OCR
Oxford Cambridge and RSA

Tuesday 14 June 2016 – Afternoon

A2 GCE APPLIED SCIENCE

G628/01 Sampling, Testing and Processing

Candidates answer on the Question Paper.

OCR supplied materials:
- Insert (G628/01 inserted)

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

Duration: 1 hour 30 minutes

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- The Insert will be found inside 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. If additional space is required, you should use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- 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 **28** pages. Any blank pages are indicated.

 OCR is an exempt Charity

Turn over

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 clean copies in the Insert.

This question is based on the article '**Manganese**'.

1 **(a)** The article describes the widespread occurrence of manganese nodules on the deep ocean floor.

(i) State why it is necessary to collect the nodules from the ocean bed.

....

.... **[1]**

(ii) Use information from the article to state how we know that manganese nodules are not homogeneous in nature.

.... **[1]**

(iii) Suggest how manganese nodules obtained from the deep ocean floor should be stored before analysis, so that atmospheric oxidation cannot occur.

.... **[1]**

(iv) A laboratory received some manganese nodules obtained from the ocean floor.
Each nodule was stored separately in a jar labelled with the sample number and the name of the collector.

State **two** additional details that should be written on the label of each jar.

1 ....

2 ....
[2]

(v) Each nodule was analysed separately. The first stage of the process was to grind the nodule to powder in a roller mill.

State why the rollers were cleaned between each use.

.... **[1]**

(vi) State and explain how the operator of the roller mill needs to be protected when grinding the nodules.

....

....

.... **[2]**

(vii) Analysis of a particular nodule gave the following percentages:

manganese 30; copper 2; nickel 2; cobalt 1; others 65

These percentages are displayed using a pie chart in Fig. 1.1.

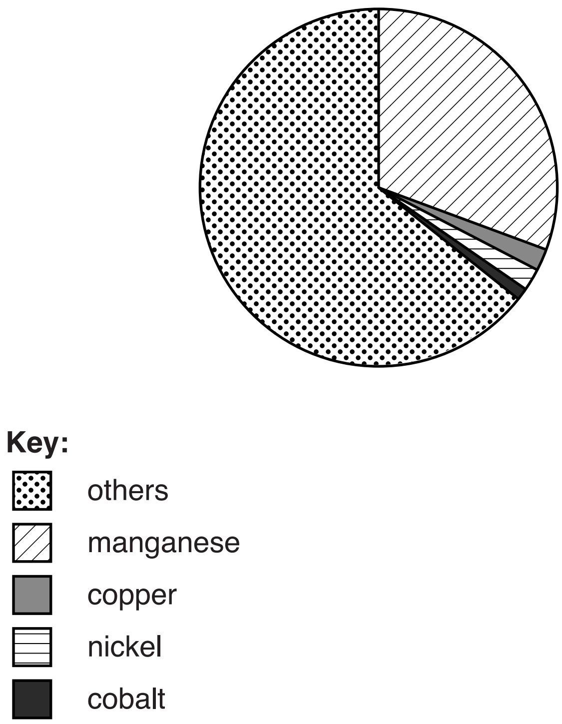


Fig. 1.1

State why this pie chart is not the best way of presenting these results and suggest a clearer way to present the results.

....

.... **[2]**

(viii) The commercial mining of manganese nodules presents a number of difficult technological and environmental problems.

Suggest **one** problem for each of the factors that the mining of these nodules presents, apart from cost.

Technological ....

....

....

Environmental ....

....

....

[2]

(b) The addition of a small quantity of manganese to aluminium used for drink cans results in an alloy that has increased corrosion resistance.

State how the mass spectrum of an aluminium alloy sample from drink cans would show the presence of manganese.

....

.... **[1]**

(c) A diagram of a dry cell is shown in Fig. 1.2.

