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RECOGNISING ACHIEVEMENT

**ADVANCED GCE**

# APPLIED SCIENCE

Sampling, Testing and Processing

# G628

*OCE/17804*

Candidates answer on the Question Paper

**OCR Supplied Materials:**
- Insert (inserted)

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

**Monday 7 June 2010**
**Morning**

**Duration:** 1 hour 30 minutes

*G628*

| 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. Additional paper may be used if necessary but you must clearly show your Candidate Number, Centre Number and question number(s).

**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 **24** 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 'Chocolate – 'God food' or bitter water?'

**1** **(a)** Cocoa trees are attacked by many pests and diseases. Capsid insects are one of the pests that feed on the sap of the tree.
State two factors that a grower should consider before buying an insecticide to kill these insects.

1. .....

.....

2. .....

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

**(b)** Give two reasons why a cocoa tree grower would remove a few pods for testing at the start of the harvesting season.

1. .....

.....

2. .....

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

**(c)** Cocoa pods are removed from the tree using a machete (a long knife with a curved blade). Some pods are difficult to reach from the ground.
Suggest a method that can be used to collect pods from the upper branches without the need to climb the tree.

.....

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

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**(d)** A grower showed some students around his plantation.
They found that each hectare in the plantation contained 20 rows of cocoa trees and each row contained 25 trees.

**(i)** Calculate the number of trees in each hectare.

number of trees per hectare = ..... **[1]**

**(ii)** Assuming that each tree produces 20 pods, calculate the mass of raw cocoa obtainable from this plantation.
Use information from the article to help you in your answer.

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

**(e)** The students were given a selection of cocoa pods in order to carry out a series of tests.

**(i)** Why was it important, for the testing, that the pods came from different trees?

.....

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

**(ii)** The students were not certain that their pods were ripe.
Where would they find information to help them know about this?

.....

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

**(iii)** The samples could not all be tested on the same day.
Suggest two factors to be taken into account when storing them.

1. .....

.....

2. .....

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

**(iv)** State why the pods were washed and dried before they were opened.

.....

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

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**(v)** A pod was opened using a sharp knife.
The knife was then cleaned before opening the next pod.
Suggest why this was done.

.....

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

**(vi)** After opening the pod, the beans were removed from the pulp and left to ferment for several days.
Use the article to state how the students knew that the beans were ready for the next stage.

.....

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

**(vii)** The students checked the mass of the beans before they were dried and found them to have a mass of 7500 g.
They were told to let the beans dry until 55% of the starting mass remained.
Calculate the mass of the beans that the students should obtain after drying.

mass of the beans = ..... **[1]**

**(viii)** State why it was important to record the results from **(vii)**.

.....

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

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**(ix)** Instead of calculating the percentage in **(vii)** the students could have used a graph, Fig. 1.1.

