OCR
RECOGNISING ACHIEVEMENT

ADVANCED GCE

APPLIED SCIENCE

G628

Unit 9: Sampling, Testing and Processing

Candidates answer on the question paper
A calculator may be used for this paper
Candidates may not bring the Pre-released Case Study into the examination room

OCR Supplied Materials:
- Insert (inserted)

Other Materials Required:
- Electronic calculator
- Ruler (cm/mm)

Friday 16 January 2009
Afternoon

Duration: 1 hour 30 minutes

CUP/T78674

G6284

Candidate Forename		Candidate Surname	

Centre Number						Candidate Number				

INSTRUCTIONS TO CANDIDATES

- Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use 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.
- Write your answer to each question in the space provided, however additional paper may be used if necessary.

INFORMATION FOR CANDIDATES

- 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**.
- You are advised to show all the steps in any calculations.
- This document consists of **20** pages. Any blank pages are indicated.

FOR EXAMINER'S USE		
Qu.	**Max.**	**Mark**
1	**38**	
2	**32**	
3	**20**	
TOTAL	**90**	

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 'Brown shales in the sunset?'.

1 **(a)** A group of students collected some samples of oil shale.
Use Fig. 1.1 in the insert to help you answer the questions below.

(i) State, giving a reason, whether the oil shale layer is homogeneous.

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

(ii) State **two** environmental hazards that the students should consider when collecting the samples.

1 .....

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

(iii) The students collected samples that each had a mass of around 200 g.
Suggest a reason why samples of this mass were chosen.

.....

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

(iv) Suggest why a sealed plastic bag was used to store each sample collected.

.....

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

(v) State **two** details that should be written on the label for each sample.

1 .....

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

(b) The students used a **standard procedure** similar to that used in industry for analysing each oil shale sample.

(i) State **two** sources where details of a standard procedure could be found.

1 .....

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

(ii) State why it was important to use a **standard procedure** in analysing the oil shale samples.

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

(c) The students obtained the following results from analysing the oil shale samples, Table 1.2.

Table 1.2

sample	mass of oil shale sample before heating/g	mass of solid residue/g	mass of water/g
A	24.70	16.90	0.49
B	25.20	17.40	0.50
C	32.30	16.90	0.52

Use the table to answer the following.

(i) Solid residue, water, oil and gases are produced when oil shale is heated.
Calculate the total mass of oil and gases produced from Sample A.

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

(ii) State, giving reasons for your answer, which sample may have been taken from a different oil shale layer.

.....

.....

.....

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

(iii) Sample C produced 21.7% of oil.
Calculate the mass of oil produced from Sample C.

[1]

(d) The article contains a number of scientific terms.
State what is meant by

sedimentary rock .....

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

hydrocarbon .....

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

immiscible .....

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

(e) The students were asked to calculate the period of time for which the oil shale deposit can be used.

(i) The deposit is 2.5 m in depth and extends over an area of 5 000 km^2.
Show that the volume of the deposit is $1.25 \times 10^{10}\,m^3$.

[1]

(ii) Each year 1.3 million tonnes of oil shale are mined, this has a volume of $5.2 \times 10^6\,m^3$.

Assuming that all the oil shale in the deposit can be recovered and the rate of mining remains constant, calculate how many years this oil shale deposit will last.

[1]

(f) Water produced by the 'retorting' process is contaminated with toxic phenols.
Scientists have studied a number of possible solvents to remove phenols from the water.
Their search of the literature showed that a particular flammable solvent was the most effective for this purpose.

(i) State what the scientists should do before they start work with this solvent.

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

(ii) In a test, 100 cm^3 of contaminated water containing 4.00 g of phenols was treated with 100 cm^3 of the solvent.
This first use of the solvent removed 90% of the phenols in the water.

Calculate the mass of phenols remaining in the water layer.

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

(iii) The water layer was treated with a further 100 cm^3 of the solvent, 90% of the remaining phenols was again removed.

Calculate the mass of phenols remaining in the water layer after this second treatment with the solvent.

