OCR
Oxford Cambridge and RSA

Thursday 16 May 2019 – Afternoon

LEVEL 3 CAMBRIDGE TECHNICAL IN APPLIED SCIENCE

05847/05848/05849/05874/05879 Unit 2: Laboratory techniques

Time allowed: 2 hours
C341/1906

C341--1906

You must have:
- a ruler
- the Data Sheet (Insert)

You may use:
- a scientific or graphical calculator

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.
- Answer **all** the questions.
- Write your answer to each question in the space provided.
- If additional answer space is required, you should use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- The Periodic Table is printed on the back page.

INFORMATION
- The total mark for this paper is **90**.
- The marks for each question are shown in brackets **[ ]**.
- This document consists of **24** pages.

FOR EXAMINER USE ONLY	
Question No	**Mark**
1	/18
2	/16
3	/14
4	/14
5	/14
6	/14
Total	**/90**

Answer **all** the questions.

1 Athletes can be tested for banned substances to ensure they are not cheating by taking samples of their blood.

The blood samples are analysed in a laboratory.

(a) Suggest why laboratory technicians must complete health and safety training before they are allowed to work in the laboratory.

.....

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

(b) Hazard warning signs are displayed in laboratories.

Identify the meaning of each sign shown below.

Write your answer below each sign.

……..……..……..…… ……..……..……..……

[2]

(c) A number of hazards may be experienced when taking and analysing blood samples.

State **two** of these hazards and suggest precautions to be taken by the technicians to reduce the risks.

Complete the table.

	Hazard	**Precaution**
1		
2		

[4]

(d) Blood samples taken from the athletes are “booked in” at the laboratory and labelled correctly so that they are not mixed up.

(i) The name of the athlete is not stated on the blood sample label.

Suggest why it is important to ensure that the name of the athlete is **not** stated on a blood sample.

.....

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

(ii) Suggest **three** pieces of information that must be recorded for each sample.

1 .....

2 .....

3 .....

[3]

(e) **(i)** Technicians must calibrate scientific instruments used in the laboratory.

Describe how thermometers can be calibrated.

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.....**[4]**

(ii) **Table 1.1** and **Table 1.2** shows the results of a stopwatch calibration test carried out by the technicians.

Two types of stopwatch were tested: analogue and digital.

The stopwatches were tested by the direct comparison method for exactly 180 seconds and then for exactly 600 seconds.

Each test was carried out four times.

Type of stopwatch	180 s stopwatch test (min:s)			
	Repeats			
	1	2	3	4
Analogue	3:01	3:02	3:01	2:59
Digital	3:01.44	3:01.55	2:59.80	3:00.88

Table 1.1

Type of stopwatch	600 s stopwatch test (min:s)			
	Repeats			
	1	2	3	4
Analogue	9:58	10:03	10:02	10:03
Digital	10:01.30	9:59.92	10:01.11	10:00.17

Table 1.2

A student has a work placement at a laboratory. She carries out an experiment to investigate the rate of reaction between magnesium and hydrochloric acid.

The student plans to measure the volume of gas produced every 30 seconds over a period of 10 minutes.

Suggest which stopwatch the student should use.

Justify your choice using the information in **Table 1.1** and **Table 1.2**.

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

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2 A biochemical company analyses the chemical composition of substances in food.

The composition of amino acids in a diet supplement is determined using thin-layer chromatography (TLC).

Table 2.1 shows the R_f values of some amino acids in a mobile phase using solvent A.

Amino acid	R_f value in solvent A
Alanine	0.53
Arginine	0.13
Threonine	0.53
Tyrosine	0.92

Table 2.1

Fig. 2.1 is a chromatogram of the amino acids in **Table 2.1**.

