OCR
RECOGNISING ACHIEVEMENT

Wednesday 16 January 2013 – Morning

A2 GCE APPLIED SCIENCE

G628/01 Sampling, Testing and Processing

G623730113

Candidates answer on the Question Paper.

OCR supplied materials:
- Insert (inserted)

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

Duration: 1 hour 30 minutes

G 6 2 8 0 1

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 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.

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 'Pomegranates'.

1 **(a)** Pomegranate growers need to inspect their growing fruits regularly to check for attack by pests. They remove some growing shoots and immature pomegranate fruits for further investigation.

(i) State why they collect samples from a number of widely-spaced trees rather than from just one or two trees growing closely together.

.....

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

(ii) State why it is necessary to take the samples in **(i)** throughout the growing season.

.....

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

(iii) A pomegranate grower needs to remove shoots from the top of a 6 m high pomegranate tree. He asks others for advice on how to do this task.

The suggestions are:

1 climb up the tree and remove the samples by hand
2 stand on the ground and use a long pole with cutters on the end
3 stand on steps to reach the top shoots and remove them by hand.

Considering the health and safety risks, comment on the relative suitability of **each** method.

1 .....

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2 .....

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3 .....

.....

[3]

(iv) Use the article to give a reason why the pomegranate trees need to be examined after periods of heavy rain.

.....

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

(b) The pomegranate growers find that their fruit is being attacked by caterpillars of the pomegranate butterfly. They decide to use the commercial insecticide, Lannate.

(i) Lannate can be supplied as a concentrated dispersion in water or as a dry solid. Suggest which one of these forms of the insecticide would be safer to handle when making a diluted solution in order to test its suitability, giving a reason for your choice.

.....

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

(ii) Lannate is a contact insecticide.
State **two** disadvantages of using a contact insecticide when compared to a systemic insecticide.

1 .....

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2 .....

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[2]

(iii) Lannate can cause injury to workers.

The safest method of using this insecticide is by aerial spraying using a light aircraft.
State a health and safety fact that needs to be known before workers return to the pomegranate trees to find out if the spraying has been effective.

.....

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

(c) When 'organic' pomegranates are grown there is a need to avoid synthetic insecticides such as Lannate. In place of Lannate, pyrethrum can be used.

Some students were interested in how much pyrethrum could be obtained from chrysanthemum flowers.

They were given the following information.

- 10 kg of fresh chrysanthemum flowers yield, on average, 2.8 kg of dried flowers.
- The active ingredients of the pyrethrum obtained from the dried flowers are called **pyrethrins**. These make up, on average, 1.2 % of the dried flowers.

The students harvested 0.75 kg of fresh chrysanthemum flowers.

(i) The students then dried the flowers by laying them down for several days on absorbent paper. This was not very successful and took too long.

Suggest a quicker and more effective way of drying these flowers at room temperature.

.....

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

(ii) Calculate the mass of the dried flowers obtained from the 0.75 kg.

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

(iii) Use your answer to **(ii)** to calculate the mass of pyrethrins in the dried flowers.
State the units of your answer.

mass = ... units ..... **[1]**

(iv) The pyrethrum powder can be applied to the trees by either of two methods:

Method **1** mixing the powder with warm water and then spraying the suspension
Method **2** mixing the powder with paraffin, filtering and then spraying the resulting solution.

1 Suggest why commercial growers prefer spraying a solution as in method **2**, rather than spraying a suspension.

.....

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

2 Suggest **two** advantages of method **1** when compared to method **2**, apart from cost.

advantage 1 .....

advantage 2 .....

[2]

(v) State what is meant by the term *synergist*.

.....

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

(d) You are provided with some ripe pomegranates that have been obtained from a local market.
Describe how you would obtain a sample of **pure clear** juice from these fruits.
You can assume that a risk assessment has already been done.
Details of the crushing process are **not** required, but you should describe how you would find the yield of the juice obtained as cm^3 of juice per gram of fruit.

