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CAMBRIDGE TECHNICALS LEVEL 3 (2016)

Examiners' report

APPLIED SCIENCE

Cambridge TECHNICALS

Unit 2 January 2019 series

Version 1

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 can be downloaded from OCR.

Unit 2 series overview

Some candidates will have not have met a mixed science paper like this paper before. Historically candidates do not sit a paper that contains more than one science discipline at Level 3. However, it is clear that most centres are familiar with the style of paper and in general candidates are performing better overall. Candidates were better prepared for the style of paper than in previous series.

There is a lot of application and understanding of contexts that candidates may have struggled with in this paper. Centres are encouraged to use sample papers and any past papers available with the candidates in order to give them practice at the style of paper and the type of questions.

Some areas were answered well. Candidates showed good knowledge of safe working practice and use of microscopes. It is important that they give answers specific to the questions and not just generic safe working practices. They were able to carry out calculations related to titrations and give answers to specified number of decimal places.

Candidates did better overall in chromatography questions than in previous years.

This is a paper that looks at scientific techniques so candidates need to be able to describe these scientific techniques. Candidates who have had the opportunity to carry out the techniques are much more able to answer the questions successfully.

Question 1

1 HeLa cells are cancer cells that are grown in cell culture in research laboratories across the world.

(a) HeLa cells were first removed from a cancer patient called Henrietta Lacks before she died in 1951.

The cells have been kept in culture since then.

Describe **three** key features of cell cultures.

1.....

.....

2.....

.....

3.....

.....

[3]

Misconception: Many candidates mixed up cell/tissue culture with bacteria culture. Many talked about aseptic technique which does not answer the question. Most got one mark for a specific condition. Several said they were the same type of cell but this was too vague for the second mark point. They needed to say genetically identical.

Question 1(b)(i)

(b) The following is part of a protocol for producing a culture of HeLa cells from stored, frozen HeLa cells.

1 Place 10 cm^3 of DMEM growth medium in a 50 cm^3 conical tube.

2 Remove a vial of frozen HeLa cells from the freezer and thaw them.

3 Transfer the cells in the vial to the conical tube.

4 Spin the cells in a centrifuge.

5 Remove the liquid with a glass Pasteur pipette, leaving the cells behind.

6 Add 15 cm^3 of fresh DMEM growth medium and resuspend the cells by pipetting up and down.

7 Transfer the 15 cm^3 of cell suspension to a flat-bottomed, glass culture flask.

8 Place the culture flask in an incubator containing 5% carbon dioxide.

(i) Describe how DMEM growth medium can be sterilised.

.....

.....

.....

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

This question was not well answered. Some candidates gained a mark for autoclave but few gained the other marks.

Question 1(b)(ii)

(ii) Describe how the Pasteur pipette is sterilised and kept sterile until used.

.....

.....

.....

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

This question was not well answered. Some candidates wrapped the pipette in foil after they had been autoclaved which did not gain a mark. It is important that candidates write out the steps of a procedure in the correct order.

Question 1(b)(iii)

(iii) Describe how the culture flask is sterilised.

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

Many candidates suggested heating which was the minimum allowed to gain a mark.

Question 1(c)

(c) Suggest **three** actions that would help to maintain a sterile work area.

1.....

.....

2.....

.....

3.....

.....

[3]

Misconception: Many candidates talked about aseptic techniques which was not what was needed here. They also stated wipe the worktops with antiseptic rather than ethanol and so did not gain the fourth marking point. Many said have a lit Bunsen burner. This was insufficient unless it was clear it was to provide an updraft which would have gained the second marking point. Several understood they should keep the work area uncluttered. Few candidates gained more than one mark here. Many discussed PPE but as this does not affect the work area so it was not credited.

Question 1(d)

(d) The culturing of cells in a laboratory involves the use of standard aseptic procedures.

Bacteria are often added to the surface of growth media in an agar plate by streaking the plate.

Complete **Table 1.1** by describing **four** essential steps required when streaking an agar plate with bacteria.

Step	Description
1	
2	
3	
4	

Table 1.1

[4]

Many candidates did very well here, giving more than the 4 required points. They had to write the steps in the correct order but it did not matter if they wrote more than one point in a box; they would still be able to gain marks if the points were correct. Weak answers discussed rods or splints rather than loops. Some just repeated the stem without giving any additional information. So 'streaking the plate' gained no marks unless the candidate had said how this was done.