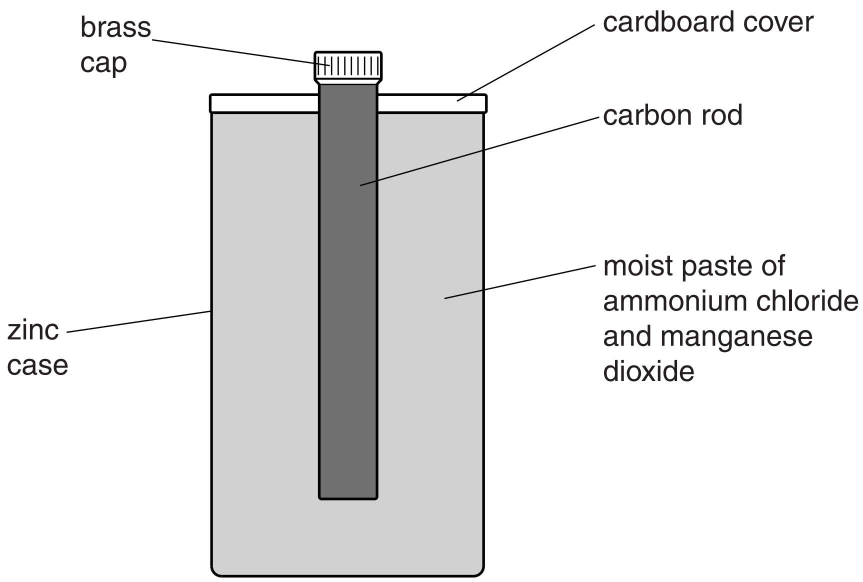


Fig. 1.2

(i) Design an experiment that would enable other students to obtain a clean dry sample of manganese dioxide from the dry cell.

Use the following information to help you with your answer:

- both zinc and brass are soft metals
- ammonium chloride is soluble in water
- manganese dioxide and carbon are both insoluble in water.

Present your answer as a numbered list, outlining the correct order of steps to complete the experiment. You should assume that a risk assessment has been done.

[6]

(ii) Examine your method in **(i) and** suggest a safety precaution that should be included in the risk assessment, giving a reason for its inclusion.

[1]

(d) The volume of oxygen produced by decomposing hydrogen peroxide can be used to find the concentration of hydrogen peroxide present in the solution. This reaction can be catalysed by manganese dioxide.

Some apparatus used for this experiment is shown in Fig. 1.3.

You can assume that the apparatus is clamped.

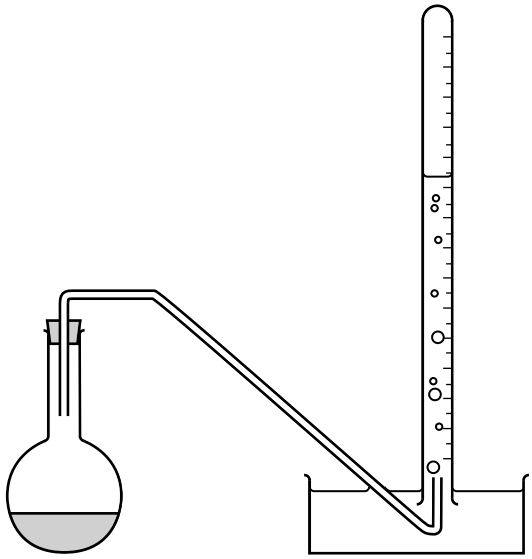


Fig. 1.3

(i) State what is meant by a catalyst.

....

.... **[1]**

(ii) In an experiment, 75.0 cm^3 of aqueous hydrogen peroxide (H_2O_2) was placed in the flask with a little manganese dioxide.

The volume of oxygen collected was 72.0 cm^3.

Use the formula below to calculate the concentration of the hydrogen peroxide.

Volume of oxygen = concentration of H_2O_2 × volume of H_2O_2 × 12.0

concentration of H_2O_2 = ... $mol\,dm^{-3}$ **[2]**

(iii) A student performed the same experiment using the same apparatus, but only obtained 66.0 cm^3 of oxygen.

Suggest **two** errors in the student's method that might have given this result.

1 ....

....

2 ....

.... **[2]**

(e) The article mentions a method to find the amount of manganese in rosebay willowherb.

Some leaves of this plant were collected, dried and then burned at 600 °C. All the organic material was oxidised to gases, leaving a white ash. This ash was then treated to give a purple solution containing potassium manganate(VII).

(i) State why the leaves from several different plants were used to obtain a representative sample for this experiment.

