liquid products – propanone (acetone), butan-1-ol and ethanol in a ratio of 3:6:1.

State the name of a technique that can detect the presence of these three products in the reaction mixture.

_____ **[1]**

(iii) Currently these three major liquid compounds are obtained from petroleum (crude oil). Although the fermentation of chestnut starch uses renewable resources, separation of the products is difficult and expensive.

Suggest TWO changes that could make this fermentation process economically viable IN THE FUTURE.

1 _____

_____

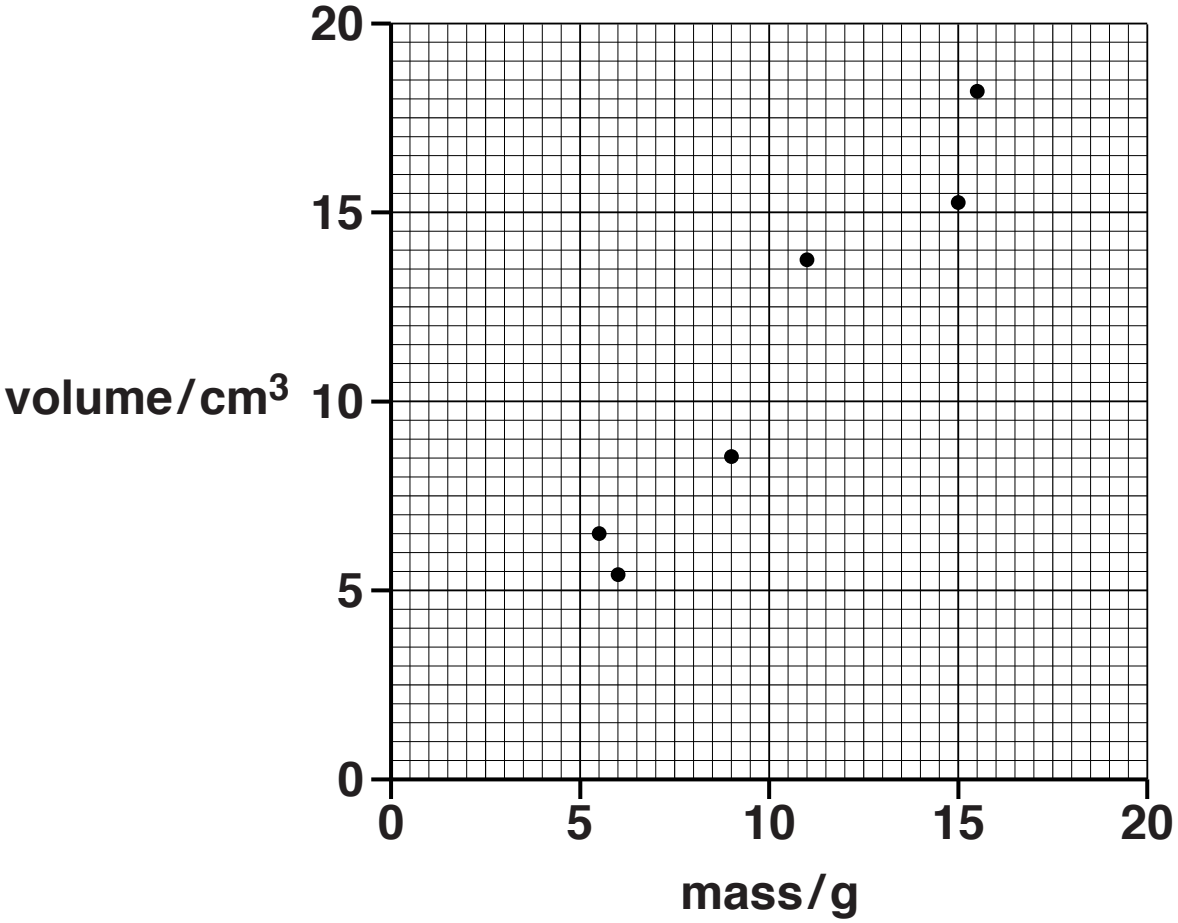
2 _____

_____

[2]

(c) A group of students prepared a saponin solution to 'whiten' textiles. They took six conkers and measured the volume of each one and then found their masses. They plotted the results on a graph, Fig. 1.1.

FIG. 1.1



(i) Draw a straight line of best fit on the graph and use your line to find the mass of a conker of volume 8 cm^3.

mass of conker = _____ g [2]

(ii) The saponin solution was used to whiten textiles by immersing the items in the solution at room temperature for ten minutes. Unfortunately the experiment was not very successful and only a small 'whitening' effect was seen.

