

T Level Technical Qualification in Health

Core knowledge and understanding

Paper B

Elements 12-13

Mark scheme

v1.1: Specimen assessment materials
22 November 2023
603/7066/X

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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) (AOs) and total marks 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 bands-based descriptors and indicative content.

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

The grids are broken down into bands, with each band having an associated descriptor indicating the performance at that band. You should determine the band 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 band, you should use a bottom-up approach. If the response meets all the descriptors in the lowest band, you should move to the next one, and so on, until the response matches the band 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 band 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 healthcare
- AO2: Apply knowledge and understanding of contexts, concepts, theories and principles in healthcare to different situations and contexts
- AO3: Analyse and evaluate information and issues related to contexts, concepts, theories and principles in healthcare 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: 42 marks plus 6 marks for quality of written communication (QWC)

1 Identify the organelle that is only present in plant cells.

- A Centrioles
- B Golgi apparatus
- C Large vacuole
- D Lysosomes

[1 mark]

AO1 = 1 mark

Award **one** mark for the following:

Answer

C: Large vacuole (1).

2 (a) Figure 1 shows some of the features of a microorganism.

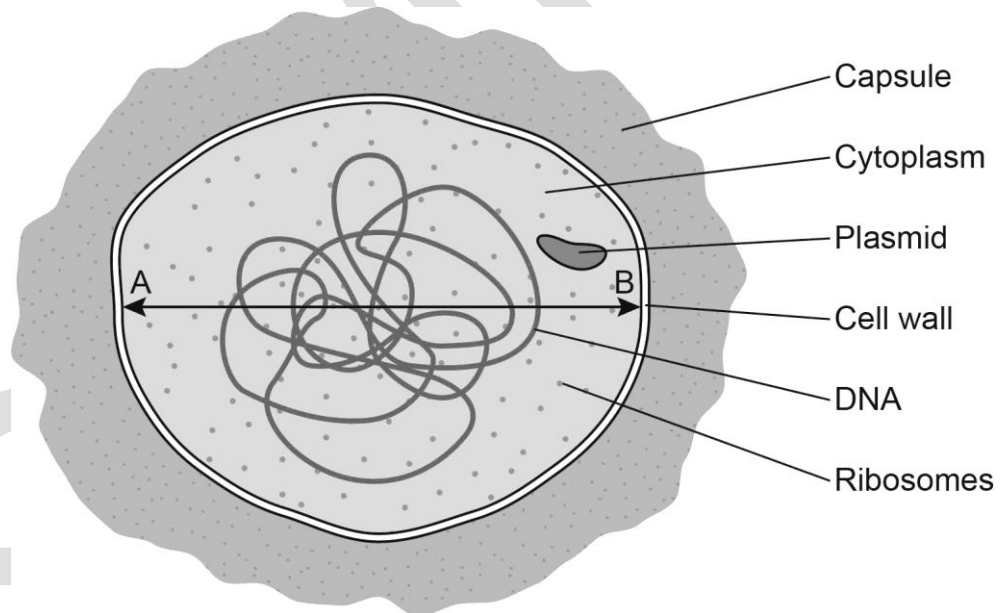


Figure 1: Features of a microorganism

Using the information in Figure 1, identify whether this is a prokaryotic or eukaryotic microorganism.

[1 mark]

AO1 = 1 mark

Award **one** mark for the correct type of organism:

- prokaryote (1).

2 (b) Using Figure 1, describe one feature which supports your answer.

[2 marks]

AO2 = 2 mark

Award **one** mark for descriptions of features, up to a maximum of **two** marks:

- Plasmids are present in figure one (1) which are only found in prokaryotes and not in eukaryotes (1).
- Prokaryotes have a capsule layer (1) whereas eukaryotes do not (1).

Accept any other appropriate responses.

2 (c) The distance between points A and B on Figure 1 is 90mm, the actual width of the cell is 2µm. Calculate the magnification used in the diagram where 1mm = 1000µm.

The equation used to calculate magnification is:

$$\text{magnification} = \frac{\text{size of image}}{\text{size of object}}$$

[2 marks]

AO2 = 2 marks

Award **one** method mark for the correct working:

- 90/0.002 (1)

Or

- 90,000/2 (1)

Award **one** mark for the correct answer.

- 45,000x (1).

Note: If only the correct answer is offered, award both marks as we can assume the correct method has been applied where only a single method has been used.

3(a) Alanine is an amino acid.

Two alanine molecules join to form a dipeptide.

Give the name of the reaction which results in the formation of a dipeptide.

[1 mark]

AO1 = 1 mark

Award **one** mark for giving the correct name of the reaction:

- condensation (reaction) (1).

Accept other appropriate responses.

3 (b) A student states that ‘the R group of an amino acid is more important than the amine or carboxyl group in producing different types of proteins.’

Evaluate this statement.

[3 marks]

AO3 = 3 marks

Award **one** mark for **each** evaluative point, up to a maximum of **three** marks:

- The R group determines the type of amino acid and is responsible for producing different types of proteins, which supports the statement (1). However, as the carboxyl group and amine group are essential in the formation of peptide bonds, there can be no proteins formed at all without them, which does not support the statement (1). Overall, the statement is not correct because though the R group in the amino acid is important, it can't be considered more important than the amine or carboxyl group as all are needed to form proteins (1).
- The carboxyl group is the same in all amino acids, so it does not play any part in creating different types of protein, which supports the statement (1). However, without the carboxyl group, no proteins would be formed (1). In conclusion, the statement is largely correct because the R group of the amino acid is responsible for producing different types of proteins (1).

Accept other appropriate responses.

