



# **T Level Technical Qualification in Science**

## **Core knowledge and understanding**

### **Paper B**

#### **Mark scheme**

v1.1: Specimen assessment materials  
September 2021  
603/6989/8

Internal reference: SCI-0015-01

This mark scheme has been written by the assessment writer and refined, alongside the relevant questions, by a panel of subject experts through the external assessment writing process and at standardisation meetings.

The purpose of this mark scheme is to give you:

- examples and criteria of the types of response expected from a student
- information on how individual marks are to be awarded
- the allocated assessment objective(s) and total mark for each question.

## Marking guidelines

### ***General guidelines***

You must apply the following marking guidelines to all marking undertaken throughout the marking period. This is to ensure fairness to all students, who must receive the same treatment. You must mark the first student in exactly the same way as you mark the last.

- The mark scheme must be referred to throughout the marking period and applied consistently. Do not change your approach to marking once you have been standardised.
- Reward students positively giving credit for what they have shown, rather than what they might have omitted.
- Utilise the whole mark range and always award full marks when the response merits them.
- Be prepared to award zero marks if the student's response has no creditworthy material.
- Do not credit irrelevant material that does not answer the question, no matter how impressive the response might be.
- The marks awarded for each response should be clearly and legibly recorded in the grid on the front of the question paper.
- If you are in any doubt about the application of the mark scheme, you must consult with your team leader or the chief examiner.

### ***Guidelines for using extended response marking grids***

Extended response mark grids have been designed to assess students' work holistically. They consist of levels-based descriptors and indicative content.

Levels-based descriptors. Each level is made up of several descriptors for across the AO range AO1–AO3, which when combined provide the quality of response that a student needs to demonstrate. Each level-based descriptor is worth varying marks.

The grids are broken down into levels, with each level having an associated descriptor indicating the performance at that level. You should determine the level before determining the mark.

Indicative content reflects content-related points that a student may make but is not an exhaustive list. Nor is it a model answer. Students may make all, some or none of the points included in the indicative content as its purpose is as a guide for the relevance and expectation of the responses. Students must be credited for any other appropriate response.

## ***Application of extended response marking grids***

When determining a level, you should use a bottom up approach. If the response meets all the descriptors in the lowest level, you should move to the next one, and so on, until the response matches the level descriptor. Remember to look at the overall quality of the response and reward students positively, rather than focussing on small omissions. If the response covers aspects at different levels, you should use a best-fit approach at this stage and use the available marks within the level to credit the response appropriately.

When determining a mark, your decision should be based on the quality of the response in relation to the descriptors. You must also consider the relative weightings of the assessment objectives, so as not to over/under credit a response. Standardisation materials, marked by the chief examiner, will help you with determining a mark. You will be able to use exemplar student responses to compare to live responses, to decide if it is the same, better or worse.

## **Assessment objectives**

This assessment requires students to:

- AO1: Demonstrate knowledge and understanding of contexts, concepts, theories, and principles in science.
- AO2: Apply knowledge and understanding of contexts, concepts, theories, and principles in science to different situations and contexts.
- AO3: Analyse and evaluate information and issues related to contexts, concepts, theories, and principles in science to make informed judgements, draw conclusions and address individual needs.

The weightings of each assessment objective can be found in the Qualification Specification.

**Section A: Biology**

**Total for this section: 45 marks plus 3 marks  
for quality of written communication (QWC)  
and use of specialist terminology**

**1 (a)€** Select which **one** of the following statements describes a role of the plasma membrane of cells.

- A.** They are the site of antibody production in the immune system.
- B.** They are the site of glucagon receptors involved in blood glucose control.
- C.** They are the site of pores allowing mRNA transfer into the cytoplasm.
- D.** They are the site of mRNA translation in the production of insulin.

**[1 mark]**

AO1 = 1 mark

AP Reference = B.1.3.0.1

**Answer**

**B.** They are the site of glucagon receptors involved in blood glucose control.

**1 (a)ii** Which **one** of the following groups of organelles shows **all** the organelles involved in the manufacture and secretion of digestive enzymes?

- A.** Nucleus, ribosomes, Golgi apparatus, permanent vacuole.
- B.** Nucleus, ribosomes, centrioles, permanent vacuole.
- C.** Nucleus, ribosomes, Golgi apparatus, centriole.
- D.** Nucleus, ribosomes, endoplasmic reticulum, Golgi apparatus.

**[1 mark]**

AO1 = 1 mark

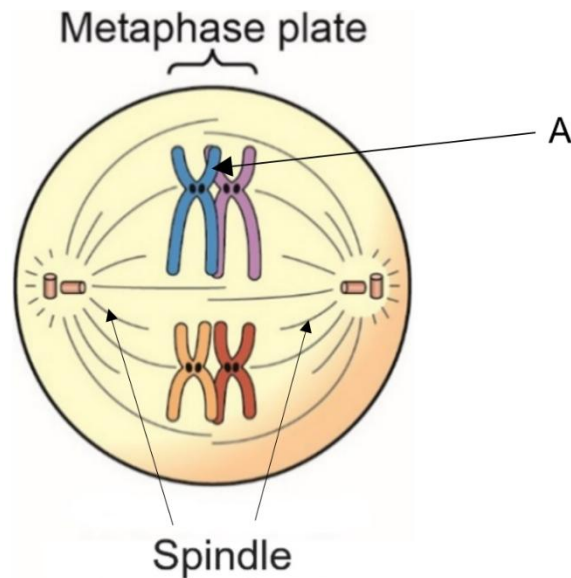
AP reference = B.1.3.0.2, B.1.3.0.4, B.1.3.0.5, B.1.3.0.6, B.1.3.0.7 and B1.3.0.11

**Answer**

**3.** Nucleus, ribosomes, endoplasmic reticulum, Golgi apparatus.

**1 (b)** The diagram below shows a cell during meiotic cell division.

Crossing over occurred at the point indicated by the arrow marked A.



Describe **two** ways in which the diagram shows that this is meiotic rather than mitotic division.

**[2 marks]**

AO1 = 2 marks

AP reference = B2.8,0.4, B2.8,0.5 and B2.8,0.6.

### Answer

Award **one** mark for each valid different characteristic, up to a **maximum** of **two** marks:

### Either

- the chromosomes are arranged in homologous pairs at the equator (1)  
**or**
- in mitosis the chromosomes would not be arranged in homologous pairs at the equator (1)  
**and**
- crossing over (between non-sister chromatids) can only occur in meiosis. (1)

**Accept any other suitable response.**

**1 (c)** Describe **two** differences between cells produced from meiosis and cells produced from mitosis.

**[2 marks]**

AO1 = 2 marks

AP reference = B.2.6.0.1, B.2.6.0.2, B.2.6.0.3, B.2.6.0.4 and B.2.8.0.4

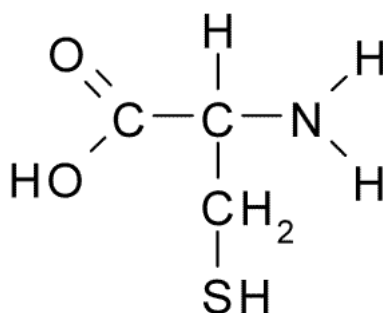
**Answer**

Award **one** mark for each valid difference up to a **maximum** of **two** marks.

- Mitosis produces two (daughter) cells during a single cycle, meiosis produces four (daughter) cells during a single cycle. (1)
- The (daughter) cells produced during mitosis are (genetically) identical. The (daughter) cells produced during meiosis show (genetic) variation. (1)
- The (daughter) cells produced during mitosis are (normally) genetically identical to the parent cell/original cell, (unless mutation/translocation/mitotic non-disjunction has occurred) The (daughter) cells produced during meiosis are genetically different to the parent cell. (1)
- The daughter cells produced in mitosis have pairs of chromosomes/diploid number of chromosomes/are 2N. The daughter cells produced in meiosis have single chromosomes/haploid number of chromosomes/are 1N. (1)
- Meiosis can produce cells with chromosomes that have undergone crossing over. (1)

**Accept any other suitable response.**

**2 (a)** The diagram below shows the structure of a specific amino acid.



Explain the unique role  
protein structure.

this amino acid can play in a tertiary

**[2 marks]**

AO2 = 2 mark

AP reference = B.1.7.0.3, B2.1.0.1.1 and B2.1.0.1.2

**Answer**

Award **one** mark for each valid explanation up to a **maximum** of **two** marks.

- This amino acid possesses an SH group (1) which can form disulphide bridges with the same amino acid further along the chain, (1) causing the protein to fold in a specific way.

**Accept any other suitable response.**

- 2 (b)** The table below shows the base sequence of two DNA codons and their complementary mRNA codons.

	Codon			Codon		
Coding strand of DNA	T	A	C	G	T	C
mRNA transcribed	A	U	G	C	A	G
tRNA anticodon						

Complete the table to show the base sequence of the corresponding tRNA anticodons.

