OCR
RECOGNISING ACHIEVEMENT

Friday 7 June 2013 – Afternoon

A2 GCE APPLIED SCIENCE

G628/01 Sampling, Testing and Processing

Candidate forename		Candidate surname	

Centre number					Candidate number				

INSTRUCTIONS TO CANDIDATES

* The Insert will be found in the centre of this document.
* Write your name, centre number and candidate number in the boxes above. 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. Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).
* Do **not** write in the bar codes.

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 the 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.
* This document consists of **20** pages. Any blank pages are indicated.

OCR is an exempt Charity

Turn over

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 in the Insert.

This question is based on the article 'Iodine, its occurrence, extraction and uses'.

1 **(a)** A group of Chilean students visited a mine where caliche was being quarried.
They noticed that the caliche occurs as a band in a shallow quarry beneath a layer of other rock (the overburden).

overburden

caliche

impervious
clay

8 m
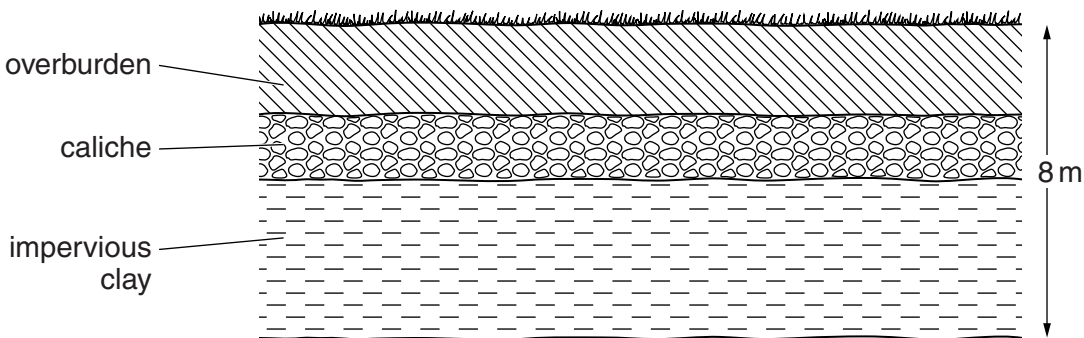
Fig. 1.1

   (i) The quarry manager said that hard hats were to be worn by the students at all times when in the quarry.

   Suggest why this was necessary.

   ....

   .... [1]

   (ii) State the meaning of the word *impervious*.

   ....

   .... [1]

   (iii) There were some large lumps of rock containing caliche on the floor of the quarry. The students used hammers and chisels to remove samples of caliche from these large lumps.

   State what additional protection they should wear to avoid injury.

   ....

   .... [1]

(iv) The students were asked to obtain samples of caliche for testing in the college laboratory.

Suggest the mass of a sample that would be suitable for laboratory testing.
Explain your reasoning.

....

....

....

.... **[2]**

(v) Each student placed samples in separate, labelled plastic bags.
On each label they wrote **four** details.

a. Date and time
b. Sample name and number

Suggest **two** other details that should be written on the labels.

c. ....

d. ....

[2]

(vi) Suggest why each sample bag was then sealed before the students returned to the laboratory.

....

.... **[1]**

(b) At the laboratory the students started work to purify the caliche samples.

(i) The colour of the samples ranged from nearly white to a yellow colour.

State how the students knew that their samples were not homogeneous.

....

.... **[1]**

(ii) Caliche is water soluble and so the samples could not be washed before they were tested.

Suggest how the samples might be cleaned and any dust removed.

....

.... **[1]**

(iii) Caliche is mainly sodium nitrate, which absorbs moisture from the air and becomes wet.

State the word found in the article that describes this property of sodium nitrate.

.... **[1]**

Turn over

(iv) Two weighed samples of caliche were left for some days. One was left in the open air and the other was kept in a closed jar. The samples were then weighed and the results are shown in Table 1.1.

	Mass of sample at the start /g	**Mass of sample after some days /g**
Sample in a closed jar	5.00	5.00
Sample left in the air	7.50	8.70

Table 1.1

1 Calculate the mass of the water absorbed by the sample that was left in the air.

mass = ... g **[1]**

2 Calculate the mass of water that would be absorbed by the 5.00 g sample if this had been left in the air under the same conditions as the other sample.

mass = ... g **[1]**

(v) A student ground up some caliche and mixed it with hot water to dissolve all the soluble material. They concluded that the yellow material present in the original sample must be insoluble.