Suggest THREE modifications that could be tried in order to produce a more successful result.

1 _____

2 _____

3 _____

[3]

(iii) The students made a modification, repeated the experiment and recorded the results.

State why it was important to record the original results.

_____

_____ **[1]**

(d) Some other students intended to make a model foam fire extinguisher using saponins extracted from conkers.

(i) They had not used saponins before.

What must they do before they start to work with this material?

_____ [1]

(ii) They followed the instructions below to extract the saponin.

1 Remove the shell from a conker and cut the remaining material into small pieces.
2 Add the pieces to some water in a 250 cm^3 beaker.
3 Boil the mixture.
4 Cool and filter the mixture.

State the information that is missing from:

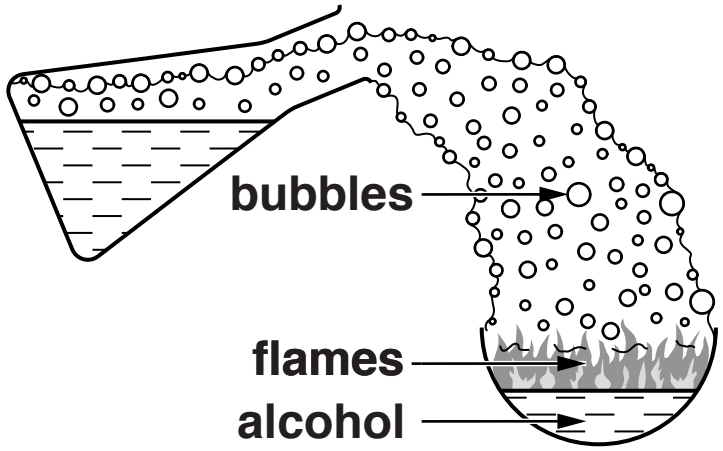
instruction 2 _____

instruction 3 _____

[2]

(iii) The students then mixed the saponin solution with sodium hydrogencarbonate solution and vinegar. This produced a foam that they used to extinguish some burning alcohol in a dish, Fig. 1.2.

FIG. 1.2



Suggest how they could modify their 'fire extinguisher' so that the production of the foam was faster.

_____

_____ **[1]**

(iv) The bubbles in the foam contain carbon dioxide gas.

State and explain how the bubbles of this gas are able to extinguish the fire.

_____

_____

_____

_____ **[2]**

(e) There has been some concern about the safety of using saponins in detergents.

In an *in vitro* test, horse chestnut saponins and three other compounds in aqueous solution were tested for their potential to cause skin irritation.

The bar chart, Fig. 1.3, shows the results. The vertical axis gives a measure of the potential to cause skin irritation.

FIG. 1.3

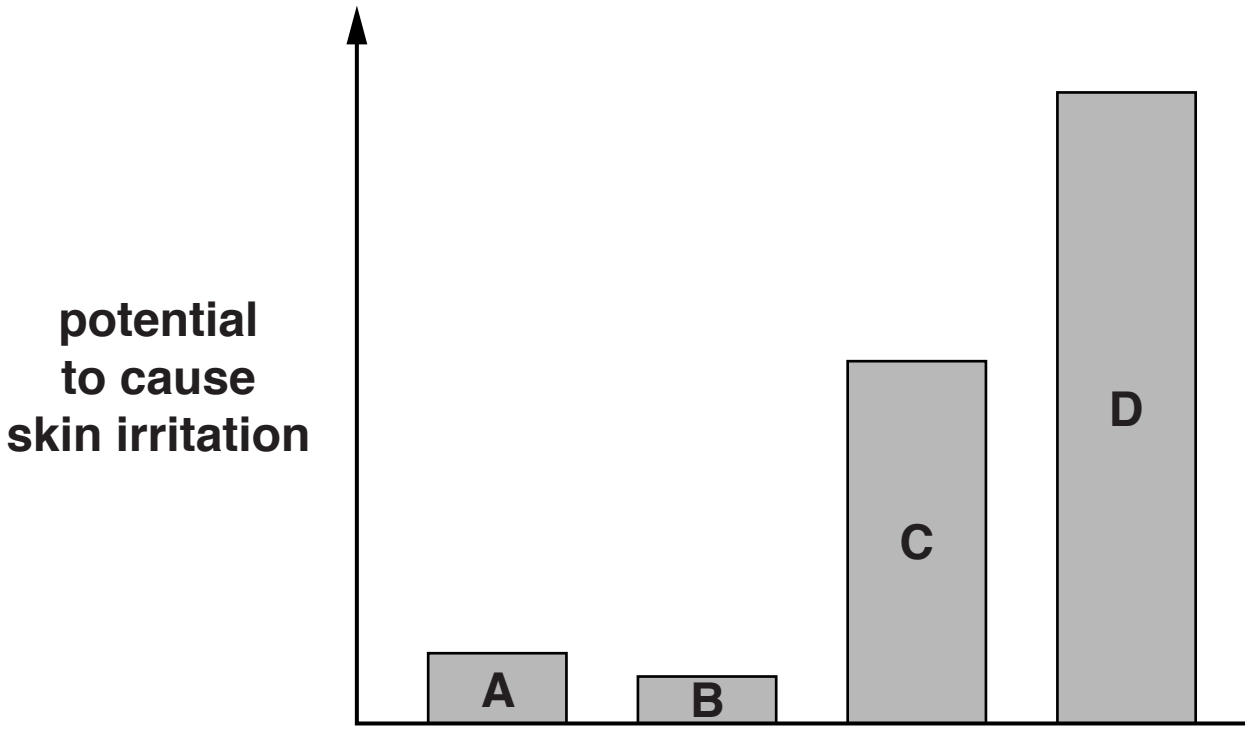
KEY:

