OCR
RECOGNISING ACHIEVEMENT

ADVANCED GCE

APPLIED SCIENCE

Sampling, Testing and Processing

G628

Candidates answer on the question paper.

OCR supplied materials:
- Insert (inserted)

Other materials required:
- Electronic calculator
- Ruler (cm/mm)

Wednesday 15 June 2011
Afternoon

Duration: 1 hour 30 minutes

Candidate forename		Candidate surname	

Centre number						Candidate number				

MODIFIED LANGUAGE

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. Pencil may be used for graphs and diagrams only.
- 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).
- Answer **all** the questions.
- Do **not** write in the bar codes.

INFORMATION FOR CANDIDATES
- Candidates may not bring the Pre-released 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.

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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 'Apples'.

1 **(a)** State two reasons why the Victorians introduced overseas apple varieties into the United Kingdom.

1. ....

....

2. ....

.... **[2]**

(b) Apples are susceptible to a number of diseases. Treatments use both *contact* and *systemic* products to eradicate diseases.
State what is meant by each of these terms and explain a problem that occurs with each type of product, apart from a build up in the soil.

contact ....

....

....

....

systemic ....

....

....

.... **[4]**

(c) Hannah helps a farmer spray apple trees with a copper based fungicide. A fungicide is a material that destroys fungi.

(i) State what she must do before she starts this work.

....

.... **[1]**

(ii) Some of the fungicide falls onto the soil around the trees and Hannah collects some soil samples in order to find its copper content.
Why should she collect representative samples?

....

.... **[1]**

Turn over

(iii) Hannah collected more soil samples a week later.
Suggest and explain how the concentration of fungicide may be different from the earlier samples.

....

....

.... **[2]**

(d) A farmer wishes to find the best conditions for storing a new variety of apple.
It is important to change only one variable when finding the 'best' storage conditions for new varieties.
Using your knowledge of planning experiments, state why.

....

.... **[1]**

(e) Gas-liquid chromatography was used to identify some of the compounds present in an apple that cause its aroma. The chromatogram, Fig. 1.1, was obtained.

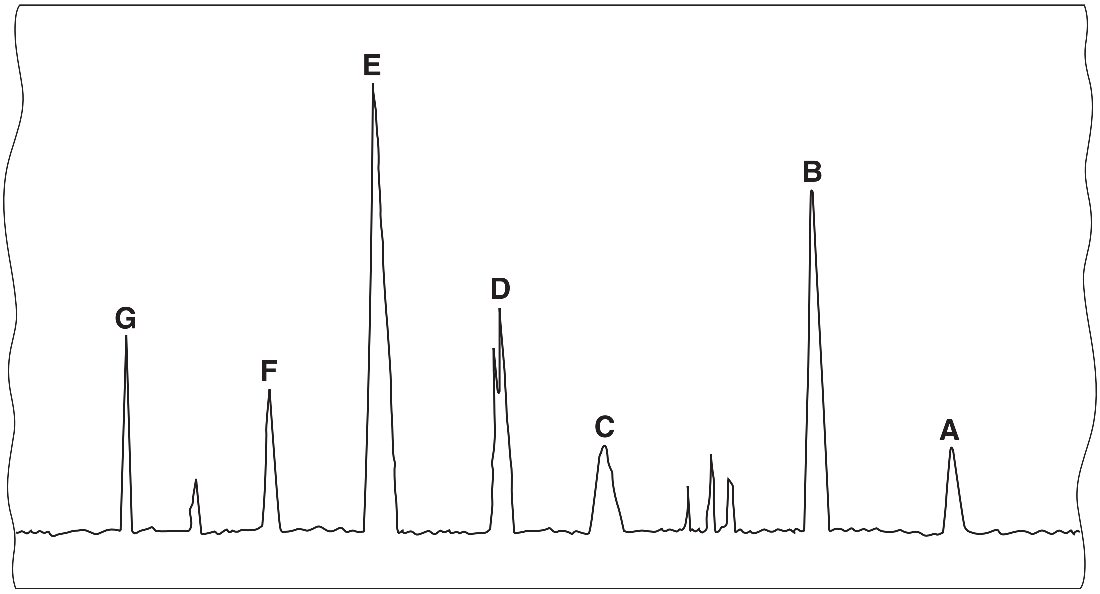

Fig. 1.1

For similar compounds the retention time is often related to the relative molecular mass (M_r). The larger the relative molecular mass, the longer the retention time. In Fig. 1.1 compound **A** has the shortest retention time and compound **G** the longest retention time. Table 1.1 gives information about some of the compounds present.

