CAMBRIDGE TECHNICALS

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Examiners' report

APPLIED SCIENCE

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Unit 2 January 2021 series

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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 paper. However, most Centres are familiar with the style of paper and in general candidates' performance is improving. Most candidates seem prepared for this style of paper.

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 in order to give them practice at the style of paper and the questions within.

Some areas were answered well, and candidates showed good knowledge of safe working practice and separation techniques. Some candidates were able to carry out calculations related to titrations and give answers to appropriate number of significant figures. They did not do as well on questions about chemical tests or microscopy.

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 is this year, so good use of demonstrations and video clips are 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 safe working practice • gave responses relating to context of the question • had practised mathematical skills.	• 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)

1 Jane is a technician working in a laboratory.

Jane carries out an experiment to find out how much a thin wire stretches when she adds increasing loads (weights) to the wire. She wants to see if the extension of the wire is directly proportional to the load.

(a) She records the results of the experiment and notes her name and the date that the work is done.

Suggest why Jane's name and the date were recorded.

.... **[1]**

Some candidates did well and commented on both the name and the date. Very few used the terms 'traceability' or 'audit trail.' Many thought it was about making sure no one else could change their results.

	AfL	Centres should discuss each step of a process with students, so they know why they are important.

Question 1 (b)

(b) **Table 1.1** shows Jane's results.

Load added / N	Length / mm	Extension of the wire
0	30	0
500	35	5
1000	40	10

Table 1.1

Jane forgets to record a key detail in one of the column headings in **Table 1.1**.

State the key detail that is missing.

.... **[1]**

Most candidates recognised the units were missing, although, a few suggested inappropriate units.

Question 1 (c) (i)

(c) **(i)** Describe **two** ways the data collected can be improved to make the results of the experiment more reliable.

1 ....

2 ....
[2]

Most candidates got both marks here. Several struggled to clearly describe adding a wider range. This was a low-demand question and so some leeway was given with language used. Candidates would do better if they could be precise with their responses.

Question 1 (c) (ii)

(ii) Design a table of results that would allow the data from the improved experiment to be collected.

[4]

Some candidates copied the table from Question 1(b). This meant that they got 2 marks. Better candidates also included the units that were missing. Many candidates then struggled to get the last mark. Those that did usually gained it for repeats. Candidates used a range of ways to show repeats. The best tables had extra columns to show repeats, but candidates were not penalised if they drew more tables to show repeats.

Question 1 (d) (i)

(d) **(i)** Jane produces a risk assessment, before completing the experiment.

Describe **one** hazard that the experiment might present.

.... **[1]**

This was a low risk experiment and so some leeway was given with awarding marks to suggested hazards. However, if a risk rather than a hazard was given, this was not credited. For example, 'sharp wire' was given a mark but 'cut from wire' was not.

?	**Misconception**	Students need to know the difference between hazards and risks.

Question 1 (d) (ii)

(ii) State **one** precaution that Jane should take to reduce the risk of the hazard identified in **(d)(i)**.

.... **[1]**

It was important that the precaution given matched the hazard given in 1(d)(i).

Question 1 (f)

(f) Amir is another technician working in the laboratory. He is using a pH meter to measure the pH of some acidic solutions. Before he uses the pH meter it must be calibrated.

Outline **four** of the steps involved in the calibration of a pH meter.

1 ....

....

2 ....

....

3 ....

....

4 ....

....

[4]

Many candidates understood that you needed to use more than one solution but did not specify known pH or any idea of adjusting the meter to match. Some candidates talked about indicator solutions.

Candidates really struggled with this question. Most responses were very vague.

It is important that these techniques are carried out (where possible) or seen demonstrated. Candidates need practice in writing out standard operating procedures such as this one. There were similar issues with 4(b) where they had to describe how to focus a light microscope.

Question 2 (b) (i)

(b) **(i)** In **Table 2.2** put a **tick** (✓) against the **three** correct advantages of linking HPLC to a mass spectrometer.