**[2 marks]**

AO2 = 2 marks

AP reference = B.2.3.0.1, B.2.3.0.2, B2.3.0.3 and B2.3.0.4

Award **one** mark for each correctly completed tRNA anticodon.

	Codon			Codon		
Coding strand of DNA	T	A	C	G	T	C
mRNA transcribed	A	U	G	C	A	G
tRNA anticodon	U	A	C	G	U	C

**2 (c)** The table below shows the mRNA codons and the amino acids coded for by each codon.

		2 <sup>nd</sup> letter					
		U	C	A	G		
1 <sup>st</sup> letter	U	UUU   Phe UUC   UUA   Leu UUG	UCU   UCC   Ser UCA   UCG	UAU   Tyr UAC   UAA   Stop UAG   Stop	UGU   Cys UGC   UGA   Stop UGG   Trp	U C A G	3 <sup>rd</sup> letter
	C	CUU   CUC   Leu CUA   CUG	CCU   CCC   Pro CCA   CCG	CAU   His CAC   CAA   Gln CAG	CGU   CGC   Arg CGA   CGG	U C A G	
	A	AUU   AUC   Ile AUA   AUG   Met	ACU   ACC   Thr ACA   ACG	AAU   Asn AAC   AAA   Lys AAG	AGU   Ser AGC   AGA   Arg AGG	U C A G	
	G	GUU   GUC   Val GUA   GUG	GCU   GCC   Ala GCA   GCG	GAU   Asp GAC   GAA   Glu GAG	GGU   GGC   Gly GGA   GGG	U C A G	

The genetic code is described as degenerate.

Use information from the table to explain the implications of a degenerate code for mutation.

**[3 marks]**

AO1 = 1 mark

AO2 = 2 marks

AP reference = B.2.2.0.3, B.2.2.0.4, B.2.2.0.5 and B.1.18.0.1

### Answer

Award **one** mark for a correct definition of a degenerate code:

- a degenerate code means that each amino acid can be coded for by more than one codon. (1) (AO1)

Award **one** mark for **each** valid implication to a maximum of **two** marks:

- except for Methionine (Met), there is more than one codon for each amino acid (1) AO2
- therefore, a (substitution mutation), for example the U in ACU to C, would still code for Threonine (Thr), and the resultant protein would be unchanged. (1) (AO2)

**Accept any other suitable response.**



**2 (d)** In a class discussion, a student stated that primary protein structure is the most important factor in the formation of functional enzymes.

Assess the validity of this statement.

Your response should demonstrate:

- reasoned judgements and/or conclusions.

**[4 marks]**

AO3 = 4 marks

AP reference = B2.1.0.1.1, B2.1.0.1.2, B2.3.0.1, B2.4.02 and B2.4.03

**Answer**

Award **one** mark for each reasoned judgement/conclusion, up to a **maximum** of **four** marks.

- Altering primary structure, may change every subsequent level of structure, therefore, the primary structure appears to be the most important. (1)
- If the gene mutates/the base sequence changes, this is likely to alter the primary structure, suggesting the structure of the gene is as important. (1)
- The primary structure is the foundation/basis, but, a change in the subsequent levels will change the protein, suggesting subsequent levels may be as important. (1)
- If the primary structure is correct, the subsequent levels of structure should only change in non-optimum conditions – this supports the importance of the primary structure. (1)
- If the enzyme requires a cofactor/coenzyme it will not function in its absence, suggesting the cofactor/coenzyme is as important. (1)
- Many factors are involved in the formation of functional enzymes, including primary protein structure, but will not produce a functional enzyme on their own. (1)

**Accept any other suitable response.**

**2 (e)** The Human Genome project determined the base pair sequence that makes up human DNA and mapped the entire human genetic material.

Explain why this would not be regarded as genetics.

**[2 marks]**

AO1 = 1 mark

AO2 = 1 mark

AP reference = B1.19.0.1 and B1.19.0.2

**Answer**

Genetics focuses on the composition/function of single genes. (1) (AO1) The human genome project investigated the whole of the human DNA/all the human genes. (1) (AO2)

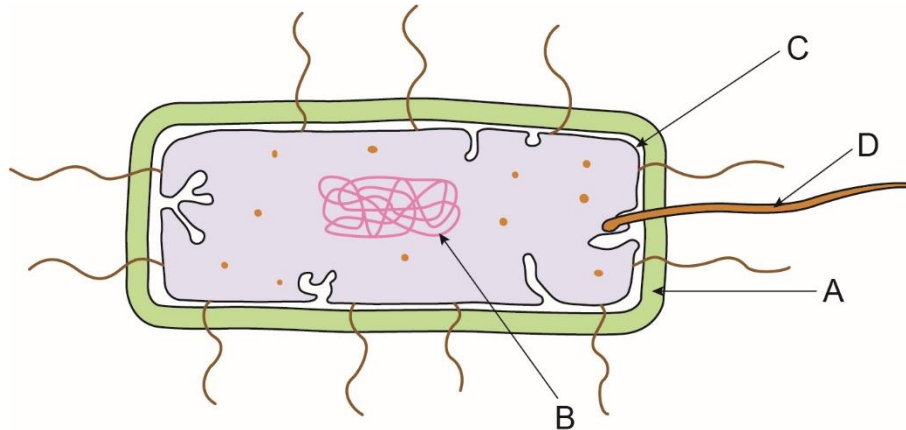
**Accept any other suitable response.**

**3 (a)** The diagram below represents a micrograph of a typical bacterium. In the micrograph, the width of part A is measured as 2mm.

The magnification used was x 25 000.

**(i)** Name parts A, B, C and D

**(ii)** Calculate the actual width of part A in nm.



**[5 marks]**

3 (a) (i) – AO1 = 4 marks

3 (a) (ii) – AO2 = 1 mark

AP reference = B1.6.0.3, B1.6.0.4, B1.6.0.7 and B.1.20.0.1

### Answer

3 (a) (i) Award **one** mark for each of the following, up to a **maximum** of **four** marks:

- A – Cell wall. (1) (AO1)
- B – Nucleoid/nuclear material. (1) (AO1)
- C – Cell membrane. (1) (AO1)
- D – Flagellum. (1) (AO1)

3 (a) (ii) Award **one** mark for the following:

- actual width: 80nm. (1) (AO2)

**3 (b)** A laboratory grew a culture of a bacterium with glucose solution as the bacterial substrate. The starting population of the bacteria in the culture was  $1.5 \times 10^4$  cells per ml.

Assume that each cell divides every 30 minutes and that no cell dies during this time.

Calculate how many cells there would be in 1ml of the culture after 3 hours.

Give your answer to the calculation in standard form.

**[2 marks]**

AO2 = 2 marks

AP reference = B.1.20.0.1

**Answer**

Award **one** mark for each of the following:

$9.6 \times 10^5$  – award **two** marks = 1 x (AO2) for standard form, 1 (AO2) for correct answer

**or**

Award **one** mark for the following:

960 000 – award **one** mark (as this is not in standard form) 1 (AO2) for correct answer only

**3 (c)** Describe **two** factors which could prevent this rate of growth from being achieved.

**[2 marks]**

AO1 = 2 marks

AP reference = B.1.20.0.1

**Answer**

Award **one** mark for each of the following brief descriptions of a factor, up to a **maximum** of **two** marks:

- The glucose solution may not contain sufficient glucose to provide enough energy for this rate of growth. (1)
- This simple glucose solution will not contain all the nutrients required for replication (at this rate). (1)
- An accumulation of toxic waste products (could prevent this rate of growth). (1)
- If the temperature is unsuitable (this could prevent this rate of growth). (1)
- The concentration of the glucose solution may be high enough to cause water to leave the bacterial cells by osmosis, this could prevent this rate of growth. (1)

**Accept any other suitable response**

**4** A scientist removed four identical squares of the small intestine of a rat and placed these in four separate beakers: A, B, C and D.

The scientist then added two different sugars and a respiratory inhibitor as shown in the table.

After 20 minutes, they measured the amount of sugar absorbed in each, in mg per minute.

	Beaker A	Beaker B	Beaker C	Beaker D
Type of sugar added	Sugar X	Sugar X	Sugar Y	Sugar Y
Respiratory inhibitor added	No	Yes	No	Yes
Amount of sugar absorbed mg per minute	25	25	42	4

The scientist made the following conclusions:

- sugar X was transported passively by diffusion
- sugar Y was mainly transported actively
- sugar Y was also transported to a lesser extent passively by diffusion
- sugar Y may be a significantly larger molecule than sugar X.

