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)

Monday 17 January 2011
Afternoon

Duration: 1 hour 30 minutes

OCE/25792

G6288

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. 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 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 **16** 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 'Woad – a plant of antiquity with modern uses'.

1 **(a)** A science student on a work placement joined a research team that was studying the growing of woad and its uses.

(i) State two sources of information where he could find out about woad, before joining the team.

1. .....

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

(ii) The student discovered that the team had carried out tests to find the most suitable growing conditions for woad.

State why it is important to keep all variables but one constant whilst conducting these tests.

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

(iii) As part of his work the student was asked to help in the extraction of indigo from the leaves.

Suggest why he was asked to wear gloves during this work.

.....

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

(iv) The student was asked to make sure that all his tests and results in the extraction were properly recorded.

What was the reason for this request?

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

(b) On return from his placement, the student encouraged others in his class to study the growing of woad and the extraction of indigo from its leaves.
The students followed a set of instructions obtained from a book.

(i) They cut a number of woad leaves and washed them well with cold water.
Suggest why the leaves were washed.

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

(ii) The instructions that the students had obtained by research said 'shred the leaves and leave them in hot water'.
Suggest four other pieces of information that the students would need so that they could carry out this instruction correctly.

1. .....

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2. .....

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3. .....

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4. .....

..... **[4]**

(iii) The hot mixture then needed to be cooled and any solids removed.
Suggest a suitable filtering method (other than the use of a large filter paper).

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

(iv) Some soda ash was then added to the filtered liquid to make it alkaline.
The students had not used soda ash before.
State what they should do before using it.

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

(v) The instructions then stated that the pH of the solution, after adding the soda ash, should be 9. However, when they tested their solution, after adding the soda ash, they found that its pH was 8.
How should they modify the process so that the pH of the mixture became 9?

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

(vi) What should the students do when they have modified their procedure so that others can follow it in the future?

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

(vii) The instructions then continued:

- aerate the mixture for ten minutes
- remove the fine insoluble indigo pigment that is formed
- ensure that the indigo is free from traces of soluble impurities and is dry

Design a procedure that will carry out these instructions. You should state the apparatus that is used at each stage and how you would carry out the procedure.

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..... **[4]**

(viii) The students were interested in finding out how much indigo they could obtain from their woad plants.
They found that 3.0 g of indigo was obtained from 1.0 kg of dried leaves.
Calculate the percentage of indigo that was isolated from the leaves.

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

(ix) A book stated that the students might be expected to obtain between 1.0 g and 4.0 g of indigo from each kilogram of dried woad leaves.
They asked a biologist why the yield varied so much.

State two factors that the biologist could have said in her reply.

1. .....

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2. .....

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

(c) The students extended the project to investigate the dyeing of materials with the indigo that was extracted from woad. They wrote a report describing the method followed and any modifications that they made.

(i) Spectralite is a reducing agent that is needed to prepare indigo for dyeing. The students had not used this substance before but information about this substance said that it was irritating to the eyes and the skin.
A student accidentally got some of this substance on his face near to an eye.

State what he should do about this accident.

1. .....

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2. .....

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

(ii) Dyeing with indigo in an aqueous solution using Spectralite needs a constant temperature of 50 °C. The students carried out the dyeing using 5 dm^3 of the dyeing solution in a large metal vat. The use of a gas flame was not appropriate.

Suggest a method of keeping the vat and contents constant at 50 °C.

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

(iii) The students decided that the fabric to be dyed should also be kept at 50 °C before placing it in the dye solution.
Suggest why this was done.

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

(iv) The students reported that the fabric was lowered into the dye solution, left for a period of time and then removed from the solution and left in the air.

What detail is missing from this report?

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

(v) The fabric was then rinsed to remove traces of green-brown dye solution.

State how the students would know when all the dye had been removed.

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

(vi) Unfortunately the dyed fabric turned out to be light blue instead of the dark blue that they expected.

Suggest two reasons for this and how these problems could be solved.

1. .....

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2. .....

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

(d) The students also obtained some indigo by a synthetic method.
Some 2-nitrobenzaldehyde was dissolved in flammable propanone. Water was then added and the mixture stirred. The mixture was then made alkaline using sodium hydroxide solution. A very exothermic reaction occurred and indigo was precipitated.
This reaction is shown in Fig. 1.1.

