

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 plus your additional time allowance

You must have:

a ruler

the Data Sheet (Insert)

copy of The Periodic Table

You may use:

a scientific or graphical calculator

Modified Enlarged 18pt

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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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 supplied separately.

INFORMATION

The total mark for this paper is 90.

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

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. [4]

	HAZARD	PRECAUTION
1		
2		

- (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.

(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.

_____ **[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.

TABLE 1.1

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 1.2

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

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.

[3]

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).

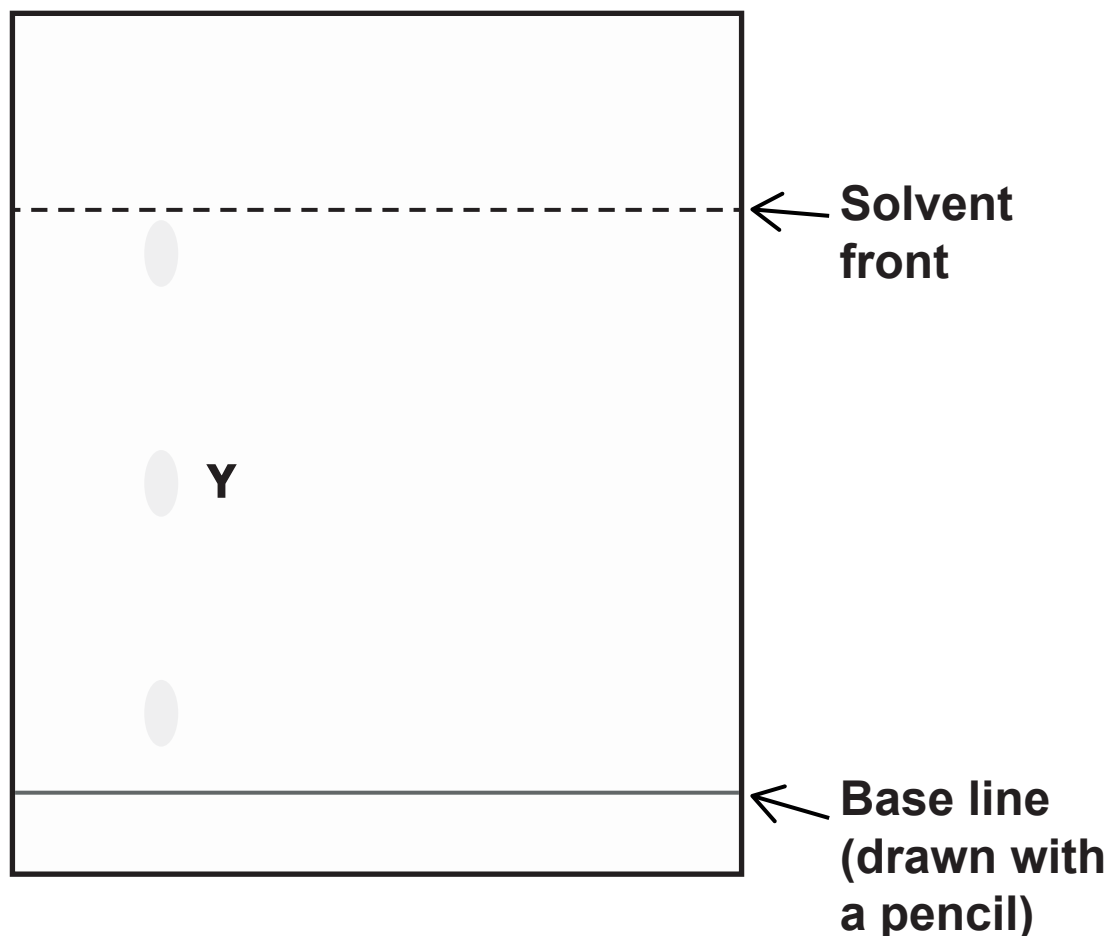
TABLE 2.1 shows the R_f values of some amino acids in a mobile phase using solvent A.

TABLE 2.1

AMINO ACID	R_f VALUE IN SOLVENT A
Alanine	0.53
Arginine	0.13
Threonine	0.53
Tyrosine	0.92

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.