Advantage	Tick
Positive identification of unknown chemicals	
Technicians need less training	
Reduced cost	
Quantification of known compounds	
Reduces the time taken to separate the molecules	
Provides information on structure of compounds	

Table 2.2

[3]

Candidates are showing good techniques with these 'tick the box' questions. It is rare to see an answer left blank or with too many ticks.

Question 2 (b) (ii)

(ii) Complete the sentences to explain the features of mass spectroscopy.

Use words from the list.

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

electrons **gas** **gravitational** **liquid** **magnetic** **solid**

The sample eluted from an HPLC column is converted into a

....

The compounds in the sample have .... removed to form positive ions.

A .... field is then used to separate the ions according to their mass : charge ratio.

[3]

Most candidates gained 2 marks here for 'electrons' and 'magnetic'.

Question 2 (c)

(c) Explain how thin layer chromatography (TLC) can be used to separate and identify chemicals present in samples.

Your answer should include:

- How TLC is set up.
- How TLC separates different chemicals.
- How to identify chemicals on a TLC plate by calculating R_f values.

You may include a diagram in your answer.

[6]

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 they must explain the procedure they are describing.

Most candidates gained level 2 as they wrote good descriptions of the technique. In order to gain level 3 they needed to explain some of the steps to the method or how Rf value is used.

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 procedure but is unlikely to link them or give a full description. It is possible that they will confuse steps, or that the procedure as they have written it will not work.

A Level 2 candidate will have a good description with some linkage and will have covered the three bullet points to some extent. There will no or minimal attempt to explain.

A Level 3 candidate has a good description and covers all three bullet points and explains at least some of the steps. Remember not everything has to be covered for full marks.

	AfL	It is a good idea to let students see examples of Level 1, Level 2 and Level 3 responses and ask them to order them so they can see what is needed at each level.

Question 3 (a)

3 Titrations can be used to determine the concentration of acids or bases.

(a) 50 cm^3 of 0.1 mol dm^{-3} sodium hydroxide, NaOH, is gradually added to 25 cm^3 of 0.1 mol dm^{-3} hydrochloric acid, HCl. The pH is plotted against the volume of NaOH added.

On the axes in **Fig 3.1** sketch the shape of the titration curve and label the equivalence point.