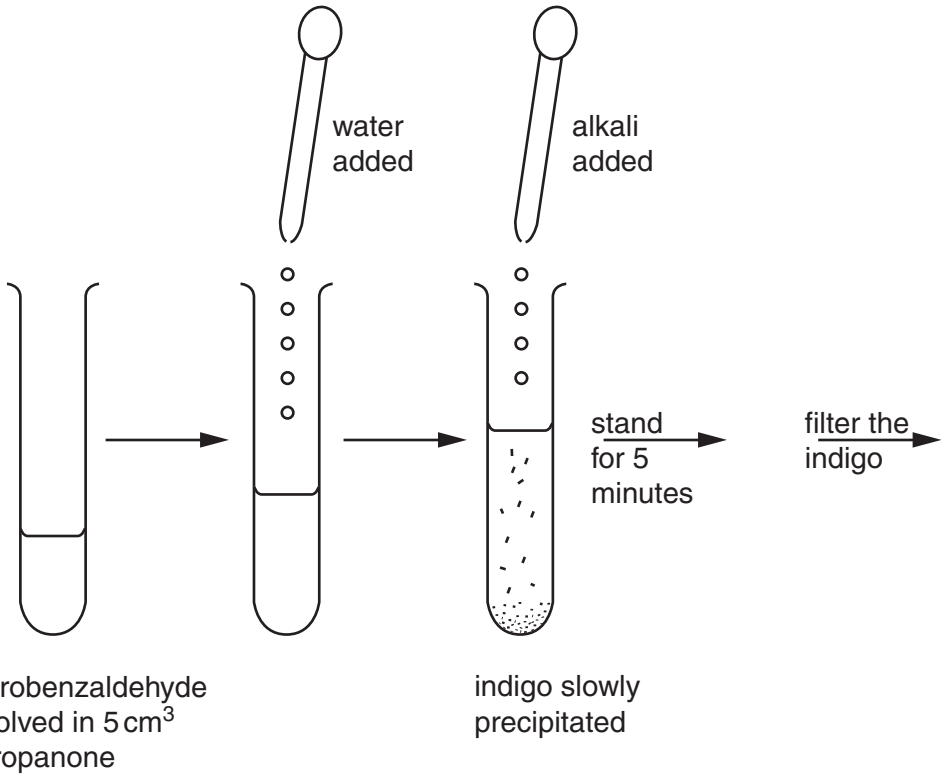

Fig. 1.1

(i) State how the students knew that heating was unnecessary for this reaction.

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

(ii) State why this experiment should be carried out in a fume cupboard.

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

(iii) Suggest why the experiment was left for 5 minutes after adding the alkaline solution.

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

(iv) Although a good yield of indigo was made in this reaction, the students felt that they could not recommend this method for preparing indigo on a large scale.
Suggest two reasons for this conclusion.

1. .....

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2. .....

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

(e) (i) The article in the Insert describes the presence of glucobrassicin (GBS) in woad plants. A control was used in the tests carried out to find the amount of GBS present in the woad plants.

State what is meant by a *control* and explain why this is used in testing.

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

(ii) Use the article to help you calculate the mass of GBS in 500 g of dried woad plants, which were acting as a control.

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

[Total: 39]

This question is based on the article 'The search for phosphorus – an essential element'.

2 **(a)** Some students who were studying the history of industrial science, were asked by their teacher to imagine how coprolites were mined from a pit for investigation in 1880.

How does the article indicate that the **rocks** in a coprolite pit are **not** homogeneous?

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

(b) A student suggested that coprolite samples would have been extracted along the length of the seam and at varying heights.

What was the reason for this?

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

(c) State two safety precautions that should have been observed when collecting coprolites from a pit.

Give a reason for each of your answers.

1. .....

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2. .....

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

(d) One of the students suggested that if they found the density of some coprolites they found in the laboratory, it might show whether coprolites all had a similar chemical composition.
They cleaned each coprolite and found its mass. They then found its volume by displacing water.
They obtained the following results, Table. 2.1.

Table 2.1

sample	mass/g	volume/cm^3
A	6.2	1.9
B	15.2	4.9
C	27.9	9.3
D	32.5	13.0
E	48.6	15.2
F	52.3	16.9

State why sample **A** would be expected to give the least accurate results.

