

Modified Enlarged 18 pt

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Thursday 26 May 2022 – Morning

Level 3 Cambridge Technical in Applied Science

05847/05848/05849/05874/05879

Unit 2: Laboratory techniques

Time allowed: 2 hours plus your additional time allowance

You must have:

the Data Sheet

a ruler (cm/mm)

the Periodic Table

You can use:

a scientific or graphical calculator

an HB pencil

Please write clearly in black ink.

**Centre
number**

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**Candidate
number**

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First name(s) _____

Last name _____

**Date of
birth**

D	D	M	M	Y	Y	Y	Y
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READ INSTRUCTIONS OVERLEAF

INSTRUCTIONS

Use black ink. You can use an HB pencil, but only for graphs and diagrams.

Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.

Answer ALL the questions.

INFORMATION

The total mark for this paper is 90.

The marks for each question are shown in brackets [].

ADVICE

Read each question carefully before you start your answer.

Answer ALL the questions.

- 1 AIDS is an infectious disease caused by the human immuno-deficiency virus (HIV).**

The virus is spread from person to person through infected body fluids, such as blood.

A phlebotomist is the name of a person trained to take blood samples from patients.

Blood samples are taken from patients and tested to see if the patient has been infected with HIV.

A blood sample is removed from the patient's arm, using a needle attached to a syringe.

Each sample is collected in a small tube or vial.

- (a) Phlebotomists must follow regulations set out in the Health and Safety at Work Act 1974.**

Put a tick (✓) in the boxes that show TWO of the responsibilities of phlebotomists, when taking blood samples. [2]

Take care of their own health and safety and that of others.	
Be paid more than the minimum wage.	
Co-operate with their employer on health and safety issues.	
Not work more than 8 hours.	
Take a rest break during the working day.	

- (b) The phlebotomists and their supervisors often carry out a risk assessment of the procedure for taking blood samples.

There are five steps involved in completing a risk assessment.

Complete the sentences using words from the list to show the five steps.

record

hazards

review

harmed

risks

- 1 Before completing the procedure, look for potential

_____ .

- 2 Identify who might be _____
and how.

- 3 Evaluate the _____ and
consider ways to reduce them.

- 4 Write up the findings of the assessment as a formal
_____ .

- 5 Revise and modify the procedure as part of a
_____ . [2]

(c) State TWO hazards to the phlebotomist when taking blood samples.

1

2

[2]

(d) State ONE precaution that the phlebotomist could take to reduce the chances of infection by the blood.

[1]

(e) State how the phlebotomist should dispose of the needle safely.

[1]

(f) It is important to label substances with warning signs to inform others of the dangers.

(i) Put a tick (✓) under the correct symbol used by phlebotomists to identify the hazard of blood samples. [1]

☐☐☐

- (ii) Explain why the label on the blood sample has a code and not the patient's details.

[1]

- (iii) The label must be attached to the side of the tube and not the lid.

Give a reason for this.

[1]

- (g) Suggest why the blood sample must be transported in a sealed bag.

[1]

- (h) A range of biological materials can be stored for long periods of time in laboratories.

Draw a line to link each TYPE OF BIOLOGICAL MATERIAL to the most appropriate STORAGE METHOD. [3]

TYPE OF BIOLOGICAL MATERIAL

Embryos

Hair

Blood samples

STORAGE METHOD

Refrigerator

A dry place

Liquid nitrogen

- 2 Environmental scientists study air samples to provide evidence of how humans affect the atmosphere.**

One technique used to identify the chemicals in the atmosphere is GC-MS.

- (a) Tick (✓) the box next to the correct meaning of GC. [1]**

Generic chemistry	<input type="checkbox"/>
Gas chromatography	<input type="checkbox"/>
Geographical climate	<input type="checkbox"/>
Glacial constituent	<input type="checkbox"/>

- (b) GC-MS is frequently used to study pollutants in the atmosphere of cities.

In one such investigation, scientists analysed snow samples collected in a city park over the winter period. By studying the GC spectra of fresh snow and old snow, the scientists could compare the pollutants present in the snow.

