OCR
Oxford Cambridge and RSA

Thursday 13 January 2022 – Morning

Level 3 Cambridge Technical in Applied Science

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

Time allowed: 2 hours
C341/2201

C341-I-220T

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

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

0 5 8 4 7 – 0 2

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 **20** pages.

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

FOR EXAMINER USE ONLY	
Question No	**Mark**
1	/16
2	/16
3	/14
4	/12
5	/17
6	/15
Total	**/90**

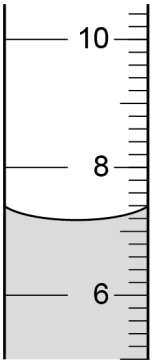
Answer **all** the questions.

1 It is Ali's first day as a work experience student in a chemistry laboratory.

Eve is a technician in the laboratory and is showing Ali how to use some laboratory equipment accurately.

(a) The first piece of equipment to be used is a measuring cylinder.

The level of liquid in the measuring cylinder is shown in the diagram.



(i) State **two** ways to obtain an accurate reading of the volume of liquid in the measuring cylinder.

1 .....

.....

2 .....

.....

[2]

(ii) State the value for the volume of liquid in the measuring cylinder shown in the diagram.

Give your answer to an **appropriate number** of significant figures.

Volume = ...cm^3 **[1]**

(b) Eve then shows Ali how to use a balance. The balance has recently been calibrated.

(i) Why is it important to calibrate scientific equipment?

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

(ii) Describe how Eve should check the calibration of the balance.

.....

.....

.....

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

(iii) Eve shows Ali how to measure the mass of a powder accurately.

Write the numbers **2 to 6** in the table to show the order of steps that Ali should follow.

The first one has been done for you.

Step	**Order**
Place a weighing boat onto the balance.	
Transfer the powder from the weighing boat.	
Add powder to the weighing boat using a clean spatula, to the correct mass.	
Ensure that the balance is clean and that there are no substances on the balance.	1
Check that no powder is left on the weighing boat by placing it back on the balance.	
Press the tare button on the balance.	

[2]

(c) Eve then teaches Ali about methods of waste disposal.

The first column in the table lists some items for safe disposal.

Complete the table to show the best method of disposal for each item.

Tick (✓) **one** box in each row.

Item for disposal	Autoclave	Sharps bin	Recycling	Rinsed down the sink
Broken glassware				
Low concentration hydrochloric acid				
Petri dishes with microbes growing on them				
Used batteries				

[4]

(d) When Eve buys chemicals they are delivered with data sheets.

State **four** pieces of information given on a data sheet for laboratory chemicals.

1 .....

2 .....

3 .....

4 .....

[4]

2 Nina is a food scientist. She is analysing amino acids and nucleotide bases in a food supplement for athletes.

The amino acids found in the food supplement can be identified and quantified using different techniques.

(a) Which **two** techniques will allow Nina to identify and quantify the amino acids in the food supplement?

Tick (✓) **two** boxes.

Method	Identification and quantification
Paper chromatography	
PCR	
GC	
TLC	

[1]

(b) Nina analyses the nucleotide bases found in the food supplement.

Fig. 2.1 shows an HPLC chromatograph separation of nucleotide bases.