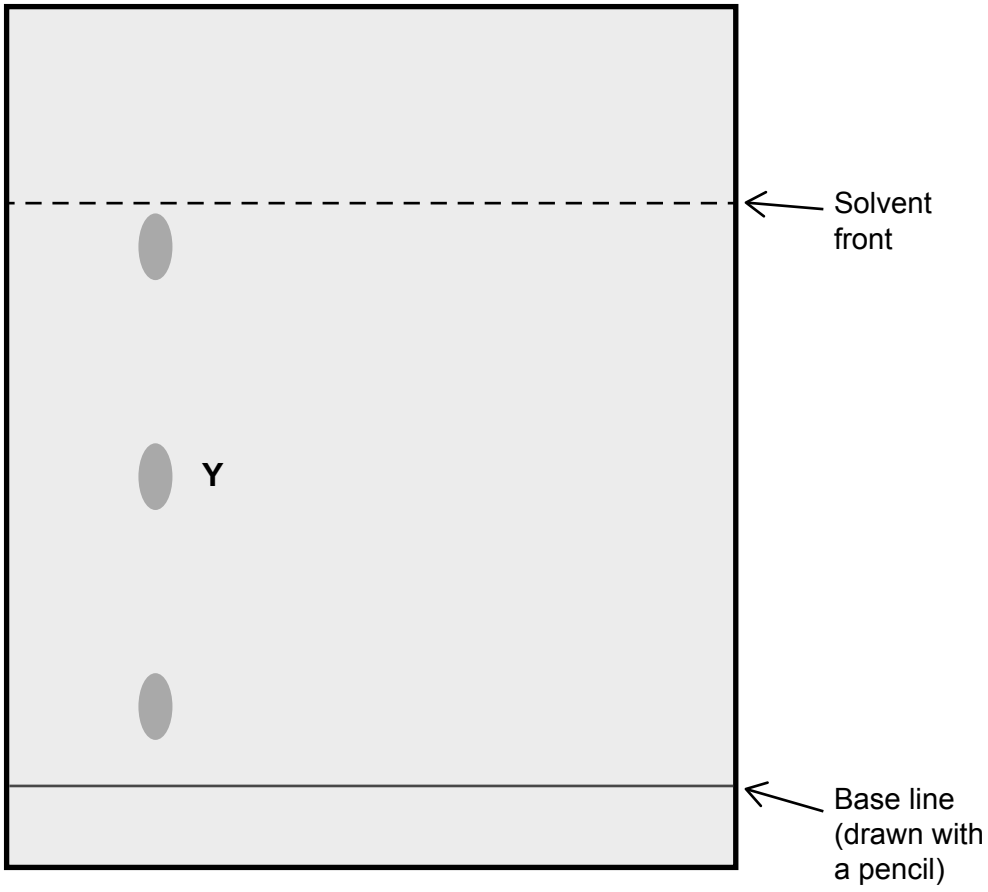

Fig. 2.1

(a) Suggest why a pencil is used to mark the base line on the solid phase.

.....

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

(b) Give **two** reasons why gloves must be worn when analysing amino acids by TLC.

1.....

2.....

[2]

(c) Which spot in **Fig. 2.1** is arginine?

Draw **X** next to the correct spot in **Fig. 2.1**.

[1]

(d) Use a ruler to measure the distance that tyrosine moved during chromatography.

Distance = ….....…….....…….....… mm

[1]

(e) Explain how the R_f value of the spot labelled **Y** is approximately 0.53.

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

(f) Suggest why it is not possible to separate alanine from threonine in the TLC plate shown in **Fig. 2.1**.

.....

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

(g) State **two** alternative chromatography methods that could be used to determine the **amounts** of each amino acid in the diet supplement.

1.....

2.....

[2]

(h) A mass spectrometer can be coupled to chromatography equipment.

(i) Give an **advantage** of using a mass spectrometer when coupled to chromatography equipment.

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

(ii) Describe the principles of how a mass spectrometer works.

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.....**[4]**

3 Cleanezi Ltd manufacture and sell household cleaning products.

One of their products, Flushisafe, is a toilet cleaner that contains phosphoric acid.

The amount of phosphoric acid in Flushisafe is measured by titration with a 0.5 mol dm^{-3} solution of sodium hydroxide.

Phosphoric acid is a strong acid.

(a) Which **two** descriptions apply to sodium hydroxide?

Tick (✓) **two** boxes.

Acid	☐
Alkali	☐
Base	☐
Organic solvent	☐
Salt	☐

[1]

(b) **(i)** Use the Periodic Table to calculate the molar mass of sodium hydroxide (NaOH).

Molar mass of NaOH = ….....…….....…….....… g mol^{-1}

[1]

(ii) Calculate the mass of sodium hydroxide needed to make 1 dm^3 of a 0.5 mol dm^{-3} solution of sodium hydroxide.

Mass = ….....…….....…….....… g

[2]

(c) **Table 3.1** shows the results of three titrations of 10.0 cm^3 samples of a batch of Flushisafe.