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..... **[6]**

(e) Pomegranates are ripe when the soluble solids present in the juice reach 15 % by mass. Some pomegranates were collected and crushed to obtain the juice.

An acceptable limit for harvesting the fruit is when the percentage is between 15 and 20 %.

This is shown by the shaded area in Fig. 1.1.

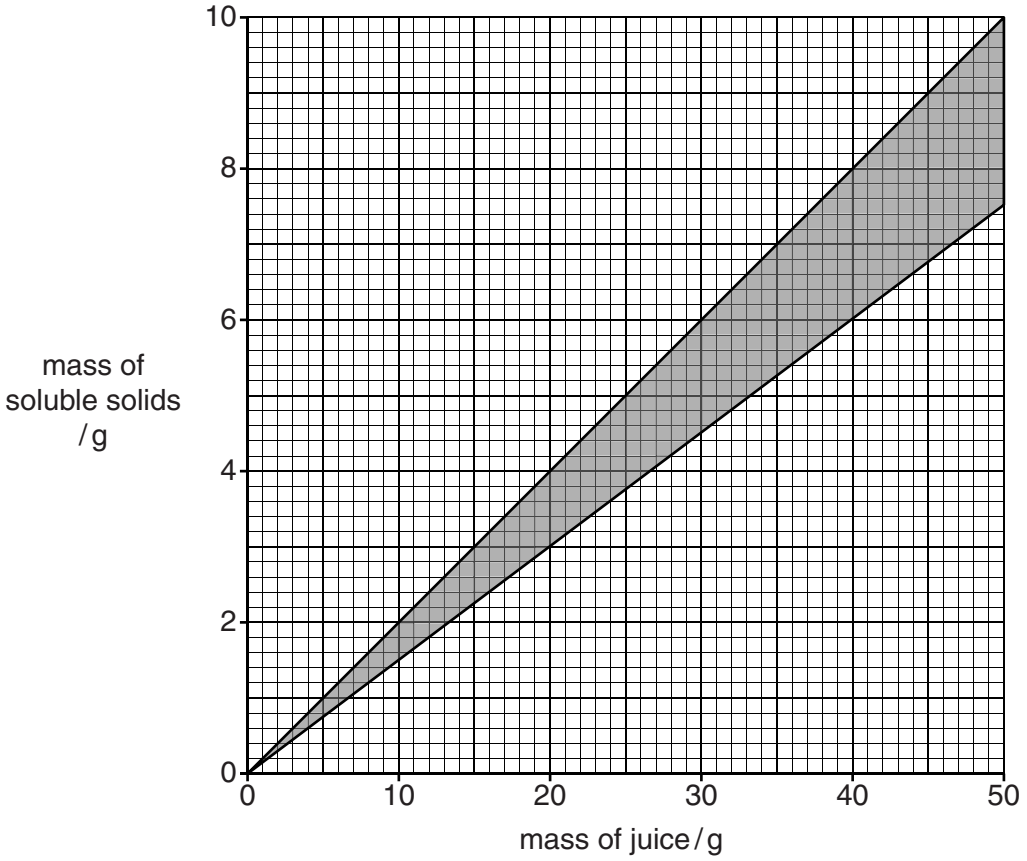

Fig. 1.1

(i) The juice of a pomegranate had a mass of 25.0 g.
Use the graph to find the acceptable range of soluble solids in the juice.

range = ... g **[1]**

(ii) A student found that the juice of an over-ripe pomegranate contained 4.50 g of soluble solids. However, he forgot to find the mass of the juice.

Use the graph to suggest a mass for the juice of this pomegranate.

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

(f) The juice of a ripe pomegranate was reacted with sodium hydroxide solution in order to find its acidity.

A titration method was used with the sodium hydroxide solution in the burette.

The following results were obtained.