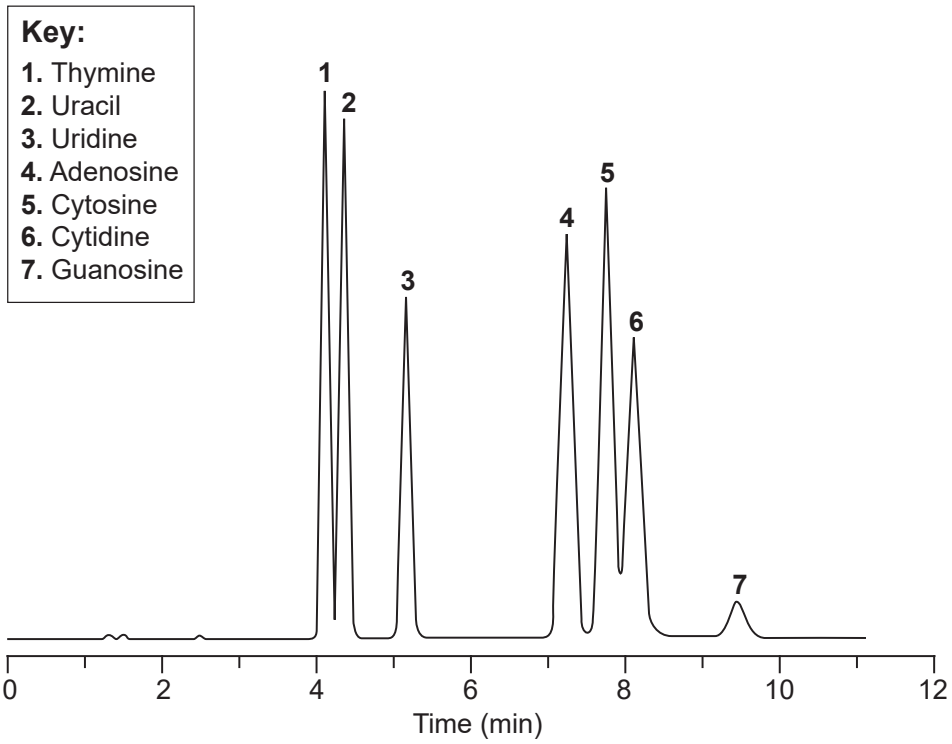


Fig. 2.1

Use **Fig. 2.1** to estimate the retention times of adenosine and cytidine.

Retention time of adenosine = ... min

Retention time of cytidine = ... min

[2]

(c) The area under each peak can be used to determine the concentration of each nucleotide base in the mixture.

To determine the concentration of cytidine, Nina calibrates the HPLC machine using known concentrations of cytidine.

The results are shown in the table.

Concentration of cytidine / mmol dm^{-3}	**Relative Peak Area**
0	0.00
2	0.15
4	0.32
6	0.48
8	0.63
10	0.78

(i) Plot a calibration graph of relative peak area (y-axis) against the concentration of cytidine (x-axis) on **Fig. 2.2**.

Label the axes, use an appropriate scale, and draw a line of best fit.

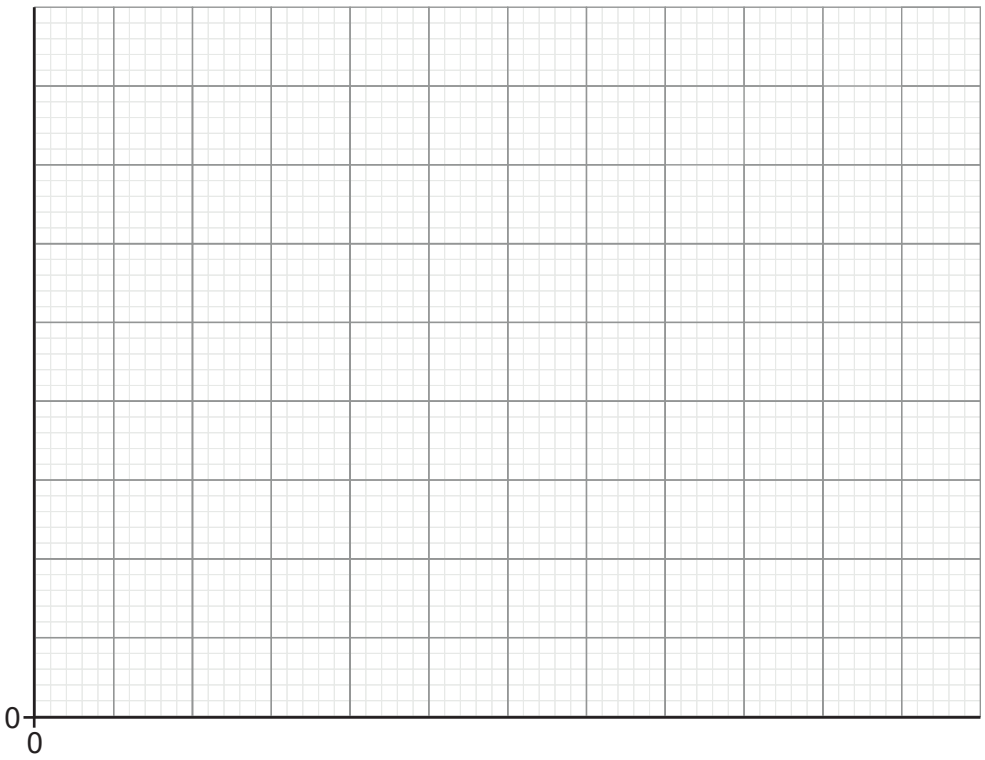


Fig. 2.2

[5]

(ii) An unknown sample of cytidine was then tested. The relative peak area was 10.4.

Suggest how Nina should prepare the sample further before she can determine the concentration.

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

(iii) After further preparation the sample was analysed again.

The relative peak area was 0.52.

Use **Fig. 2.2** to determine the concentration of cytidine in this sample.

Concentration = ... mmol dm^{-3} **[1]**

(iv) Calculate the concentration of cytidine in the **original** sample.

Concentration = ... mmol dm^{-3} **[1]**

(d) Mass spectrometry can be used in conjunction with chromatography to identify the substances present in a mixture.

(i) State **four** key principles of mass spectrometry.

1 .....

2 .....

3 .....

4 .....