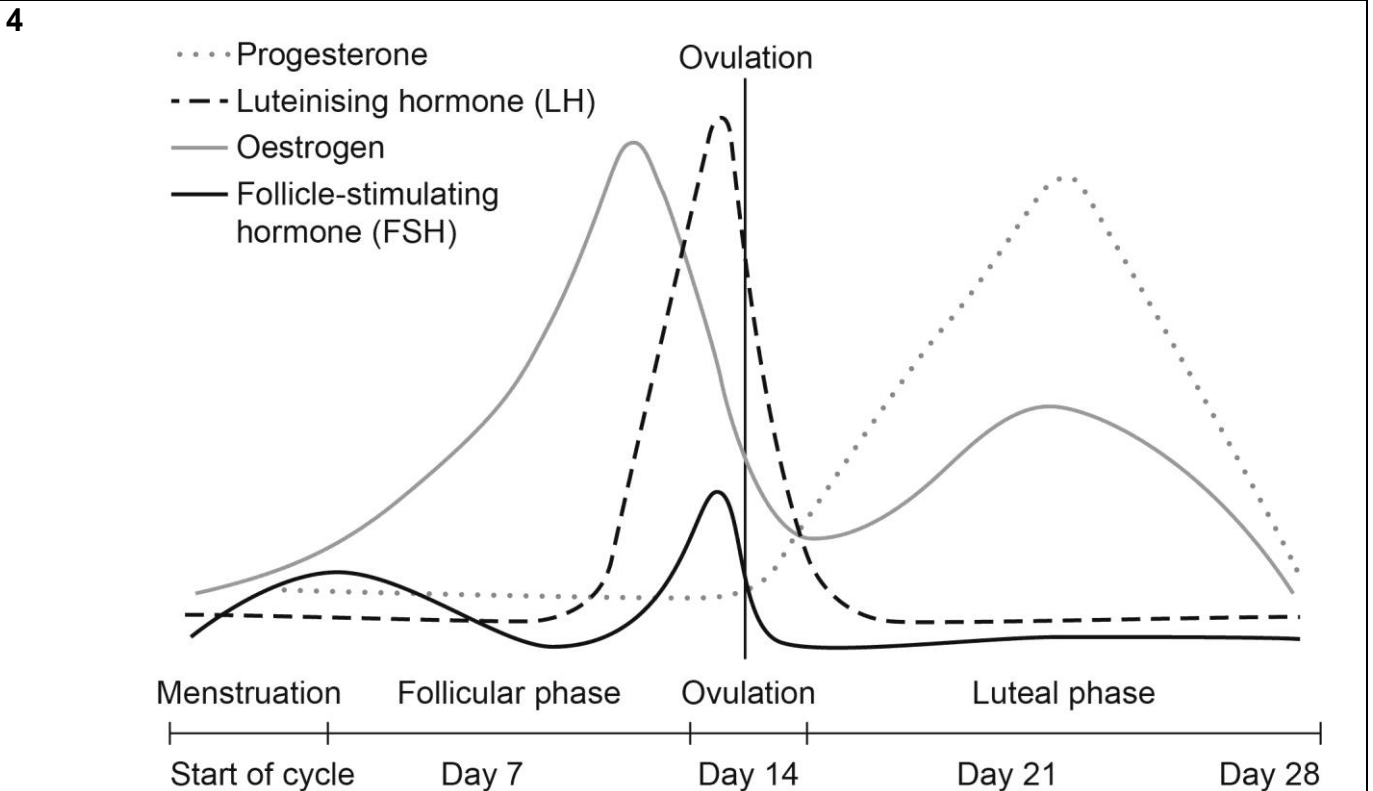


Figure 2: **Hormone levels during a menstrual cycle.**

A student studying Figure 2 made the following conclusion:

- **FSH inhibits oestrogen production and high levels of FSH cause ovulation.**

Evaluate to what extent this conclusion can be supported.

Use the information provided in Figure 2 to support your answer.

[5 marks]

AO3 = 5 marks

Award **one** mark for **each** correct evaluative point, up to a maximum of **five** marks.

- According to the data oestrogen levels appear highest when FSH levels are lowest which supports the conclusion that FSH inhibits oestrogen production (1).
- Similarly, FSH levels are highest just before ovulation, which supports the conclusion (1).
- Oestrogen levels reach a second peak during the luteal phase when FSH levels are low which supports the conclusion (1).
- As LH levels reach a peak at the same time as FSH levels this supports the conclusion (1).
- As ovulation occurs just after FSH levels have reached their highest level / peak, this does support the student's conclusions (1).
- As oestrogen levels reach a peak while FSH levels are at their lowest, this does support the student's conclusions (1).

- As oestrogen levels begin to rise at the same time as FSH levels rise at the start of the cycle, this suggests that FSH does not inhibit oestrogen production and that the conclusion is unsupported / incorrect (1).
- As LH levels reach a much higher peak than FSH levels, it suggests that LH may play a greater role in causing ovulation, which does not support the conclusion (1).
- As LH levels also reach a peak at the same time as FSH levels, LH may cause ovulation (1).
- In conclusion, the results shown are inconclusive as there is conflicting evidence regarding whether FSH inhibits oestrogen production and high levels of FSH cause ovulation. Further testing would need to be carried out to establish a solid link.

Accept any other appropriate response.

5 (a) Asthma is a condition that affects the airways of the lungs.

During an asthma attack the muscles in the bronchiole walls contract and excess mucus is secreted. Severe asthma attacks can significantly reduce blood oxygen levels.

Explain two reasons severe asthma attacks can cause a reduction in blood oxygen levels.

[4 marks]

AO2 = 4 marks

Award **one** mark for **each** explanatory point up to a maximum of **four** marks.