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

(iv) The scientists had recommended a particular solvent as the most effective in the removal of phenols from the water.

State **two** factors, apart from health and safety, which would need to be considered before using this solvent on a large scale.

1 .....

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

(v) Some students wanted to evaporate the solvent to obtain the phenols.
They decided to carry out the method shown in Fig. 1.2, using a fume cupboard.

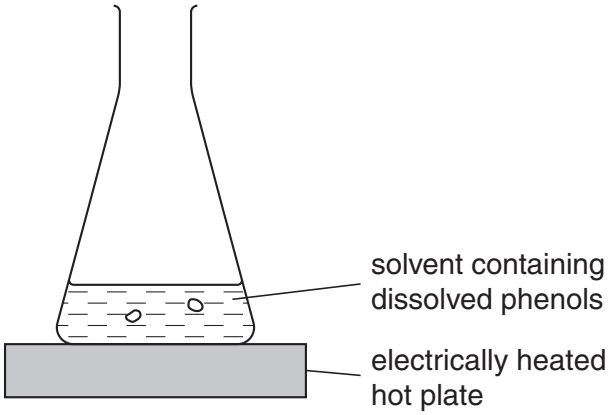

Fig. 1.2

State why the following equipment was recommended.

electrical heated hot plate .....

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

fume cupboard .....

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

(g) The article describes an 'in situ' method for 'retorting', that was developed in the United States.
Draw a labelled sketch of how this method might be used in an area where the oil shale was covered with a layer of limestone.

[2]

(h) State **two** problems with the use of oil shale in the 'combustion' process in a power station.

1 .....

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

(i) A group of students read that white crystals of potassium aluminium sulphate (alum) can be made from oil shales that occur in Britain.

They decided to follow the method below.

Stage 1 Lumps of shale are mixed with coal and the mixture burnt.

Stage 2 Water is added to the cooled product.

Stage 3 The solid material is removed.

Stage 4 The resulting solution is concentrated and cooled.

(i) Suggest **two** ways by which Stage 1 could be modified to improve the chemical breakdown of the oil shale.

1 .....

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

(ii) Suggest **two** essential statements that are missing from the instructions to Stage 2.

1 .....

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

(iii) Suggest a method by which solid can be removed in Stage 3 if filter paper is not available.

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

(iv) At the end of Stage 4 the students were disappointed to find that the crystals were brown instead of white. The brown colour was due to the presence of iron(III) sulphate.
They devised a method to find the percentage of iron(III) sulphate present in their crystals using colorimetry.
Their solution gave an absorption reading of 0.65.
Use the graph, Fig. 1.3 to find the percentage of iron(III) sulphate present in their crystals.

