OCR
Oxford Cambridge and RSA

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
C341/2206

C341-2206

You must have:
- the Data Sheet
- a ruler (cm/mm)

You can use:
- a scientific or graphical calculator
- an HB pencil

05847-02

Please write clearly in black ink.

Centre number | | | | | | Candidate number | | | | |

First name(s) _____

Last name _____

Date of birth | D | D | M | M | Y | Y | Y | Y |

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 **[ ]**.
- The Periodic Table is on the back page.
- This document has **24** pages.

ADVICE
- Read each question carefully before you start your answer.

FOR EXAMINER USE ONLY	
Question No	**Mark**
1	/15
2	/15
3	/15
4	/15
5	/15
6	/15
Total	**/90**

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.

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.	

[2]

(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.

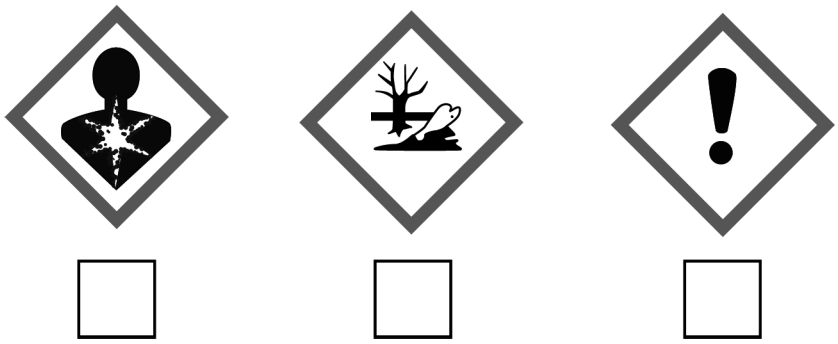
..... **[1]**

(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**.

Type of biological material	Storage method
Embryos	Refrigerator
Hair	A dry place
Blood samples	Liquid nitrogen

[3]

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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.

Generic chemistry	
Gas chromatography	
Geographical climate	
Glacial constituent	

[1]

(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 shows the GC spectra of old snow and fresh snow in the investigation.

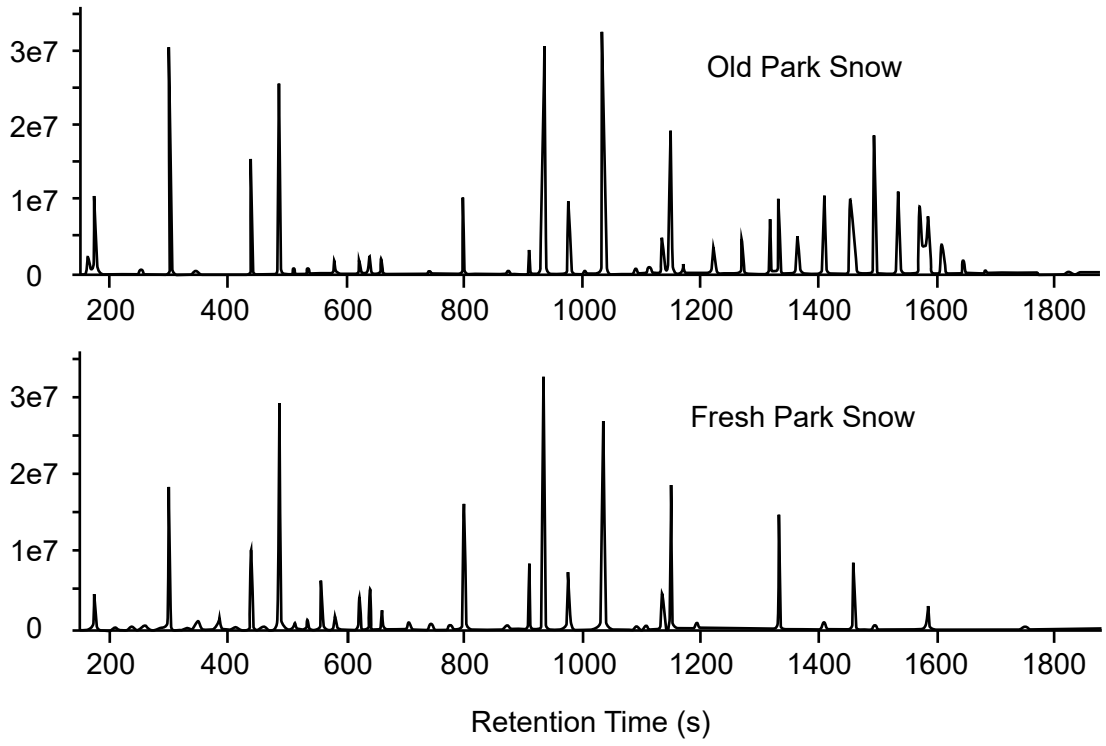

Fig. 2.1

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

.....