Burette reading end	=	26.85 cm^3
Burette reading start	=	1.30 cm^3
Volume of pomegranate juice used	=	25.00 cm^3

(i) State the volume of the sodium hydroxide solution used.

volume = ... cm^3 **[1]**

(ii) Use the formula below to find the percentage of acids in the juice, giving your answer to three significant figures.

$$\% \text{ acids in the juice} = \frac{\text{volume of sodium hydroxide solution used} \times 1.76}{25.00}$$

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

(iii) The volume of pomegranate juice used was 25.0 cm^3, out of a total volume of 40 cm^3 of juice.

State **one** advantage and **one** disadvantage of using a 10.0 cm^3 sample of juice instead of 25.00 cm^3.

advantage .....

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

disadvantage .....

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

(iv) The volume of juice used was measured using a graduated (bulb) pipette.

State and explain how it should be cleaned before it is used to measure the volume of juice from a different pomegranate.

.....

.....

.....

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

(g) Some students researched the vitamin C content of fresh pomegranate juice and a commercially available pomegranate drink containing 30% pure pomegranate juice.

They obtained the following results for samples of volume 250 cm^3. These showed that the drink contained more vitamin C than the pure juice. This is shown in Table 1.1.

Sample	Vitamin C present in the 250 cm^3 sample / g	% of pure pomegranate juice
Fresh pure pomegranate juice	17	100
Commercially available drink	30	30

Table 1.1

Suggest why the vitamin C content of the commercially available drink is higher than the pure pomegranate juice, even though it contains a lower percentage of pomegranate.

.....

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

[Total: 32]

This question is based on the article 'Arsenic – a favourite poison for crime writers'.

2 **(a)** Use the article to suggest why tests on the Bronze Age man appeared to show that he had worked with copper.

.....

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

(b) The third paragraph of the article states that 6 pints of contaminated beer provided a dose of around 51 mg of arsenic.

Use the information below to show that this statement is correct.

15 parts per million = 15 mg dm^{-3}
1 pint = 568 cm^3

[2]

(c) If mass spectrometry had been available in 1900, it could have been used to check the purity of the sulfuric acid used in beer making.

The arsenic may have been present as arsenic(III) acid, $HAsO_2$.

Give the numerical value for the mass of the molecular ion, M^+, corresponding to arsenic(III) acid.

[Relative atomic masses: H = 1; O = 16; As = 75]

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

(d) Tests on 'Dr. Fowler's solution' showed that it contained 0.40 g of potassium arsenite in every 250 cm^3 of the solution.

When this solution was used, 10 drops (2.0 cm^3) were added to a glass of water.

Calculate how much potassium arsenite was taken in each glass of water.

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

(e) The article describes the use of the dye, Scheele's Green.

A method for making this dye is given below.

'500 cm^3 of a solution of sodium carbonate is heated to 90 °C in a fume cupboard and solid arsenic(III) oxide added. The mixture is stirred until all the oxide has reacted, giving a solution of sodium arsenite. This colourless solution is then added to 250 cm^3 of copper sulfate solution.

Scheele's Green is produced as a green precipitate and is filtered. It is then dried in an oven at 60 °C.'

(i) Suggest a size of conical flask used to heat 500 cm^3 of sodium carbonate solution.

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

(ii) State an essential detail of the method that is missing from the first sentence of the account.

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

(iii) State why the method is carried out in a fume cupboard.

.....

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

(iv) State what is meant by the term *precipitate*.

.....

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

(v) The method should have stated that the Scheele's Green in the filter paper was then washed with distilled water.

Why did this washing need to be carried out?

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

(vi) 1.00 g of arsenic(III) oxide should produce 1.90 g of Scheele's Green.

In an experiment, a technician used 15.0 g of arsenic(III) oxide and obtained 22.8 g of pure dry Scheele's Green.

Calculate the percentage yield of Scheele's Green.

percentage yield = ... **[3]**

(vii) State and explain how the percentage yield of Scheele's Green would be affected if the 22.8 g obtained had been damp rather than dry.

