CAMBRIDGE TECHNICALS

OCR
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CAMBRIDGE TECHNICALS LEVEL 3 (2016)

Examiners' report

APPLIED SCIENCE

05847–05849, 05879, 05874

Unit 2 January 2022 series

Contents

Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates.

The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report.

A full copy of the question paper and the mark scheme can be downloaded from OCR.

Unit 2 series overview

This paper is quite different than has probably been seen before by some candidates. Historically candidates do not sit a paper that contains more than one science discipline in a Level 3 examination. However, most centres are familiar with the style of paper and in general candidates' performance is improving, even considering the difficulties of the last two years. Most candidates seem prepared for this style of examination.

There is a lot of application and understanding of contexts that some candidates may have struggled with. Centres are encouraged to use sample papers and any previously sat live papers available with the candidates to give them practice at the style of paper and the questions within.

Some areas were answered well, and candidates showed good knowledge of accurate use of equipment and medical imaging techniques. Some candidates were able to carry out calculations related to titrations and give answers to appropriate number of significant figures, although many did not understand about the importance of dismissing inconsistent titres. They did not do as well on questions about chemical tests or on molar calculations.

This is a techniques paper and so it is the techniques they need to know how to describe. Candidates who have had the opportunity to carry out the techniques are much more able to answer the questions successfully. We understand how difficult that has been this year, so good use of demonstrations and video clips is important.

Candidates who did well on this paper generally did the following:	***Candidates who did less well on this paper generally did the following:***
• attempted all questions • read the question carefully • had experience of laboratory techniques • had practised exam technique • had good knowledge of chemical tests • gave answers relating to context of the question • had practised mathematical skills • used accurate and precise science terminology.	• did not answer the question as set • had not carried out or seen the laboratory techniques required • could not recall or apply basic science knowledge.

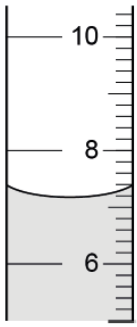
Question 1 (a) (i)

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]

	AfL	Candidates generally got 2 marks here, however in some cases their marks were limited because they did not use the scientific term. Although we allowed descriptions of the bottom of the meniscus, some candidates got confused and therefore gave incorrect answers. It is important in teaching to use the correct scientific terms as this helps candidates communicate ideas correctly.

Question 1 (a) (ii)

(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]**

	AfL	Some candidates measured from where the meniscus met the side of the measuring cylinder. Others struggled to read the scale correctly. Practising drawing and reading scales will help candidates.

Question 1 (b) (i)

(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]**

Most candidates understood this was about accuracy and so gained this mark.

Question 1 (b) (ii)

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

.....

.....

.....

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

	AfL	Candidates gained a mark for understanding that they had to check a known mass against the reading on the balance. However, very few understood that to be certain the balance was calibrated correctly, they needed to check against more than one known mass. When carrying out any technique it is important to explain the purpose of each step.

Question 1 (b) (iii)

(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]

Many candidates got full marks here. It is important for the candidates to spend time reading all the information and take care over answers. Those that did not get full marks had likely not checked their answer made sense.

Question 1 (c)

(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]

It was good to see most candidates get full marks here.

Question 1 (d)

(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]

?	**Misconception**	Few candidates got more than one or two marks here. There was clearly misunderstanding about what a data sheet from a chemical supplier was and many were obviously talking about hazcards or risk assessments. Wrong answers included vague comments on hazards or descriptions on how to use the chemical.

Question 2 (a)

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]

It is important that candidates have as much opportunity to carry out different techniques as possible but also to understand the reason for those techniques. This question was not answered well.

Question 2 (b)