**(a)** Describe the effect the respiratory inhibitor would have.

**(b)** Use the results from the table above to evaluate **each** of the scientist's conclusions.

**[5 marks]**

4 (a) – AO1 = 1 mark

4 (b) – AO3 = 4 marks

AP reference = B.1.11.0.2 and B.1.11.0.3

4 (a) Award a **maximum of one mark** for the following:

- a respiratory inhibitor would prevent respiration and therefore prevent the formation of ATP/release of energy (which is required for active transport). (1) (AO1)

4 (b) Award **one** mark for each of the following **up to a maximum of four** marks:

- As the respiratory inhibitor has no effect on uptake of sugar X, energy/ATP is not required meaning transport must be passive, this supports the scientist's first conclusion. (1) (AO3)
- As the uptake of sugar Y was reduced from 42mg/m to 4 mg/m when the respiratory inhibitor was added, energy/ATP is required, and transport is active. This supports the scientist's second conclusion. (1) (AO3)
- As there is a small amount of sugar Y transported when the respiratory inhibitor is present

this suggests sugar Y can be transported passively (but this is a slow process). This supports the scientist's third conclusion. (1) (AO3)

- As the passive uptake of Y is much slower (4mg/m) than the passive uptake of X (25mg/m), this may be due to Y being a larger molecule than X. This (partially) supports the scientist's fourth conclusion. (1) (AO3)

**Accept any other suitable response.**

**5** Human influenza viruses can undergo antigenic drift and antigenic shift.

**Antigenic drift**

Minor changes occurring frequently in the viral genes can lead to changes in the surface proteins of the virus, which form antigens, creating new closely related viruses with slightly altered antigens.

Over time the small changes accumulate, producing viruses with significantly different antigens.

**Antigenic shift**

Major changes occurring much less frequently but abruptly in the viral genes can lead to significant and sudden changes in the antigens, forming a new viral sub-type that most of the human population will not have encountered.

Using the information above, evaluate the relative impact of antigenic drift and antigenic shift to human health.

**[12 marks plus 3 marks for QWC]**

AO1 = 4 marks

AO2 = 4 marks

AO3 = 4 marks

QWC = 3 marks

AP reference = B.1.28.0.1, B.1.28.0.2, B.1.29.0.1, B.1.30.0.4, B.1.30.0.5 and B.1.32.0.1

This is a band marked question.

Band	Mark	Descriptor
4	10–12	<p><b>AO3</b> Evaluation of the relative impact of antigenic drift and antigenic shift to human health is <b>comprehensive</b>, <b>effective</b>, and <b>relevant</b>, showing <b>detailed</b> understanding and <b>logical</b> and <b>coherent</b> chains of reasoning throughout. Makes informed conclusions that are fully supported with rational and balanced reasoned judgements.</p> <p><b>AO2</b> Applied all relevant knowledge of the effects of antigenic drift and shift on immunity and shows a <b>detailed</b> functional understanding. This is effectively linked to the incidence and spread of the influenza virus.</p>

Band	Mark	Descriptor
		<b>AO1</b> A <b>wide range</b> of relevant knowledge and understanding of the immune response is demonstrated, which is <b>accurate</b> and <b>detailed</b> . A <b>wide range</b> of <b>appropriate</b> technical terms are used.
3	7–9	<p><b>AO3</b> Evaluation of the relative impact of antigenic drift and antigenic shift to human health is <b>in most parts effective</b> and <b>mostly relevant</b>, showing <b>mostly logical and coherent</b> chains of reasoning. Given conclusions supported by reasoned judgements that consider most of the relevant arguments.</p> <p><b>AO2</b> Applied mostly relevant knowledge of the effects of antigenic drift and shift on immunity showing <b>some</b> functional understanding of the immune system and how drift and shift affect the response. This is linked to the incidence and spread of the influenza virus.</p> <p><b>AO1</b> Knowledge and understanding of the immune response <b>is in most parts clear</b> and <b>mostly accurate</b>, although on occasion <b>may lose</b> focus.</p>
2	4–6	<p><b>AO3</b> Evaluation of the relative impact of antigenic drift and antigenic shift to human health is in <b>some parts effective</b> and of <b>some relevance</b>, with some understanding and reasoning taking the form of <b>generic statements</b> with some development. Judgements are <b>basic</b> and <b>brief</b>; conclusions will have <b>limited</b> rationality and balance.</p> <p><b>AO2</b> Applied little but some knowledge of the role of antigens and how the immune system response to them is <b>limited</b> and may show a lack of functional understanding of the immune system and how drift and shift affect the response. Linking to the incidence and spread of the influenza virus is attempted but not always clear.</p> <p><b>AO1</b> Knowledge and understanding of the immune response shows <b>some</b> but <b>limited</b> accuracy, focus and relevance.</p>
1	1–3	<p><b>AO3</b> Evaluation of the relative impact of antigenic drift and antigenic shift to human health is <b>minimal</b> and <b>very limited</b> in effectiveness and relevance. Given brief conclusions supported by judgements that consider only basic arguments and show little relevance to the question aims.</p> <p><b>AO2</b> Applied limited knowledge of the role of antigens and how the immune system responds to them. <b>Shows a very limited</b> functional understanding of immune system and how drift and shift affect the response. Linking to the incidence and spread of the influenza virus, is not attempted or inappropriate.</p> <p><b>AO1</b> Knowledge and understanding of the immune response shows <b>very minimal</b> accuracy, focus and relevance.</p>
	0	No creditworthy material

## **Indicative content**

**AO1 and AO2 will be implicit through the level of evaluation and reasoned judgements/and or conclusions that the student provides.**

### **(AO1) Immune responses to antigen.**

- Gaining immunity relies on specific T cells/T lymphocytes binding to antigen on the influenza virus.
- Binding of specific T cells with antigens result in the production of memory cells.
- Binding of T cells with antigens result in the production of cells which attack the virus and antibodies.
- Memory cells recognise the antigen if it enters the body again.
- Memory cells can cause a rapid production of the cells and antibodies which attack the virus.
- The rapid response of memory cells prevents a second infection.
- The same virus will have the same antigen if no changes occur in the viral genes.
- Vaccines work by exposing the body to antigen, this stimulates the immune response in the same way as the live virus.
- Vaccination will also result in the production of memory cells.

### **(AO2) Explanation of effects of drift and shift on immunity**

- As drift causes small changes in antigens, they may still be recognised by memory cells triggering a secondary response and preventing a second infection.
- Over time drift causes minor changes to accumulate producing viruses with significantly different antigens, therefore, memory cells may not recognise them.
- If memory cells do not recognise the antigens there is no secondary response and no immunity (and the person can become ill again).
- As some people will have encountered the later versions of the virus, their memory cells will recognise the antigens causing a secondary response and immunity.
- As shift causes sudden and major changes to the antigens, memory cells will not recognise the antigens and there will be no secondary response/immunity.
- Although antigens are changed by both drift and shift, they are still antigens and stimulate the same type of immune response.
- Due to constant antigenic changes caused by shift and drift, it is not possible to become immune to influenza.
- A vaccine often uses a specific antigen/antigen-bearing material. Drift and shift can cancel any immunity gained from the vaccine.

### **(AO3) Conclusions and/or reasoned judgements.**

- Drift and shift both produce new viruses but with drift a significant percentage of the population will have encountered viruses with similar antigens and have some immunity, limiting spread.
- With shift, the major and sudden changes in the antigen means that the majority of people have no immunity enabling rapid spread.
- The cause of antigenic change does not alter the outcome for an individual as people with no immunity to a virus, produced by drift or shift, are likely to develop influenza.

- Drift occurs frequently (and changes in the genes constantly accumulate), meaning viruses with sufficiently different antigens evolve frequently, hence epidemics are regular.
- With drift, significant numbers of people will encounter the virus during the accumulation process and develop some immunity which will limit the scale of an outbreak.
- As shift occurs much less frequently pandemics are relatively rare, however, few people have any immunity and therefore more people are infected than in a seasonal epidemic (leading to more people with serious illness and more deaths).
- The major and sudden changes caused by shift are more likely to lead to larger outbreaks/pandemics as very few people will have immunity.
- Individual outbreaks/pandemics through shift are likely to lead to more deaths than an individual seasonal epidemic through drift, however, seasonal epidemics occur every year, and are likely to lead to more deaths over time.
- Both drift and shift make development of a vaccine difficult, (as the antigen keeps changing) therefore vaccines need to be constantly produced to keep pace with the changes.
- Vaccines may still work with the small changes of drift but will eventually become ineffective, and shift is likely to make a vaccine ineffective immediately.

**Accept any other suitable response.**

### QWC mark scheme

Mark	Descriptor
3	The answer is clearly expressed and well-structured. The rules of grammar are used with effective control of meaning overall. A wide range of appropriate technical terms are used effectively.
2	The answer is generally clearly expressed and sufficiently structured. The rules of grammar are used with general control of meaning overall. A good range of appropriate technical terms are used effectively.
1	The answer lacks some clarity and is generally poorly structured. The rules of grammar are used with some control of meaning and any errors do not significantly hinder the overall meaning. A limited range of appropriate technical terms are used effectively.
0	There is no answer written or none of the material presented is creditworthy. <b>Or</b> The answer does not reach the threshold performance level. The answer is fragmented and unstructured, with inappropriate use of technical terms. The errors in grammar severely hinder the overall meaning.