Table 1.1

Name	M_r
methyl propanoate	88
methyl butanoate	102
ethyl butanoate	116
butyl ethanoate	116
ethyl hexanoate	144

Peak **G** is produced by ethyl hexanoate.

(i) Peak **D** is a split peak caused by two different compounds with similar retention times. Suggest how the conditions used to obtain the chromatogram could be changed so that these two peaks become separated.

.... **[1]**

(ii) State how many compounds are shown in the chromatogram, Fig 1.1.

.... **[1]**

(iii) State the names of the **two** compounds responsible for peak **D**.

1. .... 2. .... **[1]**

(iv) Use Table 1.1 to explain why either peaks **B** or **C** could be given by methyl butanoate.

....

....

.... **[2]**

(f) A student retrieved some apples from cold storage. He tested them to see how the percentage of sugar in the apples changed over a period of time. He used a refractometer to measure the refractive index of the apple juice. The refractive index of a sugar solution depends on the concentration of sugar present.
This is an outline of his method.

- clean and slice an apple and place pieces into a food processor
- collect and filter the juice
- place three drops of the juice into a refractometer and measure the refractive index
- record the results and use a data book to find the concentration of sugar
- repeat the method every two days with a different apple
- plot a graph of the results

(i) State how the apples to be tested should be stored before use after removal from cold storage.

....

.... **[1]**

(ii) What should be written on the beaker containing the juice?

1. ....

2. .... **[2]**

(iii) A knife was used to cut the first apple.
Why was it necessary to clean the knife before it was used again?

.... **[1]**

(iv) The results were plotted in a graph, Fig. 1.2.