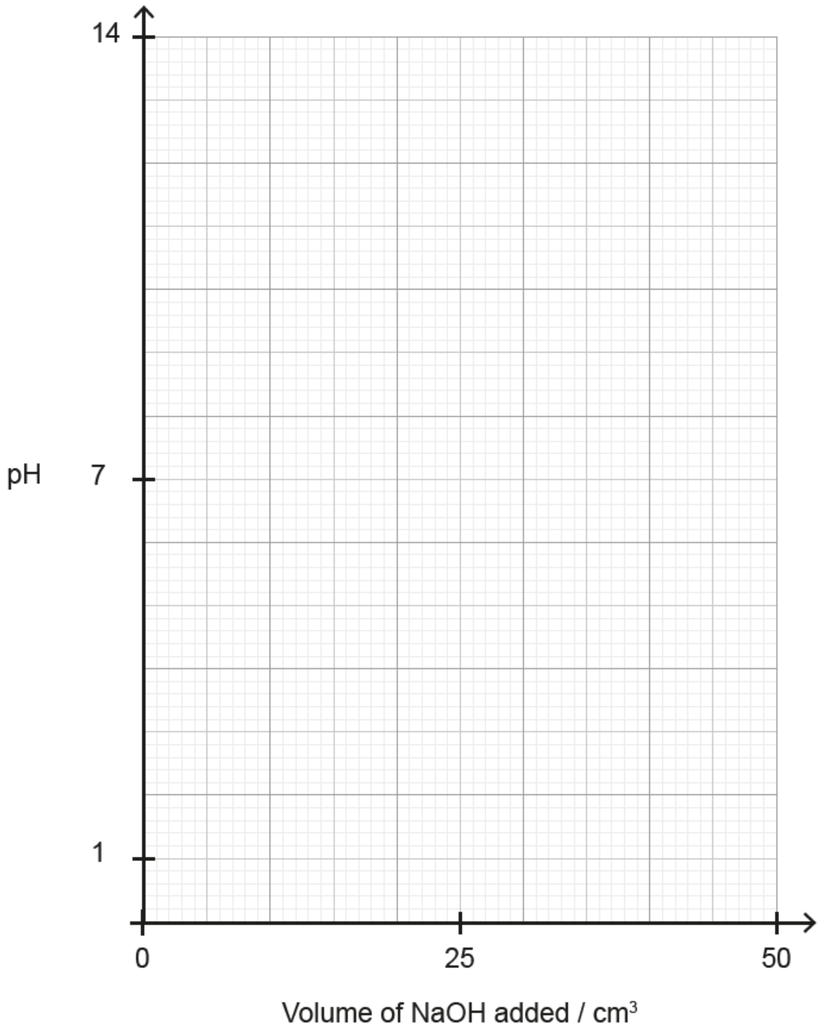

Fig 3.1

[3]

Most candidates had good exam technique and did at least try to answer this question. Candidates often did not know what to do. Many drew a diagonal line from the origin, others a bell curve. It was clear that most guessed where the equivalence point was. It seems likely that most candidates had not done or seen this as a practical as the curve is so distinct.

Question 3 (b) (i)

(b) **Fig 3.2a** shows the reading on a burette at the start of a titration.

Fig 3.2b shows the reading at the end-point of a titration.

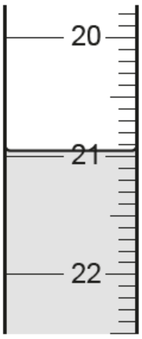

Fig 3.2a

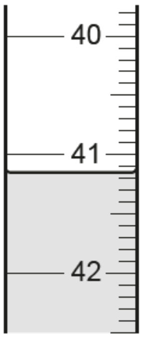

Fig 3.2b

(i) State **two** precautions that should be taken to ensure the burette reading is accurate.

1 ....

2 ....

[2]

The response expected here was to do with correct standard operating technique and not mistakes. Some candidates talked about the correct standard operating technique as was expected. Many gained 1 mark for measuring at eye level. However, most candidates gave a second response discussing having the burette on a flat surface or not at an angle so did not gain the second mark.

Question 3 (b) (ii)

(ii) Calculate the volume of titrant added.

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

Show your working.

Volume of titrant added = ... cm^3 **[2]**

Question 3 (b) (iii)

(iii) This titration was repeated. The other two titres were 20.10 cm^3 and 20.15 cm^3.

Calculate the mean volume of titrant added.

Mean volume of titrant added = ... cm^3 **[1]**

For Question 3(b)(ii), some candidates used good techniques by showing their working. Many were able to get at least one mark here because of this.

It was clear that some candidates had not had much opportunity to read off a burette as many gave responses such as 41.5-21.5 = 20. Many also either had not read the question properly or did not know what an appropriate number of significant figures was.

Good exam technique would have been to check their answer for 3(b)(ii) against the titres given in 3(b)(iii). They may then have recognised if their answer to 3(b)(ii) did not show concordance and go back and check the answer.

For Q3(b)(iii), candidates were not penalised for using a response that was not concordant from 3(b)(ii) in the calculation in 3(b)(iii). Error carried forward was applied.

	AfL	It would be useful to explain to students about the importance of concordance here. 3(b)(iii) also showed the importance of their working. 3(b)(iii) used the response from 3(b)(ii) in the calculation and allowed for error carried forward. However, if the working was not shown then it was difficult to see where a response came from, meaning that a response that could have been worthy of some credit could not gain the mark.

Question 3 (c) (i)

(c) Mia is a science student.

She completes a titration to determine the concentration of an aqueous solution of calcium hydroxide, $Ca(OH)_2$ (aq).

Mia finds that $19.50\,cm^3$ of $0.0200\,mol\,dm^{-3}$ hydrochloric acid (HC*l*) is required to neutralise $25.00\,cm^3$ of the calcium hydroxide solution.

In this reaction, **two** moles of HC*l* are needed to neutralise **one** mole of $Ca(OH)_2$.