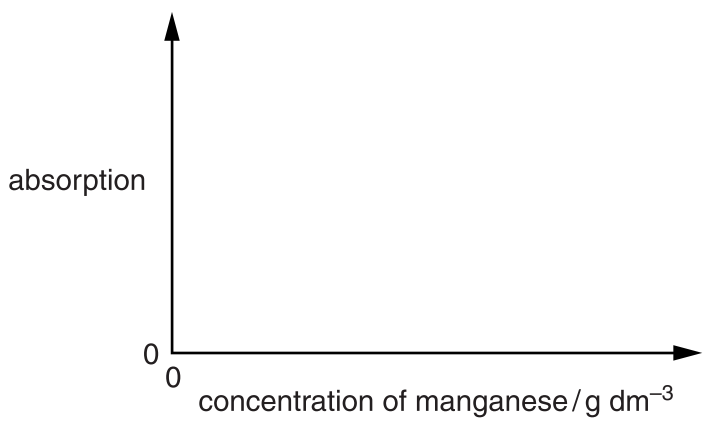
....

.... **[1]**

(ii) The concentration of manganese present in the purple solution was then found by colorimetry.

A number of samples of known manganese concentration were prepared and their absorption measured using a colorimeter.

Use the axes below to sketch the graph that would be obtained from these results.



[2]

(iii) In the experiment the graph showed that

concentration of manganese in $g\,dm^{-3}$ = 0.56 × absorption

A sample of ash of mass 8.40 g was treated and made up to produce 1.0 dm^3 of the purple solution. This solution gave an absorption reading of 0.18.

Calculate the concentration of manganese in the purple solution and hence the percentage of manganese in the ash. Show your working.

% manganese in the ash = ... **[2]**

(iv) A student said that the answer to **(iii)** above was the percentage of manganese in the plant.

Comment on this statement, explaining your answer.

....

....

....

.... **[2]**

(f) The article describes the use of potassium manganate(VII) in water purification.

(i) During this purification some sediment of brown-black manganese dioxide is produced.

Suggest how this sediment can be removed by filtration from a **large** water sample of several hundred litres.

....

.... **[1]**

(ii) In an experiment, the concentration of the potassium manganate(VII) in the test solution was $0.40\,mg\,cm^{-3}$.

It was found that $1.5\,cm^3$ of this solution was just enough to purify $2000\,cm^3$ of water.

Calculate the mass of potassium manganate(VII) that would be needed to purify $2500\,dm^3$ of water in a storage tank.

Show your working.

mass needed = ... g **[2]**

[Total: 35]

This question is based on the article '**Oranges**'.

2 **(a)** The article mentions the problem of citrus greening disease.

(i) When citrus greening disease occurs the affected area needs to be quarantined.

State what is meant by the term 'quarantine'.

....

.... **[1]**

(ii) Citrus greening occurs because of sap-sucking psyllid insects. A company sets out to produce an effective insecticide that could deal with this problem.

Suggest **two** desirable properties of the insecticide.

1 ....

....

2 ....

....

[2]

(b) Picked oranges sometimes have a green colour instead of the characteristic orange colour. These oranges are placed in a de-greening room to ensure that the oranges are ready for the next stage.

Table 2.1 shows the typical conditions inside a de-greening room.

temperature	around 29 °C
relative humidity	around 94%
ethene concentration	1 to 5 ppm
air circulation	changed every minute
time of de-greening	maximum of 60 hours

Table 2.1

(i) A student visiting a storage depot asked what would happen if the green oranges still did not change to the correct colour. The technician replied that she would investigate the problem by changing one of these conditions at a time.

Suggest why she gave this reply.

....

.... **[1]**

(ii) The technician added that 60 hours in the de-greening room was the maximum amount of time for the oranges, and that as short a time as possible was desirable.

Suggest why it is desirable for the oranges to have as short a time as possible in the de-greening room.

....

.... **[1]**

(c) Oranges are finally packed in standard-sized boxes.

(i) The total mass of the box and the oranges is checked to see if filling has been done correctly.

The mass of the empty box is 5 kg, and holds 64 oranges each of mass 240 g.

Use this information and your answer to **(c)(i)** to calculate the total mass of the box when it is filled with oranges.

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

(ii) It has been suggested that the size of the standard box could be changed.

Suggest an important factor that should be taken into account when designing this new box.

....

....

.... **[1]**

(d) Samples of ripe oranges are tested as part of quality control. Table 2.2 shows some results from a sample of Californian oranges.

Use this data and the information in the article to complete the table.

You may use the blank space for any calculations.