- Contraction of bronchiole muscles will reduce the diameter of the bronchioles (1) and restrict airflow into the alveoli (1).
- Secretion of excess mucus will reduce airflow into the alveoli (1) which will result in reduced gas exchange with the blood (1).
- Reduced airflow to the alveoli (1) will reduce the surface area available for gas exchange (1).
- Reduced gas exchange with the blood (1) will result in less oxygen entering the blood and therefore oxygen levels fall (1).

Award any other appropriate response.

5 (b) Inhalers that deliver medication directly into the lungs are regularly prescribed to patients suffering from asthma. One type of medication used in inhalers are muscle relaxants.

Suggest how this medication can stop an asthma attack.

[2 marks]

AO2 = 2 marks

Award **one** mark for each part of a suggestion up to a maximum of **two** marks.

- The muscle relaxant / inhaler causes the muscles of the bronchioles to relax (1) which increases airflow (to the alveoli) (1).
- The bronchiole muscles relax after use of the inhaler (1) and airflow to the alveoli increases the surface area for gas exchange (1).
- The relaxant medication allows airflow to the alveoli to increase the surface area for gas exchange (1) which allows more oxygen to enter the blood (1).

Award any other appropriate response.

6 Figure 3 shows the deaths caused by chronic obstructive pulmonary disorder (COPD) per 100 000 deaths in three areas of the United Kingdom.

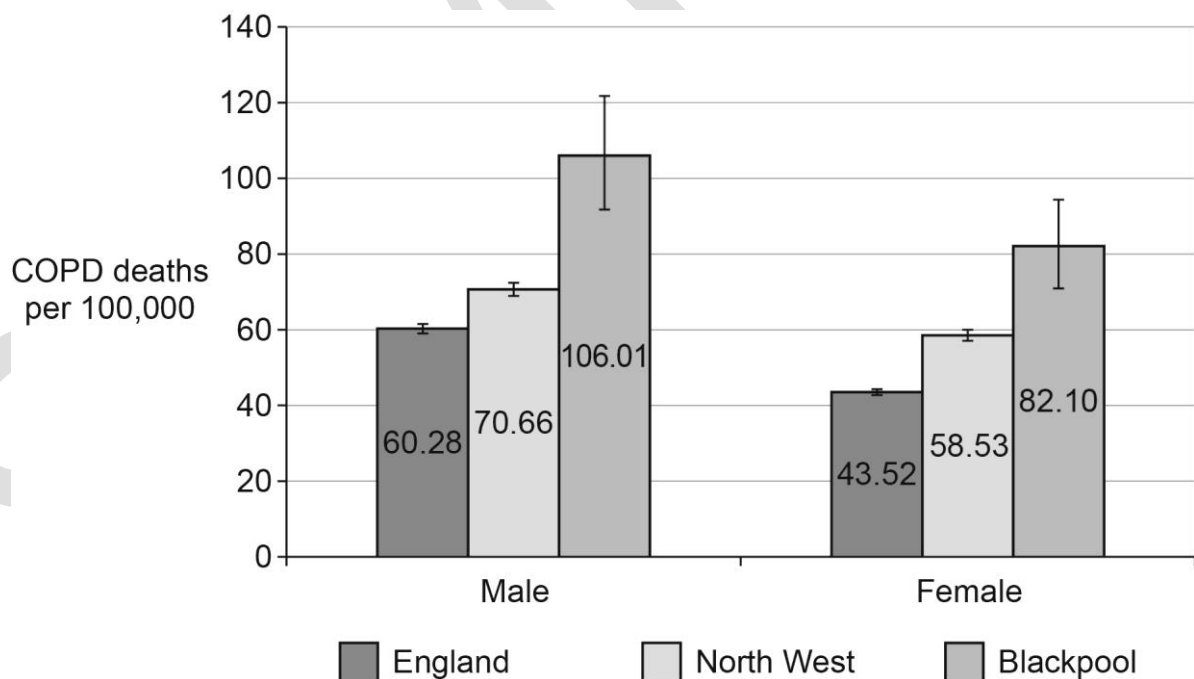


Figure 3: COPD deaths per 100 000

The data was obtained from GP records of patients who were being treated for COPD and was collected between 2017 and 2019.

A trainee data scientist analysed the data shown in Figure 3 and made the following conclusions:

- the deaths caused by COPD were overall significantly higher for males than females in all areas
- the deaths caused by COPD in Blackpool were significantly higher than the other areas in both males and females
- females in Blackpool are almost twice as likely to die from COPD as females in England
- the higher number of deaths caused by COPD in Blackpool may be linked to high levels of air pollution in Blackpool.

Using your knowledge and understanding of COPD, evaluate the accuracy of the trainee data scientist’s conclusions.

[9 marks, plus 3 marks for QWC]

AO1 = 3 marks
 AO2 = 3 marks
 AO3 = 3 marks
 QWC = 3 marks

Band	Mark	Descriptor
3	7–9	<p>AO3 - Evaluation of the extent to which the data supports the conclusions is comprehensive, effective, and relevant, showing detailed understanding and logical and coherent chains of reasoning throughout. Makes informed conclusions that are fully supported with rational and balanced reasoned judgements.</p> <p>AO2 - Applied all relevant knowledge of COPD and interpretation of data effectively. Application is highly appropriate and shows a detailed functional understanding.</p> <p>AO1 - A wide range of relevant knowledge and understanding of COPD and data interpretation, which is accurate and detailed, is evident. A wide range of appropriate technical terms are used.</p>
2	4–6	<p>AO3 - Evaluation of the extent to which the results support the conclusions is in most parts effective and mostly relevant, showing mostly logical and coherent chains of reasoning. Conclusions supported by reasoned judgements that consider most of the relevant arguments.</p> <p>AO2 - Applied mostly relevant knowledge of COPD and interpretation of data. Application is in most parts appropriate, showing some functional understanding.</p> <p>AO1 - Knowledge and understanding of COPD and interpretation of data is in most parts clear and mostly accurate, although on occasion may lose focus. A range of mostly appropriate technical terms are used.</p>