Mia knows that she must use the following relationship in her calculations:

$$\text{number of moles} = \frac{\text{concentration in mol dm}^{-3} \times \text{volume in cm}^3}{1000}$$

(i) Calculate the number of moles of HC*l* required to neutralise the $Ca(OH)_2$ solution.

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

Question 3 (c) (ii)

(ii) Use the reacting ratio to calculate the number of moles of $Ca(OH)_2$ in $25.00\,cm^3$ of the calcium hydroxide solution.

Number of moles of $Ca(OH)_2$ = ... mol **[1]**

Question 3 (c) (iii)

(iii) Calculate the concentration, in $mol\,dm^{-3}$, of the calcium hydroxide solution.

Concentration of $Ca(OH)_2$ = ... $mol\,dm^{-3}$ **[1]**

Some candidates did very well overall on 3(c). Other candidates struggled. It is a good idea to practise a range of these titration calculations, as well as practising substituting numbers into an equation.

Question 3 (d)

(d) An auto-titrator is frequently used in the food industry to determine the acidity of fruit juice.

Complete the sentences about auto-titration.

Use words from the list.

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

electrode	**endpoint**	**large**	**meter**
temperature	**small**	**volume**	

Auto-titrators use an .... to determine the

.... for acid base titrations.

They are programmed to add .... quantities of titrant in the

region of the .... so that the.. of

titrant needed for neutralisation can be accurately determined.

[4]

It was good to see most candidates attempted this question. This is a version of a multiple-choice question and so it is possible to pick up marks here with 'educated guesses'. Many gained at least 3 marks. This question highlights the importance of reading the question carefully, as in this case some words were used more than once and some not at all.

Question 4 (a)

4 Kai is a technician working in a hospital laboratory.

He uses different types of microscope to view objects too small to see with the naked eye.

(a) Complete the sentences about microscopy.

Use words from the list.

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

accuracy	**electron**	**graticule**	**light**	**resolution**
ruler	**size matrix**			

Living cells can be viewed using .... microscopy.

Electron microscopy has a higher .... than light microscopy.

A .... can be used to measure the size of an object when

viewed by light microscopy.

[3]

?	**Misconception**	The most common error here was suggesting a ruler can be used to measure the size of an object rather than a graticule. It is possible that candidates have been shown a ruler through the microscope lens to point out scale etc which has caused confusion. This is why discussing procedures and techniques is so important; it is not enough for students to follow a series of steps. Students must know why the techniques and apparatus are used.

Question 4 (b)

(b) Kai is preparing to use a light microscope to view blood cells.

Outline **four** of the steps that Kai should take to safely focus the blood cells with the greatest magnification.

1 ....

2 ....

3 ....

4 ....

[4]

Many candidates answered this question in terms of preparing a slide rather than focusing the microscope showing they had not read the question fully. Answers tended to be vague and did not use scientific terminology. Candidates struggled to outline the steps clearly and many just repeated 'focus' rather than stating how to focus. Candidates need to know how to outline a standard operating procedure. It helps if they have experience of doing the procedure themselves or failing that seeing it demonstrated with opportunities to discuss each step.

Question 4 (c) (i)

(c) **Fig 4.1** shows the image that Kai can see of a sample of blood using his light microscope.