FIG. 2.1 opposite shows the GC spectra of old snow and fresh snow in the investigation.

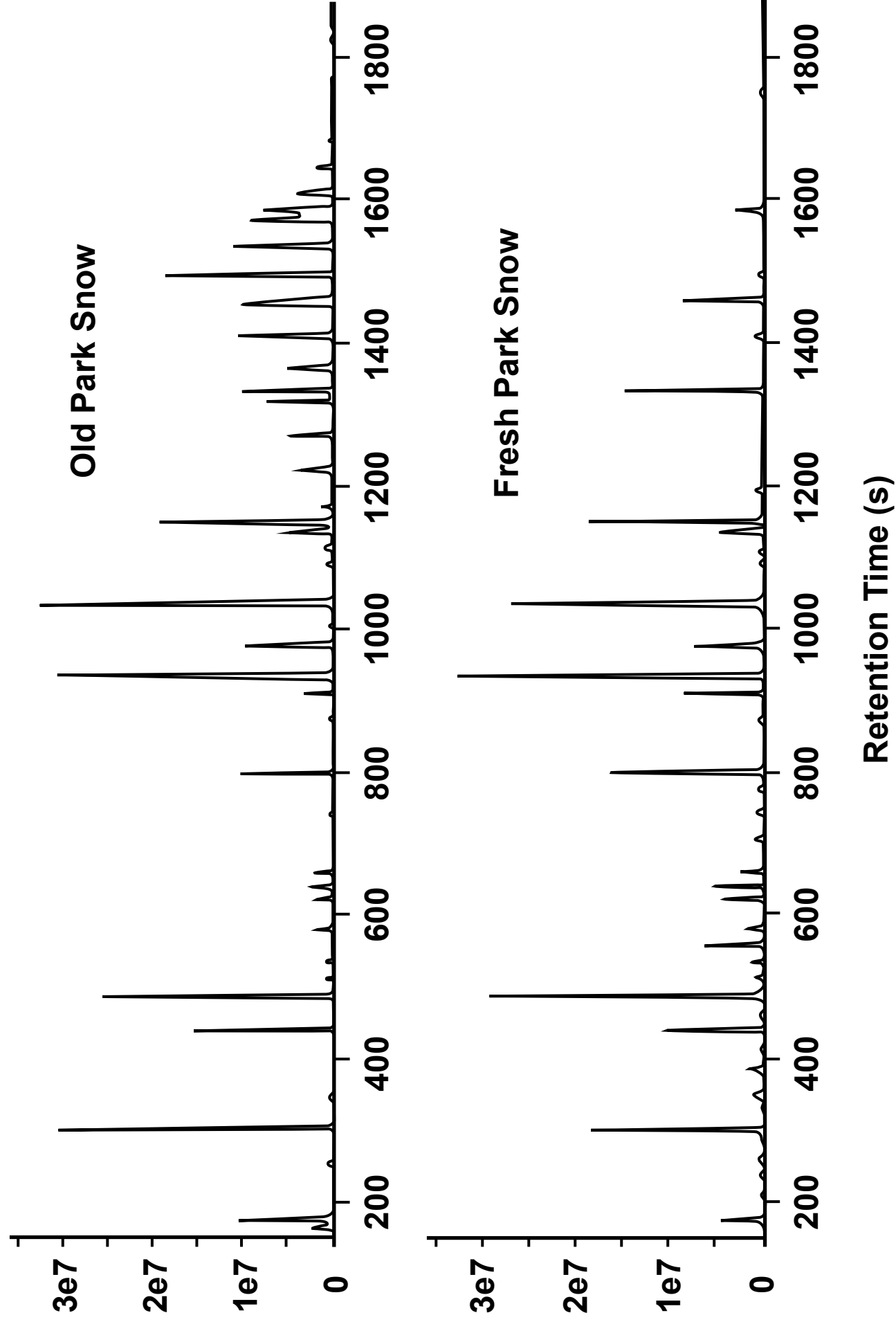
- (i) Explain how the results show that old snow is more contaminated than fresh snow.