**Section B: Chemistry**

**Total for this section: 27 marks plus 3 marks  
for QWC and use of specialist terminology**

**6 (a)** A compound with the empirical formula  $\text{CH}_2$  has the relative molecular mass of 28.

Which of the following gives the molecular formula for this compound?

- A  $\text{CH}_8$
- B  $\text{CH}_4$
- C  $\text{C}_2\text{H}_4$
- D  $\text{C}_3\text{H}_6$

**[1 mark]**

AO2 = 1 mark

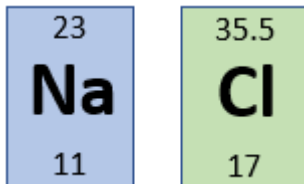
AP reference = B.2.17.0.1 and B2.17.0.2

**Answer**

**C**  $\text{C}_2\text{H}_4$

**6 (b)** Half a litre of saline solution is made up using 9g of sodium chloride.

Calculate the concentration and molarity of the saline solution.



**[3 marks]**

AO2 = 3 marks

AP reference = B2.20

**Answer**

**Concentration** =  $(9/0.5) = 18\text{g/dm}^3$  (1 mark with correct units)

$(9/(23+35.5) = 0.1538)$  (1 mark)

**Molarity** =  $(0.1538/0.5) = 0.308\text{ mol/dm}^3$  (1 mark with correct units)

**6 (c)** A concentration of  $3.2 \times 10^{-2}$  g of NaF per kg of body mass causes significant physiological problems and could be lethal.

Calculate the mass of NaF in mg a child of 30kg would need to consume to reach the potentially lethal level.

Show your working.

**[2 marks]**

AO2 = 2 marks

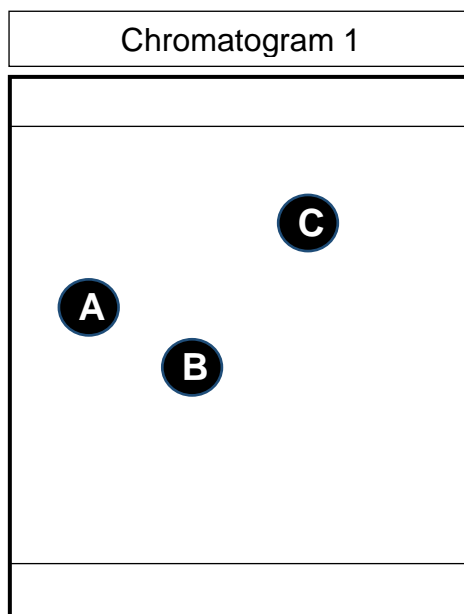
AP reference = B.2.20

### Answer

Award **one** mark for the correct sum/calculation and **one** mark for the correct answer with correct units up to a **maximum** of **two** marks:

- Potentially lethal level =  $3.2 \times 10^{-2} \times 30 \times 1000$  (1) = 960mg (1 with correct units).

**7 (a)**



The diagram above shows a thin layer chromatogram.

The chromatogram had run for 30 minutes using the following standard solutes:

- solute A = sucrose standard
- solute B = fructose standard
- solute C = glucose standard.

Calculate the R<sub>f</sub> values for solutes A, B and C.

**[3 marks]**

AO2 = 3 marks

AP reference = B 1.41.0.1, B2.28.0.1, B2.31.0.1

**Answer**

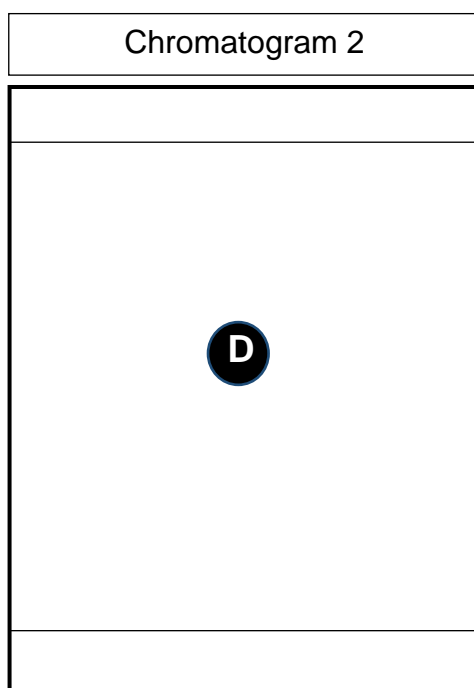
Award **one** mark for each R<sub>f</sub> value in the correct range up to a **maximum** of **three** marks.

A = allow range of 0.53 – 0.64 (1)

B = allow range of 0.39 – 0.51 (1)

C = allow range of 0.72 – 0.84 (1)

- 7 (b)** Solute D is an unknown sugar and was run for 30 minutes, in identical conditions to chromatogram 1, on a second thin layer chromatogram, shown below.



A scientist concludes that solute D is sucrose.

Explain why this is correct.

**[2 marks]**

AO1 = 1 mark

AO2 = 1 mark

AP reference = B2.27, B2.28.0.2, B2.31.0.1 and B2.31.0.2

**Answer**

Award **one** mark for each valid part of the explanation.

- R<sub>f</sub> is in range (allow) 0.53 – 0.64 (1) (AO2)
- R<sub>f</sub> of D is same (in range) of solute A, which is sucrose (identified from Chromatogram 1). (1)(AO1)

**7 (c)** If solute D had run for 60 minutes in the same conditions, what would its  $R_f$  value have been?

**[1 mark]**

AO2 = 1 mark

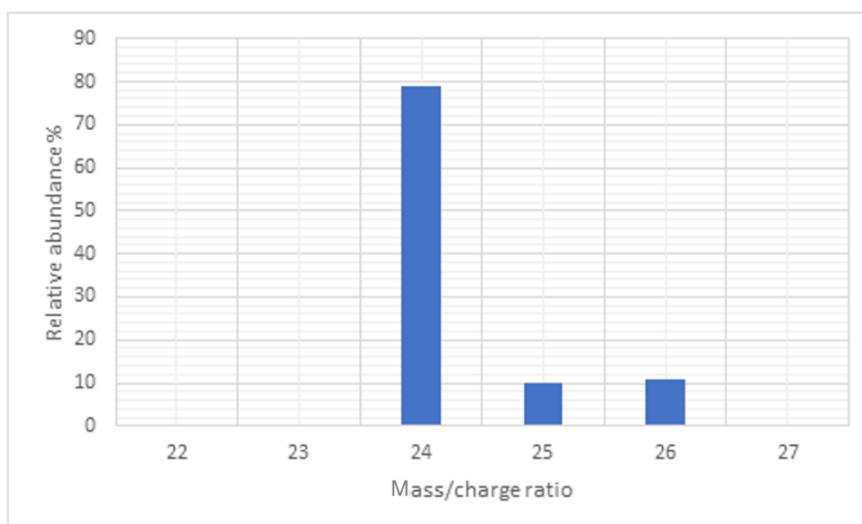
AP reference = B.2.28.0.2

**Answer**

Allow range of  $R_f$  from 0.53 – 0.64 (same as solute A).

**7 (d)** A sample of magnesium is being investigated to find out if it came from the same source as a batch of stolen magnesium. The stolen batch has an  $A_r$  of 24.34

Mass spectrometry was used to analyse the magnesium sample and produced this spectrum:



A scientist draws the following conclusions from the data about the sample of magnesium:

- the sample of magnesium is an alloy of magnesium consisting of only 3 isotopes
- these have the mass numbers 24, 25 and 26
- the relative abundance of the isotopes is 78%, 10% and 12% respectively
- the  $A_r$  for this sample of magnesium is 24.34
- the sample is from the same source as the stolen batch of magnesium.

Evaluate the scientist's conclusions.

Your response should demonstrate:

- reasoned judgements and/or conclusions.

**[6 marks]**

AO3 = 6 marks

AP reference = B1.41.0.5.1

## Answer

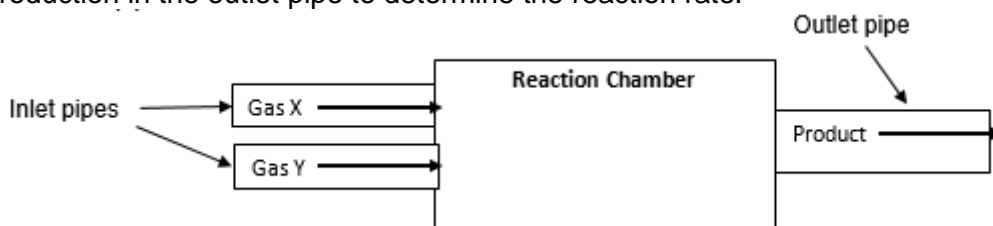
### Reasoned judgments and/or conclusions

Award **one** mark for each valid reasoned judgement/conclusion up to a **maximum** of **six** marks:

- There is no evidence to suggest that the sample is an alloy since the mass spectrum shows only the presence of magnesium isotopes, so the conclusion is not valid. (1)
- The mass spectrum suggests that there are only three isotopes present because the relative abundance values add up to 100%, so the conclusion is valid. (1)
- The isotopes do have the mass numbers 24, 25 and 26 since the mass number is the same as the mass/charge ratio so that conclusion is valid. (1)
- The graph has been read or recorded incorrectly, the correct values are 79%, 10% and 11% respectively, so the conclusion is not valid. (1)
- The scientist has used the correct formula but placed the data into the equation incorrectly, therefore the conclusion is not valid. (1)
- $A_r = 24.34$ , so the scientist carried out the calculation correctly but was using incorrect data making the conclusion invalid. (1)
- The evidence shows clearly that it is not from the same source due to natural variation in isotopic composition, (dependent on the source of the ore and other factors). (1)

**Accept any other suitable response.**

- 8** A scientist wanted to maximise production rate by finding out the optimum distribution for using a catalyst. He passed two gases, gas X and gas Y, through a reaction chamber. He measured the rate of production in the outlet pipe to determine the reaction rate.