Band	Mark	Descriptor
1	1–3	<p>AO3 - Evaluation of the extent to which the results support the conclusions is in some parts effective and of some relevance, with some understanding and reasoning taking the form of generic statements with some development. Judgements are basic and brief; conclusions will have limited rationality and balance.</p> <p>AO2 - Applied limited knowledge of COPD and interpretation of data. Application may show a lack of functional understanding.</p> <p>AO1 - Knowledge and understanding of COPD and interpretation of data shows some but limited accuracy, focus and relevance. A limited range of appropriate technical terms are used.</p>
	0	No creditworthy material.

Indicative content

Examiners are reminded that 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.

AO1 and AO2 may be implicit through the level of analysis and reasoned judgements and conclusions that the student provides.

AO1 Knowledge and understanding of COPD and interpretation of data may include:

- COPD is a disease which affects the lungs and reduces oxygen exchange at the alveoli
- COPD symptoms including wheezing, chest tightness, chronic coughing
- COPD is a collection of different lung disease (chronic bronchitis, emphysema)
- COPD can be treated but not cured
- COPD is mainly caused by smoking
- a small percentage of COPD cases can be caused by air pollution.

AO2 Application of knowledge and understanding of COPD and interpretation of the data may include:

- there is no data provided on levels of air pollution in any of the areas / there is no data to suggest that the levels of air pollution are higher in Blackpool than in the other areas
- the number of deaths caused by COPD per 100 000 deaths is higher in all areas for males than females
- the error bars for males and females in Blackpool overlap
- the error bars for males and females in England do not overlap
- the error bars for males and females in the north west do not overlap
- the number of female deaths caused by COPD per 100 000 deaths in Blackpool was 82.1
- the number of female deaths caused by COPD per 100 000 deaths in England was 43.52
- the error bars for female deaths caused by COPD per 100 000 deaths in Blackpool and in England do not overlap

- the information only has data from patients who were being treated for COPD / the information does not contain data for patients who have not been diagnosed with COPD

A03 Evaluation of the conclusion may include:

- as there is no data provided on levels of air pollution in Blackpool it is not possible to conclude that it is the cause of the increased number of deaths in Blackpool, which does not support the conclusion
- as the main cause of COPD is smoking it is unlikely that increased air pollution is the cause of the increased number of deaths in Blackpool which does not support the fourth conclusion
- although the number of deaths caused by COPD per 100 000 deaths, appears to be higher in all areas for males than females, as the error bars for males and females overlap for Blackpool, the difference in Blackpool is unlikely to be significant, which does not support the first conclusion
- as the error bars for males and females in England do not overlap, the higher number of male deaths is significant, which supports the first conclusion
- as the error bars for males and females in the north west do not overlap, the higher number of male deaths is significant, which supports the first conclusion
- the number of female deaths caused by COPD per 100 000 deaths in Blackpool was 82.1; this is almost twice as high as the 43.52 deaths in England, as the error bars do not overlap the difference is significant - this supports the third conclusion.
- however, as the trainee data scientist concluded that females were almost twice as likely to die from COPD, this cannot be fully supported as it is projecting the data into the future
- as the data does not contain any figures from patients who have not been diagnosed with COPD, the reliability of the data is reduced and does not support the conclusions made.

Accept any other appropriate responses.

Quality of written communication (QWC) = 3 marks

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. Or 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.

7 Vaccines are designed to prevent infection or reduce the seriousness of infection by a specific microorganism.

Most vaccines contain some form of antigen from the microorganism, which is introduced into the body, stimulating immunity to the microorganism.

Vaccines take a long time to develop, are expensive and most vaccines are likely to cause side effects in some people.

Symptoms of the ‘common cold’ can be caused by over 200 different viruses, many of which are closely related. Frequent spontaneous changes in the viral DNA or RNA sequence can lead to considerable genetic variation of these viruses.

‘It is unlikely that a vaccine against the common cold will be produced for the reasons provided above.’

Using your knowledge and understanding of the human immune system, evaluate this statement.

[12 marks, plus 3 marks for QWC]

AO1 = 4 marks
AO2 = 4 marks
AO3 = 4 marks
QWC = 3 marks

Band	Mark	Descriptor
4	10–12	<p>AO3 - Evaluation of the statement is comprehensive, effective, and relevant, showing logical and coherent chains of reasoning throughout. Analysis of the information provided relating to the common cold and vaccines is used to effectively.</p> <p>AO2 - Applied all relevant knowledge of the immune response to the given context effectively.</p> <p>AO1 - wide range of relevant knowledge and understanding of the immune response, which is accurate and detailed, is evident. A wide range of appropriate technical terms are used.</p> <p>The answer demonstrates comprehensive breadth and / or depth of understanding.</p>
3	7–9	<p>AO3 - Evaluation of the statement is in most parts effective and mostly relevant, showing in most parts logical and coherent chains of reasoning. Analysis of the information provided relating to the common cold and vaccines is used mostly effectively.</p> <p>AO2 - Applied mostly relevant knowledge of the immune response to the given context.</p>