[1]

- (ii) Using the spectra in FIG. 2.1 opposite put a tick (✓) for each retention time in the table to indicate if the compound is present in both fresh snow and old snow OR if it is an additional pollutant in the old snow. You should only put ONE tick in each row. [3]

Retention time (s)	Present in fresh and old snow	Additional pollutant
300		
800		
1500		

FIG. 2.1



- (iii) One of the compounds identified in the GC spectrum of old snow has a retention time of 1210 s.

Write the letter N above the correct peak on FIG. 2.1 to show its position on the spectrum. [1]

- (iv) Complete the two sentences below using words from the list.

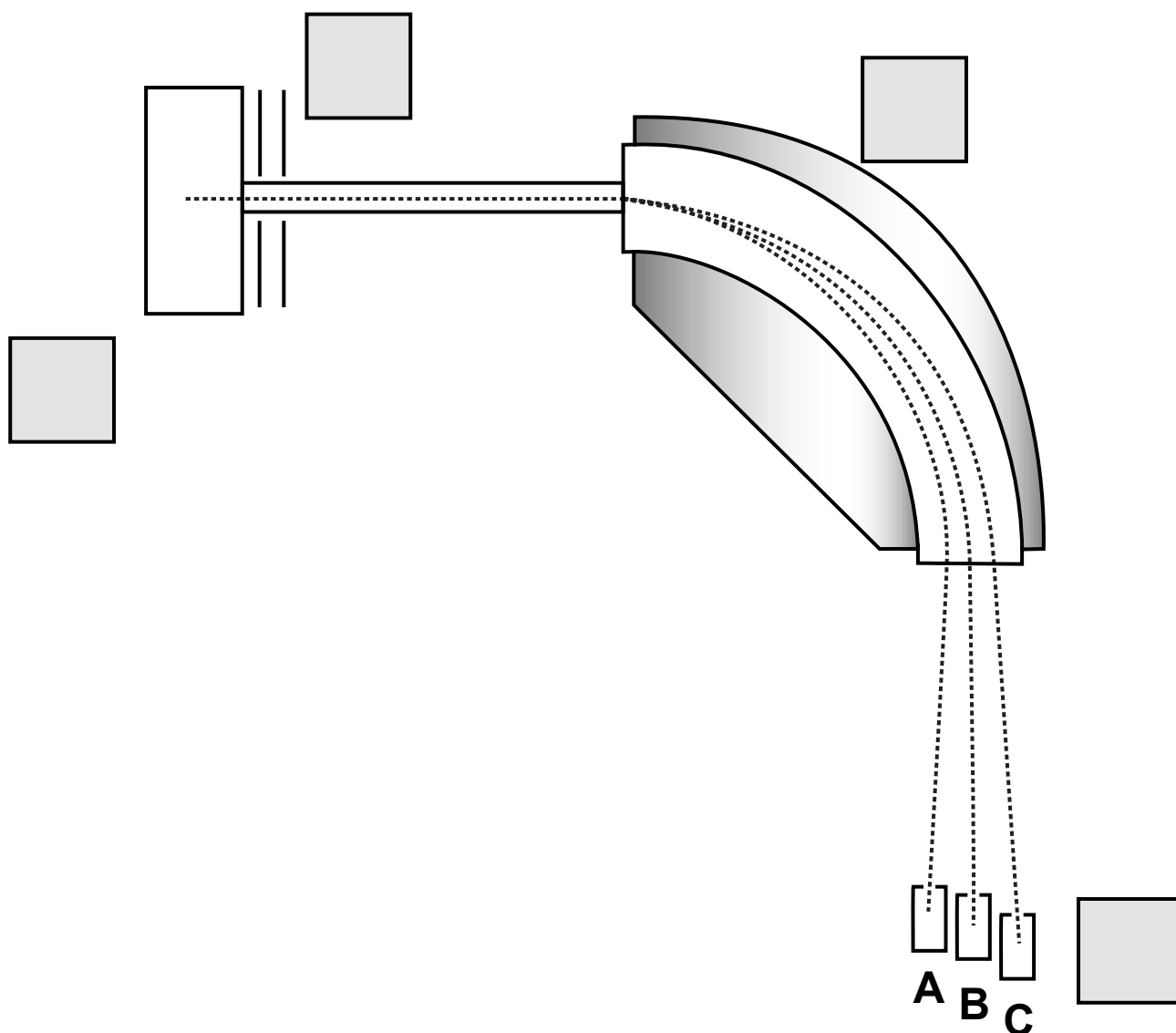
positive	standards	aliquot	calibration
area	negative	dilutions	volume