A horse chestnut saponins

B lauryl glycoside

C sodium laureth sulfate

D sodium lauryl sulfate



(i) If this test is repeated, what detail about the solution needs to be kept constant so that the results are comparable?

_____ **[1]**

(ii) It appears from the results of the *in vitro* test that horse chestnut saponins are almost non-irritant.

What should be the next stage of this research?

_____

_____ **[1]**

(f) One problem with using saponins is the difficulty of extracting them from suitable materials, such as conkers and chickpeas.

A technician compared two saponin extraction methods:

using a microwave

using reflux.

The same solvent was used for each method.

His results are summarised in Table 1.1.

TABLE 1.1

	Microwave method	Reflux method
Saponins extracted/g per 100 g of chickpeas	2.5	2.3
Time taken/minutes	15	180
Temperature of extraction/°C	60	100

(i) Using the information from Table 1.1, calculate how many grams of chickpeas will produce 10 g of saponins by the microwave method.

mass of chickpeas = _____ g [1]

(ii) Using the information from Table 1.1, suggest TWO reasons why the microwave method should be recommended for the extraction of saponins on a larger scale.

1 _____

2 _____

[2]

(g) Horse chestnut trees are susceptible to attack by larvae of the horse chestnut leaf miner moth.

The leaf miner moths are spreading northwards through England.

Suggest how a group of students could monitor this spread over a number of years.

_____

_____

_____

_____

_____

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_____

_____

_____ **[6]**

(h) Table 1a in the Case Study (INSERT) gives some of the nutritional values of sweet chestnuts.

(i) The recommended daily intake of Vitamin C for an adult is 84 mg.

Use the information from Table 1a in the Insert to calculate the mass of raw sweet chestnuts necessary to give the recommended adult daily intake of Vitamin C.

mass of raw sweet chestnuts = _____ g [2]

(ii) Some students tested raw sweet chestnuts for their Vitamin C content.

They reported that the Vitamin C content decreased by 40% after heating them.

Calculate the mass of Vitamin C now present in 100 g of raw sweet chestnuts after heating.

mass of Vitamin C = _____ mg [1]

(iii) If you were to repeat the students' experiment, state TWO conditions that you would need to know so that you could reproduce their results.

_____

_____ **[2]**

(iv) Table 1.2 gives more information about the content of 100 g of fresh raw sweet chestnuts.

TABLE 1.2

COMPOUND	ORIGINAL MASS / g
sugars	11
starch	33
water	52

The students found an article that stated that when chestnuts are stored at room temperature, water evaporates from them. The chestnuts decreased by an average of 1% of their original mass for each day they were stored in the first week.

Calculate the mass of 100 g of sweet chestnuts after storage for ONE WEEK at room temperature.

mass = _____ g [1]

(v) The Case Study states that ripe sweet chestnuts contain around 11% of sugars and it has been suggested that they could be harvested commercially to provide a source of sugars.