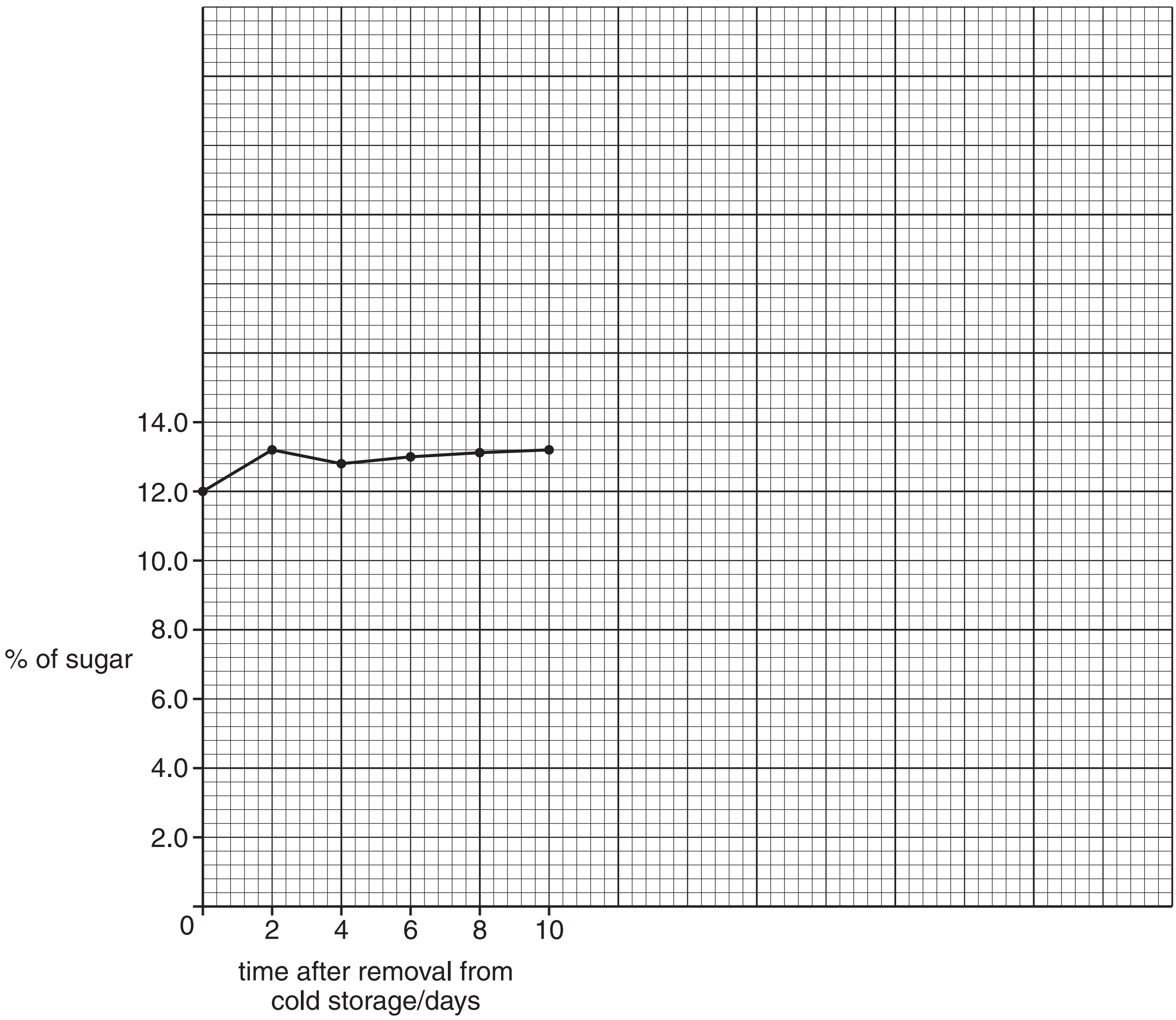

Fig. 1.2

Explain why this is a poor graph and what could be done to improve it.

....

....

....

.... **[2]**

(g) The method described in part **(f)** is an invasive method.
State what is meant by an *invasive method*.

....

.... **[1]**

(h) The results obtained in part **(f)** were not accurate as all the sugars were assumed to be sucrose. The juices also contain glucose and fructose. Scientists have recently developed a method of analysing apples for their individual sugar content by use of infrared absorption spectroscopy. In this new method, infrared energy is shone at an apple and the energy not absorbed is collected and analysed. Some results of the analysis are shown for three apples in Table 1.2.

Table 1.2

	percentage (%)		
sugar	**apple 1**	**apple 2**	**apple 3**
sucrose	3.2	2.4	3.1
glucose	3.0	2.2	3.4
fructose	5.4	5.0	5.6
TOTAL SUGARS	11.6	9.6	12.1

(i) Each apple had three measurements taken, equally spaced around the apple. Suggest why this was done.

....

.... **[1]**

(ii) Find the mean percentage of the total sugars for the three apples.

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

(iii) Suggest a reason, other than errors in measurement or calculation, for the lower percentage of sugars in **apple 2**.

....

.... **[1]**

(iv) This method uses infrared absorption spectroscopy. Briefly explain how this method works. A description of the apparatus is not required.

....

....

....

....

....

.... **[3]**

(*i*) When apples are sliced, the enzymes contained in the plant tissues are released. In the presence of oxygen (in air) an enzyme catalyses the conversion of colourless phenolic compounds in the plants to brown pigments called melanins.

This browning process can be slowed by the addition of a solution of Vitamin C to the slices of apple. Oxygen then reacts with the Vitamin C present until all the Vitamin C is used up, when browning starts to occur.

Devise an experiment that will demonstrate the relative rate at which this browning occurs and the effect of Vitamin C on the process.

Your method should be in the form of a set of instructions for other students to follow. The length of the experiment is one hour.

[10]

[Total: 39]

This question is based on the article 'Mercury – a non-biological element?'

2 (a) Scientists have investigated environmental pollution by mercury from the Luoxi processing plant in Wuchuan province, China. Mercury was deposited on the ground from the atmosphere and also from ground water.
Samples of soil were collected at various distances from the processing plant.

(i) State **one** safety precaution that should be taken when collecting these samples, giving a reason for your answer.

....

....

....

.... **[2]**

(ii) Suggest how the soil samples should be stored to avoid cross-contamination.

....

.... **[1]**

(iii) State **four** details that should be written on the labels of each sample container.

1. ....

2. ....

3. ....

4. ....

[2]

(iv) Soil samples at one site were taken from the surface and then at various depths. The mercury concentration of each sample was plotted in the graph, Fig. 2.1.

