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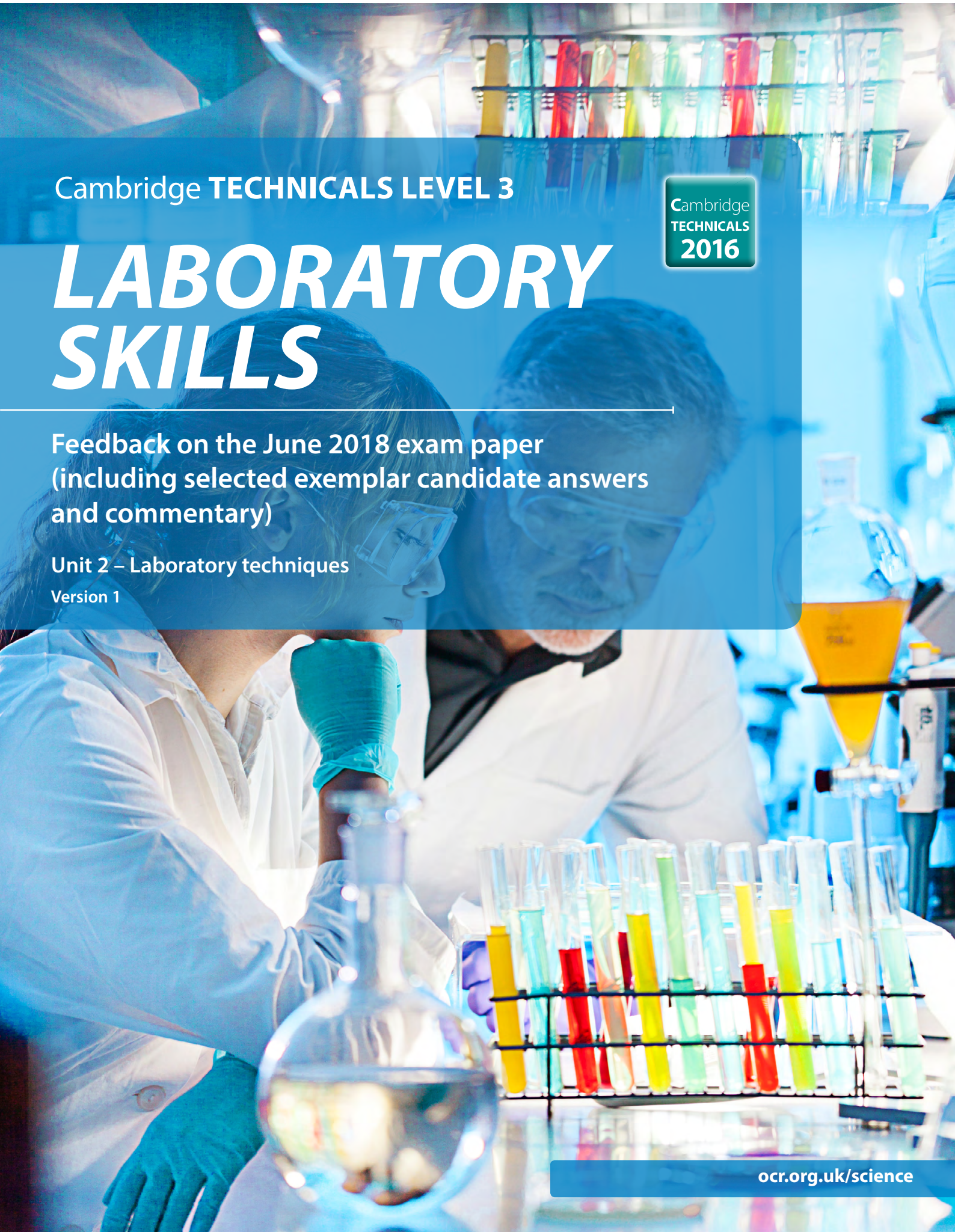


Cambridge **TECHNICALS LEVEL 3**

Cambridge TECHNICALS 2016

# LABORATORY SKILLS

## Feedback on the June 2018 exam paper (including selected exemplar candidate answers and commentary)

### Unit 2 – Laboratory techniques

Version 1

# CONTENTS

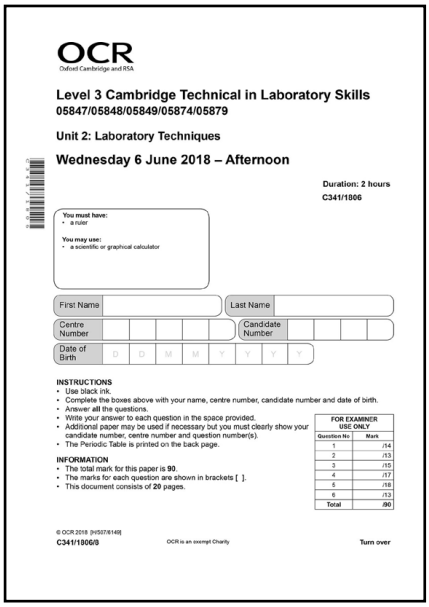
# INTRODUCTION

This resource brings together the questions from the June 2018 examined unit (Unit 2), the marking guidance, the examiners comments and the exemplar answers into one place for easy reference.

We have also included exemplar candidate answers with commentary for Questions 1(e)(i), 3(a)(ii) and 4(c)(i).

The marking guidance and the examiner's comments are taken from the Report to Centre for this question paper.