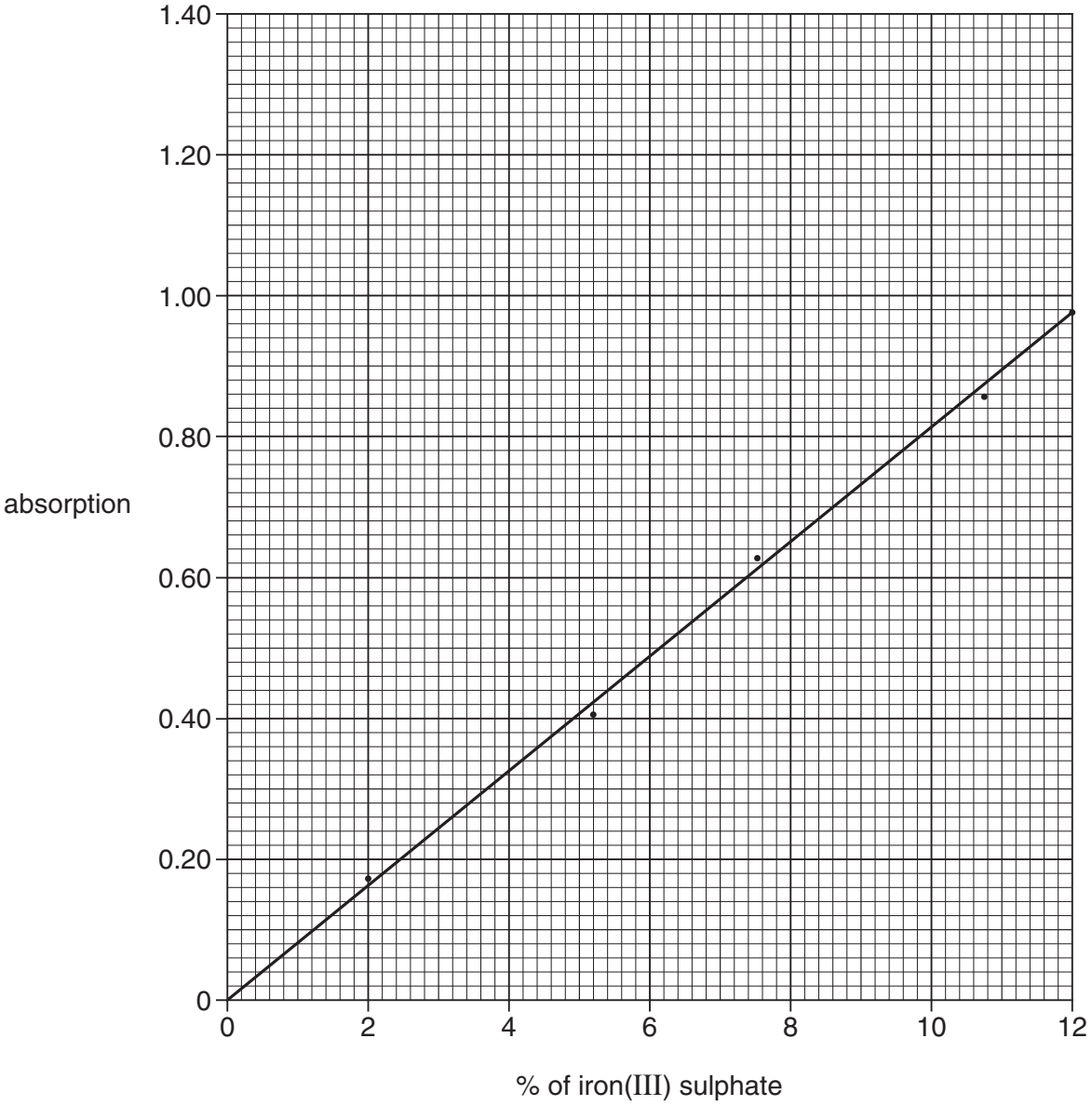

Fig. 1.3

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

(v) The students then used the result from **(iv)** to calculate the percentage purity of their alum using

$$\% \text{ Purity of alum} = 100 - (\% \text{ of iron(III) sulphate})$$

Explain why this calculation may not give an accurate result for the percentage purity of alum present.

.....

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

[Total: 38]

This question is based on the article 'Many uses for stinging nettles'.

2 **(a)** Some students at an agricultural college have grown nettles in a plot, for use in testing.

(i) State why it is important when growing the nettle plants to be tested, that they receive the same amount of water and fertiliser.

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

(ii) State **two** factors that should be taken into consideration when selecting nettle plants for testing.

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

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

(b) The harvested stems of these nettle plants were treated with an aqueous solution of an enzyme to help separate the fibres from the pectin.
The temperature and concentration of the enzyme were varied.

(i) State what else needed to be measured if the rate of breakdown to fibre and pectin was to be determined.

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

(ii) The results from the tests in **(i)** were displayed as two graphs, Fig. 2.2.