[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.

[1]

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

[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. [1]

Acid

☐

Alkali

☐

Base

☐

Organic solvent

☐

Salt

☐

- (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 dm³ 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 cm³ 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. [1]

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)			

(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 cm³ batches of Flushisafe.

[1]

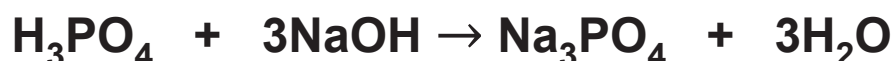
- (e) Name a suitable indicator for the titration in (c), and state the colour change.

Indicator _____

Colour change _____

[2]

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



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 = _____ cm³
[1]

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

Use the equation:

$$\text{number of moles} = \frac{\text{concentration (mol dm}^{-3}\text{)} \times \text{mean titre (cm}^3\text{)}}{1000}$$

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.

TABLE 4.1

TEST	OBSERVATION
Addition of barium chloride	No change
Addition of silver nitrate	Cream precipitate

(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. [1]

Induced Covalent Polar

☐

Inductively Coupled Plasma

☐

Interactive Covalent Plasma

☐

Ionically Covalent Polar

☐

Ion Cross Plasma

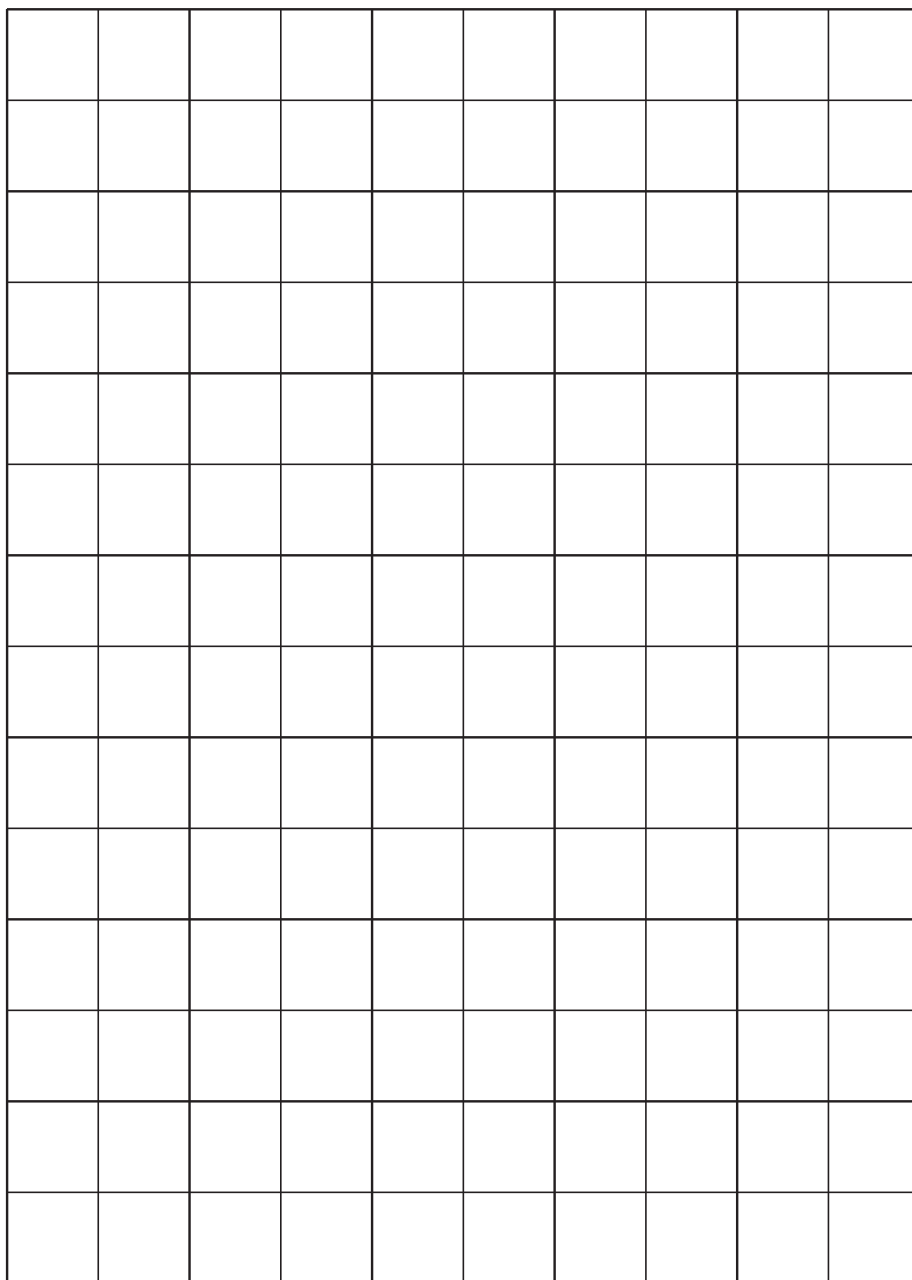
☐

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

TABLE 4.2

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

- (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 $\mu\text{g dm}^{-3}$, of lead in the tap water.

Show on the graph how you arrived at your answer.

Concentration of lead in tap water = _____ $\mu\text{g dm}^{-3}$
[2]

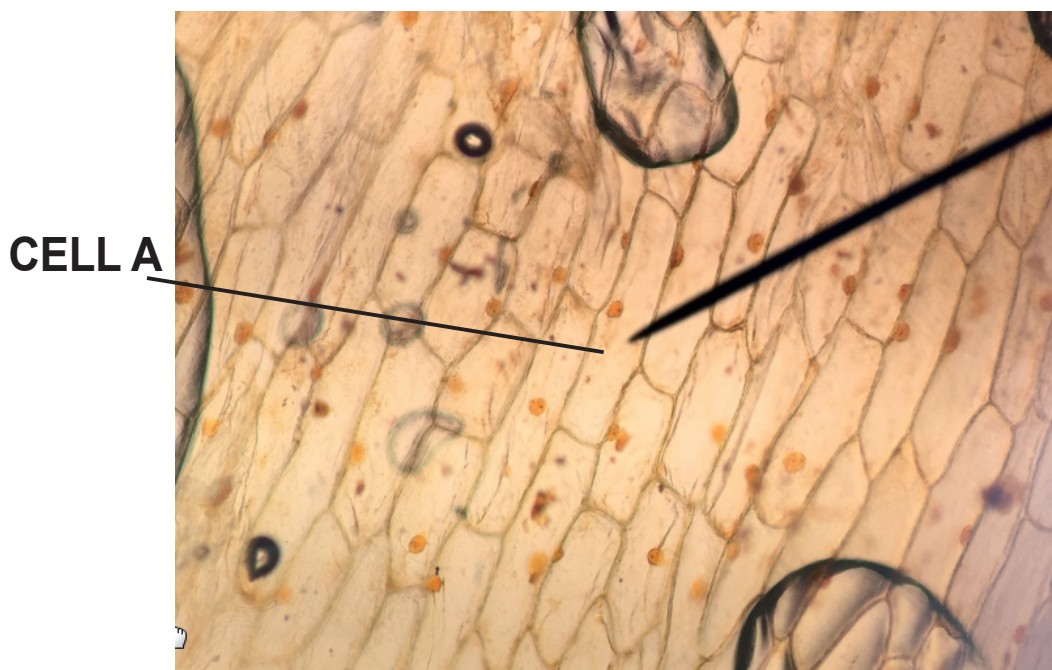
5 An epidermal strip of onion epithelial cells is obtained.

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. [3]

CELL WALL

☐

CHLOROPLAST

☐

CYTOPLASM

☐

MITOCHONDRION

☐

NUCLEUS

☐

PLASMA MEMBRANE

☐

VACUOLE

☐

- (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.