Question 2(a)(i)

2 Aki is an astrobiologist. He is studying small aquatic animals called tardigrades, also called water bears.

(a) The average length of a tardigrade is 0.5 mm. The largest is 1.2 mm in length.

(i) Aki is collecting tardigrades from wet plants in a meadow.

Suggest a piece of equipment he can use to help him to see tardigrades on the plants.

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

Many candidates named a microscope which is not appropriate.

Question 2(a)(ii)

(ii) In the laboratory, Aki produces a digital image of one of the tardigrades that he has collected.

The image is shown in **Fig. 2.1**.

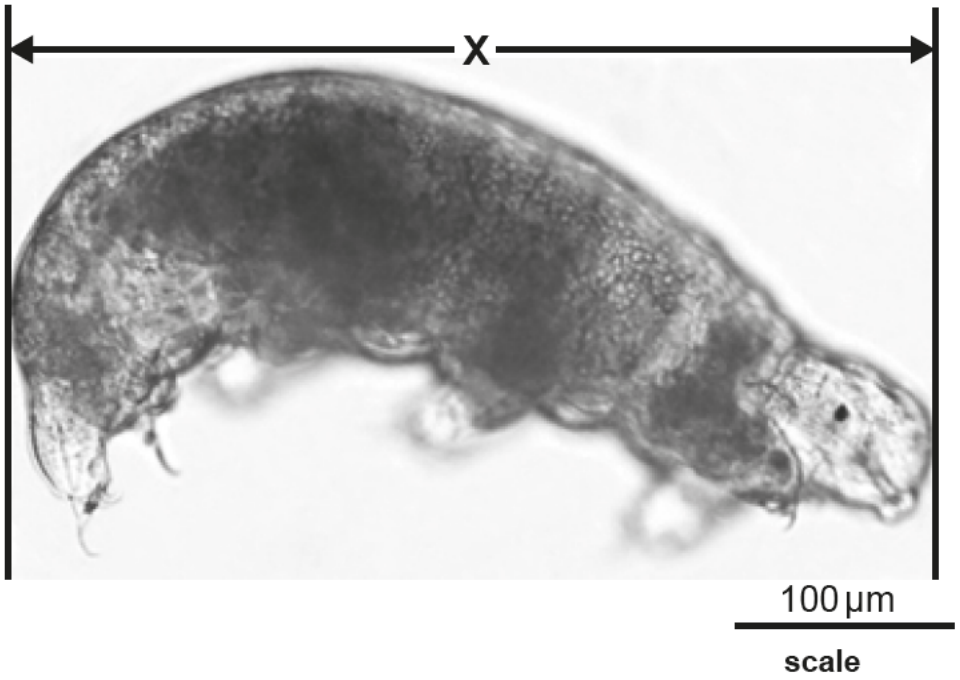


Fig. 2.1

What type of microscope was used to produce the image in **Fig. 2.1**?

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

Most candidates gained this mark.

Question 2(a)(iii)

(iii) Calculate the length of the tardigrade, as shown by line **X** in **Fig. 2.1**.

Show your working.

length of tardigrade = ... µm
[3]

It is important to show working with calculations. Candidates could have gained a mark if they showed their correct measurements even if they had not carried out the calculation. Many did not know which measurements to take. Those who calculated correctly using cm rather than mm were not penalised if they carried out the calculation correctly. However, it had to be clear what units they were using.

Question 2(a)(iv)

(iv) Calculate the magnification of the tardigrade in **Fig. 2.1**.

Use the formula: magnification = measured size ÷ actual size

magnification = × .....
[3]

Candidates in this question were required to convert units, either of the length of scale bar or of the actual length. Many did not know to do this. An alternative route was to use their answer from 2(a)(ii). Again this meant that showing their working was essential so that the examiner could award marks appropriately. Overall candidates struggled with this question.