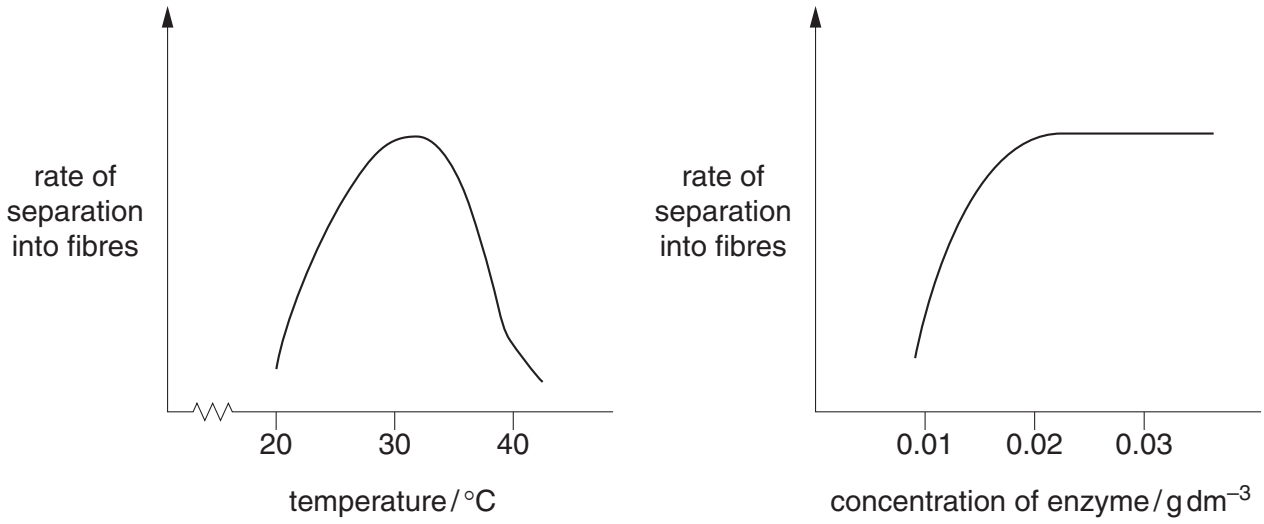

Fig. 2.2

Explain why a temperature of 32 °C and a concentration of 0.02 g dm^{-3} would be chosen to separate the fibres from the pectin.

.....

.....

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

(iii) Suggest why, after treatment with the enzyme, the fibres were washed with water.

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

(iv) When the fibres were dry, they were twisted together to form a thread of 1 mm diameter. The relative strength of the thread was then compared with threads of cotton, hemp and flax.
This was done by taking equal lengths of each thread and suspending masses from them, adding 10 g at a time, until the thread broke.
They recorded the results in Table 2.1.

Table 2.1

material	diameter of thread / mm	mass needed to snap the thread / g
cotton	0.7	160
nettle	1.0	170
flax	1.2	150
hemp	1.3	210

Suggest how the tests can be improved so that

the results can be compared .....

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

the results are more precise .....

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

(c) When nettles are to be grown commercially it is important that the ground is used economically, but without producing nettles of inferior quality.
Nettles were grown on an experimental plot of ground of area 1 hectare (100 m × 100 m).
The plants were placed 1 m apart with 50 cm between rows.
A distance of 50 cm was left at the end of each row, Fig. 2.3.

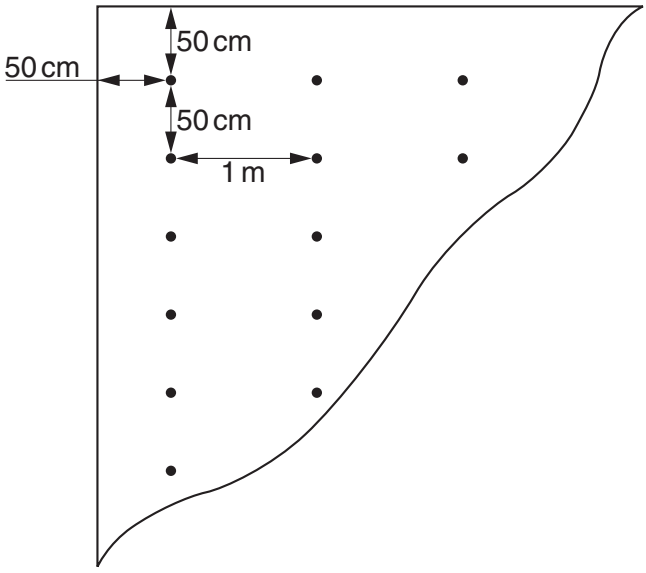

Fig. 2.3

(i) Calculate the number of plants in one row.