(i) Calculate the titres of 0.5 mol dm^{-3} **sodium hydroxide** in each titration.

Write your answers in **Table 3.1**.

	Rough titration	**Accurate titration 1**	**Accurate titration 2**
Final burette reading (cm^3)	31.70	30.55	30.75
Initial burette reading (cm^3)	0.8	0.10	0.20
Titre (cm^3)			

Table 3.1

[1]

(ii) Describe how you could ensure the accuracy of the burette measurements.

.....

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

(d) Suggest why a measuring cylinder would not be a suitable piece of equipment to measure the 10.0 cm^3 batches of Flushisafe.

.....

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

(e) Name a suitable indicator for the titration in **(c)**, and state the colour change.

Indicator.....

Colour change .....

[2]

(f) The balanced equation for the reaction between phosphoric acid and sodium hydroxide is:

$H_3PO_4 + 3NaOH \rightarrow Na_3PO_4 + 3H_2O$

The titration results can be used to find the concentration of phosphoric acid in Flushisafe.

(i) Use the accurate titration results in **Table 3.1** to calculate the mean titre.

Mean titre = ….....…….....…….....… cm^3

[1]

(ii) Use your answer to **f(i)** to calculate the mean number of moles of NaOH used in the titration.

Use the equation: number of moles = $\frac{\text{concentration (mol dm}^{-3}\text{) x mean titre (cm}^3\text{)}}{1000}$

Mean number of moles of NaOH = …..……..……..…… mol
[1]

(iii) In the reaction between phosphoric acid and sodium hydroxide, **1 mole** of H_3PO_4 reacts with **3 moles** of NaOH.

Use the reacting ratio to calculate the number of moles of H_3PO_4 in 10.0 cm^3 of Flushisafe.

Number of moles of H_3PO_4 = …..……..……..…… mol
[1]

(iv) Calculate the concentration, in mol dm^{-3}, of the phosphoric acid in Flushisafe.
Give your answer to **3** significant figures.

Concentration of phosphoric acid = …..……..……..…… mol dm^{-3}
[2]

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4 A greyish brown powder was found in a laboratory, but its container did not have a label.

(a) A series of tests was carried out on the powder to find out what it was.

- When a flame test was carried out on a sample of the powder, the substance burned with a blue-green flame.
- A second sample of the powder was then dissolved in water, and the solution was divided into two portions.
- Barium chloride solution was added to one portion, and silver nitrate solution was added to the other.

The results of the tests for the second sample are shown in **Table 4.1**.

Test	Observation
Addition of barium chloride	No change
Addition of silver nitrate	Cream precipitate

Table 4.1

(i) Name the unknown substance in the greyish brown powder.

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

(ii) Write the formulae of the **two** ions present in the unknown substance.

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

(b) Give **three** reasons why ion chromatography is used to analyse drinking water, rather than using the tests described in **(a)**.

1.....

2.....

3.....

[3]

(c) Lead is a toxic metal, but many old houses have plumbing made from lead pipes.

It is important that tap water in old houses is tested to ensure that the lead content in the water is below the safe level.

ICP-AES is one test that can be done to measure the amount of lead in the water.

Identify the term **ICP**.

Tick (✓) **one** box.