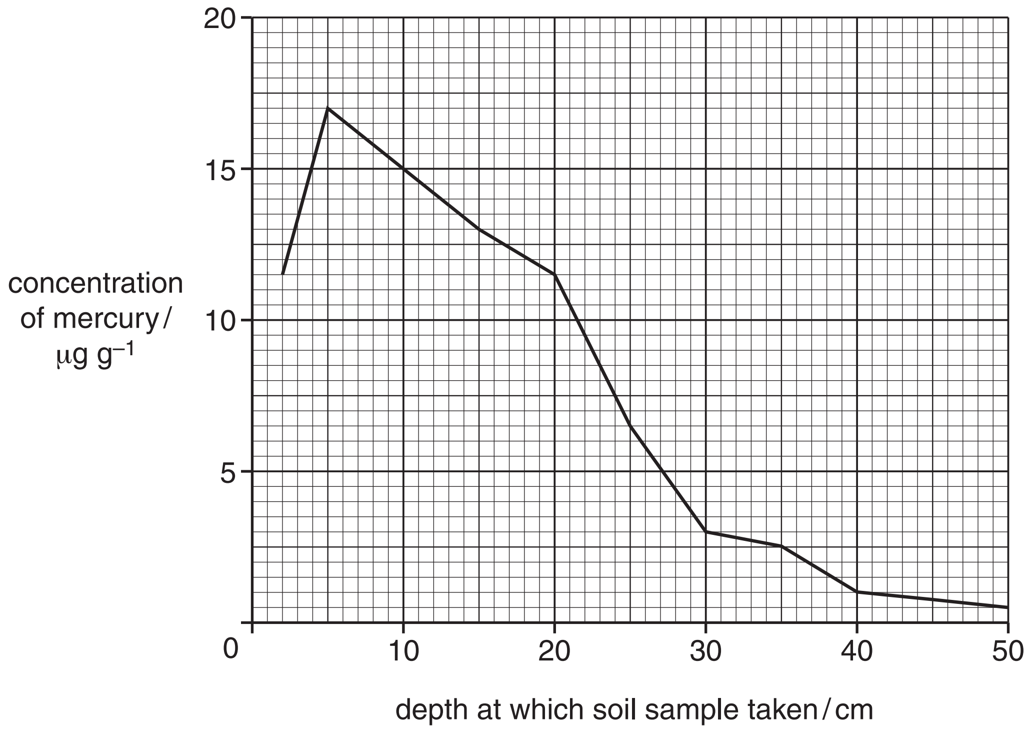

Fig. 2.1

From the graph the scientists concluded that the mercury compounds present must be water soluble rather than insoluble.

1 Explain how the scientists came to this conclusion.

....

....

....

.... **[2]**

2 The graph, Fig. 2.1, shows a final concentration of 0.5 $\mu g\ g^{-1}$ at a depth of 50 cm.
The scientists said that this concentration was also the background level in soils away from the mercury pollution.
Apart from the internet, state where they could find the information about background levels.

....

.... **[1]**

(b) The soil samples from the mercury processing plant were prepared for analysis by

- drying in air
- grinding
- passing the particles through a fine sieve.

(i) If the soil samples were not completely dry before they were analysed, state and explain any difference that this might make to the percentage of mercury measured.

....

....

....

.... **[2]**

(ii) Explain why the samples were ground and then passed through a sieve.

....

.... **[1]**

(iii) Atomic Absorption Spectroscopy (AAS) is used to find the concentration of mercury in a solution.
This can be found using the following equation.

$$\frac{[Hg]_1}{[Hg]_2} = \frac{A_1}{A_2}$$

In an experiment

A_1 = absorption of unknown solution = 0.270
A_2 = absorption of known solution = 0.360
$[Hg]_1$ = concentration of mercury in the unknown solution
$[Hg]_2$ = concentration of mercury in the known solution = 8.00 $\mu g\,dm^{-3}$

Use these values to calculate the concentration of mercury in the unknown solution.

.... $\mu g\,dm^{-3}$ **[2]**

(iv) The original soil extract solution had a volume of 1 dm^3. This was too concentrated for AAS and was diluted 100 times with water before use in part **(b)(iii)**.
Using your answer from **(b)(iii)**, calculate the concentration of mercury in the original soil extract solution.

.... $\mu g\,dm^{-3}$ **[1]**

(v) The original soil sample solution was prepared from 5.00 g of dried soil.
Use your answer from **(b)(iv)** to calculate the percentage of mercury in the soil sample.

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

(vi) Suggest two reasons why AAS was the chosen method.

1. ....

....

2. ....