The Question Paper, Mark Scheme and the Report to Centre are available from:
https://interchange.ocr.org.uk/Modules/PastPapers/Pages/PastPapers.aspx?menuindex=97&menuid=250



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**Level 3 Cambridge Technical in Laboratory Skills**
**05847/05848/05849/05874/05879**

**Unit 2: Laboratory Techniques**

**Wednesday 6 June 2018 – Afternoon**

**Duration: 2 hours**
**C341/1806**

You must have:
- a ruler

You may use:
- a scientific or graphical calculator

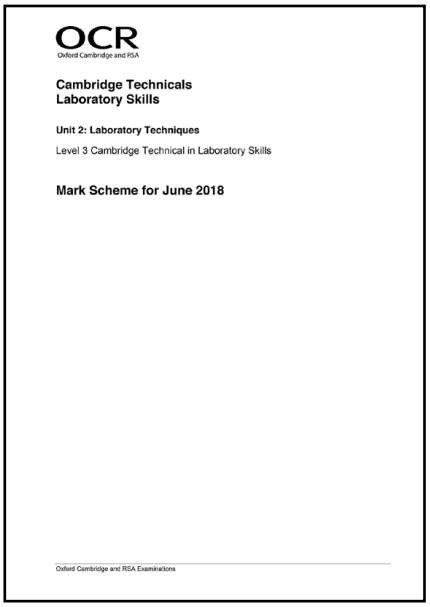
First Name | Last Name
Centre Number | Candidate Number
Date of Birth (D D M M Y Y Y Y)

**INSTRUCTIONS**
- Use black ink.
- Complete the boxes above with your name, centre number, candidate number and date of birth.
- Answer **all** the questions.
- Write your answer to each question in the space provided.
- Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).
- The Periodic Table is printed on the back page.

**INFORMATION**
- The total mark for this paper is **90**.
- The marks for each question are shown in brackets **[ ]**.
- This document consists of **20** pages.

| FOR EXAMINER USE ONLY | |
|---|---|
| Question No | Mark |
| 1 | /14 |
| 2 | /13 |
| 3 | /15 |
| 4 | /17 |
| 5 | /18 |
| 6 | /13 |
| Total | /90 |


**C341/1806/0**
OCR is an exempt Charity
**Turn over**



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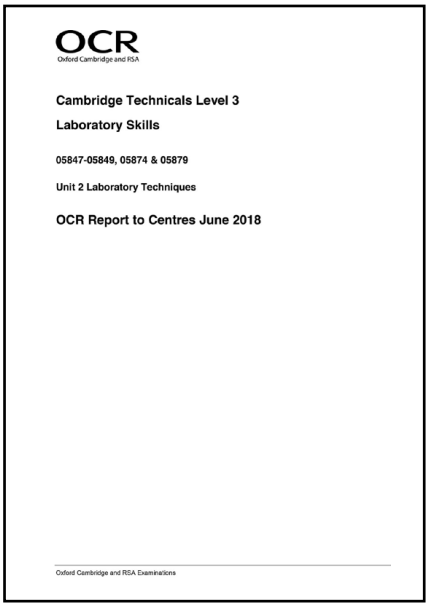
**Cambridge Technicals**
**Laboratory Skills**

**Unit 2: Laboratory Techniques**

Level 3 Cambridge Technical in Laboratory Skills

**Mark Scheme for June 2018**

Oxford Cambridge and RSA Examinations



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**Cambridge Technicals Level 3**
**Laboratory Skills**

**05847-05849, 05874 & 05879**

**Unit 2 Laboratory Techniques**

**OCR Report to Centres June 2018**

Oxford Cambridge and RSA Examinations

# GENERAL EXAMINER COMMENTS ON THE PAPER

Candidates were better prepared for this paper than in previous series. Historically, candidates do not sit a paper that contains more than one science discipline in a level 3 paper. This is only the third time this paper has been sat. The paper contained application and understanding of contexts that many candidates struggled with. Centres are encouraged to use sample papers and in future, any live papers available with the candidates in order to give them practice at these styles questions.

Some areas were answered well and candidates showed good knowledge of safe working practice and use of microscopes. They were able to carry out calculations related to titrations. The areas the candidates did not do well on involved complex laboratory techniques such as gas and ion chromatography. 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 these types of questions successfully.

It is also important the candidates read the question carefully. On this paper many candidates lost marks because they did not follow instructions e.g. they did not convert to mg in Q3cii and did not discuss the images in Q4.

**Resources which might help address the examiner comments:**

From the link below, you'll find 'The OCR guide to examinations' (along with many other skills guides)
http://www.ocr.org.uk/i-want-to/skills-guides/

Command verbs definitions
http://www.ocr.org.uk/Images/273311-command-verbs-definitions.pdf

# Questions 1(a), (b) and (c)

Answer **all** the questions.

**1** Scientists often analyse samples they have taken.

**(a) (i)** Which sampling technique would a forensic scientists use when they find strands of hair at a crime scene?

Tick (✓) **one** box.

| | |
|---|---|
| Random | ☐ |
| Representative | ☐ |
| Whole | ☑ |

**[1]**

**(ii)** Justify your choice of sampling technique in **(a)(i)**.

The strands of hair may have come from different sources. **[1]**

**(b) (i)** Which sampling technique would a statistical scientist use to identify the probability of a characteristic occurring within the UK population?

Tick (✓) **one** box.

| | |
|---|---|
| Random | ☑ |
| Representative | ☐ |
| Whole | ☐ |

**[1]**

**(ii)** Justify your choice of sampling technique in **(b)(i)**.

**Any one from:**
- sample chosen without bias
- if random, characteristic equally likely to occur in all samples
- as true an estimate of probability as is possible.

**[1]**

**(c)** Suggest how a DNA sample collected for forensic analysis should be stored.

Give a reason for your answer.

- freezer
- to prevent degradation/decay (by microorganisms)

**[2]**

## Mark scheme guidance

**Question 1(a)(ii):**

**ALLOW** the strands of hair may have come from different people.

**Question 1(c):**

**ALLOW** frozen.

Ignore refrigerator.

## Examiner comments

**Questions 1(a) and (b)** – Where candidates chose the correct sampling techniques, they usually understood the reason why. However, many candidates did not know which sampling techniques were appropriate in each case.

**Question1(c)** – Many candidates gave answers such as labelling correctly. This was not creditworthy here. Those who knew to freeze the sample did not give clear reasons why.

# Questions 1(d) and (e)

**(d)** Samples of blood can be taken from a suspect for forensic examination in a laboratory.

**(i)** Describe **one** potential hazard when collecting blood samples.

Contamination with infectious agents/pathogens. .....

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

**(ii)** Suggest **two** ways of reducing the risks associated with the hazard identified in **(d)(i)**.

1 .....

2 .....

**Any two from:**
- staff trained in necessary procedures
- vaccinated (against Hepatitis B)
- carry out Risk Assessment
- use PPE/gloves/labcoat/eye protection.

**[2]**

**(iii)** State **one** way in which 'sharps', including needles, should be treated after taking a blood sample.

**Any one from:**
- disposal using a sharps/specific bin
- do not re-sheath needles
- autoclaved/incinerated.

.....