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

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

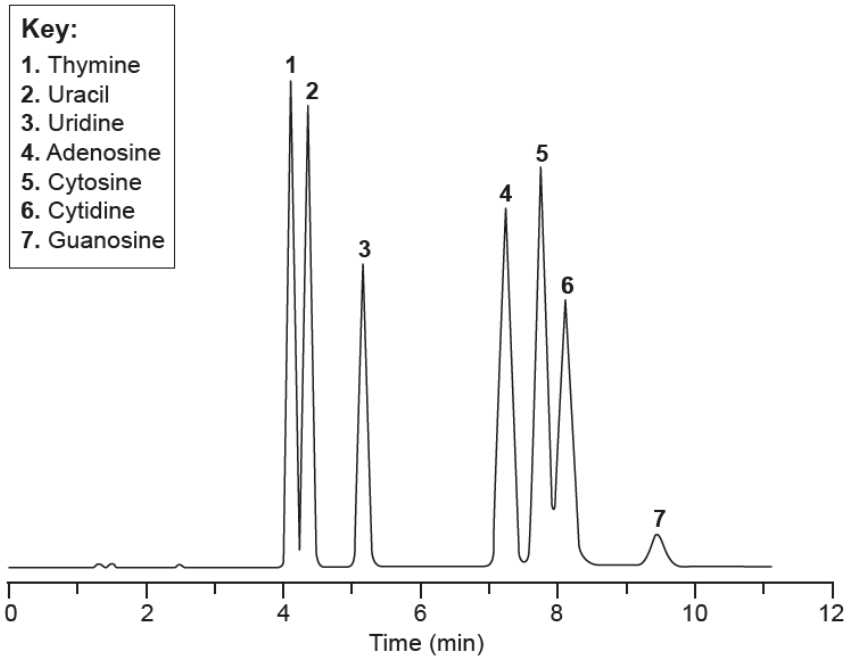


Fig. 2.1

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

Retention time of adenosine = ... min

Retention time of cytidine = ... min

[2]

	AfL	As with Question 1 (a) (ii), some candidates struggled to read the scale correctly. It is worth spending time on this skill.

Question 2 (c) (i)

(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]

	AfL	There were some very good graphs seen. However, some candidates had the axis the wrong way round and did not gain that mark. Several transferred the numbers in the table directly to the axes and so lost the scale mark. This also made it difficult to plot correctly or draw a correct line of best fit. Practising plotting graphs will help candidates gain several marks as the skill used is the same irrelevant of the context.

Question 2 (c) (ii)

(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]**

Most candidates did not know to dilute the sample.

Question 2 (c) (iii)

(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]**

	AfL	Most candidates were able to use their graph correctly to answer this. Good practice would be to show their working on the graph as if they had made errors when drawing their graph, the working makes it easier for an examiner to allow error carried forward.

Question 2 (c) (iv)

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

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

Most candidates struggled with this, many left it blank or clearly just guessed as they did not know what calculation to use.

Question 2 (d) (i)

(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]

?	**Misconception**	Many candidates misunderstood the question and so attempted to describe the process. Some managed to pick up one or two marks in this way but most did not. It was important to read the question here as it was the four principles that were needed to be stated and not a description. Again, when techniques are used it is important to explain the science and principles behind the technique

Question 3 (a) (i)

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.

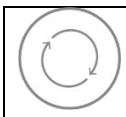
The concentration of acetic acid can be determined by titration against sodium hydroxide (NaOH), a strong base.

(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]**

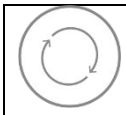
	**AfL**	It was clear that most students knew how to get the information they needed and use it correctly. It is important to give candidates practice on using the Periodic Table.

Question 3 (a) (ii)

(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 = $\frac{\text{mass (g)}}{\text{molar mass (g mol}^{-1})}$

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

	**AfL**	This is a common style question and the calculation is quite simple. It is worth allowing candidates the opportunity to practise this type of calculation. It is also important to show working as marks can be given for correct working even if the final answer is wrong if there is more than one mark available. Again, it is important to understand the science behind the calculation and this will help answer the question correctly.

Question 3 (b) (i)

(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]

In some cases, candidates had circled an answer and then changed their mind. It is important to teach good exam technique here as in some cases it was not clear which answer the candidate had decided was the correct one. They should fully cross out the incorrect answer.

Question 3 (b) (ii)

(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]**

In general this was answered well. However, precision of wording is important and several candidates used clear to pink rather than colourless to pink. Clear and colourless are not interchangeable and so clear does not gain the mark.

Question 3 (c) (i)

(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]**

Although most candidates got this mark, there were still incorrect answers, including measuring cylinder or measuring jug. As stated earlier, scientific terminology is important and as the question asks for the equipment to be named, there is no leeway here.

Question 3 (c) (ii)

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

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

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

	AfL	Candidates were able to calculate a mean correctly and it was good to see many give their answer to 2 decimal places. Those that did not had not read the instructions carefully enough. It is also important to round correctly as incorrect rounding would lose a mark. In general only one mark was given here as most candidates did not understand that they should not use the value for titration 1 as it was not consistent with the other two. Again, understanding the technique and why it is carried out a certain way is an important lesson for candidates. Practice at choosing appropriate titres would help with this.

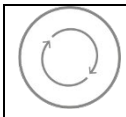
Question 3 (c) (iii)

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

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

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

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

	**AfL**	Practising choosing correct numbers from a question and substituting them in an equation will help candidates with calculations in a variety of contexts. Those that had this skill did well here.

Question 3 (c) (iv)

(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]**

A correct answer to this question shows an understanding of balanced equations. Being able to interpret an equation is an important skill.

Question 3 (c) (v)

(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]**

This is another question where the ability to choose and substitute correct numbers into an equation is an important skill.