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

(e) (i) Use the figures in Table 2.1 to plot the results for samples **B** to **F** on the graph, Fig. 2.1.

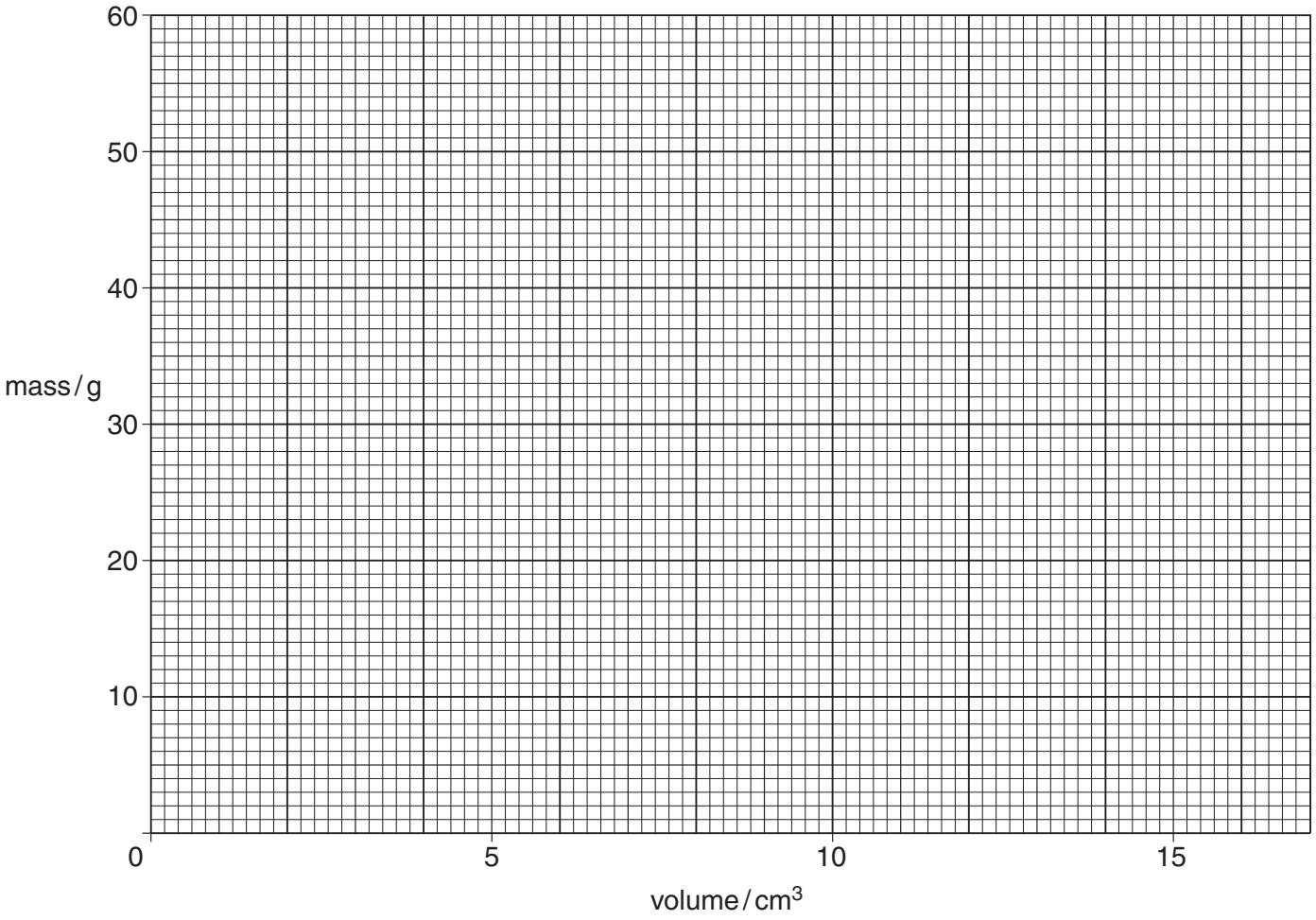

Fig. 2.1

[1]

(ii) Identify an anomalous result and suggest a reason for this anomaly.

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.....

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

(iii) Draw a line of best fit through the points and the origin. **[1]**

(iv) The average density of the coprolites is equal to the gradient of the graph.
Use your graph to calculate the density of the coprolites.