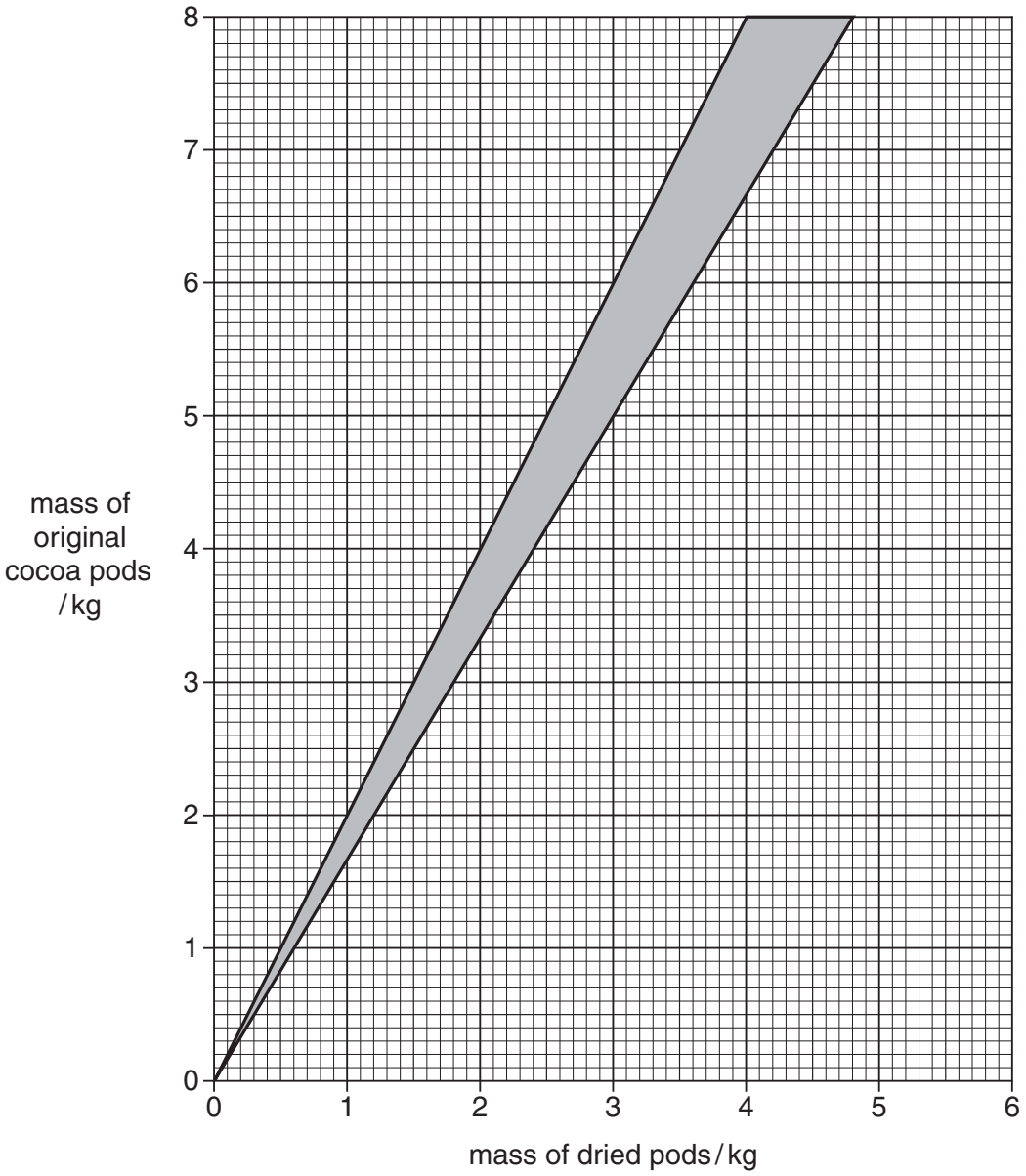


**Fig. 1.1**

The acceptable ranges are within the shaded area.
State an advantage of using the graph instead of calculating the required value.

.....

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

**(x)** The students dried another batch of cocoa beans that had a mass of 6.50 kg.
After drying for a few days, these beans had a mass of 3.00 kg.
Use the graph, Fig. 1.1, to help you decide what the students should do next, assuming that the masses are correct.

.....

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

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**(f)** The roasting of the beans requires considerable skill to obtain the best results. One problem is that beans are of different sizes and may be affected differently by the roasting process. Three possible results are shown in Fig. 1.2.

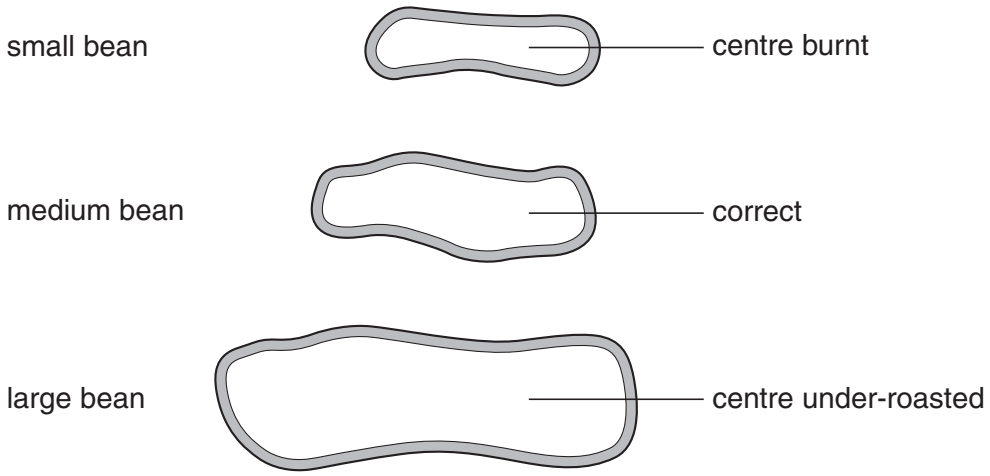


**Fig. 1.2**

How could you ensure that all the beans were correctly roasted?

.....

.....

.....

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

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**(g)** High pressure liquid chromatography (HPLC) is used to find out if the roasted beans have 'optimum chocolate flavour'.
The diagram, Fig. 1.3, shows a typical HPLC trace for a sample of over-roasted cocoa beans.

