OCR
RECOGNISING ACHIEVEMENT

ADVANCED GCE **G628**

APPLIED SCIENCE

Unit 9: Sampling, Testing and Processing

FRIDAY 18 JANUARY 2008 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-released Case Study into the examination room.
An Insert is provided.

CUP/T43779

Candidate Forename		Candidate Surname	

Centre Number						Candidate Number				

INSTRUCTIONS TO CANDIDATES

- Write your name in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use blue or black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- Do **not** write outside the box bordering each page.
- Write your answer to each question in the space provided.

INFORMATION FOR CANDIDATES

- The number of marks for each question is given in brackets [ ] at the end of each question or part question.
- The total number of marks for this paper is 90.
- You are advised to show all the steps in any calculations.
- You may use an electronic calculator.

FOR EXAMINER'S USE		
Qu.	**Max.**	**Mark**
1	**33**	
2	**31**	
3	**26**	
TOTAL	**90**	

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

[Turn over

Answer **all** the questions.

This question is based on the article 'Arsenic contamination from a mine in Northern Spain'.

1 **(a)** The spoil heap from the mine is a source of arsenic pollution.

State how you know that the composition of the spoil heap is **not** homogeneous.

.....

.....[1]

(b) **(i)** The results in Table 1.1 show wide variations for the concentration of arsenic.
State and explain which of the results from the various areas are the most valid.

.....

.....

.....[2]

(ii) Stream sediments were taken downstream from the spoil heaps.
Sketch a diagram to show your understanding of the term **downstream** and show on your diagram how the percentage of arsenic in the sediments might change with distance from the mine.

[2]

(c) Samples from the **spoil heap** were obtained from depths up to 6 m deep.

(i) Suggest how this was done.

.....

.....[2]

(ii) Suggest a reason why it was necessary to remove samples from depths up to 6 m deep.

.....[1]

(d) A large number of samples have been taken in this study.

(i) State what should be written on the label of a sample container.

1. .....[1]

2. .....[1]

(ii) What should be considered if the samples are not all analysed on the day of collection?

1. .....[1]

2. .....[1]

(iii) State why it is important that sampling equipment is cleaned before and after use.

.....[1]

(e) Analysis of the samples for mercury is done by atomic absorption spectroscopy (AAS).
A calibration curve is prepared using standard solutions containing mercury.
The results are shown in the graph, Fig. 1.1.