- 1 Peaks in a GC spectrum can be identified by comparing their retention times with the retention times of known _____ .
- 2 The amount of each substance can be determined from the _____ under the peak.
To do this a _____ curve is needed. [3]

- (c) A mass spectrometer was connected to the GC machine so that each compound in the snow could be identified.

FIG. 2.2 is a block diagram of a mass spectrometer.

FIG. 2.2



- (i) The statements (numbered 1 to 4) show the main parts of a mass spectrometer.

Put the number of the statement into each shaded box in FIG. 2.2 next to where the statement applies. [4]

1 The magnet separates the ions

2 The sample is ionised

3 The ions are detected

4 The ions are accelerated

- (ii) State which letter (A, B or C) indicates the position where the heaviest ion is registered.

[1]

- (iii) Explain how scientists can use mass spectrometry to identify an unknown compound.

[1]

3 Chemists use a variety of techniques to identify the compounds present in a sample.

(a) Ali is learning how to identify cations in unknown compounds.

They carry out a flame test by placing a small amount of the powdered compound onto a wire loop.

They then place the loop in a non-luminous flame and observes the colour of the flame.

(i) Circle the word that describes the charge on cations. [1]

positive

negative

neutral

(ii) The label on the bottle of powder is barium sulphate.

State the colour of flame that Ali should see.

[1]

(iii) When Ali carries out the flame test, the flame colour is red.

Draw a circle around the cation that is likely to be present in the powder. [1]

lithium

magnesium

sodium

potassium

copper (II)

- (b) Emma works as a technician in an analytical laboratory.**

They measure the concentration of cations in soil samples to see if the soil is contaminated.

Emma uses a technique called inductively coupled plasma-atomic emission spectroscopy (ICP-AES).

They use this to measure the amount of lead in soil samples.

Emma shows Ali how to use ICP-AES. Ali asks about the advantages of ICP-AES over flame tests.

- (i) Put ticks (✓) in the TWO boxes that show the advantages of using ICP-AES. [2]**