Use this information to calculate the mass of ripe sweet chestnuts that would be needed to obtain 200 kg of sugars.

mass = _____ g [2]

(vi) Sweet chestnut trees are susceptible to attack by oak aphids, which feed on the sap of young shoots.

Commercial growers spray the trees with suitable pesticides to try and combat this attack.

Suggest TWO reasons why a systemic pesticide (that penetrates into the tree) may be more effective than a contact insecticide in combating this aphid attack.

1 _____

2 _____

[2]

[TOTAL: 38]

This question is based on the article 'GLYCOL AND GLYCERINE'.

2 (a) State why it was necessary to increase the production of glycol during the First World War.

_____ **[1]**

(b) The article describes two methods currently used for the manufacture of glycol.

(i) State TWO advantages of the newer OMEGA-process when compared to the traditional process.

1 _____

2 _____

[2]

(ii) State a disadvantage of the OMEGA-process when compared to the traditional process.

_____ **[1]**

(iii) Both methods use vacuum distillation in the final purification step.

Commercial glycol producers like to control costs and produce a high quality product.

Suggest TWO reasons why they prefer vacuum distillation to ordinary distillation.

1 _____

2 _____

[2]

(c) One advantage of using glycol for de-icing purposes at airports is that glycol breaks down in the environment in about ten days.

To test this, some students put a sample of glycol in a large flat dish (dish A) and another sample of glycol in a deeper dish (dish B) and left both in the air. In both cases the volume of glycol was the same.

These dishes are shown in Fig. 2.1.

FIG. 2.1

(i) After standing for ten days, the infrared spectrum of each glycol sample was taken.

State what an infrared spectrum tells you about chemical compounds.

_____

_____ **[1]**

(ii) The infrared spectrum suggested that some of the glycol had reacted with oxygen to produce new products.

Suggest why dish A contained more of these new products than dish B.

_____

_____ **[1]**

(iii) After these tests, the students needed to dispose of the materials correctly.

State how, apart from using the internet, they could find details of the correct methods of disposal.

_____ **[1]**

(iv) Using the same dishes, the tests were repeated using the same quantities of glycol for the same amount of time.

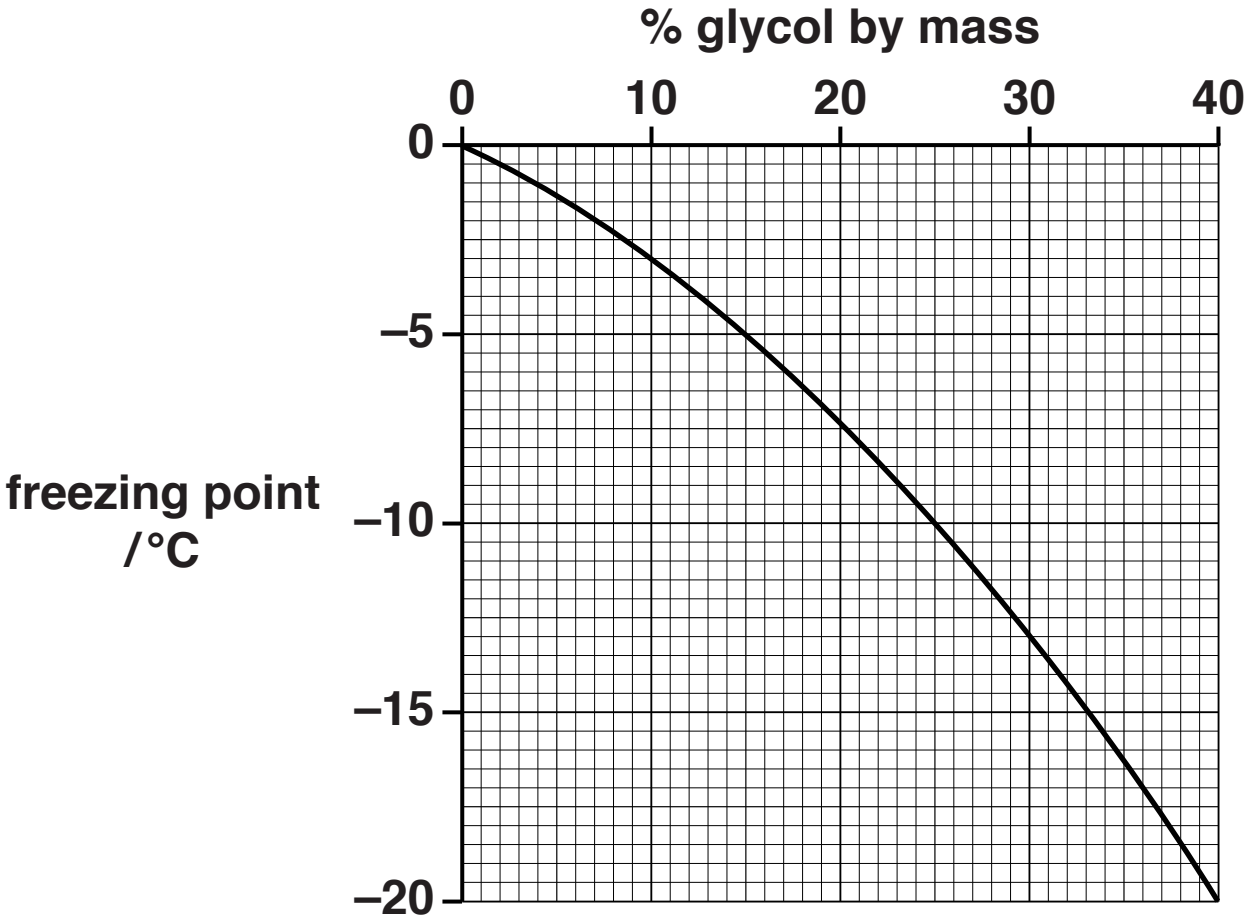
State ONE factor that could alter the proportion of new products that were obtained.