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

(ii) Using the spectra in **Fig. 2.1** 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.

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

[3]

(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.

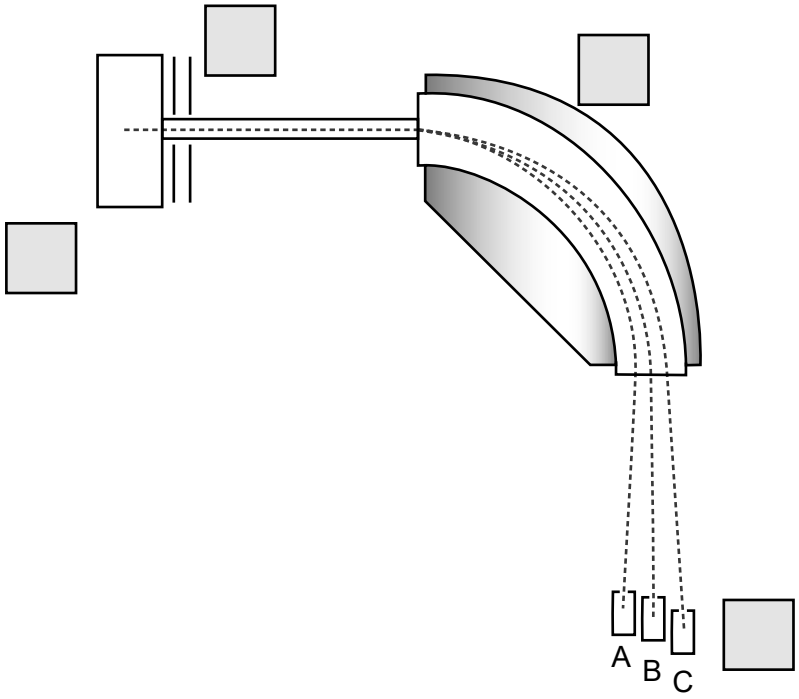

Fig. 2.2

(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.

1 The magnet separates the ions

2 The sample is ionised

3 The ions are detected

4 The ions are accelerated

[4]

(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.

positive **negative** **neutral**

[1]

(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.

lithium **magnesium** **sodium** **potassium** **copper (II)**

[1]

(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.

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.	

[2]