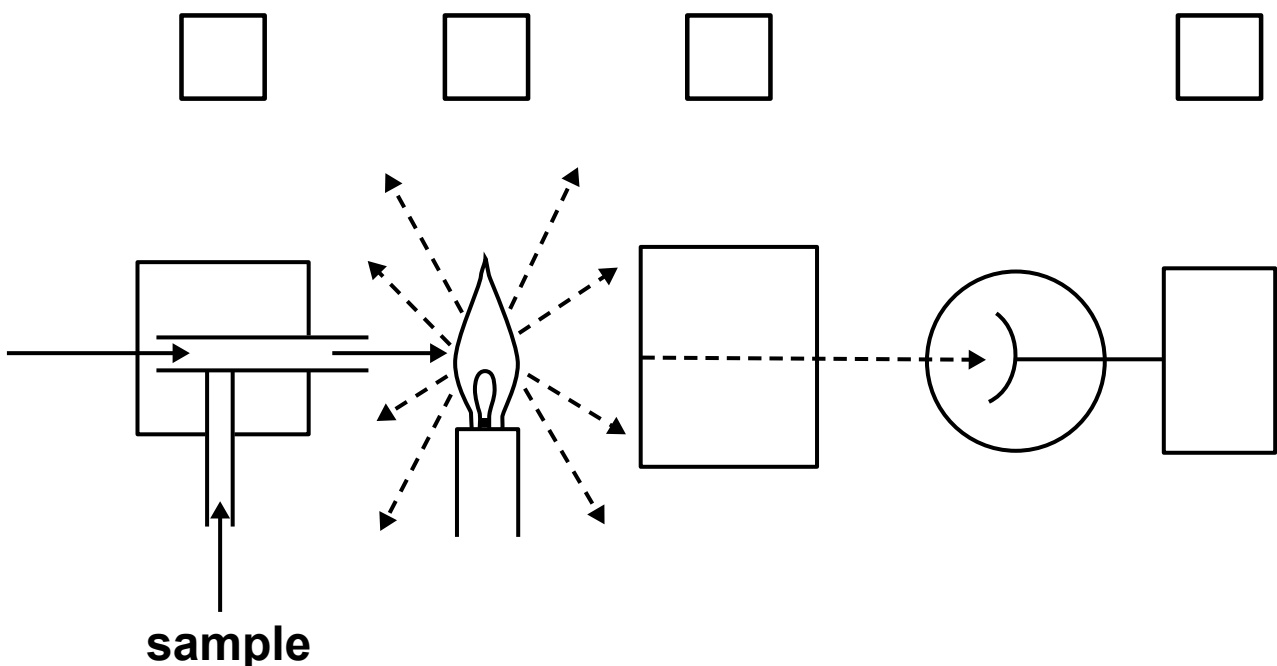
It is a very cheap way to determine the quantity of an element in a sample.	
It is a very reliable method of determining the quantity of an element in a sample.	
It can detect very small amounts of cations.	
It can detect anions as well as cations.	

- (ii) Emma uses a diagram shown in FIG. 3.1 to explain how ICP-AES works.

They label the diagram to indicate the four stages involved.

- A Light is emitted from the sample when it is heated
- B The wavelength of the emitted light is measured
- C The sample is converted to an aerosol using argon gas
- D The light is split into a spectrum

FIG. 3.1

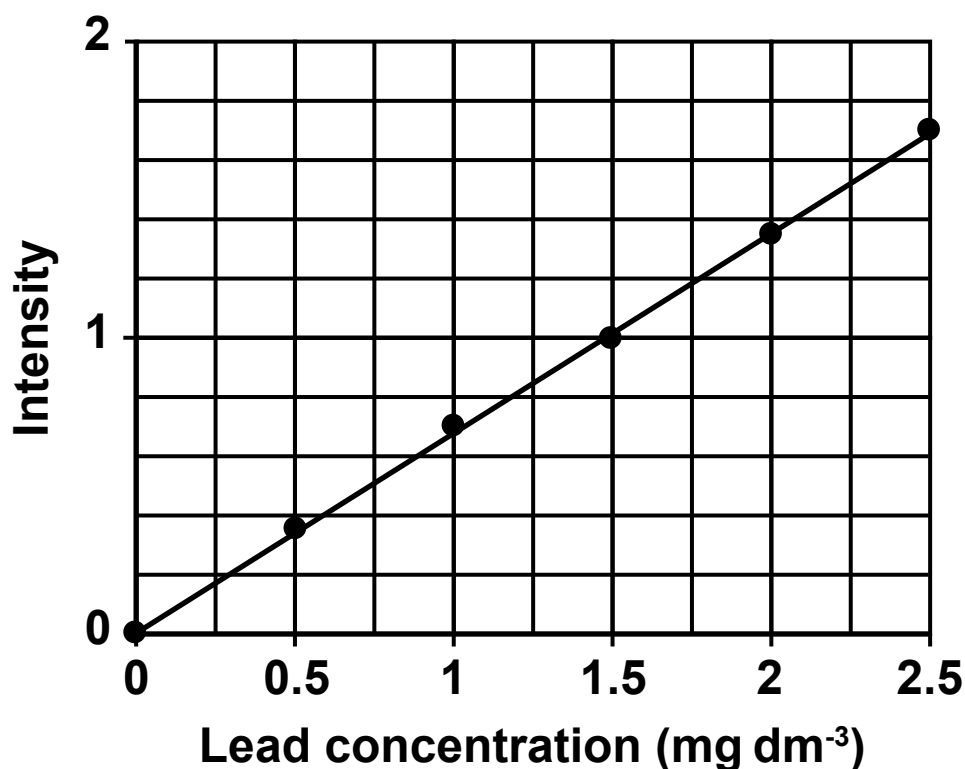


Write the letter (A, B, C or D) of the correct statement in the boxes in FIG. 3.1 to indicate what happens at each stage. [4]

- (c) Ali and Emma then test some soil samples to determine the amount of lead present.