		<p>AO1 - Knowledge and understanding of the information provided relating to the common cold and vaccines is in most parts clear and in most parts accurate, although on occasion may lose focus.</p> <p>The answer demonstrates reasonable breadth and / or depth of understanding, with occasional inaccuracies and / or omissions.</p>
2	4–6	<p>AO3 - Evaluation of the statement is in some parts effective but of limited relevance. Analysis of the information provided relating to the common cold and vaccines is sometimes used effectively.</p> <p>AO2 - Applied limited knowledge of the immune response to the given context.</p> <p>AO1 - Knowledge and understanding of the immune response shows some but limited accuracy, focus and relevance.</p> <p>The answer is basic and shows limited breadth and / or depth of understanding, with inaccuracies and omissions.</p>
1	1–3	<p>AO3 - Evaluation of the statement is minimal and very limited in effectiveness and relevance. Analysis of the information provided relating to the common cold and vaccines is ineffective and minimal.</p> <p>AO2 - Applied very limited knowledge of the immune system to the given context.</p> <p>AO1 - Knowledge and understanding of the immune system shows very minimal accuracy, focus and relevance.</p> <p>The answer has isolated points, showing very minimal breadth and / or depth of understanding, with significant inaccuracies and omissions</p>
	0	No creditworthy material.

Indicative content

Examiners are reminded that 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.

AO1 and AO2 may be implicit through the level of analysis and reasoned judgements and conclusions that the student provides.

AO1 Knowledge and understanding of the immune system may include:

- antigens are chemical markers on the surface of cells and microorganisms
- the body can recognise its self-antigens / its own antigens
- the body can recognise non-self-antigens

- T cells and B cells / lymphocytes in the body are activated by the non-self-antigens of microorganisms which enter the body
- non-self-antigens lead to an immune response
- activation of T cells leads to the cell mediated response
- activation of B cells leads to the antibody mediated response
- antibodies are proteins produced in response to an antigen and are specific to that antigen
- antibodies will counteract the microorganism which has the specific antigen
- both the cell mediated, and the antibody mediated response leads to death of the microorganism
- activated T and B cells lead to the production of memory cells
- memory cells lead to a more rapid response if they encounter the antigen again
- memory cells lead to a stronger response if they encounter the antigen again
- a more rapid and stronger response to antigen can perhaps prevent a second infection.

AO2 Application of knowledge and understanding of the immune system may include:

- genetic variation within each common cold virus may lead to changes in the antigens of the virus, making the development of an effective vaccine very difficult
- if the antigen of a virus changes the memory cells may not recognise / respond to it and infection will still occur
- 200 different viruses will have 200 types of antigens making the development of an effective vaccine very difficult
- the side effects of any vaccine must be considered against the benefits of the vaccine
- as people encounter different common cold viruses, they will develop some immunity naturally.

AO3 Evaluation of the statement may include:

- as introduction of the antigen to a common cold virus would cause an immune response, the development of a vaccine is possible
- as there are over 200 different common cold viruses, this may therefore require over 200 different vaccines
- the development of 200 different vaccines is likely to be far too expensive and time consuming to carry out
- vaccination would require patients to receive many different vaccines which would cause huge logistical problems
- as the common cold is not normally a serious disease it is not a priority for the development of a vaccine
- as there are many diseases that are much more serious than the common cold, development of vaccines to these diseases will take priority
- as the common cold is not normally a serious disease, the risk from any possible side effects may well outweigh the benefits of a vaccine
- as many of the common cold viruses are closely related, they may have very similar antigens, therefore one vaccine may work for several types of viruses
- as immunity to the common cold virus develops naturally throughout a person's life there is less need for the development of a vaccine
- as the DNA or RNA of common cold viruses can undergo frequent spontaneous changes which could change the antigen, this is likely to lessen the effectiveness of any vaccine

- as many antivaccination groups have developed in recent years this may put pressure on people not to be vaccinated
- as misinformation about a vaccine may be rapidly spread through the population, this may cause people to be reluctant to be vaccinated.

Accept other appropriate responses.

Quality of written communication (QWC) = 3 marks

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. Or 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: 20 marks plus 3 marks for
quality of written communication (QWC)**

8 Identify the standard international (SI) unit used for temperature.

- A Celsius (C)**
- B Fahrenheit (F)**
- C Kelvin (K)**
- D Rankine (R)**

[1 mark]

AO1 = 1 mark

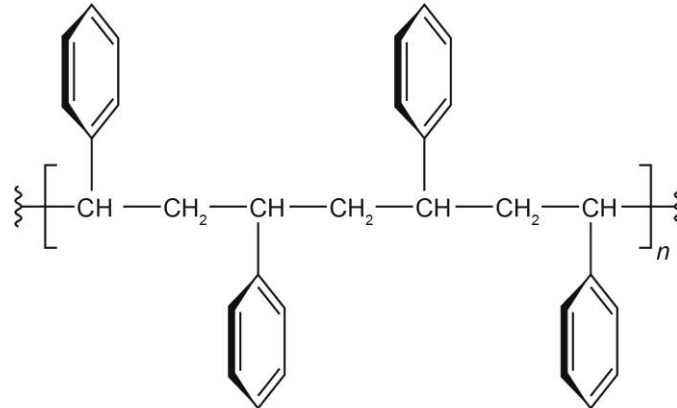
Award **one** mark for:

Answer

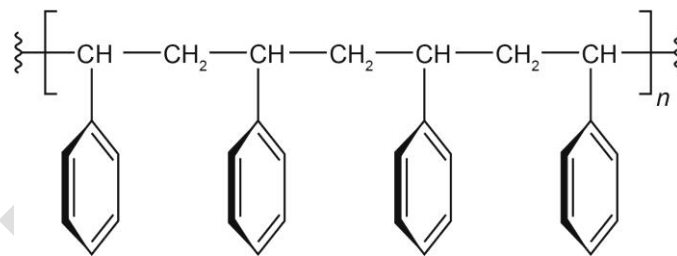
C. Kelvin (K) (1)

9 Polystyrene is a polymer often used in the manufacture of packaging for drugs and as a container for serum and blood tubes.