[4]

(ii) Identify **one** piece of information that mass spectrometry tells us about a substance in a mixture.

Tick (✓) **one** box.

Colour ☐

Concentration ☐

Molar mass ☐

[1]

3 Acetic acid, CH_3COOH, is the main component in vinegar. It is a weak acid.

James is doing a project to find the concentration of acetic acid in a sample of white vinegar.

The concentration of acetic acid can be determined by titration against sodium hydroxide (NaOH), a strong base.

(a) James first prepares 250.0 cm^3 of 0.5 mol dm^{-3} NaOH(aq).

(i) Calculate the molar mass of sodium hydroxide.

Use the Periodic Table.

Molar mass = ... g mol^{-1} **[1]**

(ii) Calculate the mass of sodium hydroxide James should weigh out in order to prepare 250 cm^3 of 0.5 mol dm^{-3} NaOH (aq).

Use the Data Sheet and the equation: number of moles = $\frac{\text{mass (g)}}{\text{molar mass (g mol}^{-1}\text{)}}$

Mass = ... g **[2]**

(b) He pipettes 25.0 cm^3 of a sample of white vinegar into a conical flask and then titrates this with 0.5 mol dm^{-3} NaOH (aq).

(i) What is the most suitable indicator for this titration?

Put a (ring) around the correct answer.

phenolphthalein **bromothymol blue** **methyl orange**

[1]

(ii) State the colour **change** at the end point for the indicator chosen in **(b)(i)**.

Assume that the white vinegar sample is colourless.

Colour change from..... to ..... **[1]**

(c) James repeats the titration twice.

The volumes of 0.5 mol dm^{-3} sodium hydroxide needed to reach the end point in the three titrations are shown in the table.

	Titration 1	**Titration 2**	**Titration 3**
Volume of 0.5 mol dm^{-3} NaOH required / cm^3	31.30	31.10	31.05

(i) Name the piece of equipment used to determine the volume of NaOH required.

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

(ii) Calculate the mean titre that James should use in his calculation.

Give your answer to **2** decimal places.

Mean titre = ... cm^3 **[2]**

(iii) Calculate the number of moles of sodium hydroxide required to reach the end point.

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

Use your answer to **(c)(ii)**.

Number of moles of NaOH = ... mol **[1]**

(iv) The equation for the reaction is

$NaOH(aq) + CH_3COOH(aq) \rightarrow CH_3COONa(aq) + H_2O(l)$

State the number of moles of acetic acid in the 25.0 cm^3 sample.

Number of moles = ... mol **[1]**

(v) The molar mass of acetic acid is 60 g mol^{-1}.

Calculate the mass of acetic acid in the 25.0 cm^3 sample.

Use your answer to **(c)(iv)**.

Use the equation: number of moles = $\frac{\text{mass (g)}}{\text{molar mass (g mol}^{-1})}$

Mass of acetic acid = ... g **[1]**

(vi) The concentration of acetic acid in a bottle of vinegar is normally shown on the label as a percentage. This is equivalent to mass of acetic acid in 100 cm^3 of vinegar.

Calculate the percentage of acetic acid in the vinegar.

Give your answer to **2** significant figures.

Use your answer to **(c)(v)**.

Percentage of acetic acid = ... % **[1]**

(d) James decides to determine the concentration of acetic acid in red vinegar.

(i) Explain why he cannot use an indicator to determine the end point of this titration.

.....

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

(ii) Suggest an alternative technique he could use to determine the end point of this titration.

.....

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

4 Images for medical diagnosis can show structures hidden inside the human body.

(a) **Fig. 4.1** shows a medical image.

Fig. 4.1

(i) State the name of the imaging technique used to create **Fig. 4.1.**

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

(ii) Describe the medical condition revealed in **Fig. 4.1.**

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

(iii) Describe **one** disadvantage of the medical imaging technique used to create **Fig. 4.1.**

.....

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

(iv) Explain why some areas of **Fig. 4.1** appear white and other areas appear black.

.....

.....

.....

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

(b) **Fig. 4.2** shows a medical image produced by a different technique.

Fig. 4.2

(i) Name the technique used to obtain the image in **Fig. 4.2.**

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

(ii) State what is shown in **Fig. 4.2.**

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

(c) The techniques used in **Fig. 4.1** and **Fig. 4.2** have different features.

Complete the table. Tick (✓) at least **one** box in each row.

Feature	Technique used in Fig. 4.1	Technique used in Fig. 4.2
Uses reflected waves		
Requires protection for the radiographer		
Can show moving structures		
Can show soft tissues with a higher resolution		
No limit to the number of images a patient can have taken		

[5]

5 Alex is a technician in a scientific laboratory. One of her jobs is to do tests to identify different chemicals.

The tests Alex can use are listed in **Fig. 5.1:**

- Adding aqueous sodium hydroxide
- Adding aqueous barium chloride
- Flame test
- Adding hydrochloric acid
- Adding aqueous silver nitrate

Fig. 5.1

(a) The labels of two bottles, each containing a white powder, are missing. Alex knows that one of the powders is potassium chloride and the other is sodium chloride.