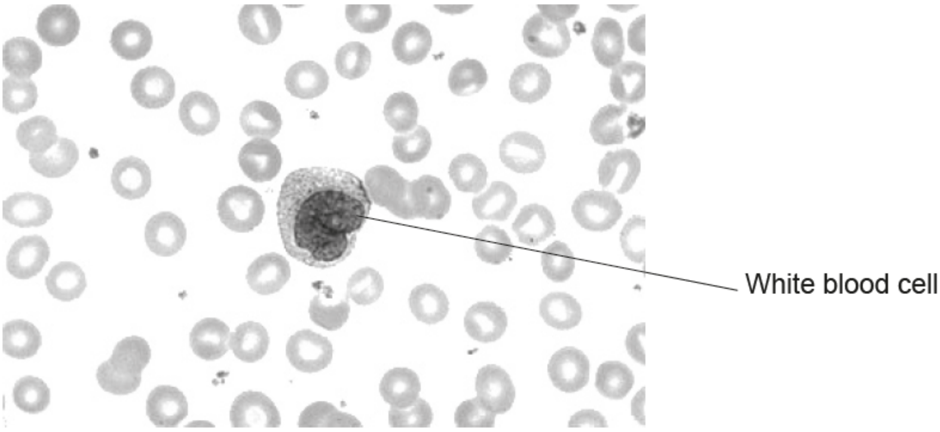

Fig 4.1

(i) In the space below make a **large** scientific line drawing of the **white blood cell** as seen by Kai in **Fig 4.1**.

[3]

Question 4 (c) (ii)

(ii) Use a ruler to measure the diameter of the white blood cell in **Fig 4.1** at the widest part, to the nearest mm.

Width of white blood cell = ... mm **[1]**

Most candidates got the mark for the drawing being larger than the original image. Some candidates made excellent drawings but then shaded in the cell which is considered bad practice. Many candidates did not do good copies of the cell and did not get the shape close to the original.

It is important that students get the opportunity to practise drawing and measuring what they see through a microscope.

Question 4 (c) (iii)

(iii) The actual size of the white blood cell is 1.5×10^{-2} mm.

Calculate the magnification used to view the white blood cell in **Fig 4.1**.

Use the formula: magnification = measured size ÷ actual size

Show your working.

Magnification = × .... **[1]**

Question 4 (c) (iv)

(iv) The eyepiece lens has a magnification of ×10.

Calculate the magnification of the objective lens.

Magnification = × .... **[1]**

Question 4 (c) (v)

(v) Kai viewed the white blood cell using a $\times 10$ objective lens and a $\times 10$ eyepiece lens.

He changes the objective lens for one with a magnification of $\times 40$. The eyepiece lens remains the same.

Calculate the size that the white blood cell will appear when viewed using the microscope with the $\times 40$ objective lens.

Size of white blood cell = ... mm **[2]**

A few candidates gained all marks here. Some were able to measure the cell accurately for 4(c)(ii). Many gained a mark for 4(c)(iii). Many candidates multiplied by 10 rather than dividing by 10 for 4(c)(iv). Fewer candidates gained marks for 4(c)(v). Error carried forward from 4(c)(ii) and at each stage was allowed. This reinforces how important it is to show the working. Examiners can only award marks based on error carried forward if it is clear what the candidate has done.

Question 5 (a) (i)

5 A student is using chemical testing to identify anions.

(a) (i) The student is asked to consider different tests and the results expected for three anions.

For **each** of the anions listed in **Fig 5.1** draw a line to link it to the correct **test**. Then draw a line to link each test to the **positive result** expected.

Anion	Test	Positive result
Carbonate	Add a few drops of nitric acid then a few drops of silver nitrate	White precipitate produced
Bromide	Add a few drops of hydrochloric acid and then a few drops of barium chloride solution	Cream precipitate produced
Sulfate	Add a few drops of acid	Bubbles produced

Fig 5.1

[5]

Question 5 (a) (ii)

(ii) One of the positive results in **Fig 5.1** produced bubbles of carbon dioxide.

Describe the test for the presence of carbon dioxide **and** the positive result.

Test ....

Positive result ....
[2]

Question 5 (a) (iii)

(iii) Name **two** other anions that can be tested for by adding a few drops of nitric acid followed by silver nitrate.

1 ....

2 ....
[1]

Question 5 (a) (iv)

(iv) Explain why nitric acid is added first when testing for halides.

....

....

.... **[2]**

Most candidates gained marks for 5(a)(i); line matching. However in general, candidates struggled with most parts of Question 5(a).

It is important for candidates to have good basic science knowledge, e.g. chemical tests and their results.

?	**Misconception**	In (a) (iv) Candidates thought nitric acid is added when testing for halides to make it more reactive or faster etc. Again, this illustrates the importance of understanding the techniques and equipment when following a method.

Question 5 (b) (i)

(b) (i) The student finds out that flame tests and ICP-AES can both be used to identify metal ions.