Two general structures of polystyrene are displayed below along with their melting points.



Structure 'A'
270°C



Structure 'B'
240°C

Figure 4: Two general structures of polystyrene

9 (a) Explain how we know polystyrene is a polymer.

[1 mark]

AO1 = 1 mark

Award **one** mark for a correct explanation.

- Each structure is a long chain molecule with forces or bonds between the chains (1).
- Each structures' repeating unit contains exactly the same amount of hydrogen (H) and carbon (C) atoms chemically bonded in the same manner (1).

Award any other appropriate response.

9 (b) Give one reason why polymers are useful in packaging for drugs and as a container for serum and blood tubes.

[1 mark]

AO1 = 1 mark

Award **one** mark for a correct reason given:

- polymers are strong (1)
- polymers are chemically unreactive (1).

Award any other appropriate response.

9 (c) Explain why structure 'A' has a higher relative strength (or melting point) than that of structure 'B'.

[2 marks]

AO2 = 2 marks

Award **one** mark for **each** part of a correct explanation, up to a maximum of **two** marks.

- The (relative) strength (or melting points) is indicative of bonds / forces or equivalent (1) thus implying stronger / more bonds / forces are present in structure A (1).
- Structure 'B' cannot join with other molecules as easily as the rings are all facing each other in figure 4 (1), this reducing any possible interactions with other structures (1).

Award any other appropriate response.

- 10** Typically, polystyrene is produced by polymerisation of styrene (C_8H_8) with an excess of acid (H^+), such as sulphuric acid (H_2SO_4). The first step of polymerisation is depicted below:

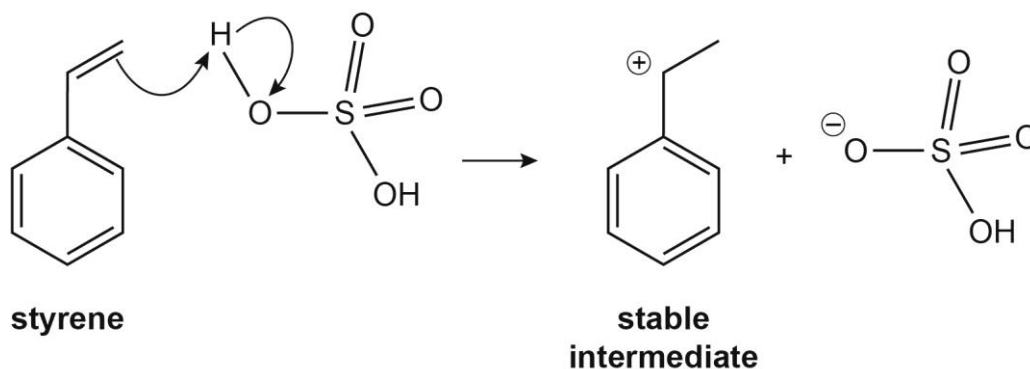


Figure 5: First step of styrene polymerisation producing an intermediate

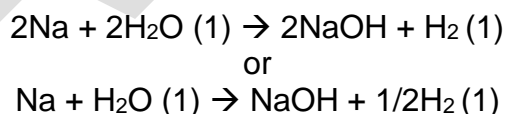
The reaction is stopped by adding a suitable base such as sodium hydroxide (NaOH).

Sodium hydroxide is formed by reacting sodium (Na) with water (H_2O), producing hydrogen gas (H_2).

- 10** Give the balanced symbol equation for this reaction.
(a)

AO2 = 2 marks

Award **one** mark for correctly arranging the pre-reaction formula in any of the following expressions and **one** further mark for the correct corresponding part post-reaction:



- 10 (b)** With reference to Figure 5, suggest why NaOH is used in excess of H_2SO_4 .
[2 marks]

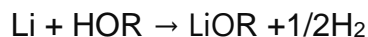
AO2 = 2 marks

Award **one** mark for each part of a correct suggestion, up to a maximum of **two** marks:

- NaOH is used in excess to that of H_2SO_4 to ensure all unreacted acid in the starting materials and products of Figure 5 is neutralised (1) thus stopping the reaction (1)

Award any other appropriate response.

- 11** The alkali metal lithium (Li) is often incorporated into pharmaceutical compounds. Its reaction with a pharmaceutical compound is shown below:



When scientists perform this reaction with the heavier group 1 metals sodium (Na) and potassium (K), they observe the following reaction rates:

Metal	Rate (gs ⁻¹)
Li	0.01
Na	0.23
K	0.40

Table 1: Rates of reaction for scheme depicted above, where gs⁻¹ = grams per second.

A scientist makes the following statement:

‘Using potassium (K) as the metal is the best course of action as it reacts the fastest.’

Using your understanding of rates of reaction, analyse to what extent the scientist is correct.

AO3 = 3 marks

Award **one** mark for **each** analysis point, up to a maximum of **three** marks.

- The scientist’s observation maybe completely correct as potassium (K) does react the quickest and this would improve reaction efficiency on larger scales, which supports the statement. (1).
- Additionally, there is no information regarding reaction conditions such as temperature, and this could be potentially experimented with to improve reaction rates for lithium (Li) and sodium (Na), so the scientist may not be completely accurate in their conclusion (1).
- Furthermore, the scientist’s statement may not have considered the use of a catalyst which maybe a safer more efficient approach to the reaction, and so the scientist’s conclusion may not be complete in terms of achieving the best reaction (1).
- However, there is no data regarding conversion rates (yields). For instance, whilst potassium reacts the quickest, it may produce the lowest yields which means the scientist may not have suggested the best course of action, which does not support the statement. (1)

Accept any other appropriate response.