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

(ii) State the total number of nettle plants in the plot.

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

(d) The percentage of dry fibre obtained from nettle plants is affected by the amount of water and fertiliser that each plant receives.
State **two** other environmental factors affecting the yield of dry fibre, that you should consider when evaluating the results of a trial.

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

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

(e) The results of trials in two countries are shown in Table 2.2.

Table 2.2

country	mass of stem / kg	mass of dry fibre / kg	% of dry fibre
Nepal	37.5	1.85	
Austria	60.0		6.8

Calculate the missing values and write them in the table. **[2]**

(f) The article describes the insulating nature of nettle fibres.
These hollow fibres had been spun into threads and then wrapped around the apparatus shown in Fig. 2.4.

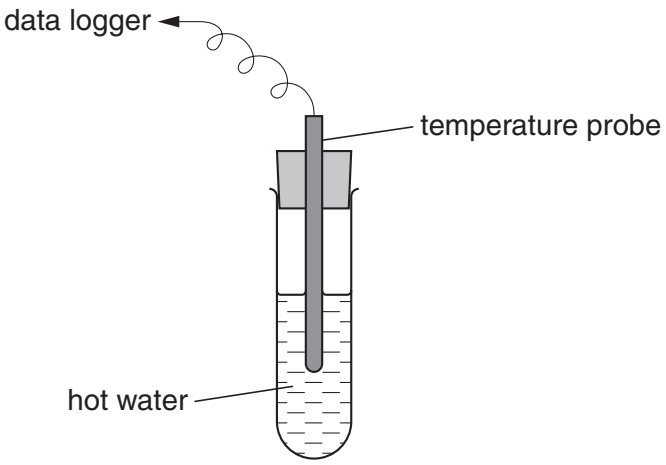

Fig. 2.4

The temperature of the water was recorded and a print out of the results is shown in Fig. 2.5.

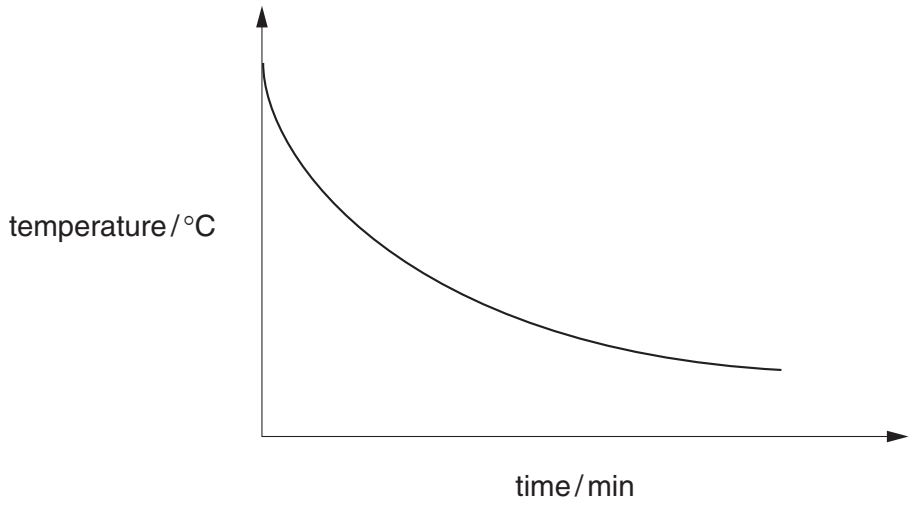

Fig. 2.5

The test was then repeated using nettle thread with the hollow air gap reduced.

(i) State **two** factors that should be kept constant, apart from the starting temperature of the water, so that the results can be compared.