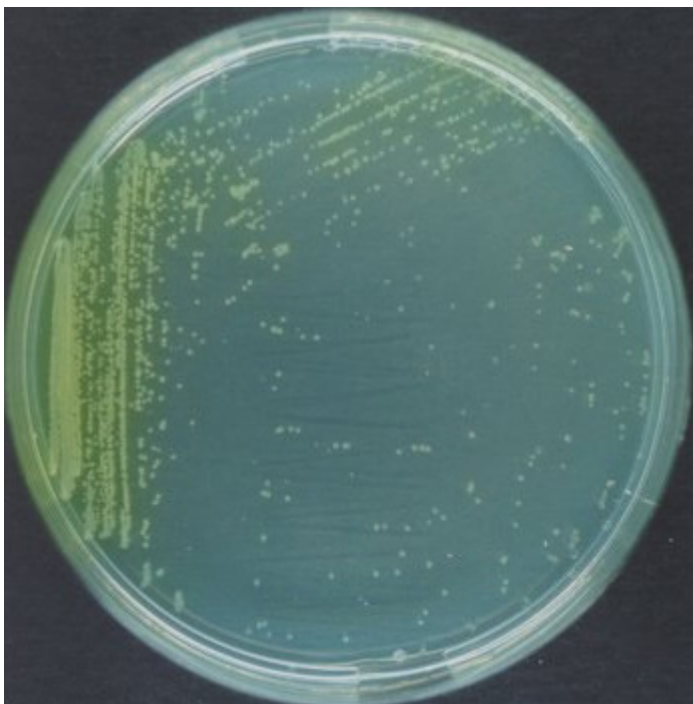
Compare the advantages AND disadvantages of using ultrasound and X-ray scanners to view internal structures of a human patient, AND explain how this makes them suitable for viewing different structures.

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. [4]

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Start  End

- (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

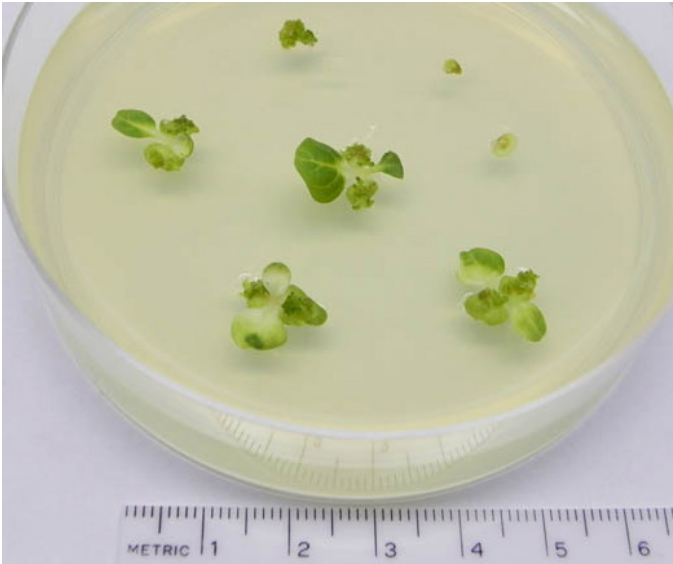
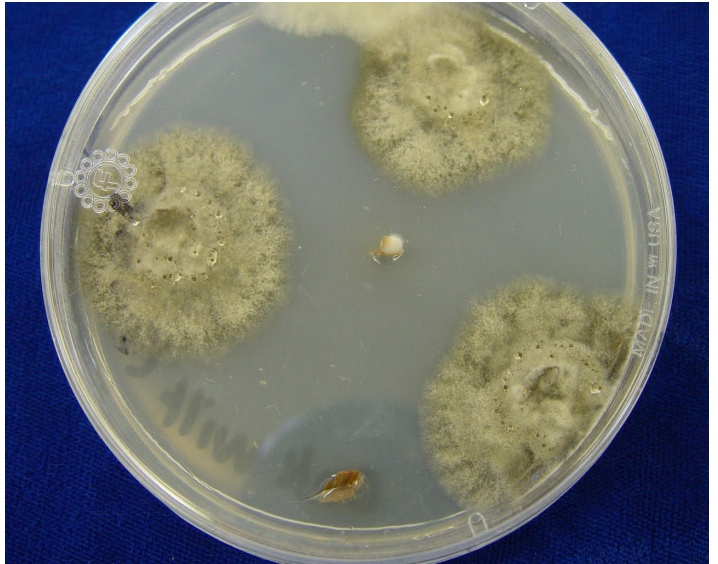


FIG. 6.3



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 _____

2 _____

3 _____

[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).

[illegible]



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