Number of oranges picked	8
Total mass of oranges / g	1945
Mean mass of each orange / g	243
Total juice from the oranges / g	....
Percentage juice	50.6
Percentage acid in juice	1.50
Total mass of acid in juice / g	....

Table 2.2

[2]

(e) The article states that frozen concentrated orange juice (FCOJ) has a Brix level of 65 °Bx (65 g of sugar in 100 g of solution). It is exported in drums that each contain 200 dm^3 of FCOJ. Ready-to-serve orange juice has a Brix level of 12 °Bx.

Calculate how much water should be added to FCOJ to bring the contents of each drum of FCOJ down to 12 °Bx.

(You should assume that both 1.0 g of water and 1.0 g of orange juice have a volume of 1.0 cm^3).

.... dm^3 **[3]**

(f) **(i)** The ready-to-serve orange juice, prepared in **(e)** above, was tested in the laboratory to see if the correct concentration had been made.

For this purpose, a sample of orange juice was placed in a measuring cylinder and a hydrometer used to measure its density (Fig. 2.1).

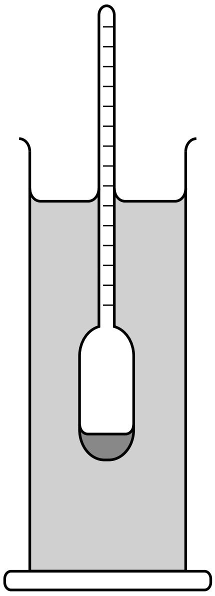


Fig. 2.1

You are provided with a narrow test tube with a blank label attached to the side, some lead shot, a pencil, ruler and a measuring cylinder. You are also provided with some distilled water (density 1.00 $g\,cm^{-3}$) and some sugar solution (density 1.20 $g\,cm^{-3}$).

Describe six stages that you would follow to make a simple hydrometer.

1 ....

....

2 ....

....

3 ....

....

4 ....

....

5 ....

....

6 ....

....

[6]

(ii) The hydrometer made in **(i)** above is to be used to find the density of some orange juice.

State what should be done before this hydrometer is used.

.... **[1]**

(g) A student found that a more accurate result for the percentage of sugar in orange juice could be found by measuring its refractive index. She used an accurate refractometer and obtained the following results for water and an orange juice containing a high percentage of sugar (Table 2.3).

percentage sugar	refractive index
0.0	1.3330
70.0	1.4651

Table 2.3

She constructed a graph of refractive index against percentage of sugar and drew a straight line between the two points, so that the percentage of sugar in other solutions could be found.

State what assumption she made in the drawing of this graph.

....

.... **[1]**

(h) The article states that infrared absorption spectroscopy can be used to find the concentration of sugar in orange juice by using the intensities of certain frequencies.

State what feature of a molecule is responsible for the peaks in an infrared spectrum.

.... **[1]**

(i) Orange flower oil is obtained from orange flowers by steam distillation.

State the difference between steam distillation and simple distillation.

....

....

....

.... **[2]**

(j) A separating funnel (Fig. 2b in the article) can be used to separate orange flower oil from the aqueous layer.

State **two** conclusions about these two liquids that can be made from the description in the article.

1 ....

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

(k) A gas-liquid chromatogram was taken of some orange oil and is shown in Fig. 2.2.