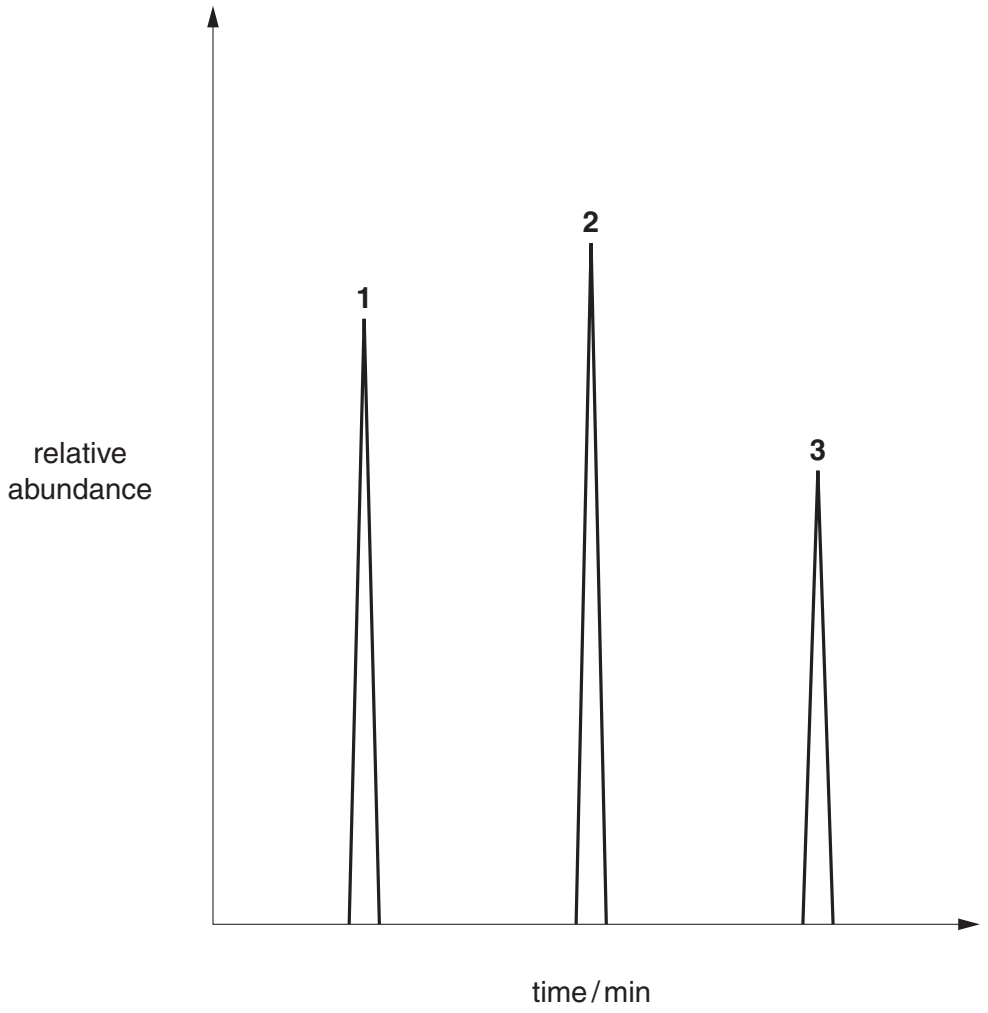


**Fig. 1.3**

The compounds shown by peaks **1** and **2** increase after long heating and indicate over-roasting.
The compound shown by peak **3** indicates roasting being carried out correctly.
State how the relative size of the peaks would change if the beans were correctly roasted.

.....

.....

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

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**(h)** Some students decided to compare the viscosities of two types of chocolate.
Liquid chocolate at 40 °C was placed in a tall beaker. A ball of mass 20 g was attached to a scale and added to the liquid chocolate as shown in Fig. 1.4.

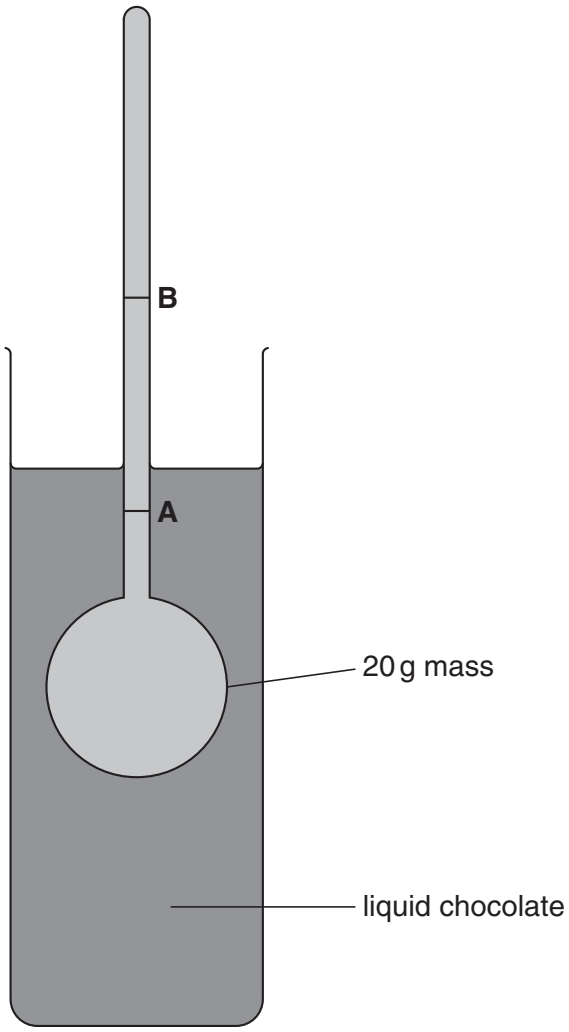


**Fig. 1.4**

They timed how long it took for the ball to sink into the chocolate from point **A** to point **B**.