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

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

(ii) Sketch a line on the graph, Fig. 2.5, to show the cooling curve obtained for threads with the air gap reduced. **[3]**

(g) Consumers are concerned about the flammability of textiles.
You are given

- a piece of untreated nettle fabric
- a fireproofing solution
- the usual laboratory apparatus.

(i) Devise an experiment to compare the flammability of treated and untreated nettle fabric. You should describe how to carry out the experiment and what you should measure.

In this part of the question, two marks are available for the quality of written communication.

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..... **[5]**

Quality of Written Communication **[2]**

(ii) The nettle fabric needs to be fireproofed before use in children's nightwear.
State **two** things that you should consider when choosing a fireproofing solution for this purpose.

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

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

(h) Clinical studies using nettle leaf extracts have indicated some success in the treatment of allergic rhinitis.

(i) The study used a placebo.
State what is meant by the term 'placebo'.

.....

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

(ii) Suggest **two** ways in which this study could be extended.

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

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

[Total: 32]

3 Fungi attack fruit trees causing loss and the spoiling of fruit. An old, but effective, fungicide is Bordeaux mixture. This is made from lime (calcium hydroxide) and copper sulphate.

(a) In a project, students were asked to investigate the effectiveness of Bordeaux mixture as a fungicide.

(i) A book stated that 3.6 kg of calcium hydroxide and 3.6 kg of copper sulphate together with water were needed to give a total volume of 45 dm^3 of Bordeaux mixture.
The students decided to make 250 cm^3 of the mixture.

Calculate the mass of calcium hydroxide, in kilograms, they needed to add to make the 250 cm^3 of mixture.

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

(ii) Suggest the size of beaker used to prepare this 250 cm^3 of mixture.

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

(iii) The instructions were unclear and the students simply added water to a mixture of the two solids. This resulted in a thick paste that was not really usable.
Suggest another method of mixing these materials that might give a more suitable product.

.....

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

(iv) An article in a book showed a graph of the effectiveness of Bordeaux mixture at destroying fungi against varied amounts of the two solids, Fig. 3.1.