The same mass of catalyst was used in arrangements A, B and C.

The reaction was carried out at different temperatures.

The rate of reaction is given in arbitrary units.

	<b>A</b>	<b>B</b>	<b>C</b>
<b>Temperature of reaction chamber °C</b>	<b>Reaction chamber lined with a layer of catalyst</b>	<b>Reaction chamber with the catalyst in granular form at the bottom</b>	<b>Reaction chamber divided into a 'honeycomb' of hundreds of smaller tubes each lined with catalyst</b>
<b>50</b>	0	0	0
<b>60</b>	0	0	0
<b>70</b>	0	0	0
<b>80</b>	5	4	6
<b>90</b>	10	8	12
<b>100</b>	22	17	25
<b>110</b>	40	33	48
<b>120</b>	150	164	210

Evaluate the methods used to find the optimum distribution for the catalyst. Use data from the table to support your answer.

Your response should include:

- reasoned judgements and/or conclusions.

**[9 marks plus 3 marks for QWC]**

AO1 = 3 marks

AO2 = 3 marks

AO3 = 3 marks

QWC = 3 marks

AP reference = B2.21.0.1, B2.21.0.2 and B.2.24

This is a band marked question.

Band	Mark	Descriptor
3	7–9	<p><b>AO3</b> Evaluation of the methods used to find the optimum distribution for the catalyst is <b>comprehensive, effective, and relevant</b>, showing <b>detailed</b> understanding and <b>logical and coherent</b> chains of reasoning throughout. Makes informed conclusions that are fully supported with rational and balanced reasoned judgements.</p> <p><b>AO2</b> Applied <b>relevant</b> knowledge of how to interpret the data from the table in order to facilitate <b>effective</b> evaluation of the methods used to find the optimum distribution for the catalyst in this scenario. Shows a <b>detailed</b> functional understanding of the scientific methodology involved.</p> <p><b>AO1</b> A <b>wide range</b> of relevant knowledge and understanding of catalysts/reaction rates which is <b>accurate</b> and <b>detailed</b>.</p>
		The answer demonstrates <b>comprehensive</b> breadth and/or depth of understanding.
2	4–6	<p><b>AO3</b> Evaluation of the methods used to find the optimum distribution for the catalyst is <b>in most parts effective</b> and <b>mostly relevant</b>, showing <b>mostly logical and coherent</b> chains of reasoning. Given conclusions supported by reasoned judgements that consider most of the relevant techniques used in the methodology to the context.</p> <p><b>AO2</b> Applied mostly relevant knowledge of how to interpret the data from the table in order to facilitate evaluation of the methods used to find the optimum distribution for the catalyst showing <b>some</b> functional understanding of how they can be applied in this scenario.</p> <p><b>AO1</b> Knowledge and understanding of catalysts/reaction rates in this context <b>is in most parts clear</b> and <b>mostly accurate</b>, although on occasion <b>may lose</b> focus.</p>
		The answer demonstrates <b>reasonable</b> breadth and/or depth of understanding, with <b>occasional</b> inaccuracies and/or omissions.
1	1–3	<p><b>AO3</b> Evaluation of the methods used to find the optimum distribution for the catalyst is <b>in some parts effective</b> and of <b>some relevance</b>, with some understanding and reasoning taking the form of <b>generic statements</b> with some development. Given brief conclusions supported by judgements that consider only basic arguments and show little relevance to the question aims.</p> <p><b>AO2</b> Applied limited knowledge of how to interpret the data from the table which adversely impacts on the effectiveness of the evaluation and may show a lack of functional understanding of the scientific methodology involved.</p> <p><b>AO1</b> Knowledge and understanding of catalysts/reaction rates in this context shows <b>some</b> but <b>limited</b> accuracy, focus and relevance.</p>

		The answer is <b>basic</b> and shows <b>limited</b> breadth and/or depth of understanding, <b>with</b> inaccuracies and omissions.
	0	No creditworthy material

## Indicative content

**AO1 and AO2 will be implicit through the level of evaluation and reasoned judgements and/or conclusions that the student provides.**

**(AO1) Catalysts/reaction rates** (knowledge of catalysts that the student may discuss).

- A catalyst is a substance that increases the rate of a chemical reaction.
- A catalyst is not permanently chemically changed during the reaction.
- The collision theory explains the relationship between surface area and rate of reaction.
- Larger surface area gives more collisions per unit time, therefore, higher rate of reaction.

**(AO2) Methods/observations** (that the student could include in their evaluation).

- There was no reaction below 70 °C in any of the catalyst arrangements.
- The reaction rate increased with increasing temperature after 70 °C with all arrangements of catalyst.
- In all 3 arrangements, once the reaction had begun, the rate appeared to approximately double for every 10 °C rise in temperature, up to 110 °C, after this there was a much larger increase.
- The rate of reaction continued to rise for every 10 °C up to the maximum temperature investigated.
- The rate of reaction in arrangement A was slightly higher than in B, until 120 °C where B was slightly higher than A.
- The rate of reaction in arrangement C was the highest of all the temperatures investigated.
- Arrangement C at 120 °C, is the optimum of these 3 arrangements of catalyst.
- Arrangement B appears to be the least optimal/worst of the 3 arrangements at all temperatures except 120 °C could be an outlier and could be due to experimental error.
- The higher the temperature the faster the rate of reaction.

**(AO3) Evaluation/reasoned judgements:**

- Only 3 arrangements of catalyst were used, however, there may be other arrangements which would produce a higher rate.
- Only 1 amount of catalyst was used, a different amount may have behaved differently.
- A control was not present, the investigation should have been repeated without catalyst.
- The highest temperature investigated was 120 °C, despite there being a significantly increased rate at 120 °C in all 3 arrangements.
- The optimum temperature could be higher than 120 °C.
- No statistical analysis has been carried out to see if the difference between the 3 arrangements is significant.
- There is no investigation of the effects of changing pressure on the rate.
- Temperature appears to be limiting the rate of reaction up to 90–100 °C above this



temperature the arrangement of catalyst appears to be the limiting factor.

- Due to the limitations of this investigation, the conclusions drawn may not be valid.

**Accept any other suitable response.**

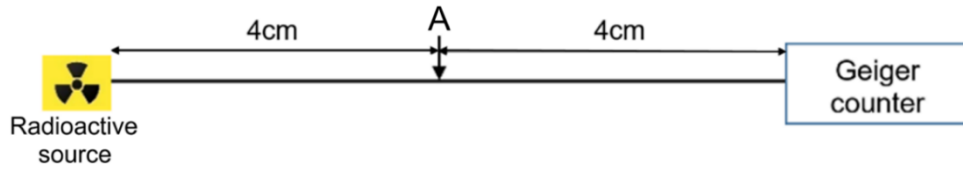
### QWC mark scheme

Mark	Descriptor
3	The answer is clearly expressed and well-structured. The rules of grammar are used with effective control of meaning overall. A wide range of appropriate technical terms are used effectively.
2	The answer is generally clearly expressed and sufficiently structured. The rules of grammar are used with general control of meaning overall. A good range of appropriate technical terms are used effectively.
1	The answer lacks some clarity and is generally poorly structured. The rules of grammar are used with some control of meaning and any errors do not significantly hinder the overall meaning. A limited range of appropriate technical terms are used effectively.
0	There is no answer written or none of the material presented is creditworthy. <b>Or</b> The answer does not reach the threshold performance level. The answer is fragmented and unstructured, with inappropriate use of technical terms. The errors in grammar severely hinder the overall meaning.

**Section C: Physics**

**Total for this section: 18 marks**

**9 (a)** Study the diagram below:



A physicist places sheets of different materials at point A.

The readings from the Geiger counter are shown below:

Material at point A	Reading from Geiger counter
No material	750
Paper	750
Aluminium foil	150
Lead sheeting	25

What type or types of radiation is the source emitting?