**(i)** Why was the experiment carried out at 40 °C rather than at 25 °C?

.....

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

**(ii)** State why it is important for the temperature to be kept at 40 °C during the experiment.

.....

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

**(iii)** State why **each** experiment should be run at the same temperature.

.....

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

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**(i)** The students also compared the relative thermal expansion of chocolate and a concentrated sugar solution at a range of different temperatures. If the difference in the amount of expansion of these two materials is too great, then cracking of the confectionery can occur when the temperature changes.
The apparatus shown in Fig. 1.5 was used.

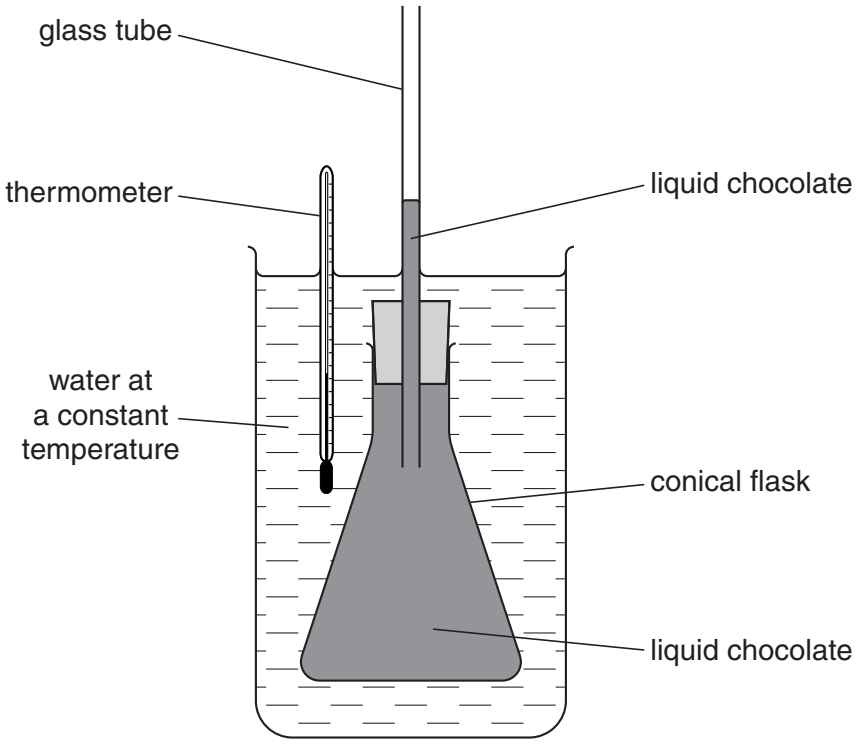


**Fig. 1.5**

The flask contains liquid chocolate, which is immersed in hot water at a certain temperature. The method followed by the students is given below.

- pour liquid chocolate into the flask so that some of it is in the glass tube
- immerse the flask and tube in hot water kept at a constant temperature
- leave for 15 minutes
- measure the height of the chocolate in the glass tube
- measure the temperature of the water
- increase the water temperature, leave for 15 minutes and again measure the height and temperature
- repeat at a range of temperatures
- repeat the experiment using concentrated sugar solution

**(i)** State why the students left the flask for 15 minutes before taking a measurement.

.....

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

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**(ii)** State what should be done before using the same equipment to test for the expansion of a sugar solution.

.....

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

**(iii)** The students found that the sugar solution expands more than the chocolate as the temperature rises.
Use the graph below, Fig. 1.6, to sketch straight line graphs showing the expansion of these two materials. You should label each line. **[2]**