They start their investigation by producing a calibration graph using known concentrations of lead. The graph is shown in FIG. 3.2.

FIG. 3.2



Below is a summary of the method they use to test the soil sample.

Add 10 cm³ of nitric acid to 1.5g of soil and heat the mixture for 20 minutes.

When all the lead compounds in the soil have dissolved, filter the mixture to remove any solids.

Add distilled water to the filtrate until the total volume is 50 cm³.

Place the sample solution in the ICP-AES machine and measure the light intensity.

- (i) The soil sample gave a light intensity of 0.60.
Determine the concentration of lead in the sample solution.
Show on the graph how you arrived at your answer.

Concentration of lead in sample solution =
_____ mg dm^{-3} [2]

- (ii) Calculate the mass of lead in the 50 cm^3 sample.

Mass of lead = _____ mg [2]

- (iii) The safe allowable level of lead in soil is 22 mg per kilogram of soil. Above this value, the soil is classed as being contaminated.

State if the soil sample was contaminated, justifying your answer with an appropriate calculation.

[2]

- 4 Bryozoans are microscopic sea creatures that can form layers on surfaces.

They are important because they affect the performance of submersed man-made structures by fouling them.

They are also an important part of ecosystems and if they die this can indicate pollution.

FIG. 4.1 opposite shows an electron micrograph of a layer of bryozoans. FIG. 4.2 opposite is a light micrograph of a layer of bryozoans. In both images a single bryozoan has been labelled B.

Electron microscopy and light microscopy have different advantages.

FIG. 4.1

$$1 \text{ nm} = 1 \times 10^{-9} \text{ m}$$

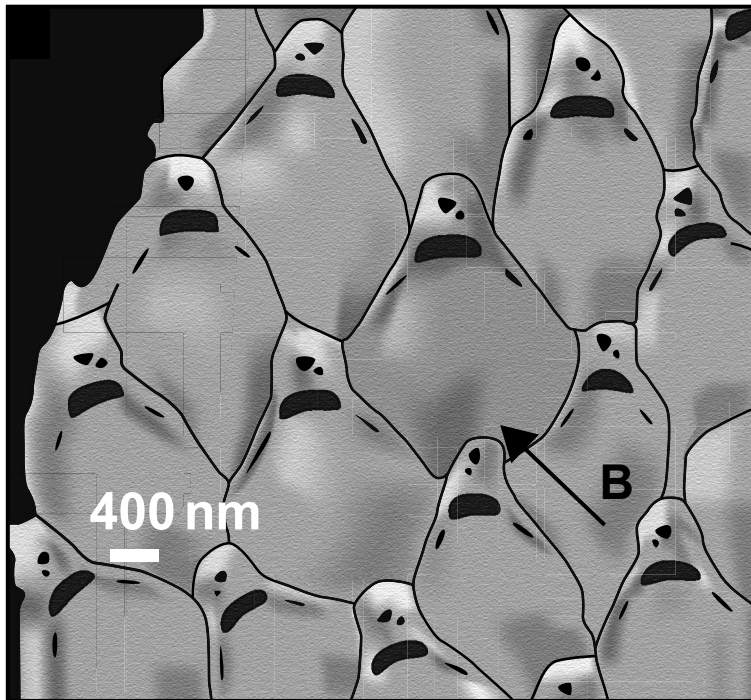
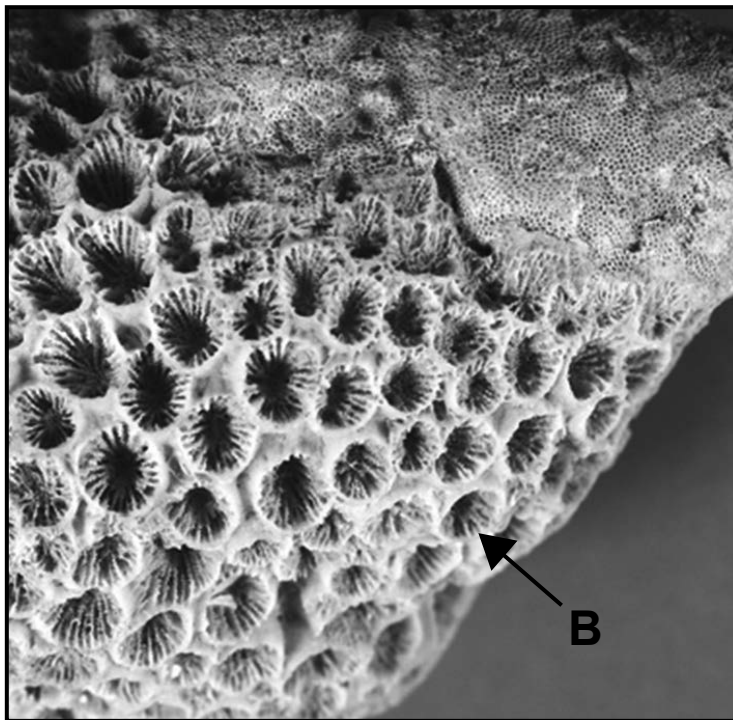