Give the full name for AES.

.... **[1]**

Only a small number of candidates gained this mark. It is important that all testing procedures in the specification are taught.

Question 5 (b) (ii)

(ii) **Table 5.1** lists some features of flame tests and ICP-AES for metal ions.

Put a tick (✓) in the correct box in each row to show if the feature is found in a **flame test** or in **ICP-AES**.

Feature	Flame test	ICP-AES
Quantitative analysis		
Cheap and easy to do		
High levels of sensitivity		
Requires high level of training		
Can be done outside of the laboratory		
Can detect multiple metals in the same sample		

Table 5.1

[4]

Candidates did well here. It is important that they know the reasons for using different tests.

Question 6 (a)

6 A biological research company focuses on the growth of microorganisms in a laboratory.

One of the sources for testing microorganisms is river water.

The scientists in the laboratory must make sure that the materials and equipment they use are sterile.

(a) For each item in **Table 6.1** put a tick (✓) for the most appropriate way to sterilise it.

Item	Autoclave	Spray with ethanol solution	Filter	Open flame	Dry heat
Bacterial growth medium					
Inoculating loop					
Antibiotic solutions					
Empty glassware					
Open bottle of sterile diluting water					
Inside of controlled air flow cabinets					

Table 6.1

[6]

A few candidates gained full marks. These are standard operating procedures and so candidates should be familiar with them, even if this year it was through demonstrations/videos.

Question 6 (b)

(b) The research scientists grow microorganisms on agar plates.

They find that this is a useful way to assess the purity and number of microorganisms present in a sample.

Fig 6.1 shows a plate of yeast colonies.

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State how the plate in **Fig 6.1** shows that the yeast culture is **not** contaminated with other microorganisms.

....**[1]**

Some candidates thought that if colonies of a yeast culture were different sizes then this meant they were different types of microorganism and the culture was contaminated.

Question 6 (c) (i)

(c) The plate in **Fig 6.1** was produced by the spread plating method as follows:

- A yeast culture was grown in liquid growth medium.
- 10 cm^3 of culture was diluted with sterile water to make a final volume of 1000 cm^3.
- 0.1 cm^3 of the dilution was then spread onto the sterile plate.
- The plate was then incubated for 24 hours to allow the yeast to grow.

(i) Count the number of yeast colonies growing from the 0.1 cm^3 spread.

Number of yeast colonies on plate = ... **[1]**

This is a difficult skill, and it is a good idea to give candidates practice at this.

Question 6 (c) (ii)

(ii) Calculate the number of yeast colonies in the initial 10 cm^3 of the undiluted culture.

Number of yeast colonies in 10 cm^3 of undiluted culture = ... **[2]**

Many candidates did not know how to calculate the dilution. They came up with very random, or very large or small answers. They need to have good exam technique and compare their answer to the figures in the question to see if they are sensible.

Question 6 (c) (iii)

(iii) Explain why spread plating the **undiluted** yeast culture would not have been useful to work out the number of yeast colonies in the culture.

.... **[1]**

Many candidates were confused here and talked about the cultures being too small or mentioned contamination.

Question 6 (d) (i)

(d) The research scientists grew microorganisms from a sample of river water on an agar plate.

The plate is shown in **Fig 6.2**.

Fig 6.2

(i) Estimate how many **different** types of microorganism were growing in the river water.

Explain your answer.

....

....

.... **[2]**

Again, candidates got confused and thought cultures of different sizes were showing different types of organisms.

Question 6 (d) (ii)

(ii) State **two** reasons why it is important to maintain aseptic techniques when analysing microorganisms in river water.

1 ....

2 ....
[2]

Most candidates gained a mark here, although few gained both marks. There were a lot of vague responses about the microorganism not becoming harmful, and other vague responses about contamination. This question was about the microorganisms in the river water and not just about an aseptic technique in general. This meant the response should relate to that context. Some candidates suggested preventing (cross) contamination without explaining what would get contaminated. This was too vague for either of the mark points but as it showed some understanding, a compensatory mark was given if no other marks were gained.

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