12 A company that manufactures hand sanitiser uses ethanol as their main disinfectant. Ethanol can be produced via the hydrolysis of esters. The chemical process of which is detailed below:



A scientist in a laboratory conducts experiments on this type of reaction using different conditions. They obtain the following results:

Reaction conditions	% Yield of product (ethanol)	Rate of reaction (gs ⁻¹)
Room temperature (20 °C)	55	1.43
100 °C	65	1.55
Room temperature with catalyst	67	1.89

Table 2: Results from three different conditions of hydrolysis reaction, where gs⁻¹ = grams per second.

The scientist then makes the following conclusions:

- heat or a catalyst improves the overall product yield compared to that of normal conditions
- catalysts have a greater effect on the rate of reaction to that of increased temperatures.

Evaluate the scientist's conclusions.

[9 marks, plus 3 marks for QWC]

AO1 = 3 marks
 AO2 = 3 marks
 AO3 = 3 marks
 QWC = 3 marks

Band	Mark	Descriptor
3	7–9	<p>AO3: Evaluation of the scientist's conclusions in relation to catalysis and heat is comprehensive, effective, and relevant, showing detailed understanding and logical and coherent chains of reasoning throughout.</p> <p>AO2: Applied relevant knowledge of how both heat and catalysts affect this particular reaction. Shows a detailed functional understanding of the scientific mechanics involved.</p> <p>AO1: Demonstrates a wide range of relevant knowledge and understanding of catalysts and temperature effects on a reaction which is accurate and detailed.</p>

		The answer demonstrates comprehensive breadth and / or depth of understanding.
2	4–6	<p>AO3: Evaluation of the scientist’s conclusions is in most parts effective and mostly relevant, showing mostly logical and coherent chains of reasoning.</p> <p>AO2: Applied mostly relevant knowledge of how catalysts and temperature effect this reaction is in most parts appropriate, showing some functional understanding of the scientific mechanics involved.</p> <p>AO1: Knowledge and understanding of reaction conditions in this context are in most parts clear and mostly accurate, although on occasion may lose focus.</p> <p>The answer demonstrates reasonable breadth and / or depth of understanding, with occasional inaccuracies and / or omissions.</p>
1	1–3	<p>AO3: Evaluation of the scientist’s conclusions is in some parts effective and of some relevance, with some understanding and reasoning taking the form of generic statements with some development.</p> <p>AO2: Applied limited knowledge of how heat and temperature can be used to affect this reaction and may show a lack of functional understanding of the scientific mechanics involved.</p> <p>AO1: Knowledge and understanding of heat and catalysis in this context shows some but limited accuracy, focus and relevance.</p> <p>The answer is basic and shows limited breadth and / or depth of understanding, with inaccuracies and omissions.</p>
	0	No creditworthy material.

Indicative content

Examiners are reminded that 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.

AO1 and AO2 may be implicit through the level of analysis and reasoned judgements and conclusions that the student provides.

AO1 Knowledge and understanding of heat and catalysis in this context may include:

- catalysts are substances that increase the rate of a chemical reaction without themselves being permanently chemically changed
- an increase in temperature makes molecules move faster, resulting in increased collisions and rates of reaction
- lower temperatures result in decreased collisions and rates of reaction

- for a reaction to occur, molecules must collide with enough energy to break and reform bonds
- molecules must collide in the correct spatial orientation

AO2 Application of knowledge and understanding of how heat and temperature affect this reaction may include:

- In terms of reaction rates and activation energy, catalysts affect reactions
- the catalyst increases the rates of reaction by lowering the activation energy for this reaction to occur - table 2 shows an increase in reaction rate compared to room temperature without a catalyst, thus validating this point
- reaction temperatures do not need to be increased with the aid of catalyst; this is evidenced by the larger difference between a temperature increase without a catalyst to that of room temperature with a catalyst in table 2
- yields are slightly improved as the reaction is assisted towards the products with the aid of either increased temperatures and / or a catalyst – this is due to lowered activation energies; this is evidenced by the similar and improved yields obtained for a temperature increase and the use of a catalyst at room temperature indicated in table 2.

AO3 Evaluation of the conclusion may include:

- Based on table 2, both heat and the catalyst increase the % yield of ethanol compared to that of normal conditions, which supports the scientist's conclusion. This is supported by the increased reaction rate that also results from using a higher temperature and / or a catalyst.
- This is because an increase in temperature, increases the rate of reaction by increasing the speeds of molecules, resulting in more successful collisions between molecules (ethyl acetate and sodium hydroxide) leading to a higher % yield of ethanol.
- The use of catalyst increases the rate of reaction by lowering the activation energy which results in more successful collisions between molecules (ethyl acetate and sodium hydroxide) leading to a higher % yield of ethanol.
- According to table 2, the use of a catalyst does have a greater effect on the rate of reaction as it increases to 1.89 gs^{-1} at room temperature compared to 1.55 gs^{-1} at the higher temperature of $100 \text{ }^{\circ}\text{C}$; this does support the scientist's second conclusion, however the increase in yield of ethanol is only 2% (67 compared to 65). Therefore, further investigations could be done using higher temperatures and the use of a catalyst.
- Increased reaction rate using a catalyst compared to higher temperatures would improve industrial efficiencies as well as reduce production costs.
- The near identical % yields of heat and a catalyst maybe due to the reaction producing other products apart from ethanol. Higher temperatures may also lead to degradation of the product thus reducing/impacting the yield.

Accept any other appropriate responses.