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

(f) Fig. 2.1 shows a simplified outline of the geology of the Zimapan area of Mexico.
Water samples were collected by environmental scientists from the base of Wells **1**, **2** and **3** and analysed for their soluble arsenic content.

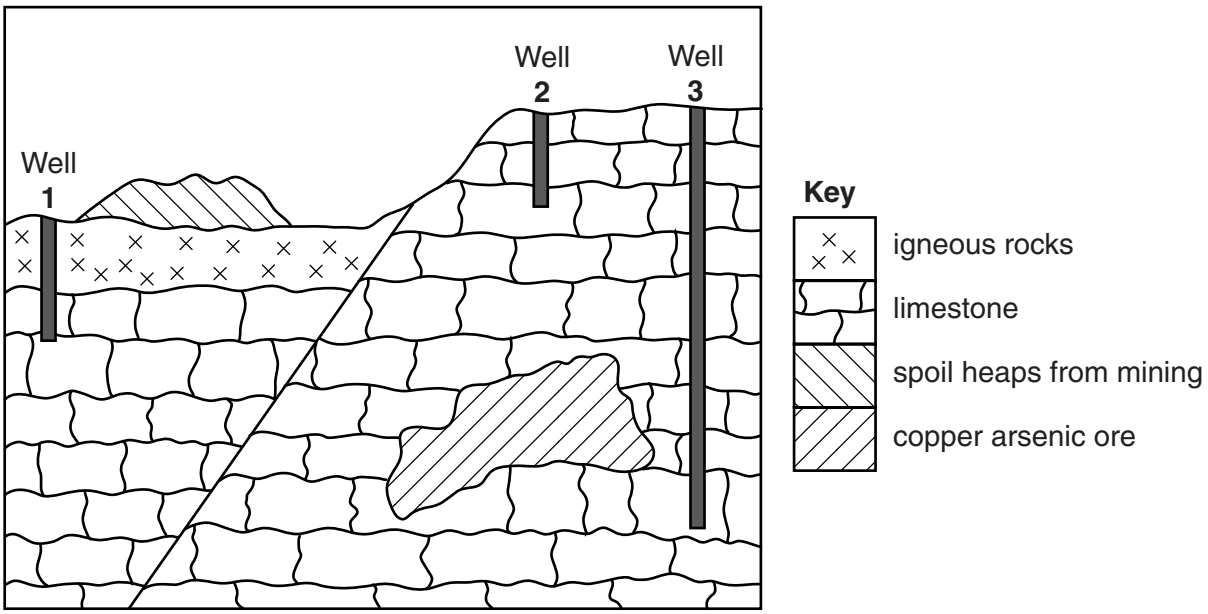

Fig. 2.1

(i) State why the sample bottles needed to be rinsed with the sample water several times before collection.

.....

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

(ii) The water samples were then filtered through a fine membrane to remove any solid material.

Suggest why this was necessary as part of the procedure to prepare samples for analysis.

.....

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

(iii) Analysis of the water from Well **1** gave the following results as shown in Table 2.1.

Sample	Arsenic concentration / mg dm^{-3}
A	0.022
B	0.024
C	0.019
D	0.035
E	0.021
F	0.023

Table 2.1

1 Calculate the mean arsenic concentration for these six samples.

concentration = ...mg dm^{-3} **[1]**

2 Sample **D** has a much higher arsenic concentration than the others.
Suggest what should be done about this.

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

(iv) The arsenic concentration in water from Well **2** is much less than the concentration found in Wells **1** and **3**. Suggest **two** reasons why.

1 .....

2 .....
[2]

(g) The results from another nearby well gave much lower arsenic concentrations than might have been expected since all the wells are quite close together.

It was suggested that the clay around the well had absorbed much of the arsenic, preventing it from entering the groundwater.

You are given a supply of arsenic-contaminated water and some clay that has been ground to a powder.