Suggest **one** fact about the appearance of the solution that led them to this conclusion.

....

.... **[1]**

(vi) After filtering the mixture the student measured the mass and volume of the resulting solution.

$$\text{Mass of solution} \quad = \quad 364.0\,\text{g}$$
$$\text{Volume of solution} \quad = \quad 308.5\,\text{cm}^3$$

1 Calculate the density of the solution using the formula: $\text{density} = \dfrac{\text{mass}}{\text{volume}}$

density = ... g cm^{-3} **[1]**

2 Fig. 1.2, shows how the density of the solution varies with the percentage of sodium nitrate present in the solution.
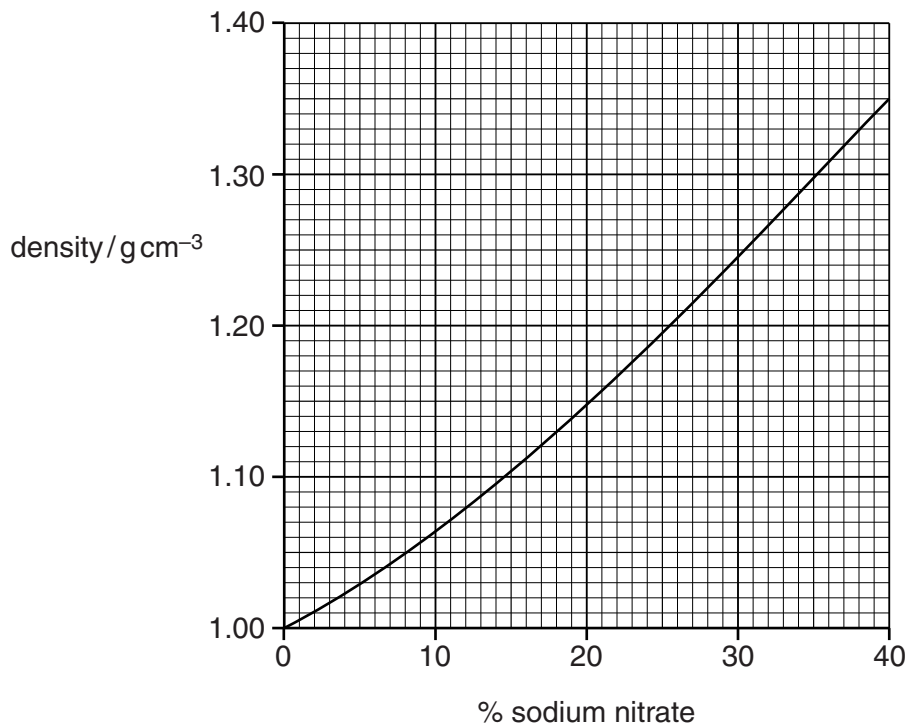
Fig. 1.2

Use your answer in part **1** above and Fig. 1.2 to find the percentage of sodium nitrate present in the student's solution.

percentage = ... % **[1]**

3 Use the percentage, found in part **2** above, and the mass of the solution to calculate the mass of sodium nitrate in the student's solution.

mass = ... g **[2]**

(c) At the caliche mine the students saw an evaporation tank from which crystals of impure sodium nitrate were obtained by crystallisation.

Devise an experiment that the students could use in the laboratory to obtain dry crystals of impure sodium nitrate from the solution described in **(b)(v)**.
Include full details of any apparatus used.

You should note that solid sodium nitrate begins to decompose above 350 °C.

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.... **[6]**

(d) The crystals obtained in **(c)** were analysed for their iodine content.
The students found a method where the iodine present is converted to silver iodide, which is then weighed. Part of this method involved passing toxic sulfur dioxide gas into the solution.

   (i) State what should be done before the experiment is started.

   ....

   .... **[1]**

   (ii) Suggest where in the laboratory this method should be carried out, giving a reason for your answer.

   ....

   .... **[1]**

(iii) The following results were obtained.

Mass of crystals at the start   =   12.480 g
Mass of silver iodide obtained from the crystals   =   0.471 g

The mass of iodine is obtained by multiplying the mass of silver iodide by 0.540.

Calculate the mass of iodine present in the silver iodide and hence the percentage of iodine present in the crystals.