.... **[2]**

(c) An analysis of surface water for insoluble solids containing mercury was also carried out. Some of this water was filtered and the solid obtained washed and dried.

(i) State why the filtered solid was washed with pure water.

....

.... **[1]**

(ii) After drying the filtered solid for 24 hours, it was weighed and then reheated for a further 48 hours and then weighed again.
Why was this second drying and reweighing carried out?

....

.... **[1]**

(iii) The following results were obtained.

mass of filter paper and dried solid = 3.9642 g

mass of filter paper = 3.9597 g

∴ mass of dried solid = ... g

Complete the results, showing the mass of dried solid. **[1]**

(iv) The dried solid is described as the total suspended solid (TSS).
Analysis of this TSS for mercury showed that the solid weighed in **(c)(iii)** contained 338 ng (3.38×10^{-7} g) of mercury.
Calculate the percentage of mercury in the TSS.

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

(d) When a detonator containing mercury fulminate explodes it produces a shockwave that then sets off a secondary explosive.
A graph of the shockwave velocity against the density of the packed primary explosive is shown in Fig. 2.2.

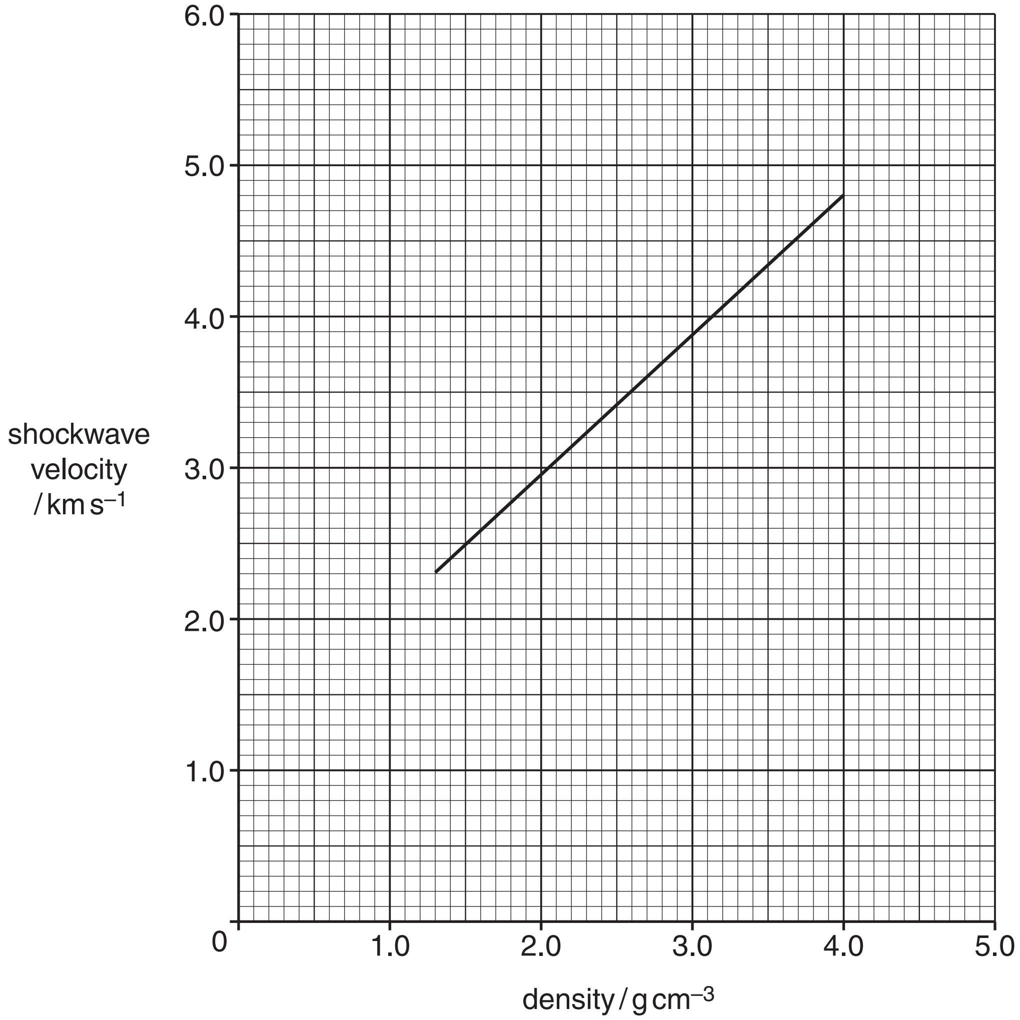

Fig. 2.2

(i) Use the graph to find the shockwave velocity when the density is 3.0 $g\,cm^{-3}$

shockwave velocity = ... $km\,s^{-1}$ **[1]**

(ii) Extend the graph to find the shockwave velocity when the density is 4.4 $g\,cm^{-3}$, explaining the assumption that you have made in finding this answer.

shockwave velocity = ... $km\,s^{-1}$

assumption ....