FIG. 4.2



- (a) State ONE advantage of electron microscopy shown in FIG. 4.1.

 [1]

- (b) With reference to FIG. 4.1 and FIG. 4.2, state TWO advantages of light microscopy.

1

2

 [2]

- (c) State ONE disadvantage of light microscopy that is NOT shown in FIG. 4.2.

 [1]

- (d) Other than cost, suggest ONE advantage of using a hand lens to view bryozoans.

 [1]

- (e) Put a tick (✓) in the TWO boxes that are types of electron microscopes. [2]

Scanning	<input type="checkbox"/>
Sonorous	<input type="checkbox"/>
Tangential	<input type="checkbox"/>
Transmission	<input type="checkbox"/>

- (f) Use the scale bar of 400 nm in FIG. 4.1 to estimate the actual size of a bryozoan.

Use the bryozoan labelled B in the centre of the electron micrograph image.

Using a ruler, measure the widest part of the bryozoan.

Give your answer in metres.

Width = _____ m [2]

- (g) Use a ruler to estimate the width of the image of the bryozoan labelled B in FIG. 4.1 and in FIG. 4.2.

Use the widest part of each bryozoan to complete your measurements.

Calculate how many times greater the magnification of the electron microscope is than that of the light microscope.

Electron microscope = _____ x
greater magnification [2]

(h) A student is using a light microscope.

The microscope has a x10 eyepiece lens and a x40 objective lens.

Calculate IN NANOMETRES the actual length of an object that will appear 3 mm long when viewed by the student using the microscope.

Give your answer in standard form.

Actual length = _____ nm [4]

5 Acid rain is caused by emissions into the atmosphere when fossil fuels are burned.

(a) A science student is doing a project on acid rain. They decide to carry out a titration to determine the concentration of acid in samples of rainwater. They plan to use 0.2 mol dm^{-3} sodium hydroxide for the titration.

(i) The student asks the science technician to prepare 250 cm^3 of a 0.2 mol dm^{-3} solution of sodium hydroxide (NaOH).

Explain how the technician should do this accurately.

In your answer you should include a calculation to work out the mass of sodium hydroxide they would need and the apparatus they should use. The molar mass of NaOH is 40 g mol^{-1} .

[4]

- (ii) Write a method to describe how the student should carry out the titration accurately.**

They have access to normal glassware available in a teaching laboratory.