..**[1]**

**(e)** Blood is often transported to laboratories for analysis.

**(i)** Give **two** reasons why tubes containing blood samples are enclosed in plastic, watertight containers.

**Any two from:**
- two containers limits possibility of (breakage and) loss of sample if one container broken
- handler protected (from blood) if sample tubes broken
- (waterproof container) eliminates possibility of influx of water into container/ prevents contamination/degradation by water.

.....

.....

..**[2]**

**(ii)** Give **one** reason why tubes and containers are labelled separately.

If transporting container is broken, sample (in the tube) is still labelled. .....

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

**(iii)** Give **one** reason why blood samples are transported in a temperature-controlled environment.

To reduce microbial degradation/degradation by microorganisms. .....

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

## Mark scheme guidance

**Question 1(d)(i):**

**ALLOW** infection.

## Examiner comments

**Question 1(d)(i)** – Many candidates understood there was an issue with contamination. They were not credited the marks unless they made it clear that the scientist handling the blood could get infected with a pathogen.

**Question 1(d)(ii)** – Most candidates knew to use PPE however, very few gave any other answer. They will not gain two marks for two examples of PPE, e.g. 'wear gloves and mask' is only worth one mark.

**Question 1(d)(iii)** – Many candidates knew the needle was to go in a sharps bin. Some did not know what the bin was called but were able to describe it sufficiently well to gain a mark. It is important that candidates know the correct terminology of equipment.

**Question 1(e)(i)** – To answer this question the candidates had to show an understanding that there was only one type of blood. Many thought it was about not getting two different samples mixed up. Few understood that of one container broke then the other container would prevent loss of the sample. Most candidates only got one mark here for preventing contamination.

**Question 1(e)(ii)** – Again many candidates thought this was about two different samples and so did not get the mark for understanding that if one container broke or the label was removed the sample would still have a second label.

**Question 1(e)(iii)** – Very few candidates understood that controlling temperature reduces microbial degradation. Many inaccurately used the term denatured, obviously confusing this with work on enzymes.

# Exemplar Candidate Work

## Question 1(e)(i) – Low level answer

**(e)** Blood is often transported to laboratories for analysis.

**(i)** Give **two** reasons why tubes containing blood samples are enclosed in plastic, watertight containers.

So that the container doesn't break easily and so that they are easy to store away in large quantities [2]

### Commentary

This candidate has not shown an understanding that the blood is stored in two containers, one inside the other. This does not make the containers harder to break. The answer should discuss that if one container gets broken then the sample is still contained in the other.

The question also tells the candidate that the containers are watertight. The candidate could have used this information to state that water cannot get in to contaminate the sample.

Candidates need to consider the procedures they used when they carried out practical work. it is important when teaching this course that the practical work is as realistically done as possible and that the reasons for all stages, methods and procedures are discussed and explained.

# Questions 2(a) and (b)

**2** Jamie is analysing the flavour compounds in a beer sample.

The technique he is using for the analysis is gas chromatography.

**Fig. 2.1** shows a block diagram of a gas chromatograph.

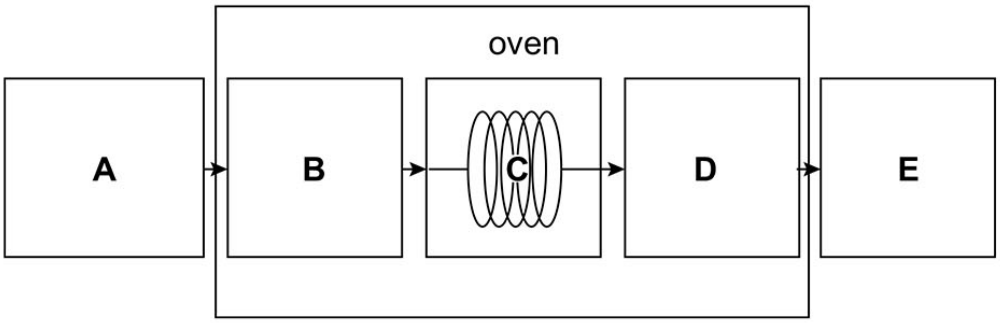


**Fig. 2.1**

**(a)** Identify the parts of the gas chromatograph shown in the block diagram in **Fig. 2.1**.

Draw lines to connect parts **A – E** to the correct name of the part.

| Letter | Name of part |
|---|---|
| A | Carrier gas |
| B | Column |
| C | Data system |
| D | Detector |
| E | Injection |

**[5]**

**(b)** Jamie adds a chemical to the beer sample. The chemical acts as an **internal standard**.

Suggest **two** properties of a suitable internal standard.

1 ....

....

2 ....

**Any two from:**
- (internal standard) is chemically related to chemicals in the beer/behaves similarly to chemicals in beer (in GC)
- (but) not present in beer
- has a different retention time to other possible components.

.....

**[2]**

## Examiner comments

**Question 2(a)** – Many candidates did well on this question. A common error was to confuse the carrier gas and the injection.

**Questions 2(b) and 2(c)(ii)** – Very few candidates gained marks on these two questions. They did not know the properties of a suitable internal standard and did not know how they were used in analysis. It is important that the chemicals, techniques and calculations needed are understood for all analysis techniques in the specification.

# Question 2(c)

**(c)** The gas chromatograph measures the retention time in the column of each component in the beer sample.

The chromatogram Jamie produces from the analysis of the beer sample is shown in **Fig. 2.2**.