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

(f) In 1880, after collecting a number of coprolites for use as a fertiliser, they were taken to be ground between millstones.

State why it was important that the millstones were cleaned before this occurred.

.....

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

(g) In the 1860s farmers were unsure about the use of fertilisers.

Explain how the use of powdered coprolite could be tested as a fertiliser in the growing of turnips from seed.

Your answer should include:

- details of the method
- factors that should be kept constant during this test
- how the results of the test would be evaluated

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..... **[8]**

(h) Phosphatic nodules occur in the Pleasanton shales of Kansas.
Some conclusions about the separation of 'phosphate' from the shale are given in Table 2.2.

Table 2.2

separation method	amount of separation
crushing to gravel size and sieving	very poor
using a froth flotation method where the phosphate particles are carried upwards in froth and shale particles remain in the liquid	around half the available phosphate is separated
adding the crushed material to a dense liquid, when the shale sinks and the phosphate floats	about 60% separation is achieved

(i) Under what economic conditions would you recommend that the company treating the rock starts to use the froth flotation or the dense liquid method?

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

(ii) If you were a consultant what would you recommend to be the next stage of the company's research into the separation of 'phosphate' from shale?

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

(i) Some students were visiting a company where 'superphosphate' fertiliser was being made by reacting phosphate rock with sulfuric acid.
They were told that the worldwide annual production of 'superphosphate' was 36 million tonnes.

(i) Each tonne of phosphate rock gave 0.45 tonnes of 'superphosphate'.
Calculate how much phosphate rock was needed to produce 36 million tonnes of 'superphosphate'.

amount of phosphate rock = ... million tonnes **[1]**

(ii) Each tonne of phosphate rock required 680 kg of sulfuric acid.
Calculate, using your answer to **(i)(i)**, how much sulfuric acid was needed to produce 36 million tonnes of 'superphosphate'.

(1000 kg = 1 tonne)

amount of sulfuric acid = ... million tonnes **[1]**

(j) During the production of 'superphosphate' a large quantity of corrosive, toxic hydrogen fluoride gas is also obtained.
Give one environmental and one economic consideration that the manufacturers of 'superphosphate' need to take into account when making 'superphosphate' in this way.

environmental consideration .....

.....

economic consideration .....

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

(k) The percentage of phosphorus in a fertiliser can be found using colorimetry.
Briefly outline the main steps in finding the percentage of an element using colorimetry.
You should assume that your phosphorus-containing material is present in a suitable solution.
Include only essential practical details and how to draw and use a graph of the results.

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

[Total: 33]

3 There is concern about some snack foods because of the amount of fat and salt they contain.

(a) Food chemists can extract the fat from the foods by using flammable methylbenzene.
In a test, 24.30 g of a sample of crisps was heated with 50 cm^3 of methylbenzene using the apparatus shown in Fig. 3.1.