- A**  $\beta$  and  $\gamma$  only.
- B**  $\alpha$  and  $\beta$  only.
- C**  $\gamma$  only.
- D**  $\beta$  only.

**[1 mark]**

AO2 = 1 mark

AP reference = B1.56.0.1, B1.56.0.1.1, B1.56.0.1.2, B1.56.0.2, B1.56.0.2.1, B1.56.0.2.2, B1.56.0.3, B1.56.0.3.1 and B1.56.0.3.2

**Answer:**

- A**  $\beta$  and  $\gamma$  only.

**9 (b)** Petri dishes are packed and sealed in plastic and sterilised as part of the manufacturing process.

The petri dishes are packaged before being sterilised by irradiation.

Comparing alpha and gamma radiation, recommend which would be the most suitable for sterilisation and explain why.

**[3 marks]**

AO1 = 2 marks

AO2 = 1 mark

AP reference = B.1.56.0.3.1, B1.60.0.3

### **Answer**

Award **one** mark for each relevant property of each type of radiation, up to a **maximum** of **two** marks:

Alpha has low penetrating power (1) (AO1). Gamma has high penetrating power. (1) (AO1)

### **Explanation**

Award **one** mark only:

Therefore, the Gamma radiation can penetrate both the plastic wrapping and the petri dishes. (1) (AO2)

**Accept any other suitable response.**

9 (c)

Colour	Red	Orange	Yellow	Green	Blue	Violet
Wavelength range nm		590–620	570–590	495–570		380–450
How deep the light penetrates in metres	10	20	35	45	100	80

The table above shows the wavelength range of visible light and penetration of clear water.

Use the information from the table to fill in the blank wavelength ranges.

**[2 marks]**

AO2 = 2 marks

AP reference = B.1.53

Complete the boxes. Award **one** (AO2) mark for a correct value in Red and **one** (AO2) mark for a correct value in Blue.

Colour	Red	Orange	Yellow	Green	Blue	Violet
Wavelength nm	<b>620–750</b>	590–620	570–590	495–570	<b>450–495</b>	380–450
How deep the light penetrates in metres	10	20	35	45	100	80

OR – Accept any **single value** within the range 620–750 for red (1) and 450–495 for blue. (1)

9 (d)

A marine biologist makes this hypothesis:

“We should expect to find marine animals which have a red or black colouration living in water below depths of 15m because this will give them an advantage.”

Assess the marine biologist’s hypothesis.

Your response should include reasoned judgements and/or conclusions.

**[4 marks]**

AO3 = 4 marks

AP reference = B.1.53

## Answer

Award **one** mark for each valid evaluative response, up to a **maximum** of **four** marks.

- As there is no red light at this depth, there is no light to reflect, and therefore the animal will be difficult to see. This supports the hypothesis. (1)
- This would help prevent prey or predators from seeing it, thus giving it an advantage. This supports the hypothesis. (1)
- As black reflects very little visible light, a black animal would also be difficult to see. This supports the hypothesis. (1)
- Below depths of 100m there is no light of any wavelength to reflect, therefore the colour would be irrelevant. This does not support the hypothesis. (1)

**Accept any other suitable response.**

<b>9 (e)</b> Describe the differences between longitudinal and transverse waves.
--

**[2 marks]**

AO1 = 2 marks

AP reference = B.1.54.0.1 and B1.54.0.2

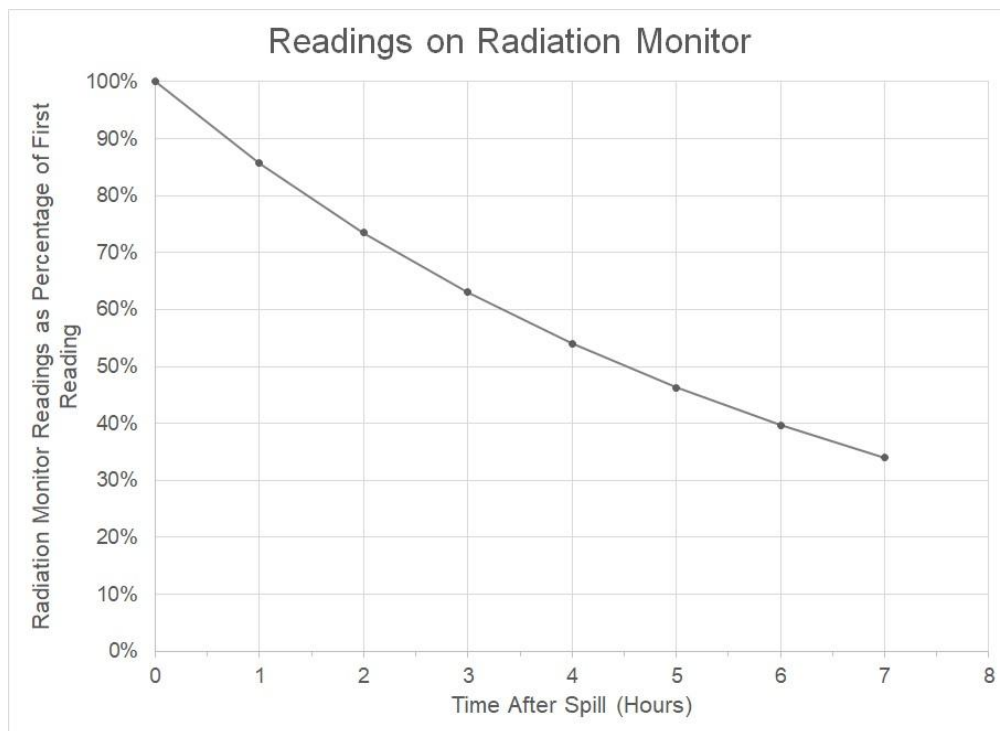
## Answer

Award **one mark** for each valid difference up to a **maximum** of **two** marks.

- The displacement of particles in a longitudinal wave is parallel to the direction of travel of the wave. (1)
- The displacement of particles in a transverse wave is perpendicular/at  $90^\circ$  to the direction of travel of the wave. (1)

**Accept any other suitable response.**

- 10** A workbench has become contaminated by a gamma-emitting radioactive material, and radiation monitor readings have been taken throughout the day. The results are shown below:



The lab is closed at weekends, so the manager is considering two options to deal with the spill:

- have staff manually decontaminate the workbench now
- temporarily seal the lab and resume work on Monday.

Evaluate which option would be better. Your response should consider:

- the concept of 'half-life'
- a discussion of the two options
- reasoned judgements and/or conclusions about which would be better.

**[6 marks]**

AO1 = 2 marks

AO2 = 2 marks

AO3 = 2 marks

AP reference = B1.57.0.1 and B1.57.0.2

## Answer

**(AO1) Half-life:** Award **one** mark for each valid fact about half-life, up to a **maximum** of **two** marks:

- The half-life of a radioactive material is the time taken for the radioactive activity to decrease by 50% or half. (1)
- The half-life can be used to calculate when the amount of radiation reaches safe levels. (1)

**(AO2) Discussion of options:** Award **one** mark for each valid point, up to a **maximum** of **two** marks:

- the half-life of the material is 4 hours 30 minutes (1)
- within 48 hours the amount of radiation would have (effectively) reached zero. (1)

**(AO3) Reasoning and conclusions:** Award **one** mark for each valid reasoned judgement/conclusion, up to a **maximum** of two marks:

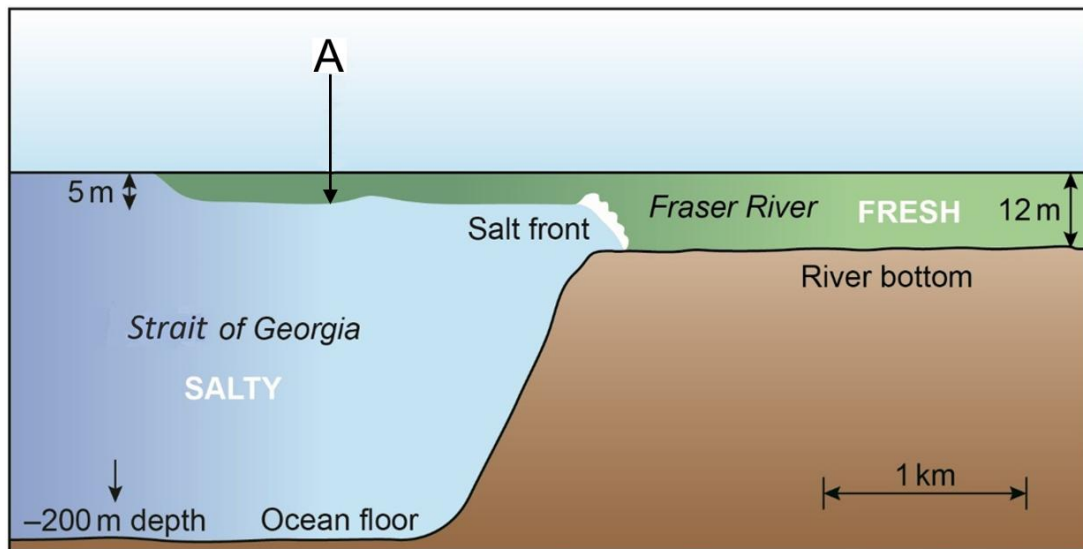
- Option 2 would be better as a negligible amount of radioactivity will remain by Monday morning (due to radioactive decay with a short half-life). (1)
- Option 2 would be better as Gamma radiation (is ionising radiation which) poses a risk to those decontaminating the workbench and exposure is not necessary due to the short half-life. (1)

**Accept any other suitable response.**

**Section D: Scientific concepts**

**Total for this section: 20 marks plus 3 marks for QWC and use of specialist terminology**

- 11** A solid rubber ball is accidentally dropped from a boat. The ball sinks **slowly** through the water but stops at the point marked by arrow A, as shown on the diagram below.