Induced Covalent Polar ☐

Inductively Coupled Plasma ☐

Interactive Covalent Plasma ☐

Ionically Covalent Polar ☐

Ion Cross Plasma ☐

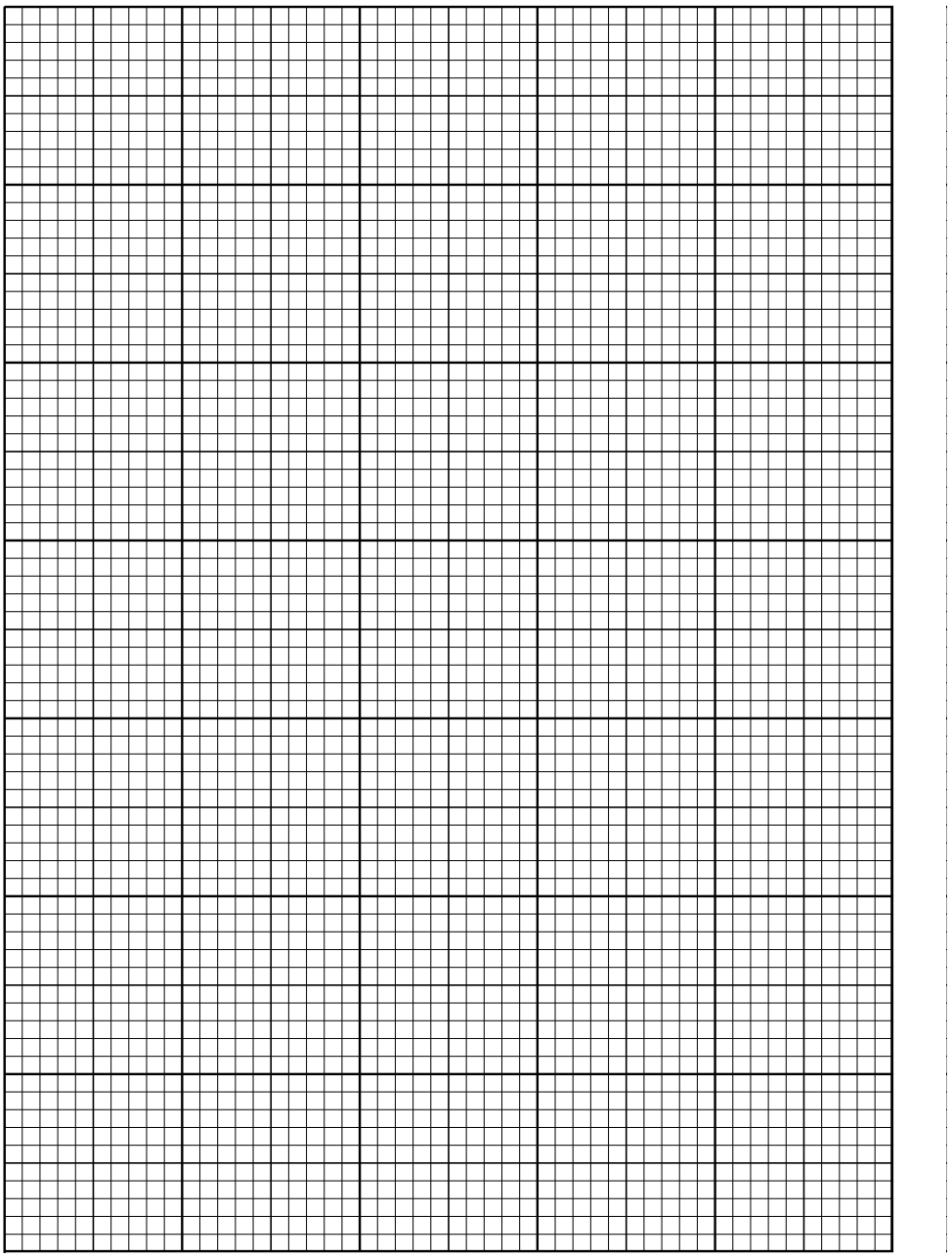
[1]

(d) **Table 4.2** shows ICP-AES results for standard lead solutions, and for a sample of tap water taken from an old house.

Lead concentration in standard lead solutions (μg dm^{-3})	**Intensity (arbitrary units)**
0	0.00
5	0.32
10	0.68
15	1.00
20	1.30
Tap water sample	0.50

Table 4.2

(i) Use the results shown in **Table 4.2** to plot a calibration graph of the **standard lead solutions** and draw a line of best fit.



[5]

(ii) Use the calibration graph you plotted to determine the concentration, in μg dm^{-3}, of lead in the tap water.

Show on the graph how you arrived at your answer.

Concentration of lead in tap water = ….....…….....…….....…. μg dm^{-3}

[2]

5 An epidermal strip of onion epithelial cells is obtained.

A stain is added to the onion epithelial cells.

The cells are then photographed when magnified under a light microscope.

Fig. 5.1 shows a photograph of the magnified onion epithelial cells.