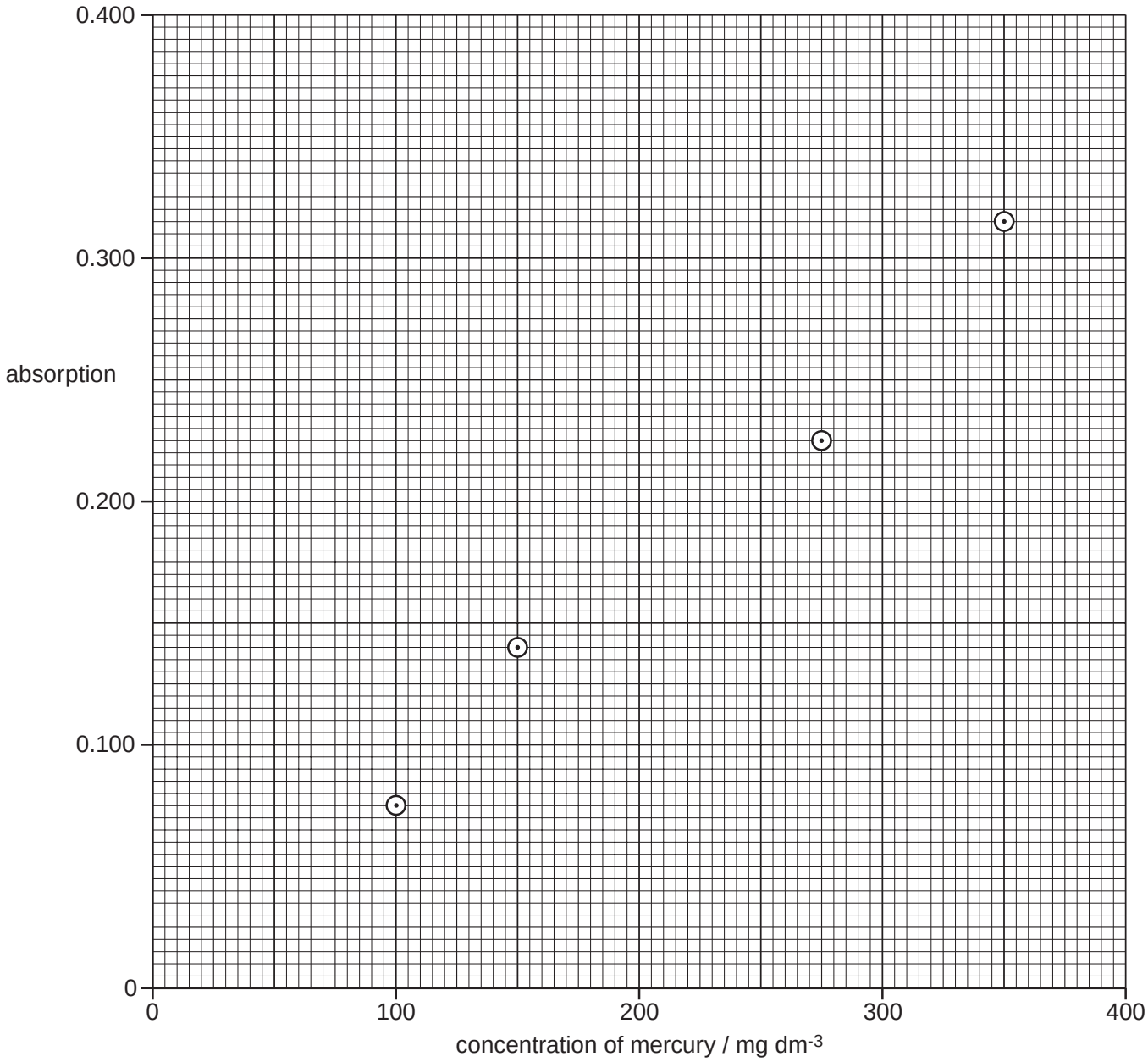

Fig. 1.1

(i) Draw a straight line of best fit on Fig. 1.1. [2]

(ii) A sample of mass 200 g was taken from the spoil heap and treated so that all the mercury present was in a solution of volume 1 dm^3.
This sample gave an absorption reading of 0.200.
Use the graph to find the mass of mercury present.

.....[1]

(iii) Use your answer from **(ii)** to find the concentration of mercury in the spoil heap sample in mg kg^{-1}.

..... mg kg^{-1} [1]

(f) Another method was used for finding the percentage of mercury present in a number of spoil heap samples.
The results obtained are given in Table 1.2.

Table 1.2

mass of mercury in sample / mg	mass of sample / g
565	452
861	673
270	189
370	303

(i) The results have not been presented in a clear way.
Suggest **two** ways you could improve the table to present the information in a more helpful way for those studying these figures.

1. .....

.....

2. .....

.....[2]

(ii) Unfortunately, simple improvements to the table may not enable the results to be compared easily.
Explain why this statement is true and what should be done so that valid comparisons can be made.

.....

.....[2]

(g) The samples are usually analysed for arsenic by inductively coupled plasma-emission spectroscopy (ICP-ES).
State **three** reasons, apart from cost, why this is the usual method.

1. .....[1]

2. .....[1]

3. .....[1]

(h) Modern instrumental methods such as ICP-ES are not normally available in small laboratories close to where the samples are obtained. Instead older methods are used to give an idea of the concentration of arsenic and mercury in the samples.
One method is outlined below.

- The sample is powdered.
- The powdered sample is treated so that all the arsenic present is in solution.
- Insoluble material is removed by filtration.
- The arsenic is then precipitated as magnesium ammonium arsenate (MAA).
- The MAA is then filtered into a sintered glass crucible (Fig. 1.2). A sintered glass crucible contains porous glass which retains the precipitate but lets the liquid through.