Explain why the ball behaved in this way.

**[3 marks]**

AO2 = 3 marks  
 AP reference = B.2.35.0.1

**Answer**

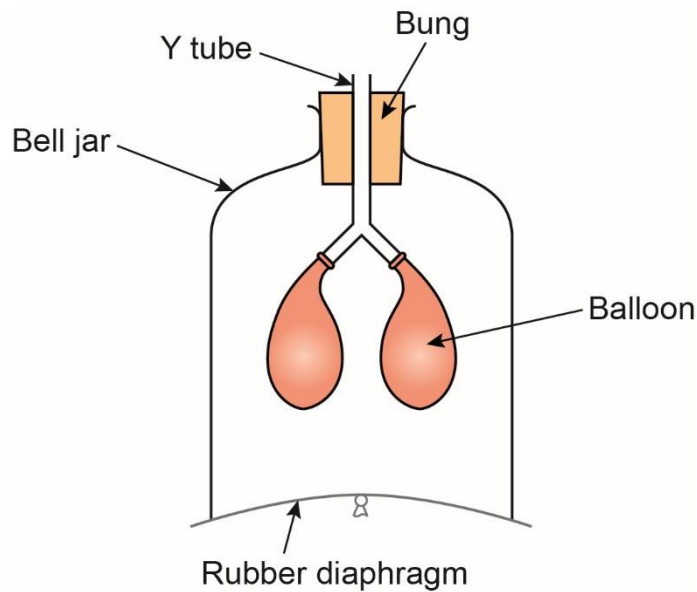
**Explanation** – Award **one** mark for each valid explanatory point, up to a **maximum** of **three** marks.

- The ball has a greater density than the freshwater, therefore it sinks. (1)
- The ball has a lower density than the salt water, therefore it floats on top of it. (1)
- The density of the ball must only be slightly denser than the fresh water which is why it sinks slowly. (1)

**Accept any other suitable response.**



**12** The model shown below is used to explain the mechanism of inhalation.



When the rubber diaphragm is pulled down, the volume of the bell jar increases.

Explain what happens to the pressure inside the bell jar and why this will cause the balloons to inflate if the temperature remains constant.

**[2 marks]**

AO2 = 2 marks

AP reference = B.2.32.0.1

### Answer

Award **one** mark for each valid explanatory point, up to a **maximum** of **two** marks.

- When the volume within the bell jar increases, the pressure inside the bell jar decreases. (1)
- The pressure inside the bell jar becomes lower than the pressure inside the balloons and air moves into the balloons to equalise the pressure. (1)

**Accept any other suitable response.**

**13** Viruses should **not** be regarded as living organisms.

Discuss this statement.

Your response should demonstrate:

- reasoned judgements and/or conclusions.

**[3 marks]**

AO3 = 3 marks

AP reference = B1.1.0.1, B1.1.0.2, B1.1.0.3 and B1.20.04

### Answer

Award **one** mark for each valid reasoned judgement/conclusion, up to a **maximum** of **three** marks.

- As viruses cannot reproduce without their host cells and reproduction is a fundamental characteristic of organisms, viruses not being able to reproduce supports the statement. (1)
- As viruses making the host cell produce more viruses they are reproduced. Stating “viruses cannot reproduce” to argue they are not alive, relies on a definition which is insufficient to cover all organisms. This does not support the statement. (1)
- As viruses contain either DNA or RNA as their genetic material, which is a characteristic they share with almost all other organisms, this does not support the statement. (1)
- As a characteristic of organisms is that they are made of one or more cells and viruses have no cellular structure this supports the statement. (1)
- As fungi are regarded as living but have no cells, because they have no cell boundaries (membranes). This does not support the statement. (1)

**Accept any other suitable response.**

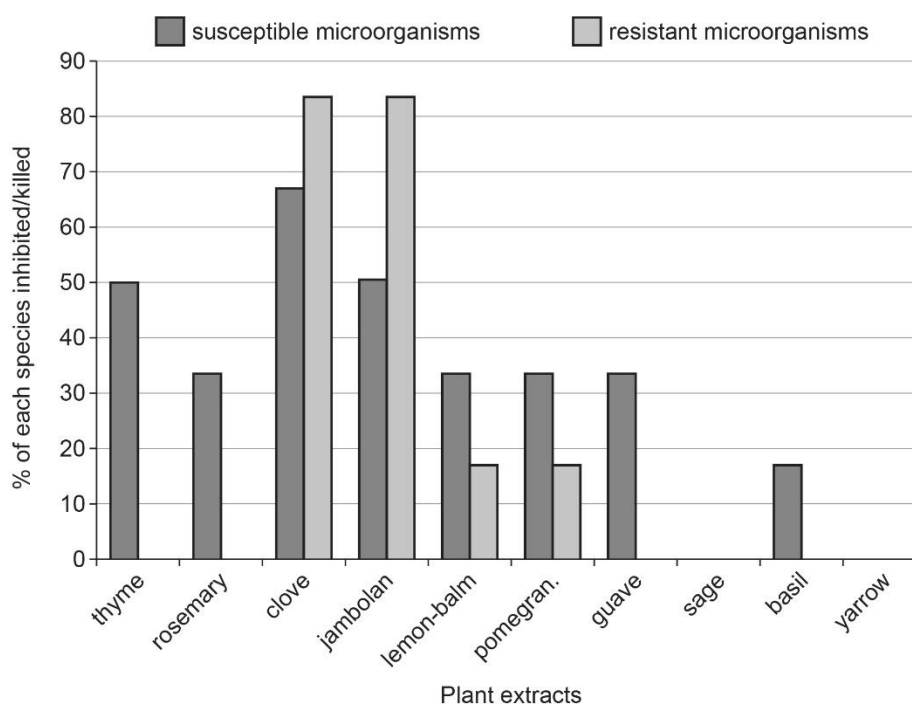
## 14 Scenario

Scientists studied the effectiveness of extracts from 10 different plants on 14 different pathogenic bacteria.

Some bacteria were susceptible to antibiotics and others had significant resistance.

The plant extracts were applied to the bacteria growing on agar plates, followed by examination to see if the bacteria had been inhibited.

The graph below shows their results.



**14 (a)** The scientists realised that each of the plant extracts contained a variety of molecules.

Identify a procedure the scientists could use to separate these.

**[1 mark]**

AO1 = 1 mark

AP reference = B.2.27

### Answer

Award a **maximum** of **one** mark for a valid procedure:

- thin layer chromatography (1)
- gas chromatography. (1)

**14 (b)** Give **two** reasons why clove extract may be the **most** effective against pathogenic bacteria.

**[2 marks]**

AO2 = 2 marks

AP reference = B2.13.0.1 and B2.14.0.1

### Answer

Award **one** mark for each valid explanatory point, up to a **maximum** of **two** marks:

- it has the joint highest inhibition/killing percentage for resistant bacteria (1)
- it has the highest inhibition/killing percentage for susceptible bacteria. (1)

**14 (c)** A student studied the results shown on the chart given in the scenario at the beginning of this question.

The student concluded that:

- some plant extracts are effective against pathogenic bacteria and could be used in the control of infection and disease
- sage and yarrow extracts were not effective.

Evaluate the student's conclusions. Use information from the scenario to support your answer.

Your response should demonstrate reasoned judgements and/or conclusions.

**[9 marks plus 3 marks for QWC]**

AO1 = 3 marks

AO2 = 3 marks

AO3 = 3 marks

QWC = 3 marks

AP reference = B.1.24.0.1, B1.1, B.2.14.0.1, B.2.14.0.2, B.2.14.0.3, B12.14.0.4, B.2.14.0.5 and B.1.27

This is a band marked question.

Band	Mark	Descriptor
3	7–9	<b>AO3</b> Evaluation of the student's conclusions in relation to how effective plant extracts are against pathogenic bacteria is <b>comprehensive</b> , <b>effective</b> , and <b>relevant</b> , showing <b>detailed</b> understanding and <b>logical</b> and <b>coherent</b> chains of reasoning throughout. Makes informed conclusions that are fully supported with rational and balanced reasoned judgements are included.