Devise a simple experiment to test this suggestion.
Details of the apparatus and the method of analysis of the water for arsenic are **not** required.

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..... **[6]**

(h) The arsenic content of a spoil heap sample was found by a weighing method. The arsenic in the sample was converted to magnesium pyroarsenate.

The following results were obtained.

Mass of spoil heap sample	=	129.4 g
Mass of crucible + magnesium pyroarsenate	=	18.90 g
Mass of crucible	=	15.13 g

Find the mass of magnesium pyroarsenate obtained and use this to find the percentage of arsenic in the spoil heap sample.

[The percentage of arsenic in magnesium pyroarsenate is 48.4%]

Give your answer to **two** decimal places.

percentage = ... **[3]**

(i) The article describes the use of the Chinese Brake Fern as a means of removing arsenic from contaminated soil.

(i) The concentration of arsenic in the soil before and after growing the plants in it, and the percentage of arsenic in the plants were found using a graphite furnace atomic absorption spectrometer (GF-AAS).

Use the article to give **one** advantage and **one** disadvantage of using GF-AAS when compared to colorimetric methods.

advantage .....

.....

disadvantage .....

.....

[2]

(ii) The article states that one plant was able to remove 24.4 mg of arsenic from the soil during 8 weeks of growth.

Table 2.2 below shows a summary of the results of arsenic removed by a number of plants.

Arsenic removed in mg per plant	Arsenic removed in mg per kg of soil
24.4 ± 3.5	16.3 ± 2.3

Table 2.2

1 State the lower limit for arsenic removed per plant.

lower limit = ... mg **[1]**

2 Suggest **two** reasons why the lower limit for arsenic removed per plant is higher than the maximum arsenic removed from the soil.

1 .....

.....

2 .....

.....

[2]

[Total: 35]

3 **(a)** In recent years there has been an increased demand for traditional boiled sweets such as fruit drops. A group of students visited a sweet factory to find out about the different processes involved in their manufacture.

(i) In the first stage, sugar was dissolved in water and glucose syrup was added. This mixture was then boiled to remove water. Manufacturers usually boil off the water at reduced pressures. Fig. 3.1 shows the boiling point of water at various pressures.

State the boiling point of water at a pressure of 0.3 atmospheres (atm).