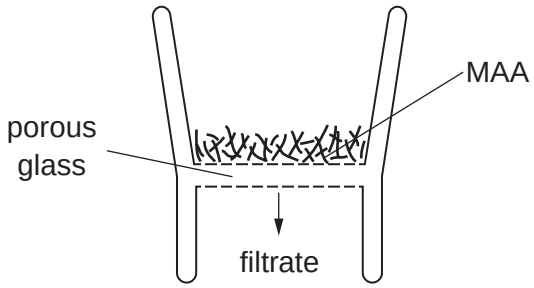

Fig. 1.2

- The filtered MAA is washed and dried.
- After drying for ten minutes the crucible and contents are weighed.

(i) State why the sample is powdered at the start of the method.

.....[1]

(ii) State what needs to be done to ensure that the method chosen is as safe as possible, before starting any practical work.

.....[1]

(iii) Describe how all traces of soluble arsenic are removed from the insoluble material that has been removed by filtering.

.....

.....[1]

(iv) The method describes how MAA is filtered and then eventually weighed.
What other piece of information needs to be known in order to calculate the mass of MAA?

.....[1]

(v) If some of the solid MAA went through the sintered glass and into the filtrate, suggest how this method should be modified to collect all the MAA.

.....

.....[1]

(vi) MAA decomposes on heating.
Suggest how the crucible and contents could be dried.

.....

.....[1]

(vii) A typical set of results is given below.

mass of sample = 18.760 g
mass of MAA = 0.652 g

The percentage of arsenic in the sample is given by the formula

$$\% \text{ of arsenic} = \frac{\text{mass of MAA} \times 25.89}{\text{mass of sample}}$$

Calculate the percentage of arsenic in the sample.
Give your answer to three significant figures.

.....% [2]

(viii) The amount of arsenic in these samples gives a relatively small mass of MAA.
State **one** problem when measuring these small quantities.

.....[1]

[Total: 33]

This question is based on the article 'Jute – a fibre with a thousand uses'.

2 **(a)** Jute growers sell their product to wholesalers who test the fibres before selling them to jute mills.

Give one reason why the wholesalers need to test the jute before selling it.

.....

.....[1]

(b) The growers supply the wholesaler with a number of bales of dried jute.

(i) State why the wholesaler needs to test more than one sample of jute.

.....

.....[1]

(ii) Suggest from where the wholesaler should select the samples of jute.

.....[1]

(c) The wholesaler cannot test his samples immediately.
Suggest **two** conditions under which the jute should be stored.

1. .....

2. .....[2]

(d) Jute fibres, when used for fabrics, need to have low extensibility (do not stretch much).

(i) You are given some jute fibres about 1 metre long whose diameter varies from 2 to 4 mm.
Design a procedure that would measure any stretching of the fibre as masses are added.
Your answer should clearly describe the apparatus used and a method.
A diagram may be helpful in presenting your answer.
In this part of the question two marks are available for the quality of written communication.

.....

.....

.....

.....

.....

.....[6]

QWC [2]

(ii) A student reported that a length of jute fibre stretched by 2 mm.
State **three** details that should have been added to this statement to make it more scientifically meaningful.

1. .....

2. .....

3. .....[3]

(iii) During the tests one of the results did not fit in a pattern with the others.
What should be done about this?

.....[1]

(e) State what is meant by each of these terms, that are used in the article.

synthetic .....

.....[1]

biodegradable .....

.....[1]

matrix .....

.....[1]

(f) Identify a phrase in the article that is describing photosynthesis.

.....

.....[1]

(g) Jute is susceptible to attack by jute-hairy caterpillars, but a natural insecticide has proved to be effective. This is sprayed directly onto the leaves of the plant and it kills the caterpillars when it is in contact with them.
If you were to test the effectiveness of this insecticide suggest **three** factors that you should consider.

1. .....

2. .....

3. .....[3]

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QUESTION 2 CONTINUES ON PAGE 12

(h) Jute bags are susceptible to insect attack and are protected by spraying them with a solution of sodium arsenate.
In a laboratory in Bangladesh a sample of this solution is prepared by the following method, Fig. 2.2.