Question 2(b)(i)

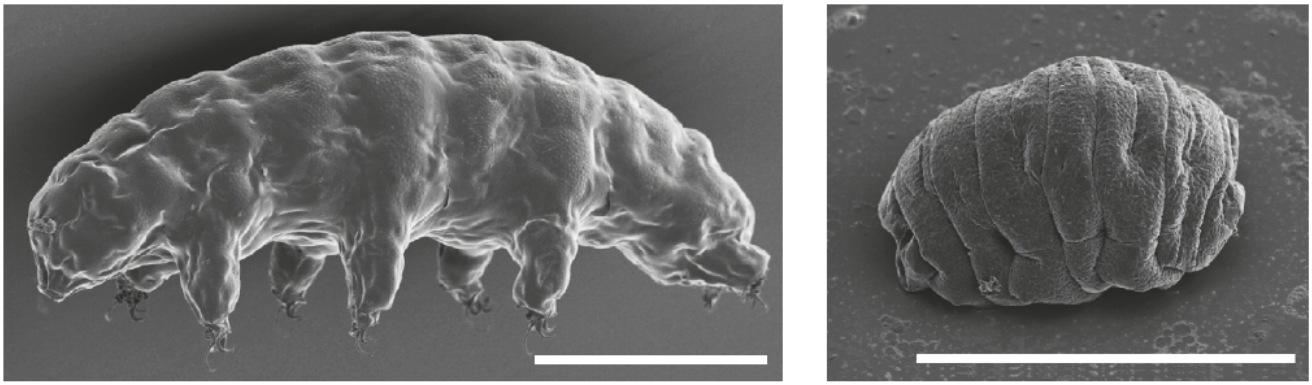
(b) Aki is researching the ability of tardigrades to survive for periods of time in extreme conditions.

He is exploring their potential to travel in space.

Aki dehydrates a number of tardigrades.

Fig. 2.2 shows one tardigrade in its normal and dehydrated state.

The scale bars represent 100 µm.



Normal **Dehydrated**

Fig. 2.2

(i) What type of microscope has been used to produce the images in **Fig. 2.2**?

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

Many candidates gave electron microscope as an answer and so did not gain the mark. They needed to write scanning electron (microscope) in order to gain credit.

Question 2(b)(ii)

(ii) Describe **one advantage** and **one disadvantage** of the microscope used in **Fig. 2.2** to investigate the effects of dehydration on the tardigrade.

Advantage .....

.....

.....

Disdavantage .....

.....

.....

[2]

This question generally only gained one mark. Candidates were able to state that they could see the effect on surface structure but did not realise that there was no information on internal structure. Many candidates appeared to be answering a previous year's question on the differences between x-rays and ultra sound and gave answers such as 'not in 3-d' or 'only black and white'. It is important that candidates read the question and answer the question set.

Question 2(b)(iii)

(iii) The body of a tardigrade:

- consists of divisions called segments
- has four pairs of legs
- has claws on each leg
- has a head with a mouth that pierces plant food.

Describe the effects of dehydration on the tardigrade shown in **Fig. 2.2**.

.....

.....

.....

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

This question was generally well answered and nearly all candidates attempted it. Candidates need to be specific and clear in their answers. Answers such as 'the legs have disappeared/been lost' were not sufficient for the 'retracted legs' mark point. Candidates needed to say the length was shorter and could not gain a mark for 'it is smaller'. Few candidates measured the tardigrades or gave relative lengths which would have gained marks.

Question 3(a)(i)

3 Andy is a Health and Safety Manager in a large pathology laboratory.

(a) The pathology laboratory receives and then analyses blood samples.

(i) Describe and explain the Health and Safety procedures followed by his employees when working with blood suspected of being contaminated with pathogens.

.....

.....

.....

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

The command words for this question are describe and explain. Candidates are unlikely to gain more than Level 1 unless they have explained the steps they describe. Many candidates were able to give a list of safety procedures but few explained why these were necessary. Many discussed not contaminating the blood samples. This was not credited as the focus is on health and safety. Many candidates used the term 'contaminated' incorrectly. They should have discussed entry of pathogens into the body rather than contamination of people.

Question 3(a)(ii)

(ii) Blood can be contaminated with other substances in addition to pathogens.

Suggest **one** other contaminant substance of blood samples.

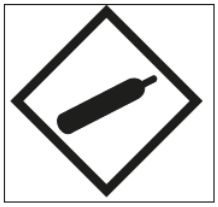
.....**[1]**

Misconception: Many candidates gave examples of specific types of pathogen e.g. virus and so did not gain a mark. A few wrote 'chemicals' but this was seen as too vague. Drugs or named drugs were the best answers seen. It was clear that many candidates did not know what a pathogen was.

Question 3(b)(i)

(b) The laboratory uses some chemical agents which may be hazardous.

(i) Draw lines to link the pictograms to the correct hazard description.

Pictogram	Hazard description
	Corrosive
	Gas under pressure
	Health hazard
	Irritant
	Oxidising
	Toxic to the aquatic environment

[4]

Candidates did very well on this question. Exam technique has also improved as very few were seen drawing more than one line from an option.