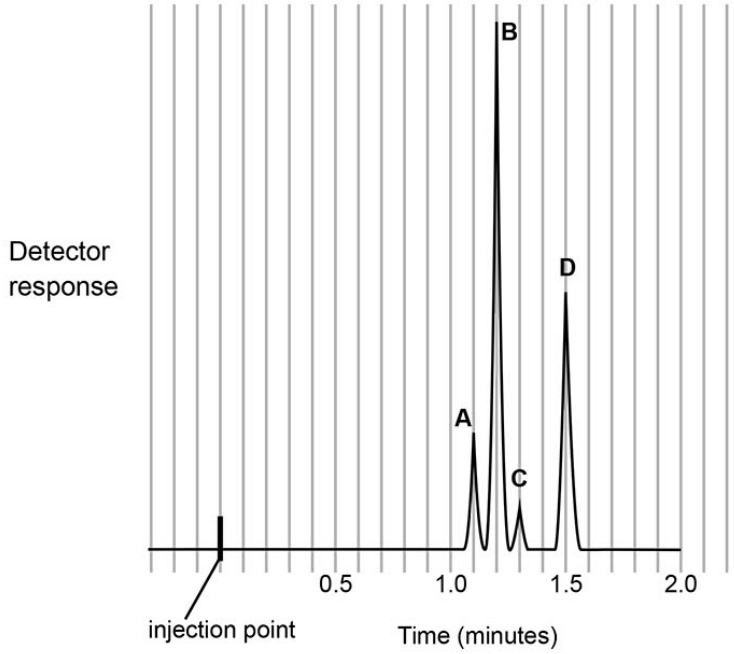


**Fig. 2.2**

The relative retention time (RRT) can be calculated for each component. The RRT is the length of time each component in the sample is retained in the column, relative to the time that the internal standard is retained.

RRT can be calculated using the equation:
RRT = retention of unknown ÷ retention time of internal standard.

In this system, the retention time of the **internal standard** is **1.7 minutes**.

Published values of RRTs for this system are shown in **Table 2.1**.

| Compound | RRT |
|---|---|
| Ethanal | 0.65 |
| Ethanol | 0.71 |
| Ethyl ethanoate | 0.88 |
| Internal standard | 1.00 |
| 2-methylpropan-1-ol | 0.94 |
| 3-methyl-1-butanol | 1.36 |
| Propan-1-ol | 0.76 |

**Table 2.1**

# Questions 2(c)(i) and (ii)

**(i)** Identify peaks **A – D** in **Fig. 2.2**.

Draw a line to connect peaks **A – D** to the correct compound.

| Peak | Compound |
|---|---|
| A | Ethanal |
| | Ethanol |
| B | Ethyl ethanoate |
| | Internal standard |
| C | 2-methylpropan-1-ol |
| | 3-methyl-1-butanol |
| D | Propan-1-ol |

**[4]**

**(ii)** Outline how internal standards can be used for a **quantitative** analysis of the beer sample.

**Any two from:**
- known amount of <u>each</u> internal standard in mixture of standards
- peak areas measured of internal standards and sample
- amount in sample calculated
- concentration in beer calculated.

.....
.....
.....

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

## Examiner comments

**Question 2(c)(i)** – Most candidates were able to interpret the data and identify the correct compounds.

# Question 3(a)

**3** Jodie is a consumer product scientist analysing the composition of antacid remedies. She has been provided with samples of milk of magnesia to analyse.

Milk of magnesia is a suspension of magnesium hydroxide in water.

**(a)** Jodie does not titrate the milk of magnesia directly against hydrochloric acid. Instead she uses a technique called a back titration to measure the concentration of magnesium hydroxide. A back titration is a two-stage technique.

Jodie first reacts the milk of magnesia with an excess of hydrochloric acid.

**(i)** Write a **balanced** symbol equation for the reaction between magnesium hydroxide and hydrochloric acid to produce magnesium chloride and water.

$Mg(OH)_2$ + $HCl$ → ..... $MgCl_2$ ..... + ..... $2H_2O$ .....

**[2]**

**(ii)** In the titration she uses a 5.00 $cm^3$ dose of milk of magnesia. She adds 16.0 $cm^3$ of 1.00 mol $dm^{-3}$ hydrochloric acid.

Calculate the number of moles of hydrochloric acid added to the milk of magnesia.

Use the equation: n = c × V

c = concentration (mol $dm^{-3}$)

n = number of moles

V = volume ($dm^3$)

**FIRST CHECK THE ANSWER**
**If answer = 0.016 (moles) award 3 marks.**

Conversion of 16 $cm^3$ to 0.016 $dm^3$
= 1 × 0.016
= 0.016 (moles)

number of moles = .....moles

**[3]**

## Mark scheme guidance

**Question 3(a)(ii):**

**ALLOW** answers with two significant figures only.

**ALLOW answers in standard form.**

## Examiner comments

**Question 3(a)(i)** – Many candidates did not know the formula for magnesium chloride and therefore lost marks.

**Questions 3(a)(ii) and (b)** – These questions were generally done very well.

# Exemplar Candidate Work

## Question 3(a)(ii) – High level answer

3 Jodie is a consumer product scientist analysing the composition of antacid remedies. She has been provided with samples of milk of magnesia to analyse.

Milk of magnesia is a suspension of magnesium hydroxide in water.

**(a)** Jodie does not titrate the milk of magnesia directly against hydrochloric acid. Instead she uses a technique called a back titration to measure the concentration of magnesium hydroxide. A back titration is a two-stage technique.

Jodie first reacts the milk of magnesia with an excess of hydrochloric acid.

**(ii)** In the titration she uses a 5.00 $cm^3$ dose of milk of magnesia. She adds 16.0 $cm^3$ of 1.00 mol $dm^{-3}$ hydrochloric acid.

Calculate the number of moles of hydrochloric acid added to the milk of magnesia.

Use the equation: n = c × V

c = concentration (mol $dm^{-3}$) → 1.00 mol · $dm^{-3}$ ~~5.00 $cm^3$ → Volume~~

n = number of moles

V = volume ($dm^3$) → 16.0 $cm^3$

$n = 16\,cm^3 \times 1\,mol\,dm^{-3}$

$= 16$

number of moles = ..... 16 ..... moles

**[3]**

### Commentary

This candidate did not write down the correct answer on the answer line. They did show their working. Because of this they were able to gain some credit for showing correct steps. It is important that candidates practice calculations from the specification. They should always show their working with their answer given on the answer line.

This candidate has not carried out the conversion of $cm^3$ to $dm^3$. However, they have carried out all subsequent steps correctly and so are only penalised for the lack of conversion step. If they had written 16 on the answer line but not shown their working the examiner would not have known how the candidate calculated that number and so they would have not been credited for it. In this case it is the working and not the answer that has gained credit.

# Questions 3(b) and (c)

**(b)** Jodie then titrates the unreacted hydrochloric acid against sodium hydroxide.

The volume of 0.100 mol $dm^{-3}$ sodium hydroxide needed to neutralise the unreacted hydrochloric acid is 26.1 $cm^3$.