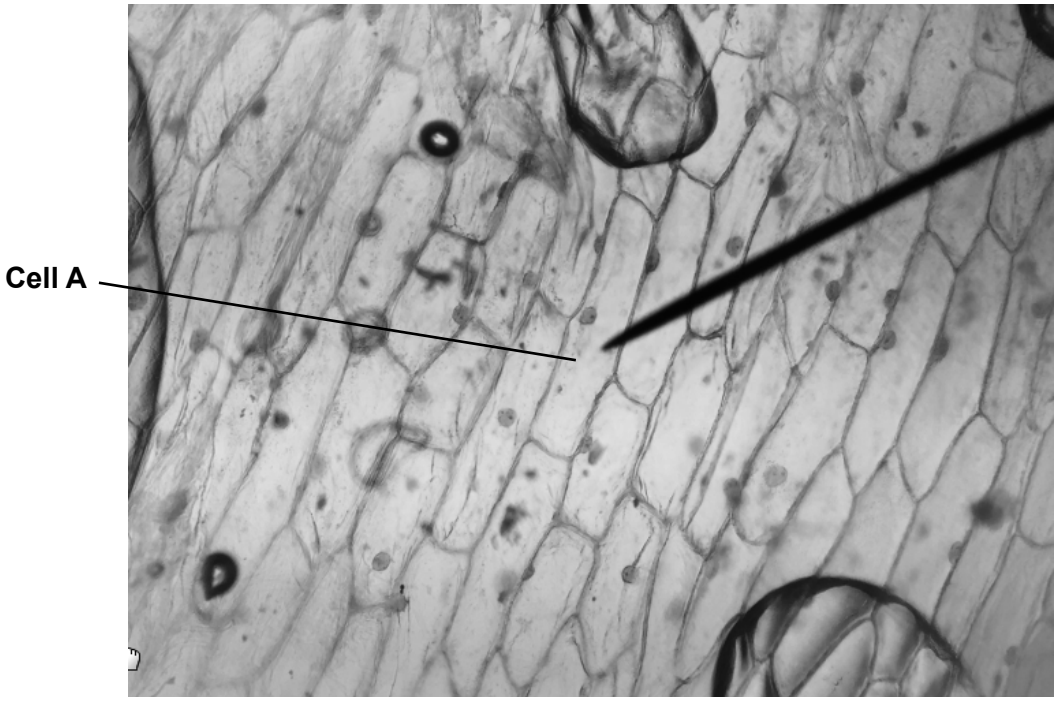


Fig. 5.1

(a) Suggest why a stain was added to the onion epithelial cells.

.....

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

(b) The photograph shown in **Fig. 5.1** was obtained using a **x10** eyepiece lens and **x60** objective lens.

(i) Calculate the magnification used in **Fig. 5.1**.

Magnification = x ….....…….....…….....…

[1]

(ii) A pointer is used in the eye piece of the microscope to show the location of **cell A**.

Use a ruler to measure the magnified length, in mm, of **cell A**.

Length of cell A = ….....…….....…….....… mm

[1]

(iii) Calculate the actual length of **cell A**.

Use the formula: magnification = measured size ÷ actual size

Show your working.

Actual length of **cell A** = ….....…….....…….....… mm

[2]

(iv) Which **three** key features of the onion epithelial cells can be clearly seen in **Fig. 5.1**?

Tick (✓) **three** boxes.

Cell wall	☐
Chloroplast	☐
Cytoplasm	☐
Mitochondrion	☐
Nucleus	☐
Plasma membrane	☐
Vacuole	☐

[3]

(c) Light microscopes are also used to observe the key features of cells sampled from human patients.

However, ultrasound and X-ray scanners must be used to observe the features of structures such as organs within human patients.

Compare the advantages **and** disadvantages of using ultrasound and X-ray scanners to view internal structures of a human patient, **and** explain how this makes them suitable for viewing different structures.

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.....**[6]**

6 *Agrobacterium* is a bacterium that can be used by plant biotechnology companies to produce genetically engineered crops.

(a) **Fig. 6.1** is a photograph of *Agrobacterium* streaked onto an agar plate.

The streaking technique involves the use of a metal wire inoculation loop.