Question 3(b)(ii)

(ii) The pathology laboratory uses a form to compile a risk assessment for each laboratory activity.

Suggest **four** sections that should make up a risk assessment form.

1.....

2.....

3.....

4.....

[4]

It was clear that candidates did not know the difference between a risk and a hazard. However, if they stated both they were credited 2 marks. Few knew that the date and person who wrote the assessment was needed. A few gave levels of risk i.e. 1, 2, 3 etc. This did not gain credit.

Question 4(a)(i)

4 Amy is using High Performance Liquid Chromatography (HPLC) to analyse drugs for contaminants.

(a) **Fig. 4.1** shows a diagram of HPLC.

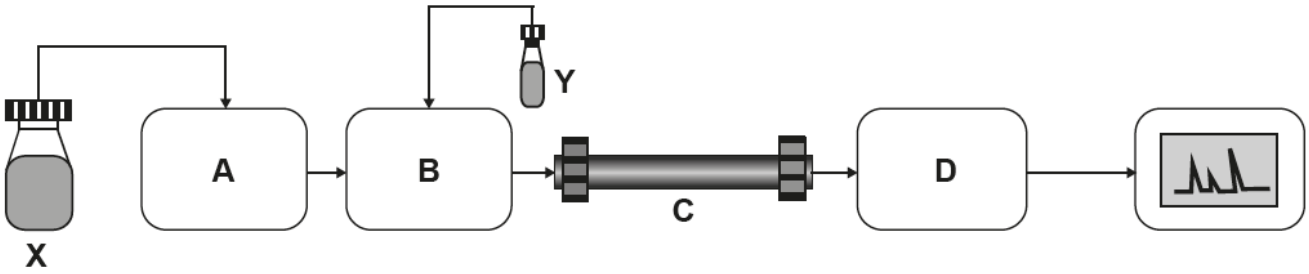


Fig. 4.1

(i) Identify the four parts of the HPLC labelled **A**, **B**, **C** and **D** in **Fig. 4.1**.

Draw lines to link the letter to the correct part shown in **Fig. 4.1**.

A	Column
B	Detector
C	Injector
D	Pump

[4]

AfL: It was clear that some candidates were not familiar with HPLC. Chromatography is an important part of the specification and so candidates should be familiar with all types.

Question 4(a)(ii)

(ii) Complete **Table 4.1** to identify the **two** components of the process, **X** and **Y**, as shown in **Fig. 4.1.**

Letter	Component of the HPLC process
X	
Y	

Table 4.1

[2]

This question was not answered well. Many confused solvent and sample and wrote them in the wrong boxes.

Question 4(b)

(b) The retention factor (k) is a way of assessing the retention of an analyte on an HPLC column.

The retention factor is equal to the ratio of the retention time of the analyte on the column to the retention time of a non-retained compound.

The retention factor is given by the equation:

$$k = \frac{(t_R - t_0)}{t_0}$$

t_R = retention time of the analyte

t_0 = retention time of the non-retained compound.

Amy is analysing samples of codeine suspected of being contaminated with drug **W**.

She must first assess the suitability of different stationary phases.

She uses the same mobile phase each time.

Fig. 4.2 shows her results using a Discovery C8 column.