Calculate the number of moles of sodium hydroxide that reacted with the hydrochloric acid.

Use the equation: $n = c \times V$

c = concentration (mol $dm^{-3}$)

n = number of moles

V = volume ($dm^3$)

**FIRST CHECK THE ANSWER**
**If answer = 0.002610 (moles) award 3 marks**

Conversion of 26.10 $cm^3$ to 0.02610 $dm^3$
= 0.1 × 0.02610
= 0.00261 (moles)

average number of moles = .....
**[3]**

**(c)** Jodie calculates the amount of magnesium hydroxide in a dose of milk of magnesia.

**(i)** Calculate the number of moles of magnesium hydroxide in the 5.00 $cm^3$ dose of milk of magnesia.

**FIRST CHECK THE ANSWER**
**If answer = 0.0067 (moles) award 4 marks.**
1 mole NaOH ≡ 1 mole HCl
∴ Number of unreacted moles HCl = 0.00261
∴ Number of moles of HCl that reacted = 0.016 – 0.00261
= 0.01339 (moles)
Number of moles Mg(OH)2 = 0.01339 ÷ 2
= 0.0067 (moles)

number of moles = .....
**[4]**

**(ii)** Calculate the mass of magnesium hydroxide, in mg, in the 5.00 $cm^3$ dose of milk of magnesia.

The molar mass of magnesium hydroxide is 58.3 g $mol^{-1}$.

**FIRST CHECK THE ANSWER**
**If answer = 391 (mg), award 3 marks.**

= 0.0067 × 58.3 (g)
= 0.39061 (g)
= 391 (mg)

mass = ..... mg
**[3]**

## Mark scheme guidance

**Question 3(b):**

**ALLOW answers in standard form.**

**ALLOW** rounding up to 3 decimal points.

**Question 3(c)(i):**

**ALLOW answers in standard form.**

**ALLOW** ECF.

Ignore units.

**Question 3(c)(ii):**

**ALLOW** ECF.

## Examiner comments

**Question 3(c)(i)** – In this question candidates did not realise they had to use their answers from a(ii) and (b). If they had made errors in those questions but used their answers correctly, they were still able to gain full marks in (c)(i).

**Question 3(c)(ii)** – Most candidates used their answer correctly from (c)(i) in this question. Candidates generally lost a mark because they did not convert their answer to mg.

# Question 4(a)

**4** Jeremy is experiencing abdominal pain.

He visits his local hospital. He has an X-ray and ultrasound scan of his abdomen.

**(a) (i)** State **two** similarities between the images generated by an X-ray scanner and by an ultrasound scanner.

1 Shows internal structures of body.
Images are monochrome/black and white.

2 .....

.....

**[2]**

**(ii)** State **two** differences between the images generated by an X-ray scanner and by an ultrasound scanner.

1 **Any two from:**
- ultrasound produces real time/live/moving images, e.g. blood flow/X-ray fixed point
- ultrasound produces good resolution of soft
- tissue/X-ray usually for more dense tissues/bones
- ultrasound produces 3D images/X-ray 2D.

2 .....

**[2]**

## Mark scheme guidance

**Question 4(a)(i):**

**IGNORE** answers not related to the images.

**Question 4(a)(ii):**

**IGNORE** answers not related to the images.

## Examiner comments

**Question 4(a)** – Candidates lost marks on these questions because they described the techniques and not the images.

**Question 4(a)(i)** – One mark was often credited for this question for showing internal structures but few got a mark for images being black and white.

**Question 4(a)(ii)** – Most candidates understood that x-rays are mostly used for dense tissue and ultrasound for soft tissue for one mark. This is only one difference so would not gain both marks.

# Question 4(b)

**(b)** A biopsy is used to remove some of Jeremy's kidney cells for examination.

A laboratory technician uses a light microscope, shown in **Fig. 4.1**, to examine the cells.


**Fig. 4.1**

**(i)** **Fig. 4.1** shows a number of characteristic features of a light microscope.

Write the letters **A** to **E** in **Table 4.1** to identify the parts shown in **Fig. 4.1.**

| Part of microscope | Label |
|---|---|
| Source of light | E |
| Location of microscope slide | B |
| Eye piece | A |
| Objective lens | D |
| Control used to focus the image | C |

**Table 4.1**

**[5]**

**(ii)** State **three** benefits of using a light microscope.

1 ..... 

2 ..... 

3 ..... 

**Any three from:**
- view live cells/tissues/specimens
- images/cells/tissues are seen in colour
- can highlight parts of cells/tissues using stains
- not expensive
- (relatively) quick to see cells/tissues
- can be transported easily.

**[3]**

## Mark scheme guidance

**Question 4(b)(i):**

One mark for each correct label.

## Examiner comments

**Question 4(b)(i)** – This question was answered well by most candidates.

**Question 4(b)(ii)** – This question was answered well by most candidates. Some candidates put easy to use or needs no training. These answers were not creditworthy.