Compound	**Relative peak area**
A	7
B and C	16
D	74
E	9
F	8

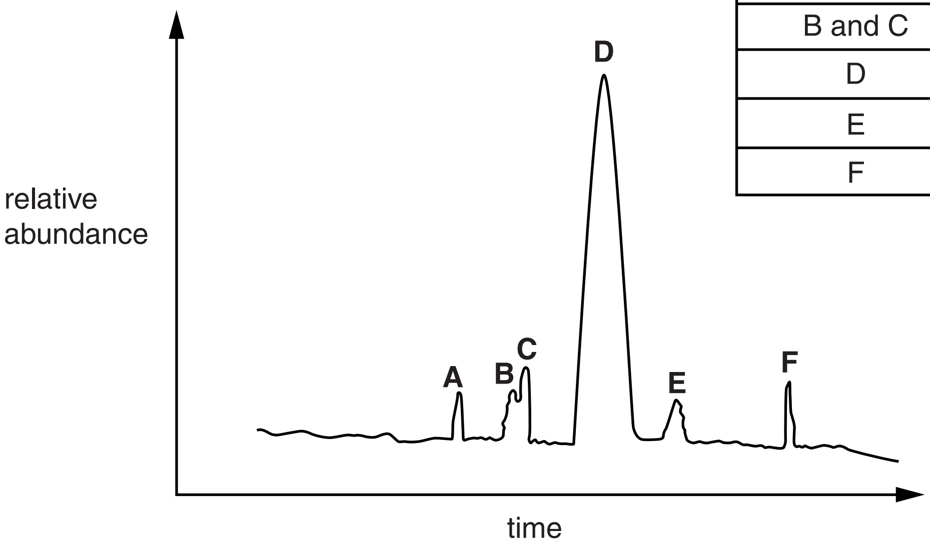


Fig. 2.2

(i) The oil consists mainly of limonene.

Calculate the total percentage (by volume) of the other components present.

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

(ii) Compound **A** is likely to be myrcene.

How could you confirm that myrcene is present using gas-liquid chromatography?

....

.... **[1]**

(iii) Peaks **B** and **C** have similar retention times.

Suggest how the technique of gas-liquid chromatography could be adapted to allow these peaks to be separated.

....

.... **[1]**

(l) The main constituent of orange oil, limonene, is an effective insecticide against fire ants. A mixture of sugar residues (molasses) and limonene are mixed in soapy water.

This mixture has been tested against fire ants, and has been shown to be a simple and effective remedy against these ants.

Suggest **one** advantage of this mixture when compared to commercially available treatments. Do not refer to cost in your answer.

.... **[1]**

[Total: 29]

3 A group of students was given some small pieces of brass (an alloy of copper and zinc) and asked to find out about its physical properties and composition.

(a) Before commencing work they had to remove the greasy coating on the brass pieces. They were told that the grease was not water-soluble.

(i) Suggest how they would treat the brass so that samples of clean dry brass were available for use.

....

.... **[1]**

(ii) Suggest how the students could confirm that the pieces of brass were completely dry.

....

.... **[1]**

(b) The density of a sample of brass was found by finding its mass and then immersing the sample in water to find its volume.

The following results were obtained:

Mass of brass = 57.8 g
Volume = 6.9 cm^3

A student used these figures to calculate the density of brass and the answer on her calculator was 8.3768 $g\,cm^{-3}$.

(i) Use the student's answer to state the density of brass to an appropriate number of significant figures.

density of brass = ... $g\,cm^{-3}$ **[1]**

(ii) The graph (Fig. 3.1) shows the density of pure zinc and of pure copper.