(i) Select a suitable test from the list in **Fig. 5.1** to enable Alex to identify the white powder in each bottle.

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

(ii) Describe how Alex should do the test selected in **(a)(i)**.

.....

.....

.....

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

(iii) State the expected result for each of the chemicals:

Potassium chloride .....

Sodium chloride .....

[2]

(b) Alex has another bottle containing a white powder.

Alex is not sure whether the powder is potassium bromide or potassium iodide. She uses aqueous silver nitrate to identify the white powder.

(i) Describe how Alex should do this test.

.....

.....

.....

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

(ii) State the expected results for each of the chemicals when using the test described in **(b)(i)**.

Potassium bromide .....

Potassium iodide .....

[2]

(c) Alex needs to test another substance to confirm that it is a carbonate.

(i) Select the most appropriate test from **Fig. 5.1** to confirm that the substance is a carbonate.

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

(ii) State the positive result for this test.

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

(iii) Describe how Alex can confirm that one of the products of this test is carbon dioxide.

.....

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

(d) **(i)** Aluminium nitrate dissolves in water to give a colourless solution.

Alex gradually adds aqueous sodium hydroxide to the solution of aluminium nitrate until there is no further change.

Describe what Alex would observe.

.....

.....

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

(ii) Iron(II) sulfate dissolves in water to give a pale green solution.

When Alex adds aqueous barium chloride to the solution, a precipitate is formed.

Draw **one** line to connect the colour of the precipitate formed with the correct chemical name of the compound formed.

Colour of the precipitate formed	**Chemical name of the compound formed**
White	Iron(II) hydroxide
Blue	Iron(II) chloride
Green	Barium sulfate

[1]

6 Kofi is a researcher using plant tissue cultures.

He must use aseptic technique in the laboratory.

(a) Explain why aseptic technique is important when creating plant tissue cultures in a laboratory and describe the range of sterilisation techniques available for this purpose.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

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

(b) Kofi is using the plant tissue cultures to obtain clones.

What is the correct definition of a clone?

Tick (✓) **one** box.

They are all the same size. ☐

They are all the same species. ☐

They are all genetically engineered. ☐

They are all genetically identical. ☐

[1]

(c) **Fig. 6.1** shows one of the tissue culture vessels used by Kofi.

Some samples of an African violet plant are seen in the image.

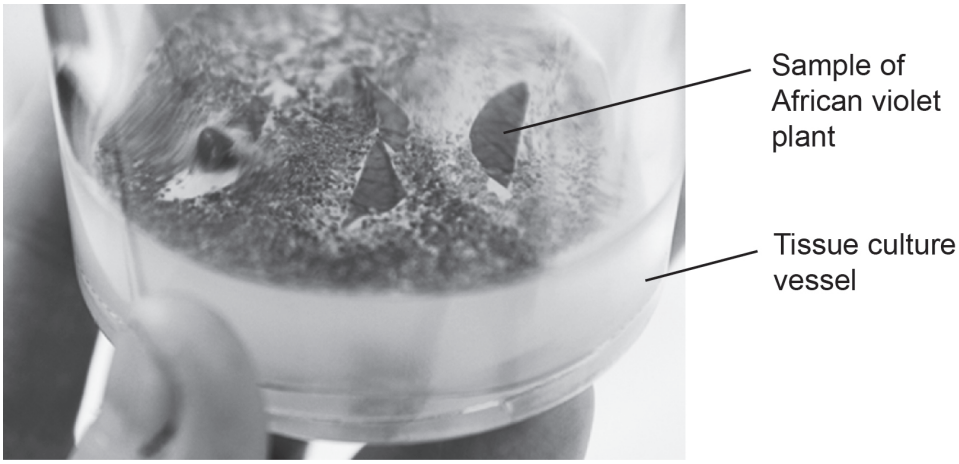


Fig. 6.1

Complete the sentences about **Fig. 6.1**. Use the words.

You can use each word once, more than once or not at all.

contaminated **pathogens** **offices** **centrifuged** **explants**
irrigated **environment** **autoclaved** **cabinet**

The problem with the tissue culture vessel in **Fig. 6.1** is that it is ..... .

This tissue culture should now be ..... to prevent people coming in direct contact with ..... .

Working in a controlled airflow ..... can help prevent contamination from the ..... .

[5]

(d) Describe how to sterilise a wire inoculation loop before a plate is streaked.

.....

.....

.....

.....

.....

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

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, 5(a)(ii) or 6(a).

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