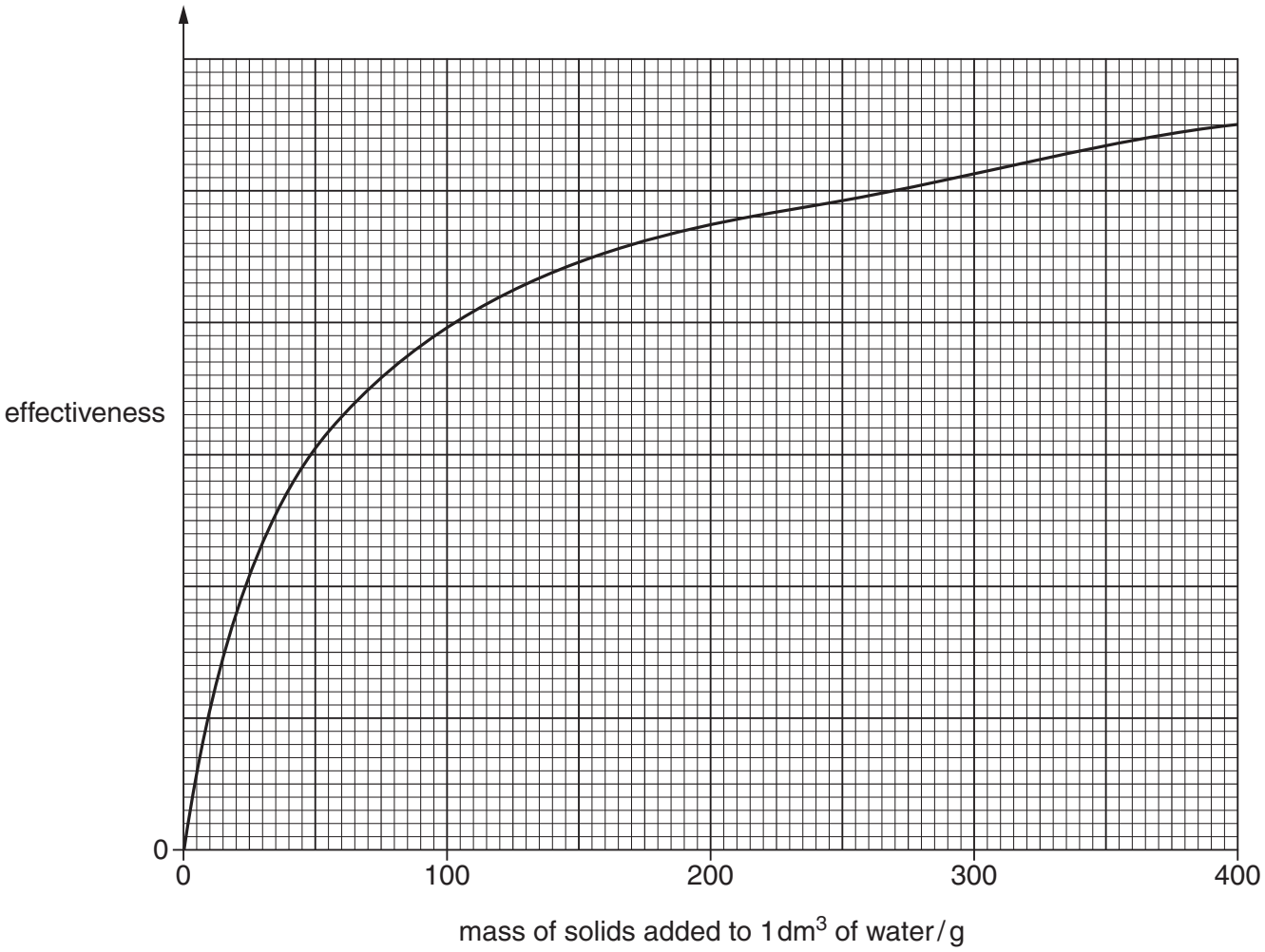

Fig. 3.1

Explain how the graph shows that a mixture containing more than 100 g of the solids in 1 dm^3 of water is not economical to use.

.....

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

(v) Research shows that the effectiveness of Bordeaux mixture partly depends on absorption of copper into the root system.
Use this comment to suggest why the curve in Fig. 3.1 has this shape.

.....

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

(vi) Bordeaux mixture is alkaline because an excess of lime is present.
State **two** precautions that the students should take when spraying this mixture.

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

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

(b) Bordeaux mixture is usually sprayed on fruit trees but a solid powder can also be used.
Suggest **two** disadvantages of using a powder.

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

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

(c) Lime, used in the preparation of Bordeaux mixture, is made by strongly heating limestone (calcium carbonate) to form calcium oxide. Lime is made by then adding water to the calcium oxide.
In the laboratory the following method can be used.

- heat limestone in a crucible at 900 °C for 15 minutes
- allow to cool
- add water slowly from a dropping pipette

In industry:

(i) Small lumps of limestone are heated, rather than large blocks.
Suggest why these smaller lumps are used in preference to large blocks.

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

(ii) Suggest why the temperature of the reaction is maintained by mixing coke with the limestone and burning the coke using an air draught rather than by external heating.

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

(iii) Suggest how the industrial process, starting with limestone, can be made to work continuously.
You may use a sketch if you wish.

.....

.....

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

(iv) The addition of water to calcium oxide generates a large amount of heat.
Suggest **two** ways how this could be done **safely** on a large scale.
You may use a sketch if you wish.

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

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

(v) State the name given to a chemical reaction that gives out heat.

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

(vi) Some students calculated that 56 g of calcium oxide needed 18 g of water to produce pure lime (calcium hydroxide).
Calculate how much water should be added to 84 kg of calcium oxide to produce pure lime.

mass of water ..... kg **[2]**

[Total: 20]

END OF QUESTION PAPER

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