Give your answer to **three** significant figures.

mass of iodine = ……………… g

percentage = ...% **[2]**

(iv) The same apparatus was used to find the percentage of iodine in another sample.

State what should be done to this apparatus before it is used again.

.... **[1]**

(e) A sample of brine contained 150 parts per million (ppm) of iodine.
One of the students, Harpal, said that this meant that in 1 tonne of brine there was 150 g of iodine.
Show by a simple calculation that Harpal was correct.
(There are 1000 kg in 1 tonne).

[1]

(f) The article states that iodine can be obtained from kelp seaweed.
Scientists found that in a 100 g sample of kelp seaweed there was 0.45 g of iodine. The ash obtained from this seaweed contained 1.5% of iodine.

(i) Use the formula below to calculate the mass of ash obtained.

$$\text{mass of ash} = \frac{\text{mass of iodine} \times 100}{1.5}$$

mass = ... g **[1]**

(ii) Use your answer to **(f)(i)** to find the mass of material lost on heating when the ash is formed.

mass = ... g **[1]**

Turn over

 (g) Starch is used as an indicator in an iodine-sodium thiosulfate titration.

 State the purpose of an indicator in a titration.

 ....

 .... **[1]**
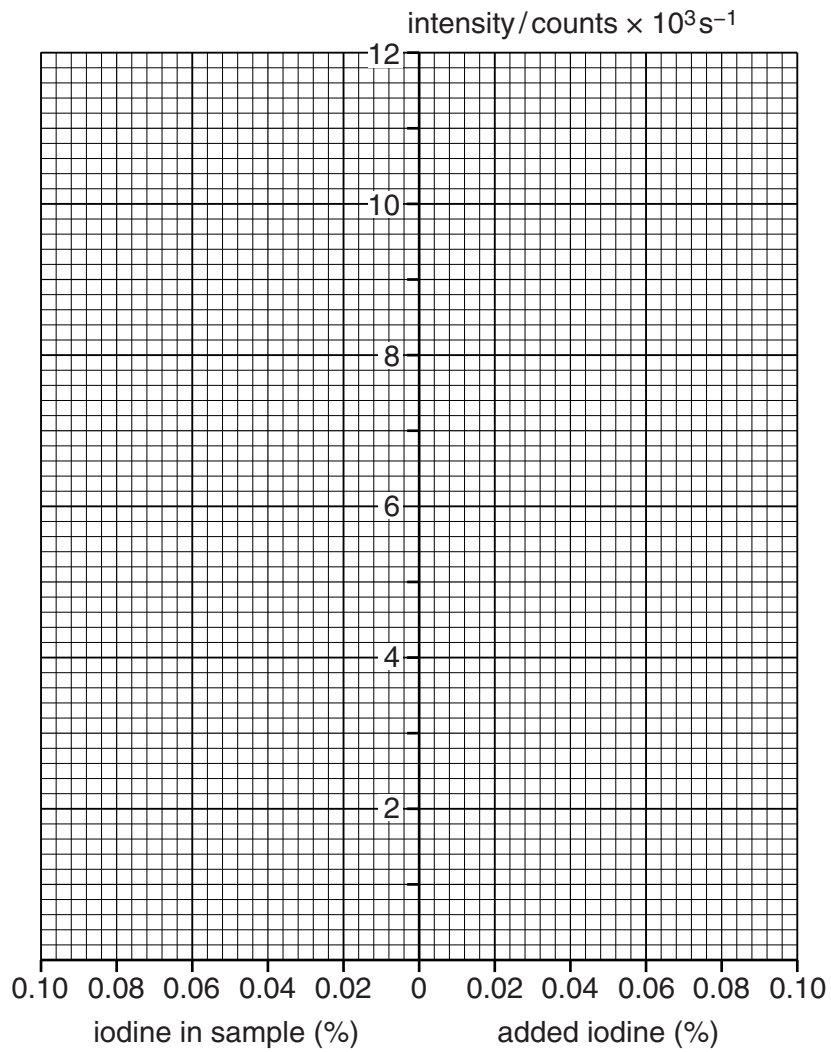
 (h) A sample of soil from Northern Ireland was analysed for its iodine content by using X-ray fluorescence spectroscopy (XRF). The results obtained are shown in Table 1.2.