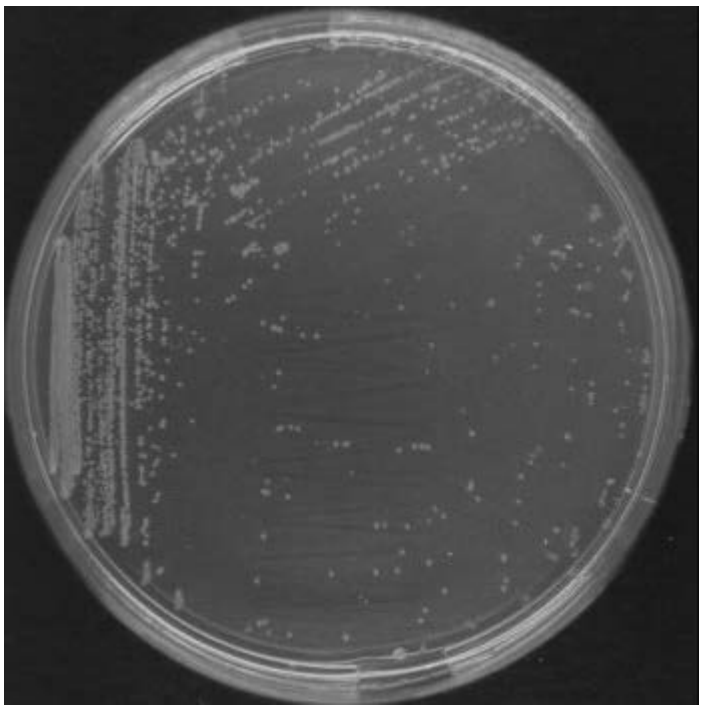

Fig. 6.1

(i) Give **two** reasons why bacteria are streaked onto an agar plate in this way.

1 .....

2 .....

[2]

(ii) Suggest why the inoculation loop must be flamed immediately before inoculating the plate.

.....

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

(iii) Give **two** reasons why the loop must be cooled before streaking.

1 .....

.....

2 .....

.....

[2]

(iv) Suggest why the loop must be flamed in between each phase of streaking.

.....

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

(v) State what you would expect to see if the plate had become contaminated.

.....

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

(b) It is possible to add genes from *Agrobacterium* to tissue cultures of plants such as cabbages.

The cabbage plants grown from the tissue cultures are now transformed (genetically engineered).

The transformed cabbage plants can be cloned.

The procedure for cloning the plants can involve five steps as shown below.

The steps are **not** in the correct order.

Step	Action
A	Place each explant onto a plate of sterile agar.
B	Incubate the explants in the light and at a suitable temperature.
C	Dip each explant in sterilising fluid.
D	Use sterile forceps to remove a small piece of tissue (explant) from a cabbage leaf.
E	Observe the agar plates each day to check the growth of new cloned plants.

Write a letter for one step in each box to show the **correct** order.

Start ⟶ End

[4]

(c) A technician working with one biotechnology company clones some plant material as shown in **Fig. 6.2** and **Fig. 6.3**.

The explants in **Fig. 6.3** are contaminated.

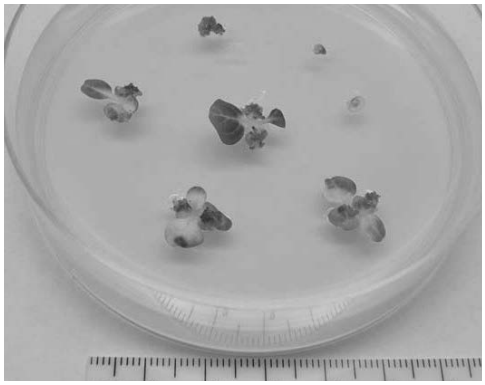

Fig. 6.2

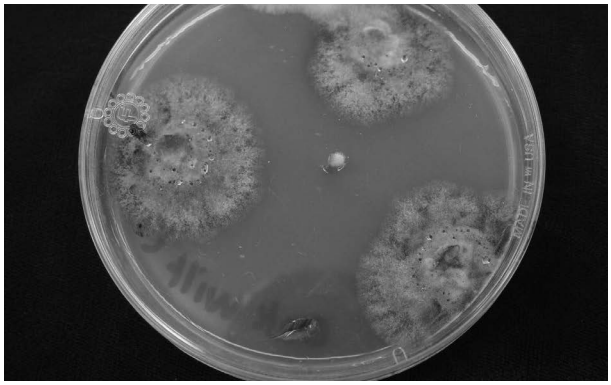

Fig. 6.3

Aseptic techniques are often carried out in controlled airflow cabinets.

Suggest **three** precautions that should be taken to maintain aseptic techniques in controlled airflow (laminar airflow) cabinets.

1.....

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2.....

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3.....

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[3]

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional answer space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s) – for example 1(e) or 5(c).

The Periodic Table of the Elements

(1)	(2)											(3)	(4)	(5)	(6)	(7)	(0)
1																	**18**
1 **H** hydrogen 1.0	**2**											**13**	**14**	**15**	**16**	**17**	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		

Key
atomic number
Symbol
name
relative atomic mass

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

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