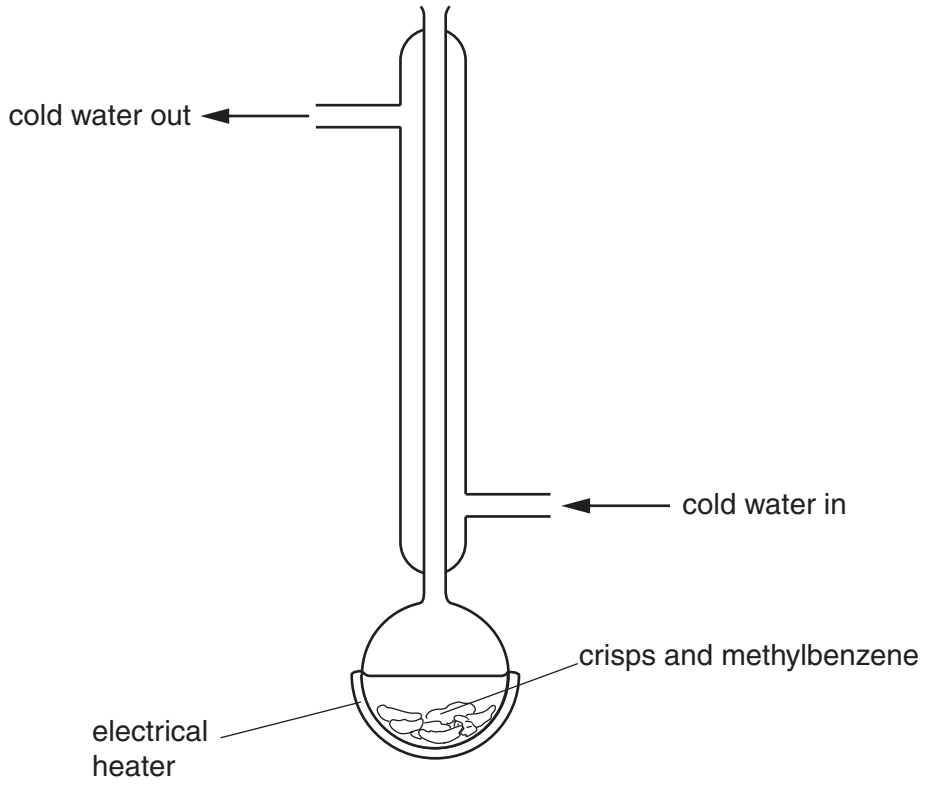

Fig. 3.1

(i) Suggest the volume of the flask that should be used for this test, giving a reason for your answer.

volume of flask ..... cm^3

reason .....

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

(ii) Suggest a reason why an electrical heater is used, apart from the dangers of fire from the flammable solvent.

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

(iii) This apparatus enables the contents of the flask to be heated under reflux.
Explain what is meant by the term *heating under reflux*.

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

(iv) After refluxing for twenty minutes, the mixture was cooled. The remains of the crisps were removed by filtering and the filtrate, containing the methylbenzene, evaporated to leave the fat.
The following results were obtained.

mass of the flask and fat = 106.93 g
mass of the flask = 98.79 g

The original mass of the crisps was 24.30 g.

Use these figures to calculate the percentage of fat in the crisps.

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

(b) The fat extracted in **(a)(iv)** was a mixture of compounds.
These were separated using thin layer chromatography. The chromatogram is shown in Fig. 3.2.

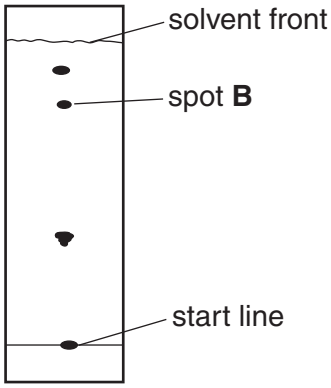

Fig. 3.2

The spots obtained in the chromatogram were colourless in visible light but appeared as dark spots against a fluorescent background when ultraviolet light was shone on the plate.

(i) State what should be done before ultraviolet light is used.

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

(ii) Use Fig. 3.2 to calculate the retardation factor (R_f value) of the fat indicated by spot **B**.
Show how you obtained your answer.

R_f = ... **[2]**

(iii) The technician who obtained the chromatogram, Fig. 3.2, thought that one of the other spots was given by two different fats that had the same R_f value.
What should be done about this so that his suspicion can be checked?

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

(c) Continuing concerns about the amount of fat in the diet have required the manufacturers of any new crisp-based product to consider the ratio of the total mass of the product to the mass of fat that they contain.
Samples from bags of a new product were analysed for their fat content.
The following results were obtained, Table 3.1.

Table 3.1

	sample			
	A	**B**	**C**	**D**
mass of crisps/g	12.73	17.63	14.30	15.62
mass of fat/g	4.21	5.80	4.50	5.41
$\frac{\textbf{mass of crisps}}{\textbf{mass of fat}}$	3.02	.....	.....	.....

(i) Complete the third row of the table. **[2]**

(ii) The manufacturer's acceptable ratio for $\frac{\text{mass of crisps}}{\text{mass of fat}}$ is 3.00 ± 0.15.

Use your results from Table 3.1 to decide which one of the samples **B**, **C** or **D** is outside their acceptable ratio, explaining your choice using the figures.

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

(iii) State what should be done about the sample that is outside the accepted range.

.....

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

(d) A solution of salt can be obtained from the crisps by simply adding some water, stirring and filtering. Unfortunately this method will probably not give a solution that contains all the salt that is in the crisps.

State three ways that this method could be modified so that more of the salt present could be obtained in the solution.

1. .....

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2. .....

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3. .....

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

[Total: 18]

END OF QUESTION PAPER