Added iodine (%)	Intensity / counts $\times 10^3 s^{-1}$
0.02	6.0
0.04	7.4
0.06	9.0
0.08	9.6
0.10	11.6

Table 1.2

(i) Plot the figures on Fig. 1.3 below and draw a straight line of best fit.

intensity/counts × 10³s⁻¹

Fig. 1.3

[2]

(ii) Extrapolate this line backwards to find the percentage of iodine present in the soil sample.

percentage = ... % **[1]**

[Total: 36]

Turn over

This question is based on the article 'Tea'.

2 (a) (i) Before a planter starts the team picking a particular area of tea bushes, what should he do to make sure that it is suitable for tea production?

....

.... **[1]**

(ii) State what the planter must do to obtain a representative sample.

....

.... **[1]**

(iii) Use the article to state why a flush should be removed by the tea pickers about every ten days.

....

.... **[1]**

(iv) Suggest why tea flushes should **not** be stored in damp conditions before testing them to see if they are suitable for tea production.

....

.... **[1]**

(b) The planter points out, to a group of visiting students, that a number of plants have been attacked by mosquito bugs and that he intends to spray the affected bushes with a contact insecticide.

(i) He asks the students to suggest **three** factors, apart from the cost, that should be considered before choosing a particular insecticide.

State **three** factors that they should consider.

1 ....

2 ....

3 ....
   [3]

(ii) State why the spraying of the plant should take place in the early evening, or at night.

....

.... **[1]**

(iii) Suggest a reason why the planter needs to record details of the spraying.

....

.... **[1]**

(iv) After a few days, the planter inspects the infected tea bushes and notices that the first spraying has not been completely effective.

Suggest how he should modify his procedure to make the spraying more effective.

....

.... **[1]**

(v) The article states that a mixture of neem oil and liquid soap at 1% concentration offers the best control against mosquito bug attack.

State how the information in the article is unclear about the amounts to be used.

....

.... **[1]**

(c) The planter points out that some tea bushes may have been attacked by caterpillars of the carpenter moth. A suggested insecticide for attack by these caterpillars is lambda-cyhalothrin.

(i) He had not used this particular insecticide before.

State where he would find details of this insecticide.

.... **[1]**

(ii) The instructions for using lambda-cyhalothrin solution state that $100\,cm^3$ should be suitable for each hectare of growing area.
(a hectare is an area $100\,m \times 100\,m$)

This latter instruction seems wrong. State why this instruction seems wrong.

....

.... **[1]**

(iii) The instructions for use of this insecticide also state that it should be used at least five days before the tea is picked.

Suggest a reason for this instruction.

....

.... **[1]**

(iv) There is some insecticide left in the spraying equipment after it has been used to spray the tea bushes.

Suggest what should be done about this remaining insecticide.

.... **[1]**

(d) You are investigating the economics of tea production.
The size of a tea plantation is 200 hectares and the total yield of freshly picked tea is 1500 kg per hectare.

(i) Calculate the mass of freshly picked tea from this plantation.

mass = ... kg **[1]**

(ii) On drying, 75% of this total mass is lost.

Calculate the total mass of dried tea that could be obtained from this tea plantation.

mass = ... kg **[1]**

(e) Tannins in tea can be measured by colorimetry.

(i) Describe how a colorimeter is calibrated ready for use in this experiment.

....

....

....

.... **[2]**

(ii) You are given a teabag and a supply of boiling water, together with any necessary glassware and some cuvettes for use in the colorimeter.
A risk assessment has been provided.

Describe a detailed method of how you would obtain a set of results to show how tannins dissolve in water over a period of time.

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.... **[6]**

(iii) On Fig. 2.1, sketch the graph that would be expected from the results.

Fig. 2.1

[3]

Turn over

(f) The article describes two commercial methods for preparing decaffeinated tea.

Suggest a reason why the carbon dioxide process is now preferred, apart from its relative cost.

....

.... **[1]**

(g) The article mentions the use of pyramid-shaped tea bags.

Suggest an environmentally friendly development for this type of teabag.

....

.... **[1]**

(h) A student makes three cups of tea using the same teabag. The tea in the bag originally contains 50 mg of caffeine.
During the making of the first cup, 70% of the caffeine was removed from the tea leaves into the drink and the second cup then removed another 23% of the total caffeine originally present.

Calculate the maximum mass of caffeine, in mg, that could be extracted into the third cup of tea.

mass = ... mg **[2]**

[Total: 32]

3 Cloves are dried, unopened flower buds of an evergreen tree that grows in tropical climates. They can be used to flavour foods and also have some uses in modern and traditional medicine.