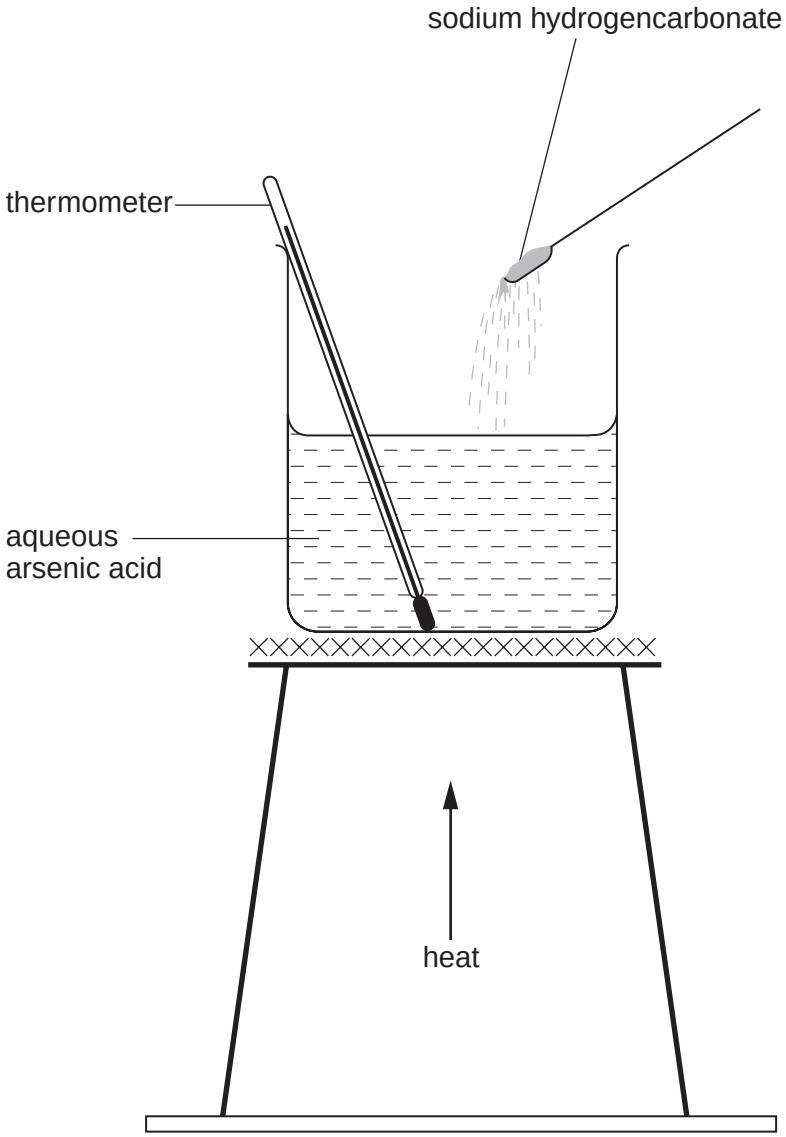

Fig. 2.2

200 cm^3 of a solution of arsenic acid is heated to 80 °C in a fume cupboard.
The required quantity of sodium hydrogencarbonate is added slowly with stirring. A solution of sodium arsenate is produced, together with gaseous carbon dioxide.
The solution is then concentrated by boiling the liquid.

(i) State why the laboratory experiment needs to be done in a fume cupboard.

.....[1]

(ii) A diluted solution of sodium arsenate was prepared from the laboratory product and was then analysed by volumetric analysis, using an aqueous solution of Compound **A**.

1.0 cm^3 of aqueous Compound **A** reacted with 0.080 g of sodium arsenate.

50.0 cm^3 of aqueous Compound **A** was required to react with all the sodium arsenate in 25.0 cm^3 of the diluted solution.

1 Calculate the mass of sodium arsenate in 25.0 cm^3 of the diluted solution.

.....[1]

2 Calculate the mass of sodium arsenate in 1 dm^3 (1000 cm^3) of the diluted solution.

.....[1]

3 The diluted solution of sodium arsenate was made by taking the concentrated solution and diluting it six times.
Calculate the mass of sodium arsenate in 1 dm^3 of the concentrated solution.