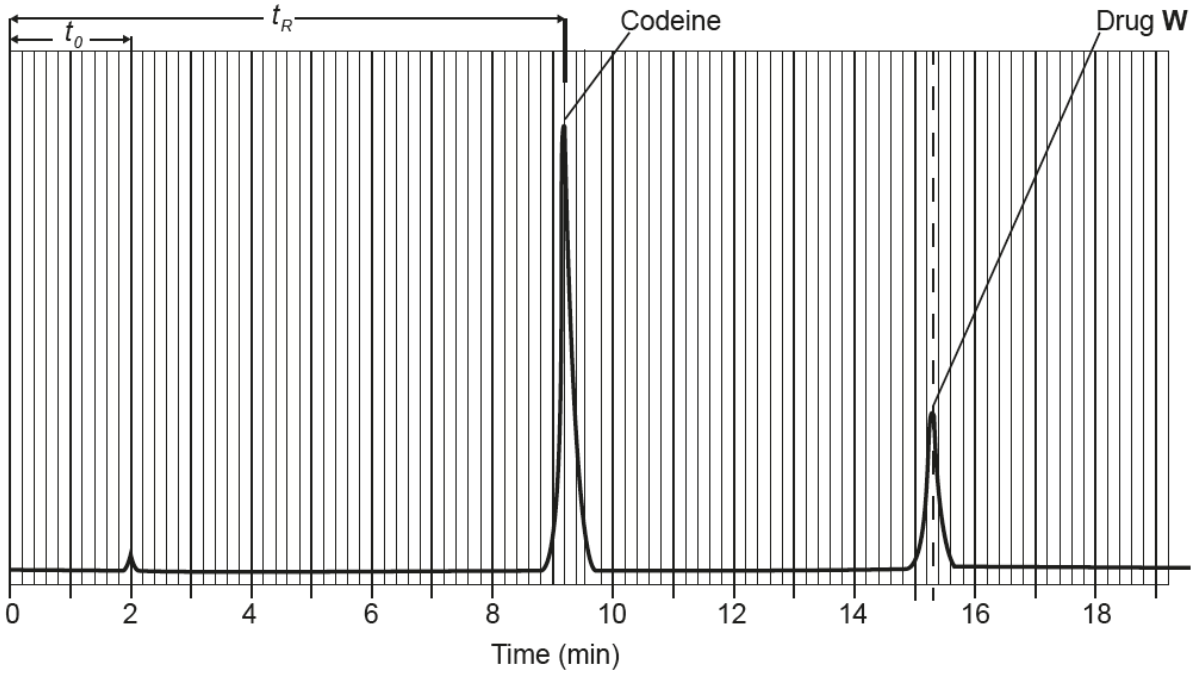


Fig. 4.2

The retention factor (k) for codeine is 3.6.

Calculate the retention factor (k) for drug **W** using the results shown in **Fig. 4.2**.

Show your working.

retention factor (k) = ...

[4]

This question was generally done well. Candidates who did not use the correct figures were still able to gain marks by using the equation correctly. Practice of using equations is important. Marks were credited for the correct use of the equation so showing working was very important in this question.

Question 4(c)(i)

(c) The selectivity factor (α) is the ability of the column to distinguish between the two drugs in the sample.

It is the ratio of the two retention factors of the two peaks observed, given by the formula:

$$\alpha = \frac{k_2}{k_1}$$

α = selectivity factor
k_1 = retention factor of first peak
k_2 = retention factor of second peak

Table 4.3 shows the characteristics of some HPLC columns.

HPLC column	Analyte	Retention factor (*k*)	Selectivity factor (α)
Discovery C8	Codeine		1.86
	Drug W		
Discovery Cyano	Codeine	1.00	1.60
	Drug W	1.60	
Discovery RP-Amide 16	Codeine	2.80	3.00
	Drug W	8.40	
Discovery C18	Codeine	3.30	2.30
	Drug W	7.70	

Table 4.3

(i) Which HPLC column in **Table 4.3** gives the best separation of the two drugs?

Tick (✓) **one** box.

Discovery C8 ☐

Discovery Cyano ☐

Discovery RP-Amide 16 ☐

Discovery C18 ☐

[1]

Question 4(c)(ii)

(ii) Explain your answer to **(c)(i)**.

.....

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

Candidates who got 4(c)(i) correct tended to gain this mark also. Some referred to difference in retention factor but this was insufficient for the mark.

Question 4(d)

(d) Suggest **one** reason why Amy is using HPLC as a separation technique rather than Gas Chromatography (GC).

.....

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

AfL: Candidates did not answer this question well. This highlights the importance of understanding the different chromatography techniques.

Question 5(a)

5 The acidity of milk increases as it ages. This is due to the increase in the lactic acid content.

Lactic acid is a **weak acid**.

Dairy technicians often use an acid-base titration to measure the concentration of lactic acid in milk samples.

Milk samples are titrated against a solution of sodium hydroxide.

(a) Jo is a dairy technician.

The first thing she does is standardise a solution of sodium hydroxide which is approximately 0.1 mol dm^{-3}. She does this by titrating a measured volume of 0.100 mol dm^{-3} potassium hydrogen phthalate (KHP) (which is a primary standard) against the sodium hydroxide.

The relative formula mass of KHP is 204.2 g mol^{-1}.

Calculate the mass of KHP needed to prepare 500 cm^3 of 0.10 mol dm^{-3} solution.

mass = ... g

[4]

Many candidates did well on this question. It was clear that they had carried out titrations and practised calculations related to them. A few missed the last 2 marks because they did not realise they had to take into account that there was only 500 cm^3 of solution.