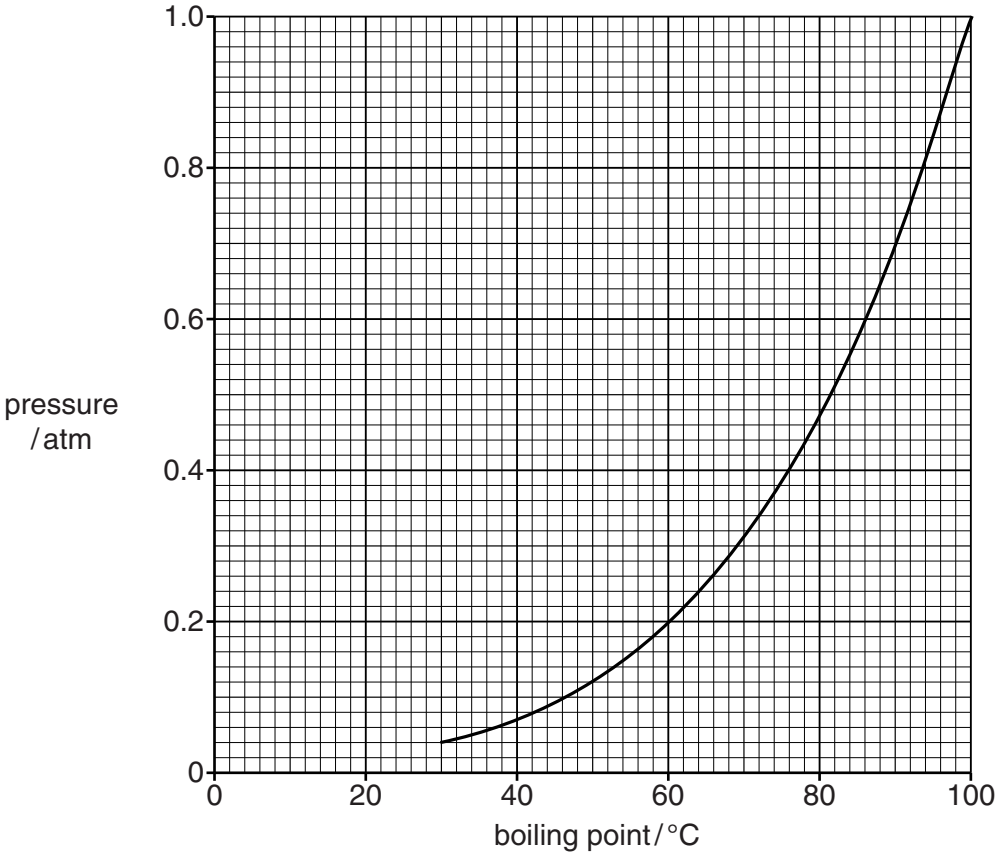

Fig. 3.1

boiling point = ... °C **[1]**

(ii) During the visit a student asked why lower pressures were used to boil the sugar solution.

Suggest a reply that was given, apart from cost implications.

.....

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

(iii) Another student said that it must be cheaper to boil off the water at lower temperatures. She was told that, although this seemed true, there was another cost implication to be considered for this lower temperature boiling.

Suggest what this other cost implication was.

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

(iv) The evaporated sugar solution was allowed to cool. It formed a large mass with a cooler solid skin on the outside but the inside remained as a hot sticky liquid.

A useful modification for quicker cooling would be to divide the material into smaller pieces.

State **why** this procedure would allow quicker cooling.

.....

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

(v) Before the sticky mass set solid, suitable colouring agents were added to it.

Suggest **four** factors that manufacturers should consider when choosing colouring agents, apart from cost.

1 .....

2 .....

3 .....

4 .....

[4]

(b) On returning to the college the students decided to find out which colours were being used in the fruit drops.

(i) Some yellow fruit drops were taken and added to cold water. Unfortunately, they took a long time to dissolve.

State **two** ways of making them dissolve more quickly.

1 .....

2 .....

[2]

(ii) They used thin layer chromatography (TLC) to try and separate any mixture of colours present.

Describe how you would obtain a thin layer chromatogram, starting with a thin layer plate with the mixture already spotted onto a base line.

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..... **[3]**

(iii) A typical TLC chromatogram is shown in Fig. 3.2

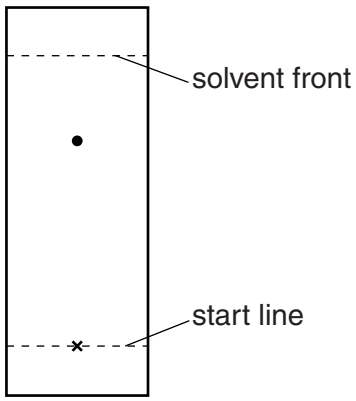

Fig. 3.2

Find the R_f value of the colour present.

R_f = ... **[1]**

(iv) The students thought that the yellow dye shown in the chromatogram in **(iii)** was annatto. They tested their idea by running another TLC plate, under the same conditions, but using annatto in place of the unknown dye.
They obtained the same R_f value as in **(iii)**.

Explain why this may **not** confirm that the yellow dye is annatto.

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

(v) They then decided to use mass spectrometry to see if the yellow dye in **(iii)** was annatto. Apart from using the molecular ion, M^+, how would this confirm that the substance is annatto?

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

(c) The fruit drops used by the students smelt of pineapples. Ethyl hexanoate is used as an artificial pineapple flavouring. This can be made in the laboratory by heating together ethanol and hexanoic acid in the presence of a catalyst. After a suitable heating period the ethyl hexanoate is separated from the mixture by distillation, using the apparatus shown in Fig. 3.3.