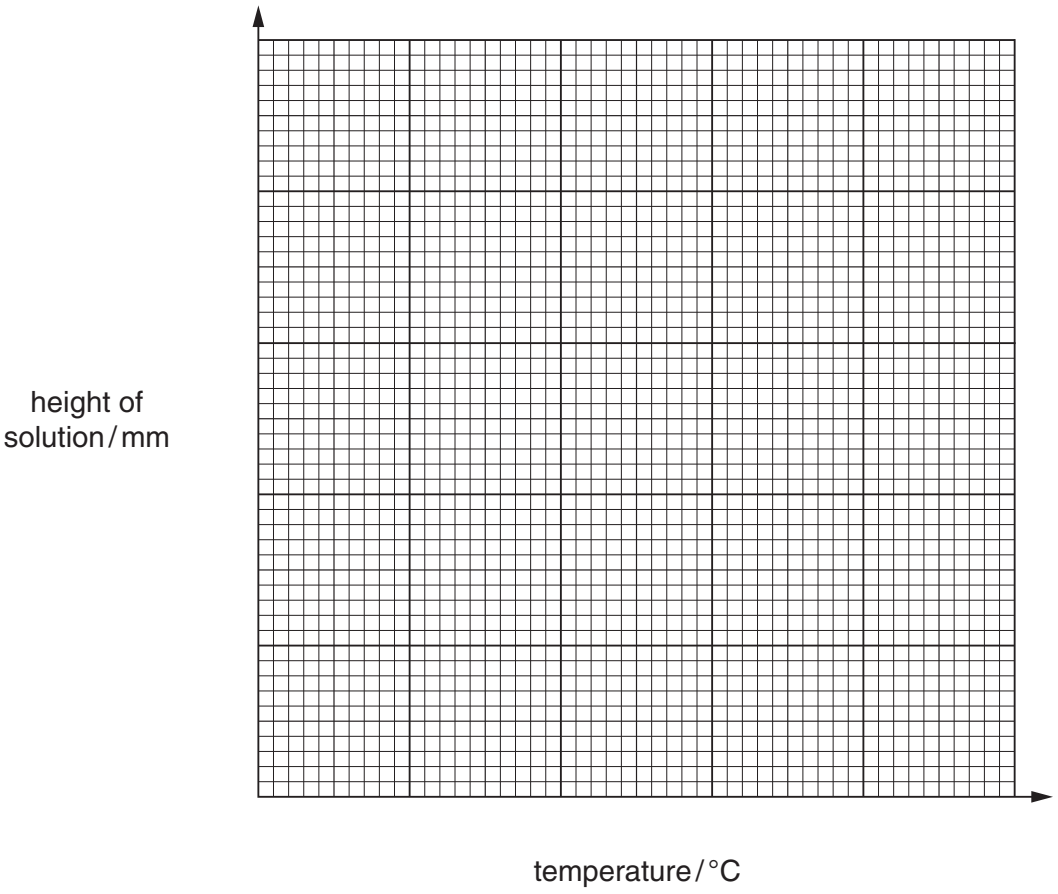


**Fig. 1.6**

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**(j)** The students then found how the hardness of a block of chocolate varied with temperature. They were given the following.

- temperature-controlled cabinet
- 100 g mass
- short metal rod with a point at one end, Fig. 1.7

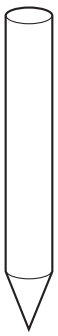

**Fig. 1.7**

- bar of chocolate
- ruler

Devise an experiment to find the relative hardness of the chocolate at various temperatures. The hardness of the chocolate is found by the effect that the pointed end of the rod has on the chocolate.
You may illustrate your method by using a sketch.
You should make clear how your results relate the depth of penetration to the hardness of the chocolate.

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..... **[7]**

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**(k)** Table 1a in the article shows the amount of caffeine and theobromine in various drinks.
Use this table and the article to compare the relative stimulant effect of eating 25 g of plain chocolate with drinking a can of cola.

.....

.....

.....

.....

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

**[Total: 39]**

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This question is based on the article 'Tin – an element of history'.

**2** **(a)** On a field trip to Cornwall some students collected samples from stream sediments to see if any tin ore was present.

**(i)** To collect the samples it was necessary to stand in the stream.
State two possible dangers of which the students should be aware.

1. .....

.....

2. .....

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

**(ii)** The stream flowed downhill from an old tin mine.
Suggest why the gravel samples from the stream contained more tin ore than those collected further downstream from the mine.

.....

.....

.....

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

**(iii)** The students collected a number of samples of 'alluvial tin' by panning the stream sediments.
However, the samples were wet and still contained some gravel.
Suggest a method that can be used to obtain dry samples of tin ore that contain less gravel.

.....

.....

.....

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

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**(iv)** The students were interested to see how much of the stream sediment was actually tin ore.
They obtained some sediment from the stream and dried and weighed it.
The material was then panned to obtain tin ore, dried and weighed.

mass of tin ore after panning = 2.4 g
mass of dry sediment taken = 320.0 g

Calculate the percentage of tin ore in the sediment.

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

**(v)** The students chose to use plastic specimen jars for collecting samples from the stream sediment.
State one advantage of using these jars rather than using jars made of glass.

.....

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

**(vi)** State two details that should be written on the label of each specimen jar.

1. .....

.....

2. .....

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

**(b) (i)** Use the article to suggest why the ore must be roasted under carefully controlled conditions, in the first stage of industrial tin production.

.....

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

**(ii)** After the first roasting, water is added to the solid to dissolve any copper sulfate present. This dissolves to give a blue solution.
State how you would show that the remaining ore did not contain any copper sulfate.