   (a) Commercially, clove oil is extracted from dried cloves by steam distillation.
   In a similar laboratory method, steam is passed into a mixture of crushed cloves and water, as shown in Fig. 3.1.
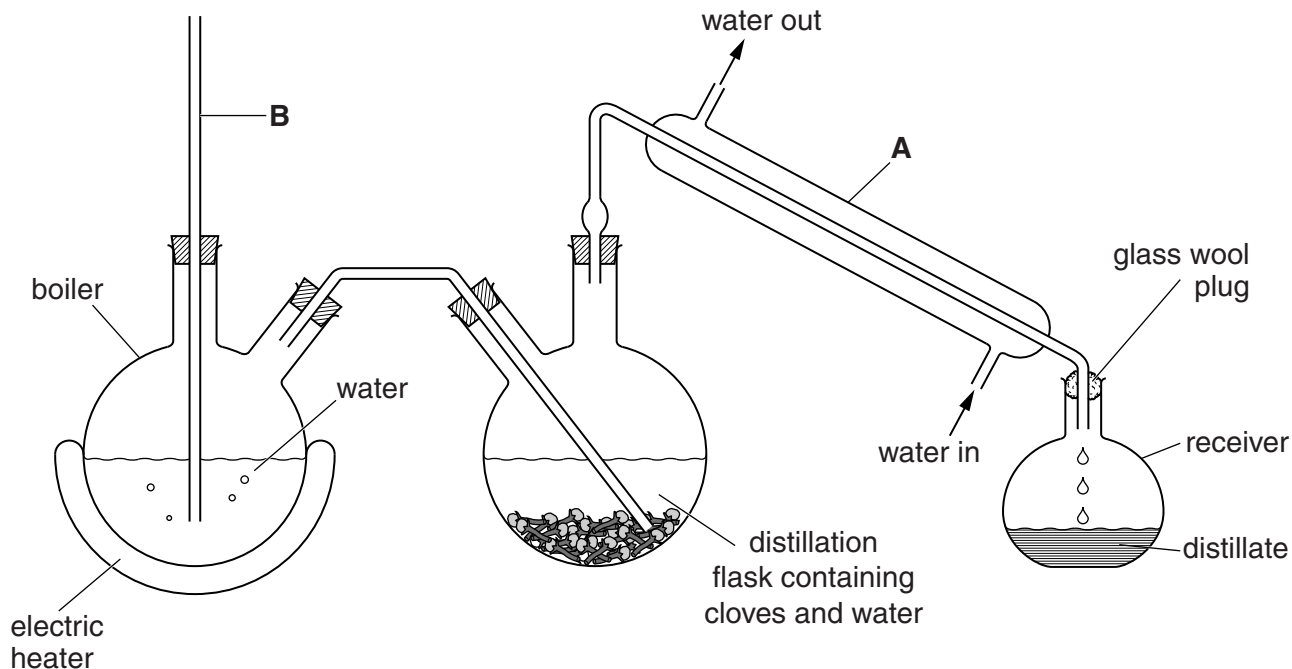
Fig. 3.1

   (i) Suggest why the cloves are crushed before being used.

   ....

   .... **[1]**

   (ii) What change of state takes place in apparatus **A**?

   ....

   .... **[1]**

   (iii) Safety is a very important consideration in any laboratory procedure.

   Suggest why tube **B** is present and how it can prevent a possible accident during steam distillation.

   ....

   ....

   ....

   .... **[2]**

(iv) This experiment is an example of a **batch process**. The experiment continues until no more clove oil is extracted.

State a **disadvantage** of this batch process if it is to be carried out on a large scale.

....