# Questions 4(c)(i)

**(c)** Jeremy's kidney cells are then examined with an electron microscope (EM).

**Fig. 4.2** shows the electron micrograph produced.

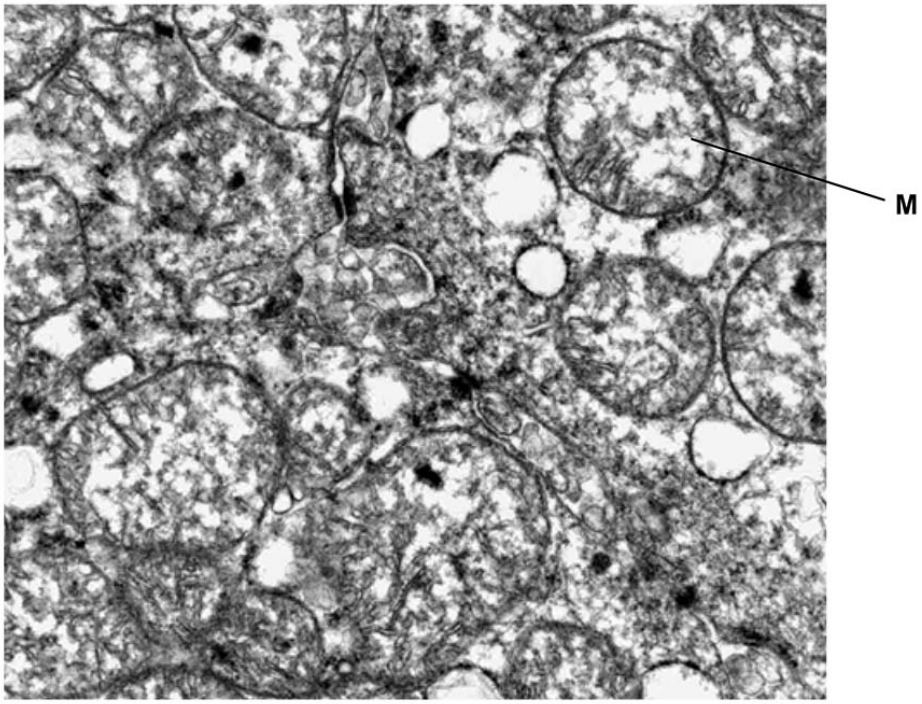


**Fig. 4.2**

The cells contain many large mitochondria.

The mitochondrion labelled **M** is 2.5 µm in diameter.

**(i)** Calculate the magnification of the mitochondrion, M.

Use the formula: magnification = $\frac{\text{measured size}}{\text{actual size}}$

Show your working.

**FIRST CHECK ANSWER ON ANSWER LINE**
**If answer = (×) 10800 award 3 marks**

width of mitochondrion = 27 mm on micrograph
= 27 000 µm

$$= \frac{27}{0.0025}$$

∴ magnification = (×) 10800

magnification = × .....

**[3]**

## Mark scheme guidance

**Allow** measurement = 27 ± 1 mm.

Ignore units.

## Examiner comments

**Question 4(c)(i)** – Candidates struggled with this question. They did not know how to convert their measurements.

# Exemplar Candidate Work

## Question 4(c)(i) – Low level answer

**(c)** Jeremy's kidney cells are then examined with an electron microscope (EM).

**Fig. 4.2** shows the electron micrograph produced.

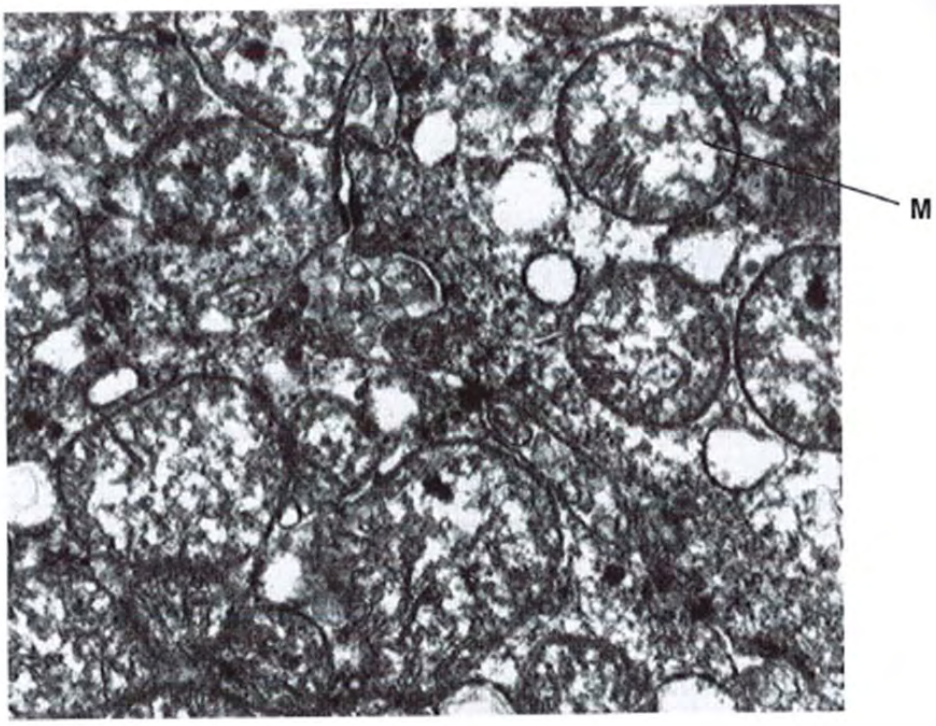


**Fig. 4.2**

The cells contain many large mitochondria.

The mitochondrion labelled **M** is 2.5 µm in diameter.

**(i)** Calculate the magnification of the mitochondrion, M.

Use the formula: magnification = $\frac{\text{measured size}}{\text{actual size}}$

Show your working. 3cm = 30000 µm

$\frac{30000}{2.5}$ =

magnification = × 1200 [3]

## Commentary

This candidate has measured the width of the mitochondrion incorrectly. The expected measurement was 27mm although a measurement in the range 26 – 28 mm would have been acceptable. This measurement was not converted correctly. The conversion should have given 30000 µm. It was then difficult for the examiner to be sure if the calculation carried out was using appropriate numbers.

Candidates should practice converting quantities for calculations. They should also have the chance to practice all calculations from the specification. It is clear to examiners where candidates had practised calculations as they were set out clearly showing each step and the answer given tended to be correct.