Question 3 (c) (vi)

(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]**

There are a lot of instructions in this question. Candidates who were given the mark read them carefully and were able to calculate the correct answer to 2 significant figures. As with Question 3 (c) (ii) it is important to round correctly.

Question 3 (d) (i)

(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]**

In some cases, candidates were unclear in their answer and did not show they understood why they could not use an indicator. Many just repeated the question by stating that the vinegar was red but did not expand it any further.

Question 4 (a) (iii)

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

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

Fig. 4.1

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

.....

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

Quite a few candidates knew this was related to radiation exposure and gained the mark. There have been questions on medical imaging on previous papers and it was clear that candidates have practised those. However, earlier questions asked about the differences between x-rays and ultrasound, whereas this question asked about the disadvantage of x-rays. It is important to read the question and answer the question set. In some cases it was clear the candidate was answering a question about the differences between x-rays and ultrasound and so gave an attribute of ultrasound as a disadvantage for x-rays.

Question 4 (a) (iv)

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

.....

.....

.....

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

?	**Misconception**	Candidates found this question challenging and there were clear misconceptions seen. Candidates thought the x-rays bounced off the bones, not that they were absorbed and so did not expose the plate behind the bones.

Question 4 (b) (i)

(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]**

Again, correct scientific terminology is important. Many students probably did know the correct answer but got confused and a range of answers such as ultraviolet or ultra scan were seen.

Question 4 (b) (ii)

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

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

Most candidates gained this mark, however many gained it for the allowable answers rather than the expected answer of foetus. Some gave embryo as an answer, which would be incorrect.

Question 5 (a) (i)

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]**

Question 5 (a) (ii)

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

.....

.....

.....

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

Question 5 (a) (iii)

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

Potassium chloride .....

Sodium chloride .....

[2]

Question 5 (b) (i)

(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]**

Question 5 (b) (ii)

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

Potassium bromide .....

Potassium iodide .....

[2]

Question 5 (c) (i)

(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]**

Question 5 (c) (ii)

(ii) State the positive result for this test.

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

Question 5 (c) (iii)

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

.....

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

Question 5 (d) (i)

(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]**

To answer these questions, candidates needed to be familiar with the tests listed in the box at the start of Question 5. If they did not know how to carry out the tests and the expected results then they struggled. It is important that candidates have experience of all these chemical tests and their results. It is also important that they give the results precisely. For flame test, we use the colours given by the Royal Society of Chemistry. For halide tests, they must state the colour and that it is a precipitate. When adding sodium hydroxide to aluminium nitrate they do not get a mark for white colour then colourless, it must be white precipitate and colourless solution. This precision of language is important here as a coloured precipitate would mean something different to a similar coloured solution.

Question 5 (d) (ii)

(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]

In previous papers there have been similar questions where 3 lines have been expected. However, in this question the candidates were told to draw one line. Candidates that drew a line from white to barium sulfate but then also drew lines from the other colours to the other compounds could not gain a mark as the examiner did not know which product the candidate thought was formed. This shows the importance of reading the question carefully. The number of lines (in this case one) is always emboldened in order to help the candidates.

Question 6 (a)

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.

.....

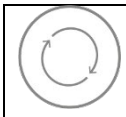
.....

.....

.....

.....

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

	**AfL**	This is a Level of Response question (LOR). It is marked holistically rather than being given a mark a point. The command word is explain, so in order to gain full marks candidates must explain the procedure they are describing. Many candidates only described or named and so limited the amount of credit they could gain. This is why it is important for candidates to have experience of different techniques and also to have the opportunity to consider why differing steps in the techniques are used. A Level 1 candidate will give some basic correct statements about the techniques but is unlikely to link them or give a full description, they will not link them to the reasons for carrying out the technique. A Level 2 candidate will have a good description of some techniques with some linkage and will have given some reasons for using the techniques. A Level 3 candidate has a good description and has good linkage to specific reasons for using the techniques. Remember, not everything has to be covered for full marks. There is a lot of indicative content and only 6 marks available. In this case we would expect the candidate to describe different sterilisation techniques and then explain their purpose in relation to preventing contamination of the culture or the scientists, or in relation to retaining the characteristics/genome of the original source of cells/tissue. Vague answers about sterilising to prevent contamination would only be Level 1.

Question 6 (c)

(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]

Candidates tended to get at least 3 marks here. They tended to miss the last 2 marking points as they were not reading the list and the sentences carefully. Many wrote environment instead of cabinet, and many wrote explant rather than environment/pathogens.

Question 6 (d)

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

.....

.....

.....

.....

.....

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

This was answered well although in some cases candidates confused sterilising the loop with cleaning it for a flame test.

This again shows the importance of understanding why they carry out a technique rather than just following a method.

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