.....

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

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**(iii)** Use the article to suggest two reasons why obtaining tin from tin ore using carbon, is not a process that should be attempted in the laboratory.

1. .....

.....

2. .....

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

**(c)** There is a world shortage of tin and a student was interested to see how much tin could be obtained by recycling the tin from tin cans.
He calculated that each tin can contains 0.40 g of tin.
If the tin in 30% of the 100 million ($1 \times 10^8$) tin cans used every year is recovered, calculate the mass of tin that could be recovered in this way every year. State the unit of your answer.

mass of tin = ..... unit ..... **[2]**

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**(d)** The use of lead is subject to strict legislation. Organ pipes contain 70% of lead and 30% of tin.
The frequency of a note produced by an organ pipe depends largely on its length.
Some measurements were made of the length of organ pipes and the frequency of their notes.
The results were plotted in graph, Fig. 2.1.

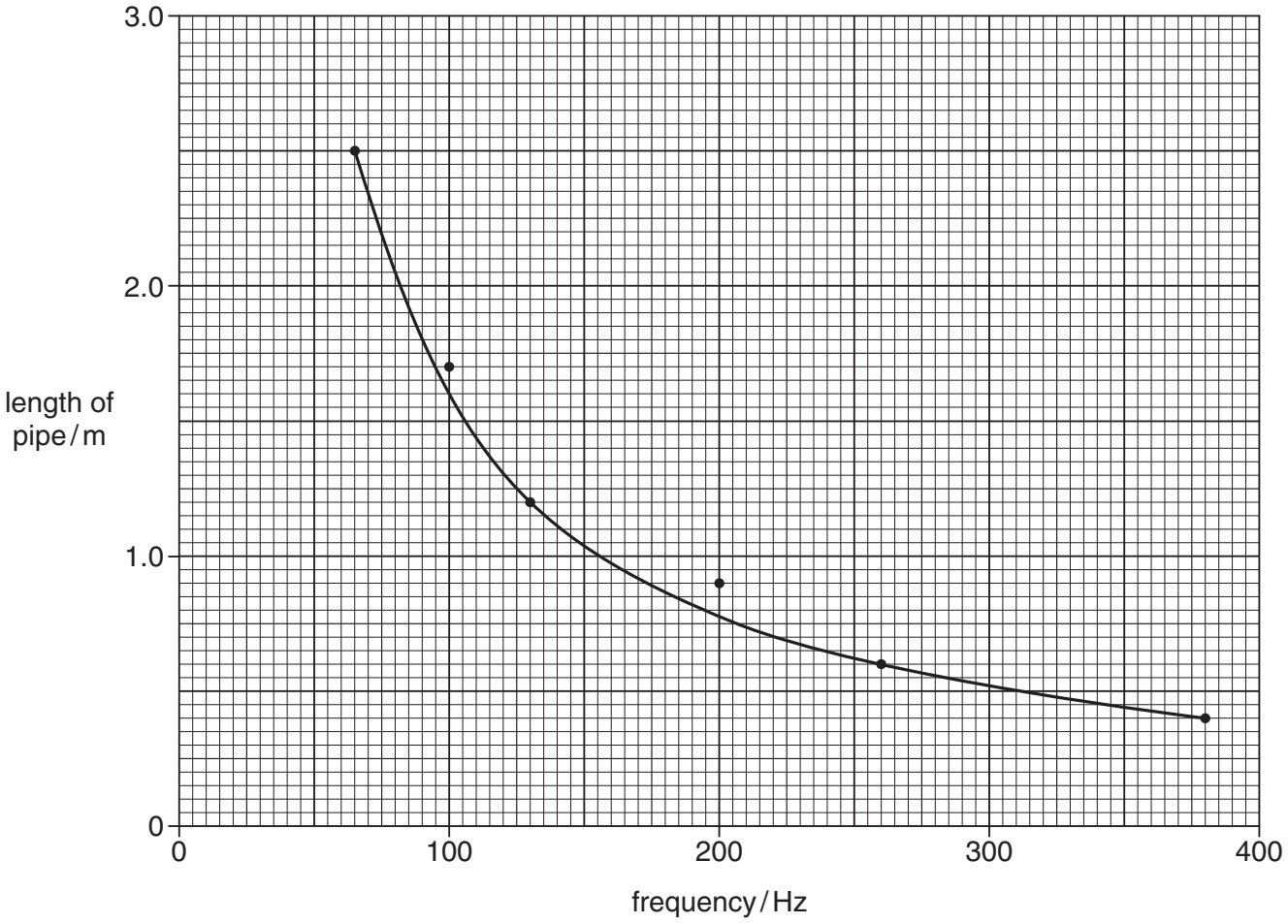


**Fig. 2.1**

**(i)** The measurement at 0.90 m, 200 Hz, does not fit on the curve drawn.
What should be done about this?

.....