Question 5(b)

(b) Describe the technique Jo uses to standardise the sodium hydroxide solution.

In your answer include the equipment she uses.

.....

.....

.....

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

Many candidates were able to answer this well. Common mistakes seen were

- filling burette with acid

- standardising against milk

- describing how to make a standard solution of sodium hydroxide.

Question 5(c)

(c) Jo now carries out a titration of the standardised sodium hydroxide against the milk.

The titration shows that 0.025 dm^3 of a milk sample contains 4.2×10^{-4} moles of lactic acid.

The relative formula mass of lactic acid is 90.1 g mol^{-1}.

Calculate the concentration, in g dm^{-3}, of lactic acid in the milk.

Use the equation: $c = n \div V$
c = concentration (mol dm^{-3})
n = number of moles
V = volume (dm^3)

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

concentration = ... g dm^{-3}

[5]

This was a harder calculation than 5(a) and so fewer candidates were able to fully answer it. However, many made a reasonable attempt and gained some marks for their working. Most could calculate number of moles but went no further. It was good to see the majority of candidates giving their answer to 2 decimal places. This was creditworthy in this question.

Question 6(a)(i)

6 Sam reads an old chemistry textbook in her college library.

The book describes an experiment where 1 dm^3 of seawater is heated and evaporated in stages.

At each stage, as the water is reduced in volume, chemicals come out of solution as a solid residue.

Each solid residue that separates is filtered using a Buchner funnel.

The residue is then either tested as a solid, or dissolved in a small amount of distilled water for each test.

(a) Information on each solid residue formed is given in **Table 6.1**.

Stage	Evaporation		Chemicals in the residue
	From (cm^3)	To (cm^3)	
1	1000	500	none
2	500	250	calcium carbonate
3	250	125	calcium carbonate
			calcium sulfate
4	125	75	sodium chloride
			sodium sulfate
5	75	50	sodium chloride
6	50	25	sodium chloride

Table 6.1

(i) Describe a test to identify the **cation** separated in **Stage 2** and the result you expect to see.

Test .....

Result.....

[2]

6(a)(i) and 6(a)(iii). Many candidates knew that a flame test should be used. Those that lost marks did not give precise colours. 6(a)(i) needed brick red and 6(a)(ii) yellow/yellow-orange/orange. If they gave a different red for 6(a)(i), for example, such as crimson red this did not gain the mark.

Question 6(a)(ii)

(ii) Describe a test to identify the **anion** separated in **Stage 2** and the result you would expect to see.

Test .....

Result.....

.....

[2]

Many knew to add to limewater but did not realise they had to add acid first so only 1 mark would have been credited for the result. Some candidates could not distinguish between cations and anions and so gave responses in the wrong places.

Question 6(a)(iii)

(iii) Describe a test to identify the **cation** separated in **Stages 5** and **6**.

Test .....

Result.....

.....

[2]

See commentary for question 6(a)(i).

Question 6(a)(iv)

(iv) Describe a test to identify the **anion** separated in **Stages 5** and **6**.

Test .....

Result.....

.....

[2]

Question 6(b)

(b) Silver nitrate solution can be used to distinguish between the halides chloride, bromide and iodide.

Draw a line to link the halides to the result you would expect to see when the halides are tested with silver nitrate solution.

Halide	Result
Chloride	Pale cream precipitate
Bromide	White precipitate
Iodide	Pale yellow precipitate

[3]

Many candidates were unsure of halide test and the resulting precipitate colours. This meant they struggles to gain marks for 6(a)(iv) and 6(b).Cation and anion tests are scientific tests that candidates are expected to know.

Question 6(c)

(c) Sam also finds out that there are alternative tests that can improve separation, sensitivity and quantification of ions.

Identify the correct feature for three of these tests.

Draw a line between each test and its correct feature.

Test	Feature
Ion chromatography	Energy supplied by electric currents produced by electromagnetic induction.
Atomic Emission Spectroscopy (AES)	Chemical analysis that uses light intensity emitted from a sample at a particular wavelength.
Inductively Coupled Plasma-Atomic Emission Spectroscopy (ICP-AES)	Separates ions and polar molecules based on their affinity to an ionic exchanger.

[3]

This question tests recall. It was not answered well by most candidates and shows the importance of candidates learning scientific facts and concepts from the specification

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