		<p><b>AO2</b> Applied all <b>relevant</b> knowledge of how to interpret the results to evaluate the student's conclusions in this scenario and is <b>highly appropriate</b> and shows a <b>detailed</b> functional understanding of the scientific methodology involved.</p> <p><b>AO1</b> A <b>wide range</b> of relevant knowledge and understanding of infection in this context is demonstrated, which is <b>accurate</b> and <b>detailed</b>. A <b>wide range</b> of <b>appropriate</b> technical terms are used.</p>
2	4–6	<p><b>AO3</b> Evaluation of student's conclusions in relation to how effective plant extracts are against pathogenic bacteria is <b>in most parts effective</b> and <b>mostly relevant</b>, showing <b>mostly logical and coherent</b> chains of reasoning. Given conclusions supported by reasoned judgements that consider <b>most</b> of the relevant arguments.</p> <p><b>AO2</b> Applied <b>mostly relevant</b> knowledge to evaluate the student's conclusions in how to interpret the results in this scenario is <b>in most parts appropriate</b>, showing <b>some</b> functional understanding of the scientific methodology involved.</p> <p><b>AO1</b> Knowledge and understanding of infection in this context <b>are in most parts clear</b> and <b>mostly accurate</b>, although on occasion <b>may lose</b> focus.</p>
1	1–3	<p><b>AO3</b> Evaluation of student's conclusions in relation to how effective plant extracts are against pathogenic bacteria is in <b>some parts effective</b> and of <b>some relevance</b>, with some understanding and reasoning taking the form of <b>generic statements</b> with some development. Judgements are <b>basic</b> and <b>brief</b>; conclusions will have <b>limited</b> rationality and balance.</p> <p><b>AO2</b> Applied <b>limited</b> knowledge of how to interpret the results in order to evaluate the student's conclusions in this scenario and may show a lack of functional understanding of the scientific methodology involved.</p> <p><b>AO1</b> Knowledge and understanding of infection in this context show <b>some</b> but <b>limited</b> accuracy, focus and relevance.</p>
	0	No creditworthy material

### Indicative content

**AO1 and AO2 will be implicit through the level of evaluation and reasoned judgements/and or conclusions that the student provides.**

### **(AO1) References to infection.**

- An infection is caused by an organism replicating inside the body.
- Infections can spread through populations.

- Infections can be caused by organisms other than bacteria, (such as fungi, prions, protists, and viruses).

### **(AO2) Application of knowledge**

- The results only investigate the effect of the extracts on bacteria.
- The investigation does not consider how infection can spread through a population.
- All the plant extracts showed variable levels of inhibition, with the exception of sage and yarrow.
- Clove, 38ambolana, lemon balm and pomegranate showed some inhibition of both susceptible and resistant bacteria.
- Thyme, rosemary, guava and basil showed some inhibition of susceptible bacteria only.
- Clove and 38ambolana showed the highest rate of inhibition of resistant bacteria.
- Clove showed the highest amount of inhibition of susceptible bacteria.
- None of the plant extracts were 100% effective against any of the bacterial species.
- The amount of inhibition of resistant organisms shown by clove and 38ambolana was almost 5x the amount shown by lemon balm and pomegranate.
- There is no evidence to show that the plant extracts have undergone clinical trials (to see if they can be tolerated by the human body/are toxic to the human body/have serious side effects).
- The results show the % of bacteria inhibited/killed by the plant extracts; they do not give any indication whether the level of inhibition was clinically significant (the level may not be sufficient to merit the extracts being used as a treatment).
- The student stated “sage and yarrow were not effective” this is not supported (by this investigation), as only 14 species were investigated, there may be other susceptible pathogenic bacteria.
- The student did not recognise that there is no evidence shown to suggest whether the scientists used (positive or negative) controls to check that any inhibition/killing of bacteria was due to the plant extracts (and no other factors).
- There is no evidence that the results have been peer assessed to establish their validity and reliability.

### **(AO3) Reasoned judgments/conclusions**

- There are a huge range of pathogenic bacteria, only 14 were tested, others may not be affected.
- As the investigation does not consider how infection can spread throughout a population, the conclusion is not supported.
- As infections caused by organisms other than bacteria are not considered, the conclusion is not supported.
- The results indicate that some extracts may be useful in treating bacterial disease. However, this investigation took place in an artificial lab environment (in vitro), the extracts may not work in the human body (in vivo) in the same way (this does not support the student's conclusions).
- There is no evidence to show that the plant extracts have undergone clinical trials to investigate their effectiveness in the human body (this does not support the student's conclusions).
- The results show some extracts are effective against a range of susceptible and antibiotic

resistant bacteria. However, clinical trials are required before any conclusions can be reached about their usefulness in treating bacterial disease. (this does not support the student's conclusions).

- A complete understanding of the scientist's methodology would be required to ensure that the results were reliable, accurate and reproducible before any conclusions could begin to be reached.

**Accept any other suitable response.**

### **QWC mark scheme**

<b>Mark</b>	<b>Descriptor</b>
3	The answer is clearly expressed and well-structured. The rules of grammar are used with effective control of meaning overall. A wide range of appropriate technical terms is used effectively.
2	The answer is generally clearly expressed and sufficiently structured. The rules of grammar are used with general control of meaning overall. A good range of appropriate technical terms is used effectively.
1	The answer lacks some clarity and is generally poorly structured. The rules of grammar are used with some control of meaning and any errors do not significantly hinder the overall meaning. A limited range of appropriate technical terms is used effectively.
0	There is no answer written or none of the material presented is creditworthy. <b>Or</b> The answer does not reach the threshold performance level. The answer is fragmented and unstructured, with inappropriate use of technical terms. The errors in grammar severely hinder the overall meaning.

## Assessment Objective Grid

### Section A Biology

Question Number	AO1	AO2	AO3	Maths	QWC	Total
1 (a) (i)	1					1
1 (a) (ii)	1					1
1 (b)	2					2
1 (c)	2					2
2 (a)		2				2
2 (b)		2				2
2 (c)	1	2				3
2 (d)			4			4
2 (e)	1	1				2
3 (a) (i)	4					4
3 (a) (ii)		1		(1)		1
3 (b)		2		(2)		2
3 (c)	2					2
4	1		4			5
5	4	4	4		3	15
<b>Total</b>	<b>19</b>	<b>14</b>	<b>12</b>	<b>(3)</b>	<b>3</b>	<b>48</b>
<b>Totals required</b>	<b>17–22 marks</b>	<b>11–16 marks</b>	<b>11–16 marks</b>	<b>8–10 across Sec A–C</b>	<b>3 marks</b>	<b>48 inc QWC</b>
<b>KiL</b>	<b>8</b>					

### Section B Chemistry

Question Number	AO1	AO2	AO3	Maths	QWC	Total
6 (a)		1				1
6 (b)		3		(3)		3
6 (c)		2		(2)		2
7 (a)		3		(3)		3
7 (b)	1	1		(2)		2
7 (c)		1		(1)		1
7 (d)			6			6
8	3	3	3		3	12
<b>Total</b>	<b>4</b>	<b>14</b>	<b>9</b>	<b>(11)</b>	<b>3</b>	<b>30</b>
<b>Totals required</b>	<b>3–7 marks</b>	<b>11–16 marks</b>	<b>6–11 marks</b>	<b>8–10 across Sec A–C</b>	<b>3 marks</b>	<b>30 inc QWC</b>



<b>KiL</b>	<b>0</b>					
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### Section C Physics

Question Number	AO1	AO2	AO3	Maths	QWC	Total
9 (a)		1				1
9 (b)	2	1				3
9 (c)		2				2
9 (d)			4			4
9 (e)	2					2
10	2	2	2			6
<b>Total</b>	<b>6</b>	<b>6</b>	<b>6</b>	<b>(2)</b>	<b>0</b>	<b>18</b>
<b>Totals required</b>	<b>3–7 marks</b>	<b>3–7 marks</b>	<b>3–7 marks</b>	<b>8–10 across Sec A–C</b>	<b>0</b>	<b>18 marks</b>
<b>KiL</b>	<b>2</b>					

### Section D Scientific Concepts

Question Number	AO1	AO2	AO3	Maths	QWC	Total
11		3				3
12		2				2
13			3			3
14 (a)	1					1
14 (b)		2				2
14 (c)	3	3	3		3	12
<b>Total</b>	<b>4</b>	<b>10</b>	<b>6</b>	<b>0</b>	<b>3</b>	<b>23</b>
<b>Totals required</b>	<b>3–7 marks</b>	<b>6–11 marks</b>	<b>6–11 marks</b>	<b>0</b>	<b>3 marks</b>	<b>23 inc QWC</b>
<b>KiL</b>	<b>1</b>					

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## Change History Record

Version	Description of change	Approval	Date of Issue
v1.0	Published.		2020
v1.1	NCFE rebrand.		September 2021