(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

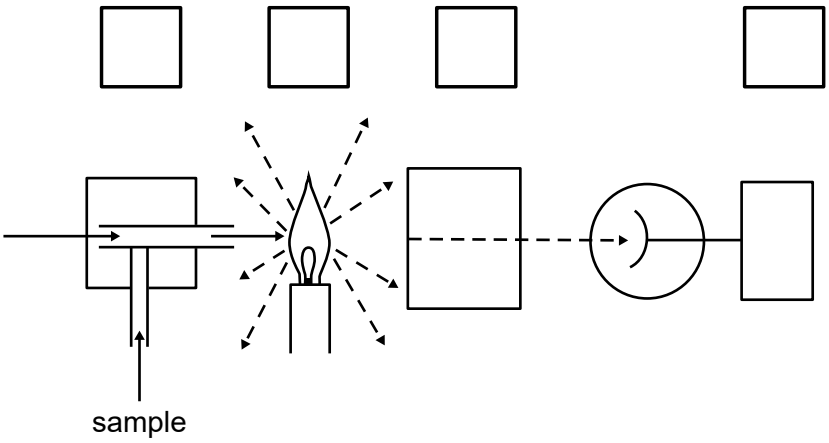

Fig. 3.1

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.**

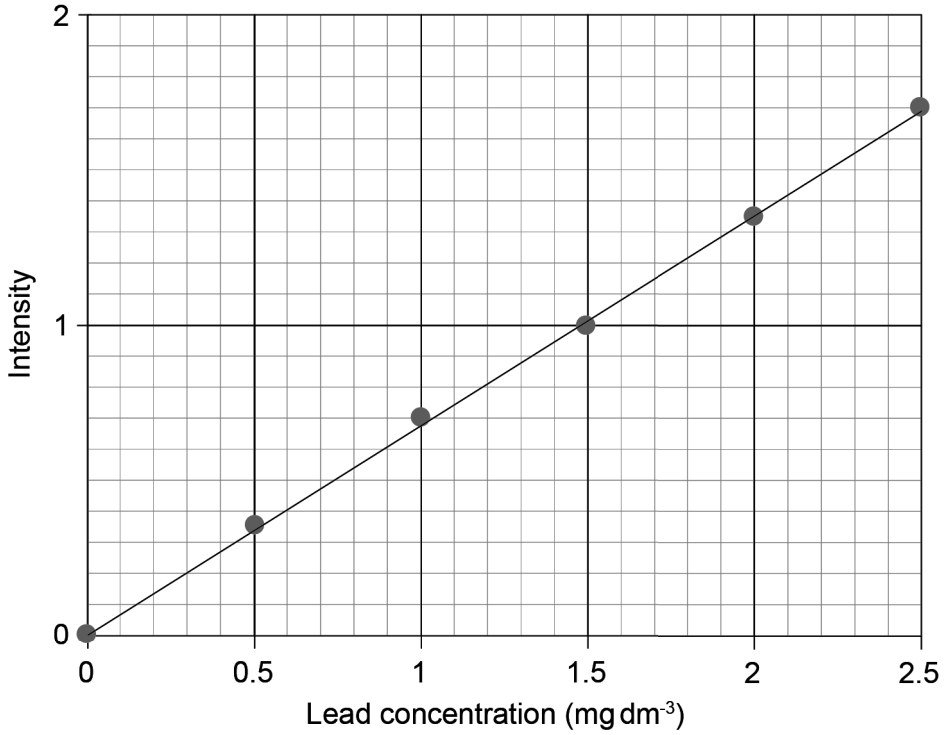

Fig. 3.2

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

- Add 10 cm^3 of nitric acid to 1.5 g 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 cm^3.
- 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 shows an electron micrograph of a layer of bryozoans. **Fig. 4.2** is a light micrograph of a layer of bryozoans. In both images a single bryozoan has been labelled **B**.

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

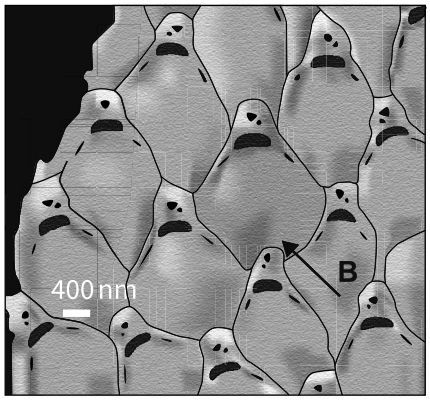

Fig. 4.1

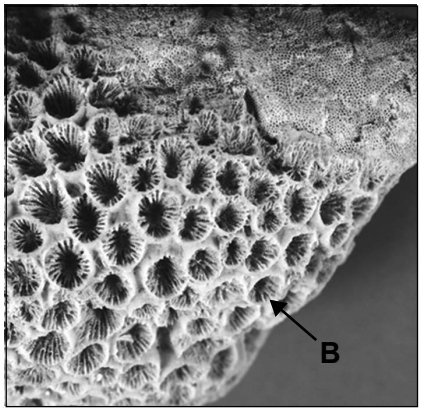

Fig. 4.2

Electron microscopy and light microscopy have different advantages.

(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.

Scanning	
Sonorous	
Tangential	
Transmission	

[2]

(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 technican 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]

.....

.....

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.....

(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.

Autoclaving	
Dry heating	
Filtration	
Flaming	

[1]

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

.....

.....

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

(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.

Problem	Course of action
Contamination	Use the plates as they are
Past 'best before' date	Re-sterilise the plates and then use them
Inoculation	Destroy the plates by autoclaving
Plasmolysis	Leave the plates until the problem corrects itself and then use them

[2]

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

- 50 cm^3 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.**

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.	

[1]

(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.

To do	Reason
Store the plates in a fridge for 3 years	To prevent people coming in direct contact with pathogens
Reuse the plates	To make sure the plates are fixed and the results cannot change
Heat the plates in an oven for 50 minutes	So that the results can be checked if there is a problem
Autoclave the plates and dispose of them	To save money and reduce waste

[2]

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

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

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional answer space is required, you should use the following lined pages. The question numbers must be clearly shown in the margins – for example, 3(c) or 5(b).