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

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**(ii)** The graph can be used to calculate the velocity of sound in air, $v$, by using the formula

$$f = \frac{v}{2l}$$

where $f$ is the frequency in Hertz (Hz) and $l$ is the length of the pipe in metres.

Use the curve at a frequency of 175 Hz to calculate the velocity of sound in air, $v$.

velocity = ..... $m\,s^{-1}$ **[3]**

**(e) (i)** There are a number of methods that can be used to analyse pre-decimal British bronze coins.
State three factors that you should consider when choosing a method for this purpose.

1. .....

.....

2. .....

.....

3. .....

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

**(ii)** A pre-decimalisation penny, of mass 9.5 g, was analysed and the following percentages by mass were obtained.

copper 96.0% zinc 1.9% tin 3.1%

A student said that it was likely that the value obtained for zinc was the most unreliable.
Suggest and explain a reason to support her statement.

.....

.....

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

**(iii)** Coins that are around 900 years old are rare and of important historical significance.
Give **two** important considerations when scientists choose a method to test for the presence of tin in coins such as the Henry I silver penny shown in Fig. 2a in the article.

.....

.....

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

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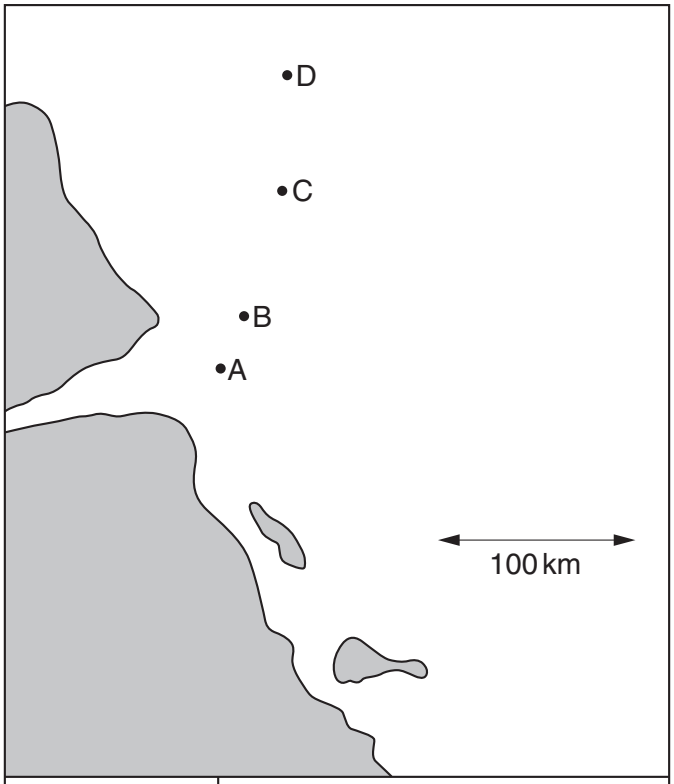
**(f)** Tributyltin compounds (TBT) cause serious harm to invertebrates.
The diagram, Fig. 2.2, shows the concentration of TBT at various places in the sea.




| sample site | concentration of TBT / ng dm$^{-3}$ | |
|---|---|---|
| | surface | 0.5 m depth |
| **A** | 21.3 | 2.7 |
| **B** | 12.7 | 2.2 |
| **C** | 7.2 | 1.7 |
| **D** | 1.0 | nil |

**Fig. 2.2**

Use this diagram to make two conclusions about the concentration of TBT in the sea.

1. .....

.....

2. .....

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

**[Total: 29]**

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**3** Ethanoic acid (acetic acid) is a very important chemical and is used to make a number of important products. A dilute solution is sold as vinegar.

**(a)** A modern method to produce ethanoic acid is to react together methanol and carbon monoxide at 200 °C at a pressure of 30 atmospheres.
State one factor that may prevent this method being used in the laboratory to make small quantities of ethanoic acid.

.....

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

**(b)** Information about two methods for making ethanoic acid in the laboratory are shown in Table 3.1.

**Table 3.1**

| | method **1** | method **2** |
|---|---|---|
| temperature / °C | 90 | 30 |
| time taken / hours | 2 | 120 |
| other products made | compound **X** | none |
| % conversion (%) | 70 | greater than 90 |

**(i)** State one advantage of method **1** compared with method **2**.

.....

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

**(ii)** State two advantages of method **2** compared with method **1**.

1. .....

.....

2. .....

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

**(iii)** The boiling points of compound **X** and ethanoic acid are 21 °C and 118 °C respectively.
Suggest a method for separating a mixture of these two liquids.

.....

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

**(iv)** The mass spectrum of compound **X** from method **1** was taken.
The spectrum showed a molecular ion peak at m/e 44.
What does this tell you about compound **X**?

.....