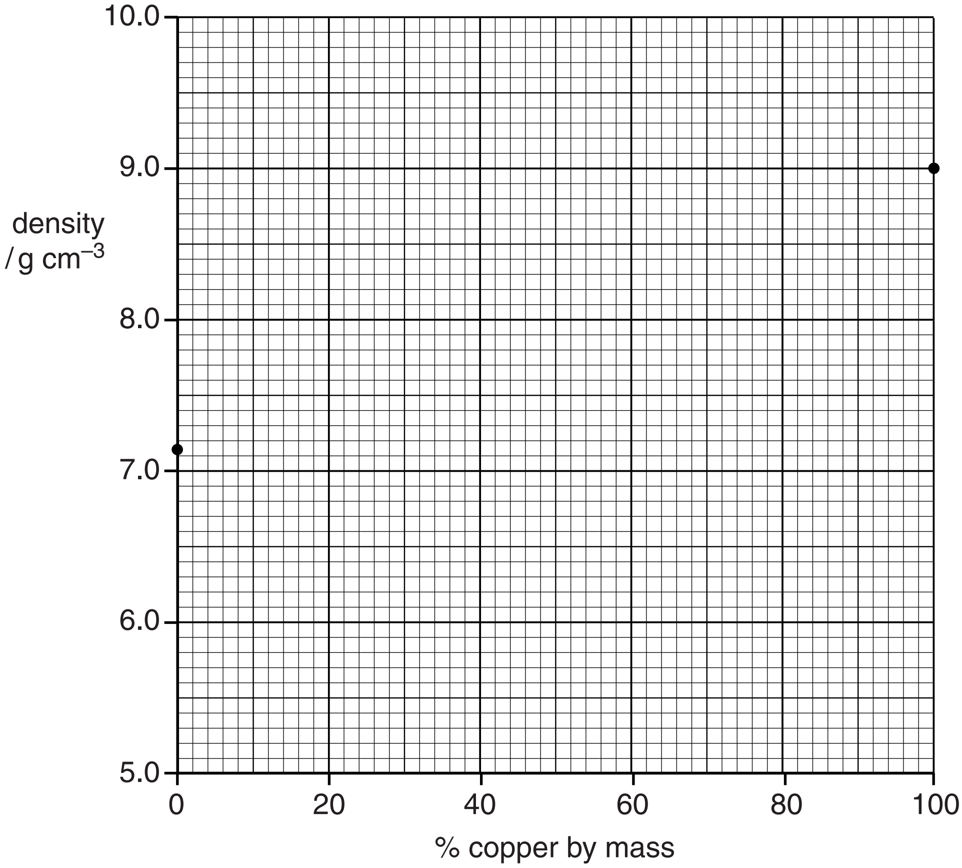


Fig. 3.1

Suggest why this graph cannot be reliably used to find the composition of the brass.

....

.... **[1]**

(c) Moh's hardness scale provides a simple way of comparing the relative hardness of materials. The lower the number, the softer the material.

material	hardness
talc	1
gypsum	2
calcite	3
fluorite	4
apatite	5
orthoclase	6
quartz	7
topaz	8
corundum	9
diamond	10

Table 3.1

A harder material will scratch a softer material, but not vice versa. For example, a piece of topaz will scratch quartz but it will not scratch corundum.

A student found that brass scratches calcite but not apatite.

(i) Suggest the Moh's hardness range for a piece of brass.

from .... to .... **[1]**

(ii) Suggest what should be done using Moh's method to obtain a more precise value for brass.

.... **[1]**

(d) The Brinell hardness test is a more precise way of testing the hardness of materials. A steel ball is pressed onto the material for 10 seconds (Fig. 3.2). The diameter of the indentation (Fig. 3.3) is measured to enable the Brinell hardness number to be calculated.

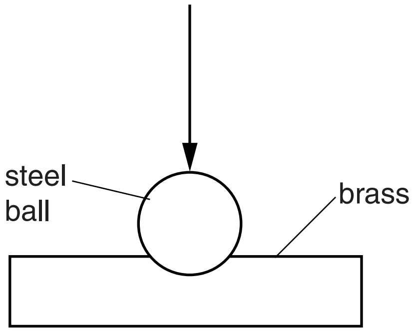


Fig. 3.2

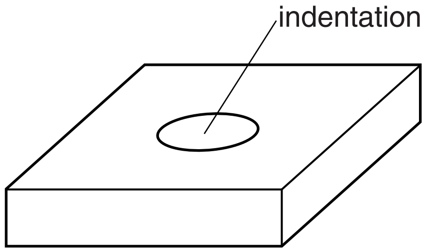
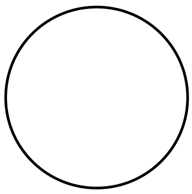


Fig. 3.3

(i) In practice, a microscope is used to measure the diameter of the indentation.
Use Fig. 3.4 and the magnification to calculate the actual diameter of the indentation.



Magnification × 300

Fig. 3.4

actual diameter = ... mm **[2]**

(ii) State **two** factors that would increase the diameter of the indentation, using the same steel ball.

1 ....

2 ....

[2]

(e) There are a number of methods to find the percentage of copper and zinc in brass. Students were asked to research simple methods that could be carried out by them in the laboratory.

(i) One suggested method is to dissolve the brass in nitric acid. The blue colour of the copper nitrate solution produced is then compared with the colours of samples of copper nitrate solution of known concentration. Zinc nitrate solution is colourless.

If this method was to be tried, what two quantities must be known when dissolving the brass in nitric acid?

1 ....

2 ....
[2]

(ii) Another suggested method is to add the brass to a different acid, when the zinc would react, giving a colourless solution of zinc chloride and leaving behind the copper.
When this method was tried by the students, it did not work very well and the solution obtained was pale blue instead of colourless.

1. How would this result affect the apparent percentage of copper in the brass?

....

.... **[1]**

2. Suggest how the experiment could be modified to give a more accurate result for the percentage of copper in the brass.