.....[1]

(iii) The same chemical method is used in the factory to produce 100 kg batches of sodium arsenate.
Outline what equipment you would use to prepare a 100 kg batch of sodium arsenate in a factory.
Your answer should include comments on the heating method and the method of adding solid sodium hydrogencarbonate.
You may illustrate your answer with a sketch.

.....

.....

.....[3]

[Total: 31]

3 A group of students was making and studying the properties of polymers as part of a project.

(a) Cellulose triethanoate (triacetate) is sold as the textile 'Tricel'.
It is made by treating cellulose with ethanoic acid and ethanoic anhydride, in the presence of a little concentrated sulphuric acid.
The students tried the laboratory method shown in Fig. 3.1 using cotton wool, which is made of cellulose.

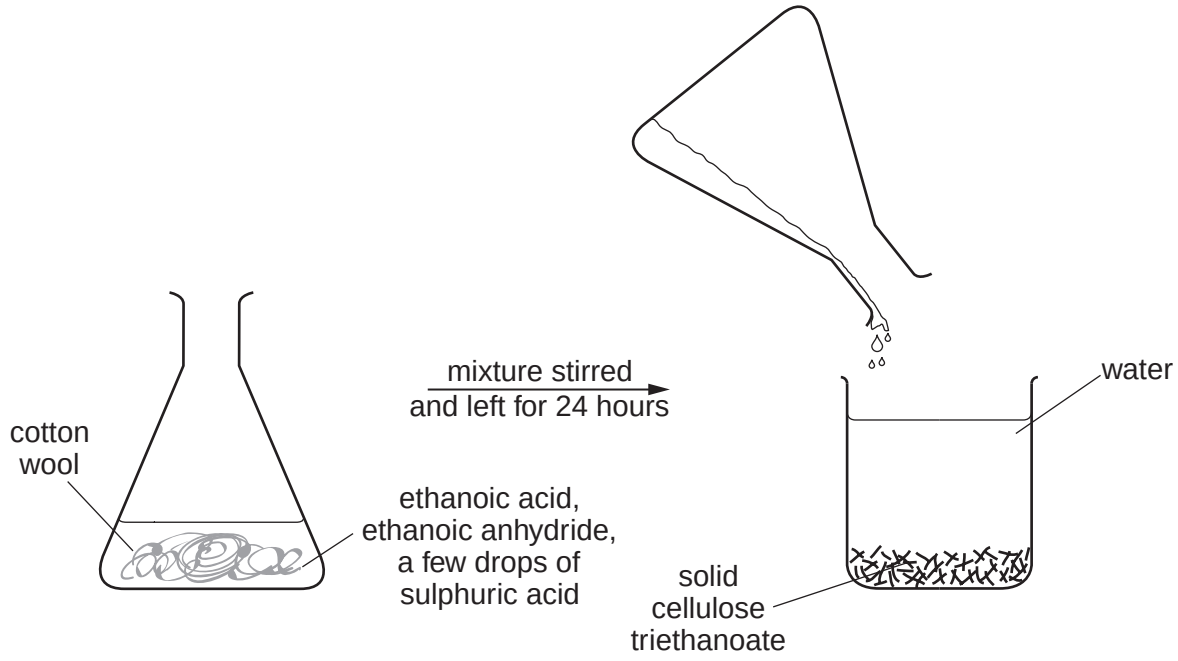

Fig. 3.1

(i) State why the mixture was stirred.

.....[1]

(ii) Suggest how the experiment could be modified if the cellulose triethanoate was not produced, as shown in Fig. 3.1, after 24 hours.

.....[1]

(iii) The cellulose triethanoate was filtered and dried.
It was dissolved in propanone to give a thick syrup from which the cellulose triethanoate can be recovered after the propanone has been evaporated.
This method is used to produce fibres and thin films of cellulose triethanoate.
Propanone vapour is toxic and flammable.
State **two** precautions that the students should take when working with propanone.

1. .....

2. .....[2]

(iv) Devise a procedure to produce a thin film of cellulose triethanoate polymer from a solution in propanone in the laboratory.
Your answer should state the apparatus needed and a method.

.....

.....

.....[3]

(v) State how you would clean your apparatus to enable other students to use the equipment.

.....