.... **[2]**

(e) Nowadays, less mercury is being used in laboratories because of its toxicity. It was used in barometers to measure atmospheric pressure.

(i) A simple form of barometer consists of a closed tube containing a column of mercury that is supported by atmospheric pressure.

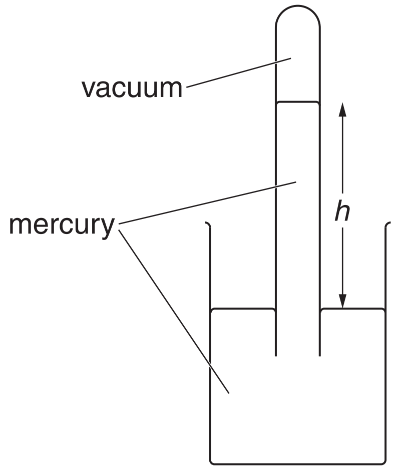

Fig. 2.3

Atmospheric pressure, P, is given by the equation

$$P = h \rho g$$

where ρ = density of mercury, h = height of mercury supported and g = a constant.

State and explain how the value of h will change (if at all) when atmospheric pressure increases.

....

....

....

.... **[2]**

(ii) Some students found that any liquid can be used to measure atmospheric pressure in this way. The height of liquid supported, h (in cm), depends on the density of the liquid, ρ (in $g\,cm^{-3}$), and can be found by using the equation shown below, when the pressure is 1 atmosphere.

$$h = \frac{1034}{\rho}$$

Calculate the height of the column when silicone oil is used.
Silicone oil has a density of $1.050\,g\,cm^{-3}$.

h = ... cm **[1]**

(f) Nessler's solution, developed in 1856, is still used as a quantitative test for dissolved ammonia. An outline of the preparation of Nessler's solution is given below.

- Dissolve 100 g of mercury(II) iodide and 70 g of potassium iodide in 100 cm^3 of distilled water.
- Add this slowly, with stirring, to a cold solution of sodium hydroxide in 700 cm^3 of distilled water.
- Make the solution up to 1 dm^3 using distilled water.
- Leave it to stand and filter if necessary.

(i) Although Nessler's solution is very toxic, suggest a reason why this is still used.

....

.... **[1]**

(ii) Explain why any water to be added must be ammonia free.

....

.... **[1]**

(iii) The total volume of solution needs to be exactly 1 dm^3.
State why a volumetric flask is used for this purpose.

....

.... **[1]**

(iv) The solution has been made up to 1 dm^3 and a stopper placed in the flask.
State and explain what should be done next before leaving the solution to stand.

....

.... **[2]**

[Total: 34]

3 **(a)** Some farming families in rural America continue to make 'mountain molasses' from sugar cane. 'Mountain molasses' is a sweet dark coloured syrup that is used in place of refined sugar.

(i) An outline of this process is given below.

- Sugar cane stalks are crushed to produce juice.
- The juice is filtered and boiled for several hours.
- Solid impurities float to the surface and are removed.
- After cooling, the thick syrupy molasses is bottled.

Use the outline above to devise a more detailed method for the farming families to make 'mountain molasses' starting with sugar cane stalks.
You should use 20 dm^3 of juice in your process, which will produce 2 dm^3 of 'mountain molasses'. Your method should mention the size and type of the equipment used and any risks.
(Hint: a bucket contains approximately 10 dm^3 of liquid.)

....

....

....

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....

.... **[7]**

(ii) The sugar content of the prepared molasses was found to be 60%. However, molasses with a sugar content of 75% was needed.

Suggest how the molasses could be treated to increase the percentage of sugar.

....

.... **[1]**

(b) In some countries, molasses and other sugar-containing mixtures are fermented to produce alcohol, which can be used as a fuel.
For economic fermentation the starting sugar solution should contain about 25% sugar.