# Exemplar Candidate Work

## Question 4(c)(i) – Medium level answer

**(c)** Jeremy's kidney cells are then examined with an electron microscope (EM).

**Fig. 4.2** shows the electron micrograph produced.

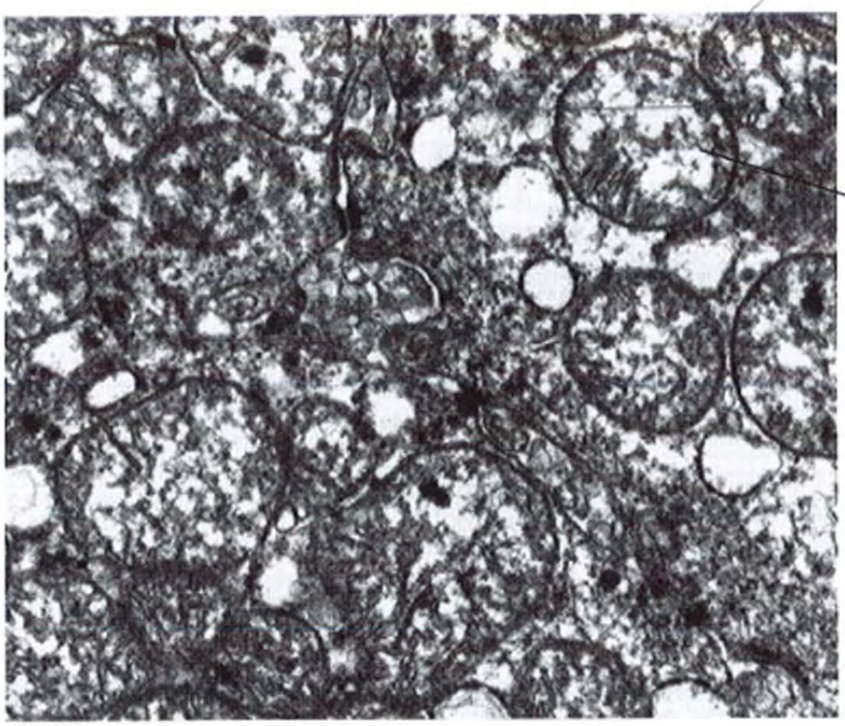


**Fig. 4.2**

The cells contain many large mitochondria.

The mitochondrion labelled **M** is 2.5 µm in diameter.

**(i)** Calculate the magnification of the mitochondrion, M.

Use the formula: magnification = $\frac{\text{measured size}}{\text{actual size}}$

$\frac{2.5}{0.0026}$

Show your working.

× 100

µm mm

2.6 cm : 0.0026

25 : 961.53.

$\frac{2.6}{100}$ : 0.0026

magnification = × 961.53846153...

**[3]**

## Commentary

This candidate has correctly measured the width of the mitochondrion. They have not converted this measurement to µm but they have tried to convert it to its actual mm width. They have used this figure in a division but have incorrectly inverted the calculation. The candidate needed more practice on converting quantities. They also needed to practice substituting figures into a given equation. Equations ae often given on this paper so substituting into an equation is an important skill. Sometimes the equation will need to be rearranged; in this case it did not. Candidates need to understand when an equation needs rearranging and again this is down to practice.

# Questions 4(c)(ii)

**(ii)** Give **two advantages** of using electron microscopy compared with light microscopy.

1 .....

2 .....

.....

**[2]**

**Any two from:**
- higher magnification
- greater resolution
- reveals cell ultrastructure/organelles

## Mark scheme guidance

**Allow** greater detail.

## Examiner comments

Most candidates got to marks here. Some did not use correct terminology and because their descriptions were unclear, they lost marks.

# Question 5(a)

**5** An analytical chemist analyses a solution from a sealed bottle found on a shipwreck.

**(a)** The scientist uses ion chromatography to analyse the cations in the solution.

**(i)** Explain how ion chromatography can be used to identify the cations in the solution.

**Valid points**

**Basic principles:**
- (Ion chromatography) based on ion exchange resin
- Resin beads
- Resin has ion exchange sites
- Resins for cation analysis have negative charge.

**Starting conditions:**
- Adsorbent/stationary phase selected
- Eluent loading
- Ionic interaction of cations in resin/displaces/flushes through/eliminates any cations on bonded onto resin/eluent cations retained on resin

**Analysis of unknown:**
- Sample injection
- Of cations in eluent
- Manually or automated process
- Different cations replace cations/cations adsorbed on resin
- Temperature and flow rate controlled
- Reaction is different for different cations/adsorbed onto resin differently
- Depends on affinity for resin/charge/size
- Causes separation of sample.

**Elution:**
- Addition of eluent/change in conditions causes elution of analytes
- Involves change in pH/salt concentration, etc.
- More than one eluent may be used.

**Detection and analysis:**
- Detection of cations/type of detector, e.g. by change in conductivity as cations eluted
- Conductivity of eluent suppressed to increase analyte sample
- Each ion that emerges produces a peak
- Plot of abundance of ion/time
- Position of peak specific to ion

**[6]**

**(ii)** List **four** other types of chromatography.

1 .....
- paper (chromatography)
- thin layer (chromatography)/TLC
- gas (chromatography)
- high performance liquid (chromatography)/HPLC

2 .....

3 .....

4 .....

**[4]**

## Mark scheme guidance

**Question 5(a)(i):**

**[Level 3]** Candidate shows a high level of understanding and gives a good description of the technique and principles of ion chromatography.

***(5 – 6 marks)***

**[Level 2]** Candidate shows an understanding of the technique and principles of ion chromatography.

***(3 – 4 marks)***

**[Level 1]** Candidate shows a basic understanding of the technique and principles of ion chromatography, with little or no explanation.

***(1 – 2 marks)***

**[Level 0]** Candidate includes **fewer than two** valid points.

***(0 marks)***

**Question 5(a)(ii):**

Answers in any order.

**Allow** gas-liquid (GLC).

**Allow** pressure for performance.

## Examiner comments

**Question 5(a)(i)** – Candidates did not do well on this question. Many saw chromatography in the rubric and just described TLC. Others saw cation and described electrolysis. Those who gained marks knew about resin beads but could not say much more. They discussed negative and positive ions and showed a lack of understanding of what was being analysed. It is important that all techniques and procedures in the specification are understood.

**Question 5(a)(ii)** – This question was done well with most candidates getting 2 or 3 marks.

# Question 5(b)

**(b)** The analytical chemist runs a mixture of standards through the ion chromatograph.

The retention times of the cations in the mixture are shown in **Table 5.1**.

| Cation | Retention time (minutes) |
|---|---|
| Ammonium | 5.4 |
| Potassium | 7.2 |
| Sodium | 4.5 |

**Table 5.1**

The results of the analysis on the solution found in the shipwreck are shown in **Fig. 5.1**.