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

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**(v)** Compound **X** was thought to be ethanal.
The mass spectrum of compound **X** showed a number of other peaks with smaller m/e values than 44. The pattern of these peaks is called the fragmentation pattern.
How could this fragmentation pattern be used to confirm that compound **X** was ethanal?

.....

.....

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

**(vi)** When the ethanoic acid and compound **X** were separated, it was thought that some ethanoic acid might remain in the sample.
Infrared absorption spectroscopy can be used to identify bonds present in compounds.
How could a scientist use infrared absorption spectroscopy to check that compound **X** was not contaminated with ethanoic acid?

.....

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

**(c)** Some students decided to make some ethanoic acid using method **2** in Table 3.1.
They reacted together aqueous ethanol and oxygen (from air) at 30 °C in the presence of the bacteria *Mycoderma aceti*.

They tried other temperatures and found that the use of higher temperatures was less effective.
They had the choice of either the glass vessels I or II to contain the aqueous ethanol that was going to react with oxygen, Fig. 3.1.

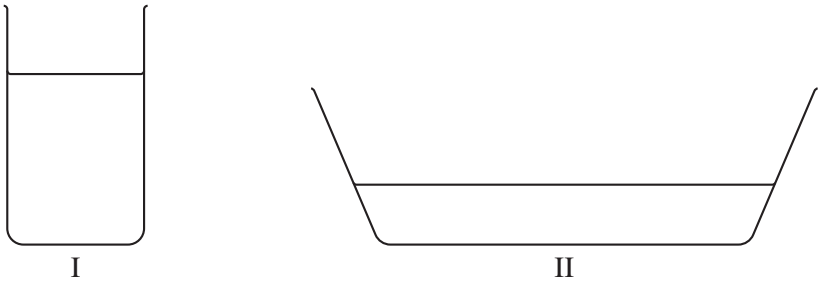


**Fig. 3.1**

**(i)** State why the students thought that using the glass vessel II would give a better result than using glass vessel I.

.....

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

**(ii)** After several hours they decided to check the effectiveness of their method.
To do this they needed to measure the density of the liquid using a hydrometer.
A hydrometer is a piece of equipment that floats in a liquid and the density is read off on a scale, Fig. 3.2.

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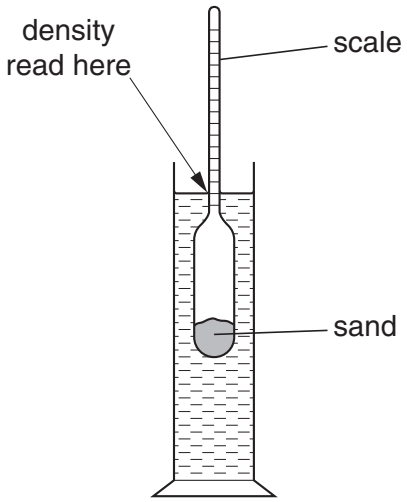


**Fig. 3.2**

You are given the following equipment and materials to make a simple hydrometer.

- long test tube and cork
- sand
- 250 $cm^3$ measuring cylinder
- marker pen
- paper and sticky tape to make a scale
- water
- salt solution

The hydrometer will need to be calibrated. For this purpose you should assume that water has a density of 1.00 $g\,cm^{-3}$ and that the salt solution has a density of 1.10 $g\,cm^{-3}$.

Describe, using the information given, how you would make a simple hydrometer that can be used to measure the density of the ethanoic acid solution that was prepared by the students.

.....

.....

.....

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.....

..... **[7]**

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**(iii)** A different method was used to find the percentage of ethanoic acid present in the solution.
In this method the ethanoic acid was neutralised by a sodium hydroxide solution of known concentration (a standard solution).
The students had not used this method before.
State what they should do before starting any practical work.

.....

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

**(iv)** The students used a total volume of 48.0 $cm^3$ of the sodium hydroxide solution to neutralise some ethanoic acid solution.
They were told that 1.0 $cm^3$ of the sodium hydroxide solution reacted with 0.030 g of ethanoic acid.
Calculate the mass of ethanoic acid that had reacted.

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

**(v)** The volume of the ethanoic acid solution used in **(iv)** was 25.0 $cm^3$.
Calculate the mass of ethanoic acid in 100 $cm^3$ of the solution.

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

**(d)** Method **2** in Table 3.1 produces ethanoic acid of almost 100% purity.
A student needs to use ethanoic acid of this purity in a project on making perfumes.
He looks at a hazard card, which states that the acid was both flammable and corrosive.
He needs to heat small quantities of the acid and an alcohol in a test tube.

**(i)** State two precautions that he should take when **handling** these materials.

1. .....

.....

2. .....

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

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**(ii)** Use the space below to describe, using a labelled drawing, how this mixture would be safely heated.

**[1]**

**[Total: 22]**

**END OF QUESTION PAPER**

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