The Periodic Table of the Elements

Key
atomic number
Symbol
name
relative atomic mass

(1) 1	(2) 2	3	4	5	6	7	8	9	10	11	12	(3) 13	(4) 14	(5) 15	(6) 16	(7) 17	(0) 18
1 **H** hydrogen 1.0																	2 **He** helium 4.0
3 **Li** lithium 6.9	4 **Be** beryllium 9.0											5 **B** boron 10.8	6 **C** carbon 12.0	7 **N** nitrogen 14.0	8 **O** oxygen 16.0	9 **F** fluorine 19.0	10 **Ne** neon 20.2
11 **Na** sodium 23.0	12 **Mg** magnesium 24.3											13 **Al** aluminium 27.0	14 **Si** silicon 28.1	15 **P** phosphorus 31.0	16 **S** sulfur 32.1	17 **Cl** chlorine 35.5	18 **Ar** argon 39.9
19 **K** potassium 39.1	20 **Ca** calcium 40.1	21 **Sc** scandium 45.0	22 **Ti** titanium 47.9	23 **V** vanadium 50.9	24 **Cr** chromium 52.0	25 **Mn** manganese 54.9	26 **Fe** iron 55.8	27 **Co** cobalt 58.9	28 **Ni** nickel 58.7	29 **Cu** copper 63.5	30 **Zn** zinc 65.4	31 **Ga** gallium 69.7	32 **Ge** germanium 72.6	33 **As** arsenic 74.9	34 **Se** selenium 79.0	35 **Br** bromine 79.9	36 **Kr** krypton 83.8
37 **Rb** rubidium 85.5	38 **Sr** strontium 87.6	39 **Y** yttrium 88.9	40 **Zr** zirconium 91.2	41 **Nb** niobium 92.9	42 **Mo** molybdenum 95.9	43 **Tc** technetium	44 **Ru** ruthenium 101.1	45 **Rh** rhodium 102.9	46 **Pd** palladium 106.4	47 **Ag** silver 107.9	48 **Cd** cadmium 112.4	49 **In** indium 114.8	50 **Sn** tin 118.7	51 **Sb** antimony 121.8	52 **Te** tellurium 127.6	53 **I** iodine 126.9	54 **Xe** xenon 131.3
55 **Cs** caesium 132.9	56 **Ba** barium 137.3	57–71 lanthanoids	72 **Hf** hafnium 178.5	73 **Ta** tantalum 180.9	74 **W** tungsten 183.8	75 **Re** rhenium 186.2	76 **Os** osmium 190.2	77 **Ir** iridium 192.2	78 **Pt** platinum 195.1	79 **Au** gold 197.0	80 **Hg** mercury 200.6	81 **Tl** thallium 204.4	82 **Pb** lead 207.2	83 **Bi** bismuth 209.0	84 **Po** polonium	85 **At** astatine	86 **Rn** radon
87 **Fr** francium	88 **Ra** radium	89–103 actinoids	104 **Rf** rutherfordium	105 **Db** dubnium	106 **Sg** seaborgium	107 **Bh** bohrium	108 **Hs** hassium	109 **Mt** meitnerium	110 **Ds** darmstadtium	111 **Rg** roentgenium	112 **Cn** copernicium		114 **Fl** flerovium		116 **Lv** livermorium		

57 **La** lanthanum 138.9	58 **Ce** cerium 140.1	59 **Pr** praseodymium 140.9	60 **Nd** neodymium 144.2	61 **Pm** promethium 144.9	62 **Sm** samarium 150.4	63 **Eu** europium 152.0	64 **Gd** gadolinium 157.2	65 **Tb** terbium 158.9	66 **Dy** dysprosium 162.5	67 **Ho** holmium 164.9	68 **Er** erbium 167.3	69 **Tm** thulium 168.9	70 **Yb** ytterbium 173.0	71 **Lu** lutetium 175.0
89 **Ac** actinium	90 **Th** thorium 232.0	91 **Pa** protactinium	92 **U** uranium 238.1	93 **Np** neptunium	94 **Pu** plutonium	95 **Am** americium	96 **Cm** curium	97 **Bk** berkelium	98 **Cf** californium	99 **Es** einsteinium	100 **Fm** fermium	101 **Md** mendelevium	102 **No** nobelium	103 **Lr** lawrencium