.... **[1]**

(v) The clove oil and water collect in the receiver. This liquid is placed in a separating funnel and 50 cm³ of liquid dichloromethane is added. The mixture is shaken and allowed to stand, giving two liquid layers as shown in Fig. 3.2.
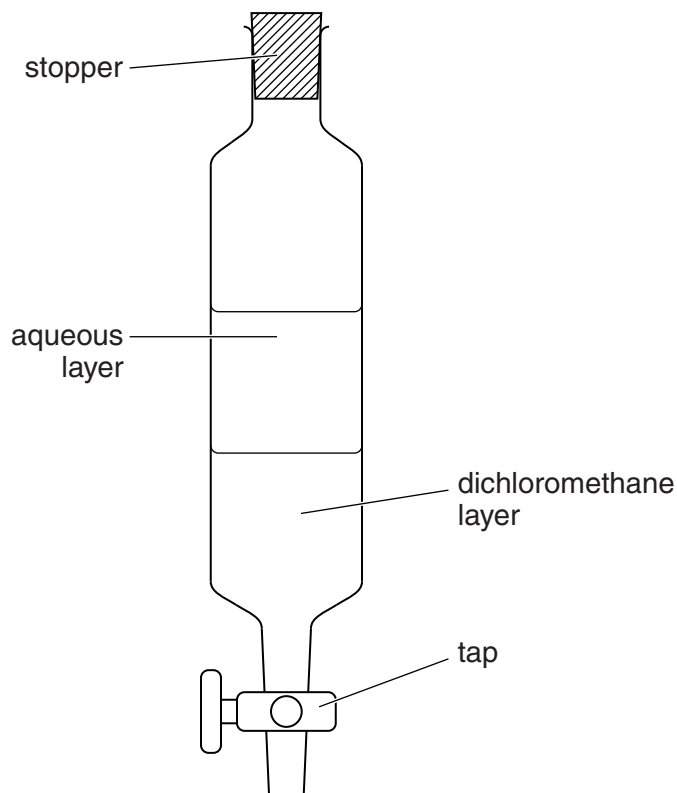
Fig. 3.2

Most of the clove oil dissolves in the dichloromethane.

Describe how the dichloromethane layer is obtained free from the aqueous layer.

....

....

....

.... **[2]**

(vi) The dichloromethane, which boils at 40 °C and produces a toxic vapour, is then evaporated off to leave clove oil.

Suggest a suitable method and the equipment used for removing the dichloromethane from the mixture.

....

....

....

.... **[2]**

(vii) The components of clove oil can be investigated using Thin Layer Chromatography (TLC). The main component of clove oil is eugenol.
The R_f value for pure eugenol, under certain conditions, is 0.66.

Use Fig. 3.3 to calculate the distance moved by the eugenol and **draw on Fig. 3.3** the position of the spot given by eugenol.

- - - - - - solvent front

- - - - - - start
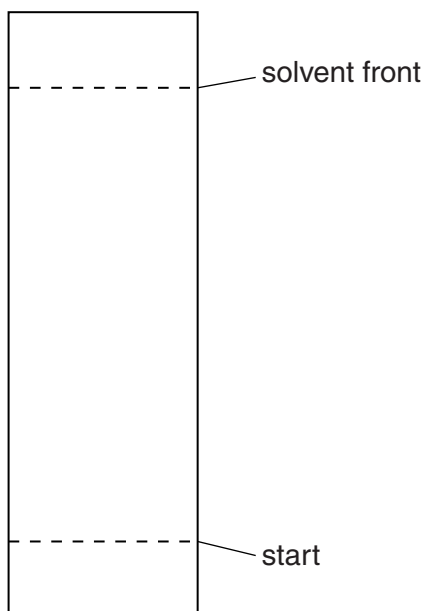
Fig. 3.3 [2]

(viii) The clove oil prepared in the laboratory was analysed using TLC.
It was suspected that the clove oil might contain another component with a similar R_f value to eugenol.

Suggest how the TLC could be extended to investigate this.

....

.... **[1]**

(ix) By extending this investigation, two spots were separated and compound **E** was isolated from one of them.
The mass spectrum of compound **E** was taken and showed a molecular ion signal, M^+, at m/z 204.

State what can be deduced about compound **E** from this molecular ion signal.

....

.... **[1]**

(x) Compound **E** is suspected to be caryophyllene. This substance contains a carbon to carbon double bond (C=C).

State the name of a spectroscopic technique that is used to show the presence of particular chemical bonds in a compound.

.... **[1]**

(b) Gas-Liquid Chromatography (GLC) shows that clove oil contains a number of compounds, of which the major compound is eugenol. The composition of different batches may contain differing amounts of eugenol. Table 3.1 shows the percentage of eugenol in different batches of clove oil.

Batch	Percentage of eugenol
A	82.2
B	80.6
C	83.3
D	56.9
E	81.8

Table 3.1

(i) Batch **D** gives a value for the percentage of eugenol that is considerably lower than the others.

Suggest what should be done about this result.

....