_____ **[1]**

(d) Britain has experienced some very cold winters in recent years. As a result, drivers have been concerned that the proportion of glycol in the coolant in their car radiators may not be sufficient to prevent freezing.

A student found a graph, Fig. 2.2, which showed the freezing point of coolant solutions containing glycol.

FIG. 2.2



Use the graph to state the percentage of glycol in the mixture that is necessary to produce a mixture that will not freeze until –15 °C.

percentage of glycol = _____ % [1]

(e) A student measured the density of some glycol solution and obtained the following results:

Mass of weighing bottle + glycol solution = 46.93 g
Mass of weighing bottle = 20.72 g

The volume of the glycol solution used was 25.00 cm^3.

(i) State why he used plastic gloves when handling the glycol.

_____ **[1]**

(ii) State the name of the piece of glassware used to measure out 25.00 cm^3.

_____ **[1]**

(iii) Calculate the mass of the glycol solution, and then its density in g cm^{-3}.

mass = _____

density = _____ **g cm^{-3}**
[2]

(iv) **Table 2.1 shows how the density of the glycol solution varies with the concentration of glycol.**

TABLE 2.1

% Glycol by mass	Density / g cm^{-3}
10.0	1.013
20.0	1.026
30.0	1.040
50.0	1.066
60.0	1.078

Use the table to estimate the density of a 40% by mass solution of glycol.

Explain your answer.

_____

_____

_____ **[2]**

(f) **Soaps can be made by batch or continuous processes.**

State TWO advantages of using a continuous process to make soap.

1 _____

2 _____

[2]

(g) Some students followed the method below to prepare soap.

STEP 1 Place 50 g of the vegetable fat in a large evaporating basin and heat it to 90 °C.

STEP 2 Add 20 cm^3 of sodium hydroxide solution, 2 or 3 drops at a time, stirring continuously.

STEP 3 After the addition, continue stirring for 30 minutes and then cool.

STEP 4 Put the product into a 400 cm^3 beaker and add some hot water.

STEP 5 Heat the mixture gently and then add some saturated salt solution.

STEP 6 Cool the mixture. The soap will separate out as a solid layer at the top.

STEP 7 Remove the soap and allow it to harden over a few days.

(i) What particular feature of THIS experiment means that the students need eye protection?

_____ **[1]**

(ii) State a piece of information that is missing from STEP 4.

_____

_____ **[1]**

(iii) State how you remove the soap from the mixture.

_____

_____ **[1]**

(iv) State TWO tasks the students should carry out with their experimental set-up on completion of their work.

1 _____

2 _____

[2]

(h) The soap made by the students in part (g) was alkaline. Outline what might be done about this so that a 'neutral' soap was obtained.

_____

_____

_____

_____ **[2]**

(i) The article suggests that the concentration of glycerine solution can be found by using a simple viscosity method.

Devise a simple experiment to show this. You can do this EITHER by the 'ball-bearing method' OR by the 'falling drop' method.