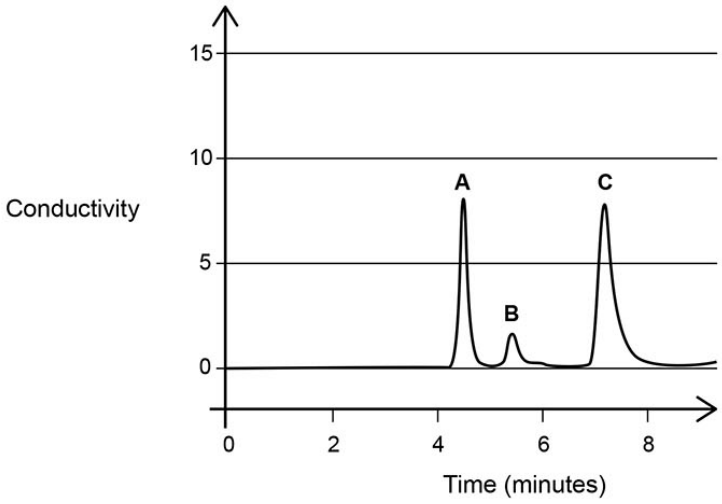


**Fig. 5.1**

Identify cations **A**, **B** and **C** in the solution. Use the retention times shown in **Table 5.1** and **Fig. 5.1**.

**A** A – sodium/$Na^+$

**B** B – ammonium/$NH_4^+$

**C** C – potassium/$K^+$

**[3]**

## Mark scheme guidance

**Question 5(b):**

If formulae used, charges must be correct.

## Examiner comments

**Question 5(b)** – Candidates were able to interpret the chromatograph in this question so gain the marks.

# Questions 5(c) and (d)

**(c)** State **two** alternative techniques that could be used to analyse the cations in the solution.

1 ..
- atomic absorption spectroscopy/AES
- atomic absorption spectroscopy-inductively coupled plasma/AES-ICP

2 ..

**[2]**

**(d)** Flame tests can be carried out on solutions of ions to identify the cations present.

Complete **Table 5.2** to show the flame test results for the three cations listed.

| Cation | Colour in flame |
|---|---|
| Barium | (light/pale) green |
| Copper | Green/blue |
| Lithium | Crimson/red |

**Table 5.2**

**[3]**

## Mark scheme guidance

**Question 5(c):**

ALLOW atomic absorption spectroscopy/AAS.

IGNORE answers related to flame testing.

ALLOW ICP-AES.

## Examiner comments

**Question 5(c)** – This question was not well answered because most candidates did not know alternative methods.

**Question 5(d)** – This question was answered well. It is important that the correct colours are given, e.g. red or crimson is for lithium was credited a mark but brick red was not credited a mark. We would recommend adherence to RSC guidelines for flame colours.

# Questions 6(a) and (b)

**6** Sundip is culturing plants for a nursery.

When culturing plants she follows the standard operating procedure shown in **Table 6.1**.

| Stage | Activity |
|---|---|
| 1 | Sterilise the workbench. |
| 2 | Heat-sterilise a pair of forceps. |
| 3 | Collect a small piece of tissue from the growing tip of the plant. |
| 4 | Using a scalpel, cut the tissue into small pieces, 3-5 mm long.<br>[These pieces of tissue are called explants. Each explant should grow into a new plant.] |
| 5 | Pick up one explant using forceps and sterilise its surface. |
| 6 | Take the lid off the vial of nutrient jelly. |
| 7 | Use the forceps to transfer the explant to the nutrient jelly. Replace the lid on the vial. |
| 8 | Incubate the explant and examine its growth. |

**Table 6.1**

**(a)** Explain why an aseptic technique must be used when culturing explants from the plant.

- prevent contamination (of explant with microorganisms)
- (that would) cause decay/degradation/death of explant

.....[2]

**(b) (i)** Describe how the forceps in **Stage 2** are sterilised.

- dip (the tips) in alcohol
- insert into (Bunsen) flame
- allow to cool before use

.....[3]

**(ii)** Describe how the surface of the explants in **Stage 5** are sterilised.

**Any two from:**
- immerse in disinfectant/sodium hypochlorite/**dichloroisocyanurate (SDICN)**
- **agitate/swirl gently periodically/every 2-3 minutes**
- for 15 minutes
- rinse in sterilised water.

.....[3]

## Mark scheme guidance

**Question 6(a):**

**IGNORE** references to infection.

**Allow** bacteria/fungi complete for nutrients.

**Question 6(b):**

**ALLOW** ethanol/methanol.

Must be suitable order.

## Examiner comments

**Question 6(a)** – Candidates gained one mark for contamination but were unable to explain that this would cause decay or degradation of the plant. Candidates knew that aseptic techniques prevent contamination but did not understand why this is important. They need to know the specific reasons for preventing contamination in particular procedures to gain higher marks.

**Question 6(b)(i)** – In this question some candidates flamed the forceps and then put them in ethanol which would be dangerous and so lost a mark. Very few allowed the forceps to cool.

**Question 6(b)(ii)** – This question was not answered well with candidates suggesting that the explants were put in alcohol or in a vague sterilising solution. Sterilising is in the question and so did not get a mark. Few who did suggest using disinfectant knew the procedure of immersing for 15 minutes and swirling.

# Questions 6(c) and (d)

**(c)** Suggest **two** additional ways in which Sundip can reduce possible contamination during the process.

1 .....

.....

2 .....

.....

**[2]**

**Any two from:**
- wash hands before work
- appropriate PPE/gloves/labcoat
- use a flow-bench.

**(d)** Give **three** more examples of practical work where an aseptic technique is essential.

1 .....

.....

2 .....

.....

3 .....

.....

**[3]**

**Any three from:**
- Cell/tissue culture
- preparation of medical test kits
- pharmaceutical production
- microbiological applications
- medical procedures
- surgical procedures.

## Mark scheme guidance

**Question 6(c):**

**ALLOW air flow cabinet**/Sterile/lamina flow cabinet.

**Question 6(d):**

**ALLOW** any other correct procedures.

**Allow** growing bacterial cultures.

**Allow** blood sample analysis.

**Allow** biotechnology.

## Examiner comments

**Question 6(c)** – Most candidates gained a mark in this question for PPE and some for washing hands. Few candidates suggested an air flow cabinet but instead discussed using a Bunsen burner. This did not gain a mark.

**Question 6(d)** – When answering this question candidates had to be clear that the practical work actually needed an aseptic technique. So taking blood samples unqualified did not gain a mark although analysing blood samples did. Similarly, streak plating was insufficient but growing bacterial cultures was fine for a mark.

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