You may include a labelled diagram of the apparatus. [6]

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and extend across the width of the page. There are no margins, text, or other markings on the paper.

(b) Commercial scientific laboratories often use autotitrators to analyse chemicals.

(i) Autotitrators are very accurate.

Suggest TWO other benefits that autotitrators can give to an analytical company.

1 _____
2 _____ **[2]**

(ii) Suggest ONE disadvantage of autotitrators that might explain why the teaching laboratory does not have one.

_____ **[1]**

(iii) Complete the following sentences using words from the list.

electrode magnetometer small
base large

Autotitrators use a pH _____
to identify the endpoint of the titration.

They are programmed to make
_____ additions of titrant so
the endpoint can be accurately pinpointed. [2]

- 6 Pollution levels in rivers can be determined by studying bacteria in the water.**

The bacteria studied often include coliforms such as *Escherichia coli*.

The presence of coliforms indicates that the water has been contaminated by faeces. The source may be from sewerage.

The more bacteria present, the greater the level of pollution.

- (a) A technician prepares 60 agar plates to grow bacteria.**

- (i) Tick (✓) the box next to the most appropriate method to sterilise the agar for the plates. [1]**

Autoclaving	<input type="checkbox"/>
Dry heating	<input type="checkbox"/>
Filtration	<input type="checkbox"/>
Flaming	<input type="checkbox"/>

- (ii) Explain why the technician needs to sterilise the agar before it is made into plates.**

- (iii) The technician sterilises the agar and makes a set of plates.

The plates are placed in a refrigerator.

After storing the plates for two days, the technician notices that some of them look like the plate shown in FIG. 6.1.

FIG. 6.1



Draw **ONE** line to connect the **PROBLEM** shown in FIG. 6.1 with the **COURSE OF ACTION** the technician should take. [2]

PROBLEM

Contamination

Past 'best before' date

Inoculation

Plasmolysis

COURSE OF ACTION

Use the plates as they are

Re-sterilise the plates and then use them

Destroy the plates by autoclaving

Leave the plates until the problem corrects itself and then use them

- (b) The following method is used to sample bacteria in river water.

50 cm³ of river water is collected into a sterilised plastic bottle.

The river water is filtered through a sterilised filter to collect the bacteria onto the filter.

Each filter is then transferred to an agar plate that will allow **ONLY** coliforms to grow.

The plates are incubated to allow the coliform colonies to grow. It is assumed that each colony on the plate came from one coliform collected on the filter.

FIG. 6.2 shows an agar plate of a water sample collected from a site on a river **BEFORE** the water had flowed past a farm.

FIG. 6.3 shows an agar plate of a water sample collected from a second site on the same river **AFTER** the water had flowed past the farm.

FIG. 6.2



FIG. 6.3



- (i) State and explain TWO differences between the plates shown in FIGS 6.2 and 6.3.

Difference 1 _____

Explanation 1 _____

Difference 2 _____

Explanation 2 _____

[4]

- (ii) Tick (✓) the box next to the conclusion that can be drawn from the two agar plates in FIGS 6.2 and 6.3. [1]

The river water is not safe to swim in.	
The river water upstream of the farm is not contaminated with faeces.	
The farm is the source of the pollution.	
The river water is more polluted downstream of the farm than upstream.	

- (iii) Use FIG. 6.2 to calculate the number of coliforms present in every 100 cm^3 of river water upstream of the farm.

Number of coliforms in 100 cm^3 of river water =

_____ [2]

- (c) Draw **ONE** line to link what the technician should **DO** with the plates when the test is completed with the **REASON** for doing it. [2]

TO DO

Store the plates in a fridge for 3 years

Reuse the plates

Heat the plates in an oven for 50 minutes

Autoclave the plates and dispose of them

REASON

To prevent people coming in direct contact with pathogens

To make sure the plates are fixed and the results cannot change

So that the results can be checked if there is a problem

To save money and reduce waste

- (d) State **ONE** other type of laboratory task requiring aseptic technique.

[1]

END OF QUESTION PAPER

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