.... **[1]**

(ii) Calculate the mean percentage of eugenol present, ignoring batch **D**.

Give your answer to 3 significant figures.

mean percentage = ... % **[1]**

(c) One way of finding the approximate percentage of eugenol present in a sample of clove oil is by measuring its density.

Fig. 3.4 shows a graph that relates the density of a sample of clove oil to the percentage of eugenol in the sample.
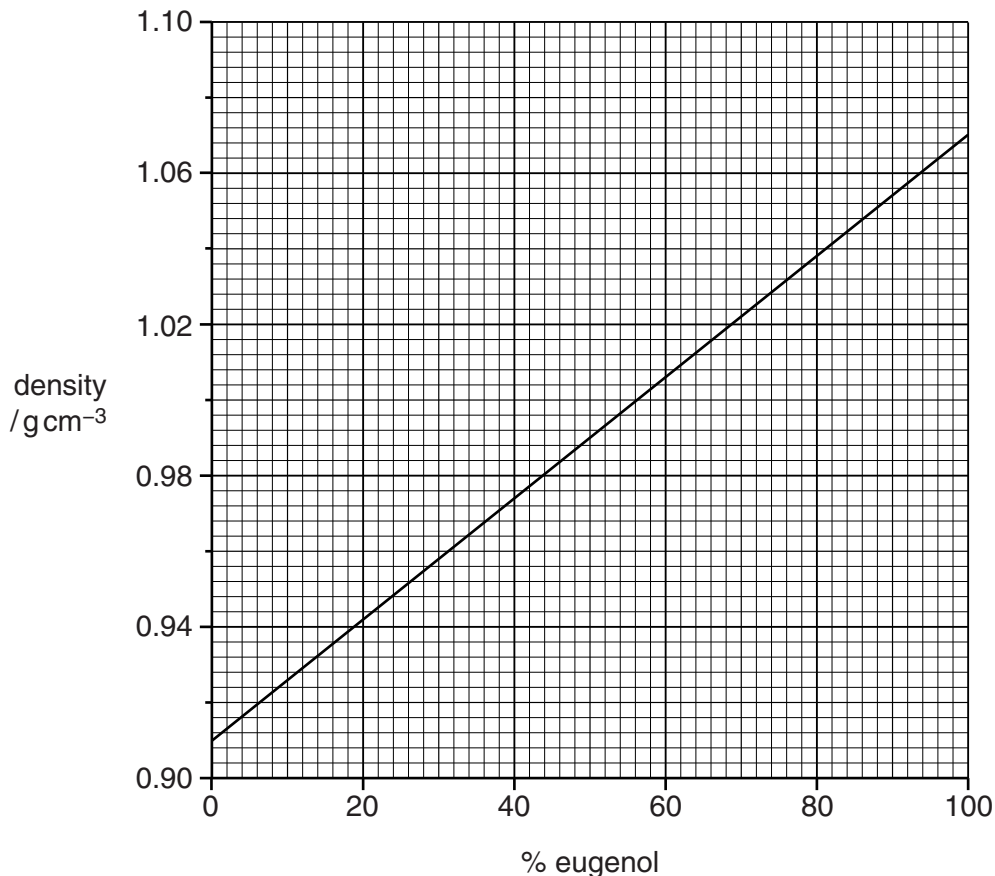
Fig. 3.4

   (i) The density of a sample of clove oil is $1.05\,g\,cm^{-3}$.

   Use Fig. 3.4 to find the percentage of eugenol present in this sample.

   .... **[1]**

   (ii) Suggest an assumption that has been made in the drawing of this graph.

   ....

   .... **[1]**

Turn over

(d) Rose oil is obtained from rose petals by a solvent extraction method.

A summary of some instructions for this method is given below. You can assume that appropriate apparatus is being used.

- Consider the risks of the process.
- Mix 100 g of crushed rose petals with hexane.
- Stir the mixture.
- Evaporate off the hexane, leaving a waxy residue.
- Add ethanol to the waxy residue and stir.
- Filter the mixture.
- Evaporate the alcohol from the filtrate, leaving rose oil.

(i) State **three** details that are missing from these instructions.

1 ....

2 ....

3 ....

[3]

(ii) The cost of solvents causes this process to be expensive.

Suggest what should be done to reduce the costs, assuming that both hexane and alcohol are still being used.

....

.... **[1]**

[Total: 22]

END OF QUESTION PAPER