In your answer you should:

describe the apparatus that you have used, including appropriate sizes where necessary

state the measurements that you would make

describe how you would display your results

identify any possible weaknesses in your method.

[6]

_____

_____

_____

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_____

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_____

_____

_____

(j) The article comments on the greater emphasis on biofuels in the future.

State why research scientists in the biofuels industry are looking for new uses for glycerine.

_____

_____ **[1]**

(k) During 2006, 365 people in Panama died after taking supposed glycerine-containing medicines for colds. Instead of the 99.5% pure glycerine that was one of the medicine's ingredients, it contained the very toxic diethylene glycol.

Complete the two sentences below.

(i) Mass spectrometry could be used to tell these two compounds apart because the molecular ion would be in a different place because they have a different

_____ . [1]

(ii) Gas-liquid chromatography could also be used to tell these two compounds apart because the chromatogram would be likely to show a different peak for glycerine and diethylene glycol because they have different

_____ . [1]

[TOTAL: 35]

3 Sodium carbonate is a vital compound in today's world. Around 50% of its production is used in making glass and another 20% is used in the detergent industry.

(a) Sodium carbonate can be obtained from plants, mostly glassworts, which live in salt marshes close to the sea.

A group of students investigated this traditional source of sodium carbonate. They went on a visit to a salt marsh.

(i) State the purpose of their visit.

_____

_____ **[1]**

(ii) Suggest a possible hazard that the students should be aware of during their visit.

_____

_____ **[1]**

(iii) Suggest sampling procedures that the students should use during their visit.

_____

_____ **[1]**

(b) The students returned to the laboratory and were given samples of freshly picked glassworts. Their teacher asked them to investigate the mass of sodium carbonate in each sample.

(i) The students were advised to start the investigation immediately rather then leaving it until the next day.

Suggest why this advice was given.

_____

_____ **[1]**

(ii) The students were told to clean the plants, weigh them and then burn them until only ash remained. They were then told to weigh the ash, reheat it, cool and weigh it again.

State why they were told to reheat the ash.

_____

_____ **[1]**

(iii) The results obtained by the students for four samples, A, B, C and D, are shown in Table 3.1.

TABLE 3.1

SAMPLE	A	B	C	D
Mass of plant/g	6.84	7.00	7.49	8.64
Mass of ash/g	0.55	0.53	0.62	0.67
% of ash obtained	8.0	7.6	8.3	7.8

One of the students suggested that these results were homogeneous.

What did he mean?

_____

_____ [1]

(iv) The ash samples from (iii) were then mixed with distilled water, washed and the mixture filtered.

State why distilled water and not tap water was used for the washing stage.

_____ [1]

(v) The residue on the filter paper was then washed with more distilled water and the washings added to the filtrate.

State why this was done.

_____ [1]

(vi) On evaporation of the filtrate, a white solid, sodium carbonate remained.

If sodium carbonate is 20% by mass of the ash, calculate the mass of sodium carbonate in the ash obtained from sample A from Table 3.1.

mass of sodium carbonate = _____ g [2]

(c) In Wyoming, USA, there are huge deposits of the mineral 'trona', from which sodium carbonate can be produced by strong heating.

A group of students was invited to the mine to collect samples of trona.

(i) The students were required to wear hard hats and goggles while they were in the mine.

State why they were asked to do this.

_____ [1]

(ii) They used small hammers and chisels to break off small pieces of trona from larger blocks.

State why it was essential to have clean tools for this purpose.

_____ **[1]**

(iii) The samples were taken back to the laboratory for analysis. The suggested size of sample to be collected was between 25 and 50 g.

Suggest why this is an appropriate size to work with in the laboratory.

_____

_____ **[1]**

(iv) The students were asked to store their samples in plastic bags and label them with their name, sample number, date of collection and location.

What else should be written on the label?

_____ **[1]**

(v) Their rock samples were then heated to produce sodium carbonate.

On heating, trona retains 70.3% of its mass, as sodium carbonate is formed.

Use the figures below to confirm that this sample of trona is pure material.

Mass of trona before heating = 1.28 g
Mass of sodium carbonate formed = 0.90 g

[1]

(vi) The balance used to find the masses is only accurate to ±0.01 g.

Use this information to calculate the MAXIMUM value for the retained percentage in part (v) above.

maximum retained percentage = _____ % [2]

[TOTAL: 17]

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional answer space is required, you should use the following lined pages. The question number(s) must be clearly shown in the margins.

BLANK PAGE