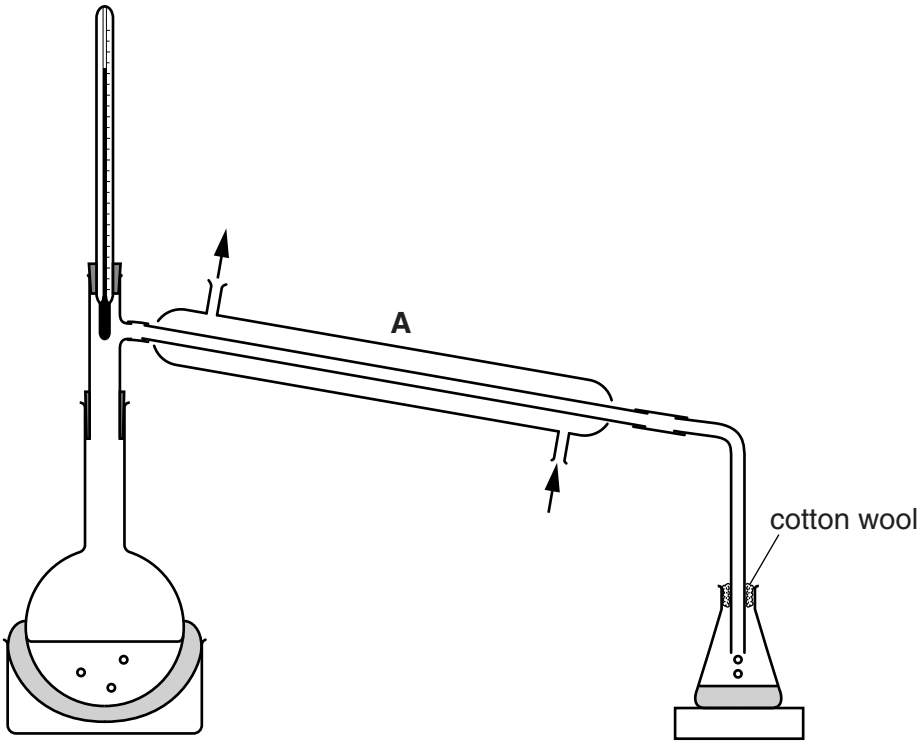

Fig. 3.3

(i) State the purpose of the piece of apparatus labelled **A**.

.....

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

(ii) The mixture in the round-bottomed flask was electrically heated.

Suggest **two** reasons why an **electric** heater was used.

1 .....

2 .....

[2]

(iii) The ethyl hexanoate collected in the conical flask. However, it was impure and contained a little unreacted ethanol and some hexanoic acid. The hexanoic acid was removed by washing it with a little weak aqueous alkali solution using a separating funnel, Fig. 3.4.

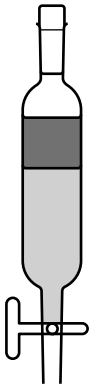

Fig. 3.4

Unfortunately a student did not know which of the two layers in the funnel was ethyl hexanoate.

Suggest a way that could be used to find out which layer was which.

.....

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

(iv) The ethyl hexanoate in the separating funnel, shown in **(iii)**, was run off and dried.
It may have still contained a small quantity of ethanol as an impurity.
The presence of traces of ethanol was checked by taking the infrared spectrum of the ethyl hexanoate.

State what is detected by infrared spectra.

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

(v) Another way of checking the purity of ethyl hexanoate is to find its refractive index.
The refractive index of ethyl hexanoate is 1.4250, when measured at 20 °C.

Suggest **why** a temperature such as 20 °C is used for these measurements.

.....

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

(vi) A student measured the refractive index of his sample of ethyl hexanoate at 20 °C. He gave the value as 1.43.

State **why** this value is not useful in assessing the purity of the sample.

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

[Total: 23]

END OF QUESTION PAPER