.... **[1]**

(f) Some students in India studied the corrosion of brass panels in a river estuary over a period of one year.

Corrosion of the brass produces toxic copper ions in the water, which inhibit the growth of biomass on the panels.

Readings of the corrosion rate and the amount of biomass deposited on the panels were obtained every two months. The results are shown in Fig. 3.5 and Fig. 3.6.

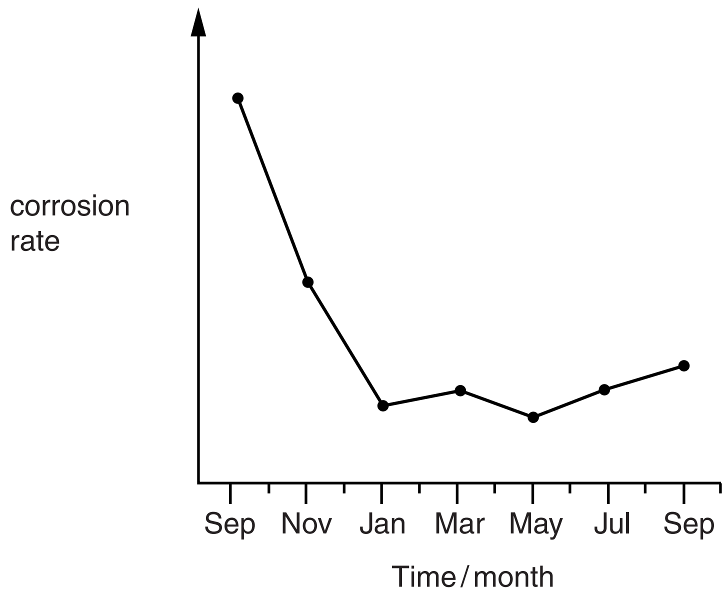


Fig. 3.5

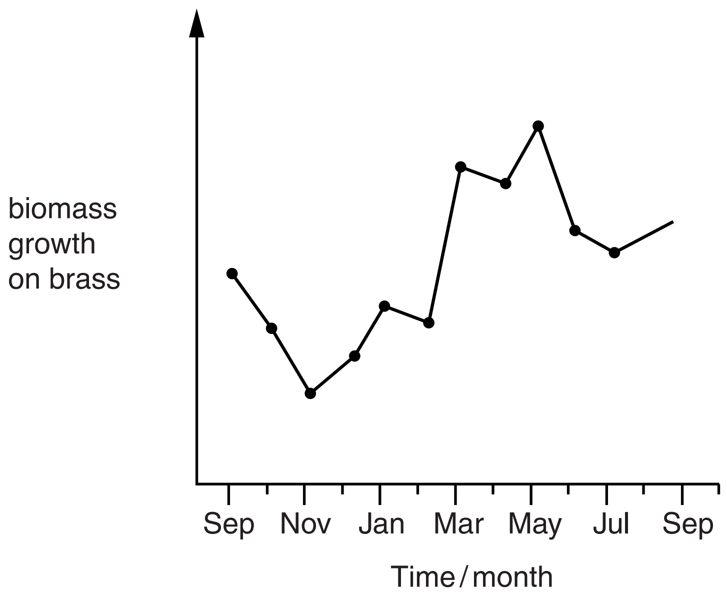


Fig. 3.6

The monsoon is a heavy rainy season that lasts from June to August.

Study Fig. 3.5 and Fig. 3.6 and then answer the questions below.

(i) State how the corrosion rate of the brass panels changes over the period of study from September to June.

....

.... **[1]**

(ii) Use both graphs to suggest why this change in corrosion rate has occurred.

....

....

.... **[2]**

(iii) Suggest why the corrosion rate and the quantity of biomass change during the monsoon season.

....

.... **[1]**

(iv) Suggest another factor, apart from the various concentrations of salinity (salt water), that could affect the corrosion rate of brass panels in this river estuary.

....

.... **[1]**

(v) Design an experiment to extend this study on brass corrosion by considering the effect of various concentrations of salinity (salt water) on samples of brass sheet.

You should assume that the brass sheets are clean and of uniform thickness.

As part of your answer, you should mention the:

- factors that you would keep constant
- factors that you would vary
- measurements that you would take.

It is not necessary to describe how you would use your results to form conclusions.

[7]

[Total: 26]

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).