(i) State how much water should be added to 2 dm^3 of molasses, which contains 75% sugar, to make a solution for fermentation that contains 25% of sugar.

water added = ... dm^3 **[1]**

(ii) The solution that contained 25% sugar was then fermented and the products fractionally distilled to obtain alcohol.
The apparatus shown in Fig. 3.1, was used to obtain some alcohol.

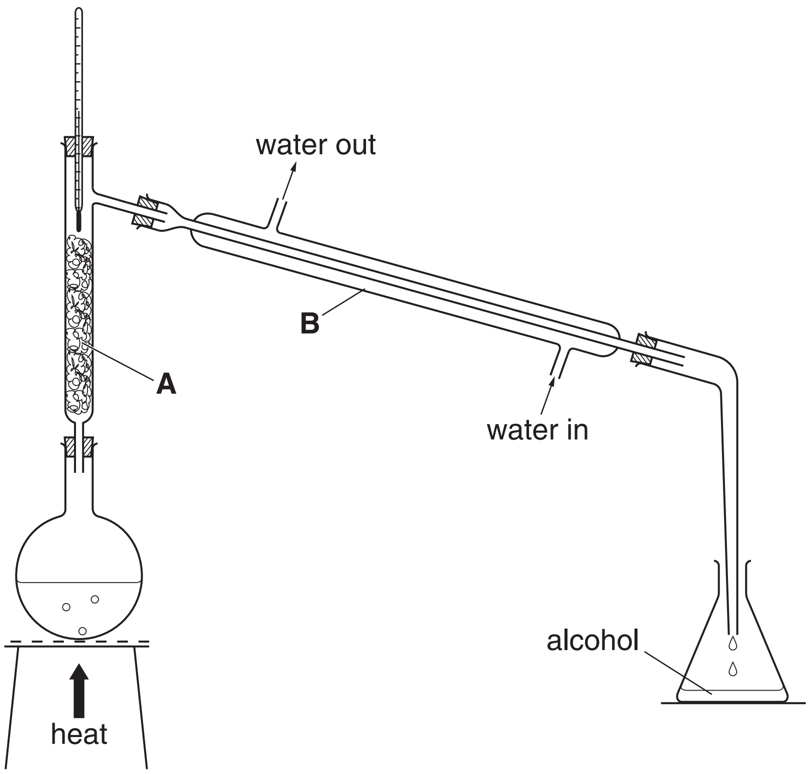

Fig. 3.1

State the function of the pieces of equipment labelled **A** and **B**.

A ....

B .... **[2]**

(c) Large quantities of sugar are used in making sweets.
Apart from cost and health and safety concerns, state two **other** factors that should be considered when a colouring agent is to be used in a sweet.

1. ....

....

2. ....

.... **[2]**

(d) Food scientists analysed a sweet to see which colouring agents had been used.
They used thin layer chromatography and obtained a chromatogram, Fig. 3.2, for the food colours present.

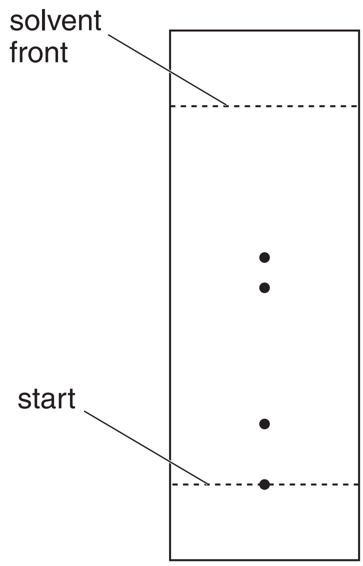

Fig. 3.2

The R_f values for some food colours are shown in Table 3.1

Table 3.1

food colour	**R_f value**
A	0.40
B	0.47
C	0.48
D	0.60

(i) Use the chromatogram, Fig. 3.2, to decide which one of these food colours is definitely present.
Explain your reasoning.

food colour = ...

explanation ....

.... **[2]**

(ii) Two of the food colours in Table 3.1 have very similar R_f values.
Suggest what should be done so that clear identification of these food colours is possible.

....

.... **[1]**

(iii) One of the spots is removed from the chromatogram and the food colouring extracted.
The mass spectrum of this food colour is then obtained.
What information does the molecular ion value in the mass spectrum tell you about this food colour?

.... **[1]**

[Total: 17]

END OF QUESTION PAPER

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