.....[2]

(vi) In industry, the cellulose triethanoate solid enters the drying room, is dried and leaves for storage, all automatically.
Suggest how this might be done, using a labelled sketch.
Your design should include

- a method for moving the solid through the room
- how moisture is removed from the solid.

.....

.....[3]

(vii) The industrial manufacture of cellulose triethanoate uses wood pulp as a source of cellulose.
Suggest a reason, apart from cost, why this source of cellulose is used.

.....

.....[1]

(b) The students next made casein glue from milk. They followed the instructions below.

- One litre (1 dm^3) of milk was made up from dried milk powder.
- It was heated to 40 °C.
- 50 cm^3 of vinegar was added and the mixture stirred.
- The casein precipitated and was filtered off.
- The casein was washed and dried.
- Borax solution and dried casein were mixed together at 30 °C and left to stand.

(i) Describe the apparatus needed to precipitate the casein from milk and vinegar.
Your answer should state the size of any glassware used.
The way in which it is heated is **not** required.

.....

.....

.....[2]

(ii) An attempt to use filter paper to obtain the casein failed as the filter paper became blocked.
Suggest another method to filter the casein effectively.

.....

.....[1]

(iii) What should be done to the glassware before it is used?

.....[1]

(iv) One group of students forgot to heat the borax / casein mixture when making the glue.
What should the students then do in order to obtain their product, apart from heating it?
Explain your answer.

.....

.....

.....[2]

(v) Describe how the students could test the effectiveness of their casein glue compared with a commercial glue sample.

.....

.....

.....[3]

(vi) The glue made by some students did not work.
Identify **two** weaknesses **in the instructions** that may be responsible.

1. .....

2. .....[2]

(vii) If fresh milk is used to prepare casein, the milk fat sticks to the casein and is removed by using butanone, in which the fat dissolves.
The following equipment is used to allow the fat to dissolve in the butanone, Fig. 3.2.

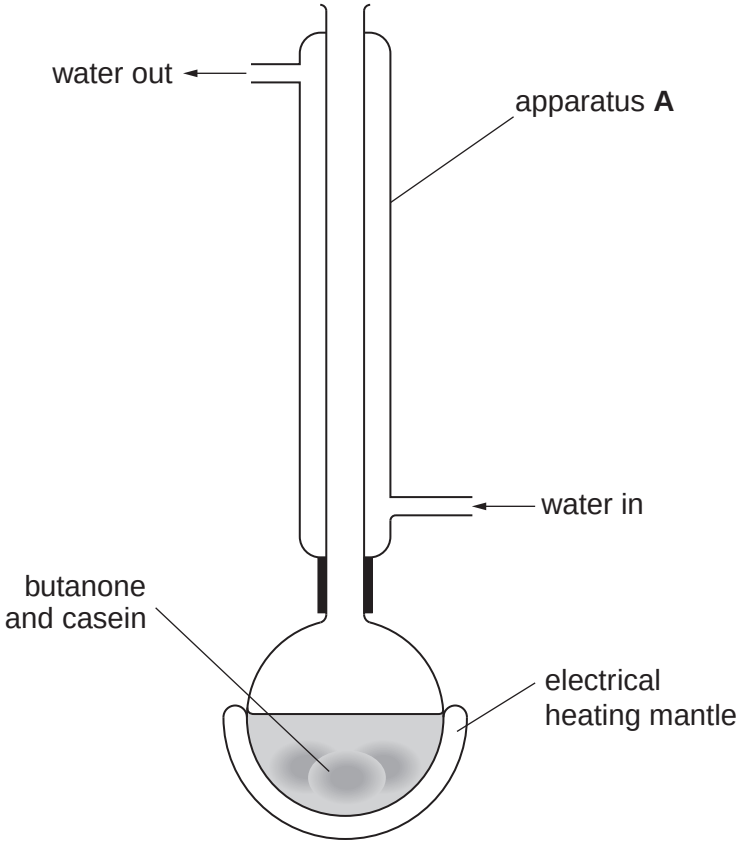

Fig. 3.2

1 State the purpose of apparatus **A**.

.....[1]

2 Suggest why the mixture is heated **electrically**.

.....[1]

[Total: 26]

END OF QUESTION PAPER

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