Quality of written communication (QWC) = 3 marks

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. Or 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: 20 marks plus 3 marks
for quality of written communication (QWC)**

13 Identify which of the following factors determine the force experienced by a magnetic material around a wire that is carrying an electric current.

- A The length of the wire
- B The strength of the current
- C The thickness of the wire
- D The weight of the particle

[1 mark]

AO1 = 1 mark

Award **one** mark for the following:

Answer

B. The strength of the current (1).

14 An experiment is set up whereby an alternating current of 5 A at 230 V with a frequency of 50 Hz is passed through a wire wrapped around an iron core. An iron ball bearing is placed in proximity to the magnet. Upon application of an electric field the iron ball moved towards the magnet.

The same experiment with a direct current at 1 A did not move the ball.

Based on these results, the scientist running the experiment states that only alternating currents can produce an electromagnetic field.

Analyse the scientist's prediction.

[3 marks]

AO3 = 3 marks

Award **one** mark for **each** of the analytic points, up to a maximum of **two** marks. Award **one** further mark for a conclusion.

- Any current passing through a wire (alternating current (AC) or direct current (DC)) will generate a magnetic field; the scientist is therefore wrong to suggest that only AC currents can generate electromagnets. It is more likely that a weaker electromagnetic field was generated from the second experiment at 1 A (1).
- The AC current will produce an electromagnetic field / electromagnet that rapidly changes direction / polarity and fluctuates in strength, which is proportional to the current, therefore, the second experiment should be run again at 5 A (1).
- In order for a direct comparison to be made all but one control should be the same; in this case the experiment should be ran using different currents, or with the same current at different electrical currents (A), frequencies (Hz) or power (V).
- As the ball itself is not magnetic, it will be attracted to either pole of the electromagnet and will therefore move towards the magnet (1).

Accept any other appropriate responses.

15 State the definition of a wave.

[1 mark]

AO1 = 1 mark

Award **one** mark for the correct definition:

- the transfer of energy, not matter (1).

Accept other appropriate responses.

16 Radium -223 is a radioactive isotope of radium.

152 g of radium-223 is placed in a test tube and left for 33 days.

The amount of radium-223 remaining in the sample is then measured and found to be only 19 g.

Calculate the half-life of radium-223. Show your working.

[2 marks]

AO2 = 2 marks

Award **one** mark for calculating the number of times the mass of radium-223 has halved:

$$152 \rightarrow 76 \rightarrow 38 \rightarrow 19 = 3 \text{ half lives}$$

Award **one** mark for the correct calculation of the half-life:

$$\text{half-life} = 33/3 = 11 \text{ days}$$

Note : Accept any other valid workings that calculate half-life =11

17 A 12 V battery discharges through a circuit with a resistance of 4.8 ohms.

Calculate the charge that passes through the circuit over a period of 60 seconds using the formula $I = V / R$ and $Q=IT$.

Show your working.

[4 marks]

AO2 = 4 marks

Award **one** mark for the correct method to calculation of the current:

$$I = 12/4.8$$

Award **one** mark for the correct answer:

$$I = 2.5 \text{ A}$$

Award **one** mark for the correct method to calculate the charge:

$$Q=It=2.5 \times 60=$$

Award **one** mark for the correct answer:

$$150 \text{ C}$$

18 A hospital radiographer is comparing the imaging techniques of CT and MRI being used to image the pelvis.

The doses of energy transferred to patients that receive each scan are measured and compared for the two techniques.

Scan type	Electromagnetic waves used to image	Scan duration (seconds)	Energy transferred to patient (J / kg)
CT	X-rays	30	0.008
MRI	Radio waves	1800	3000

Table 3: A table to show comparison between MRI and CT scans

These findings are shown in Table 3.

Based upon these observations, the radiographer concludes that CT scans are much safer, as despite X-rays being ionising, less electromagnetic radiation is transferred to the patient, and so should always be used instead of MRI.

Evaluate the radiographer's conclusion.

[9 marks, plus 3 marks for QWC]

AO1 = 3 marks

AO2 = 3 marks

AO3 = 3 marks

QWC = 3 marks

Band	Mark	Descriptor
3	7–9	<p>AO3 - Evaluation of the presented data, and the recommendation to use CT over MRI, is comprehensive, effective, and relevant, showing detailed logical and coherent chains of reasoning throughout.</p> <p>AO2 - Applied all relevant of knowledge of the imaging processes of CT and MRI in order to evaluate the statement is highly appropriate and shows a detailed functional understanding.</p> <p>AO1 - A wide range of relevant knowledge and understanding of the properties of electromagnetic radiation, which is accurate and detailed.</p> <p>The answer demonstrates comprehensive breadth and / or depth of understanding of medical imaging.</p>
2	4–6	<p>AO3 - Evaluation of the presented data, and the recommendation to use CT over MRI, is in most parts effective and mostly relevant, showing mostly logical and coherent chains of reasoning throughout.</p>

Band	Mark	Descriptor
		<p>AO2 - Applied mostly relevant knowledge of the imaging processes of CT and MRI in order to evaluate the statement, which is in most parts appropriate, showing some functional understanding.</p> <p>AO1 - Knowledge and understanding of the properties of electromagnetic radiation is in most parts clear and mostly accurate, although on occasion may lose focus.</p> <p>The answer demonstrates reasonable breadth and / or depth of understanding of medical imaging, with occasional inaccuracies and / or omissions.</p>
1	1–3	<p>AO3 - Evaluation of the presented data, and the recommendation to use CT over MRI, is in some parts effective and of some relevance, with some understanding and reasoning taking the form of generic statements with some development.</p> <p>AO2 - Applied limited knowledge of the imaging processes of CT and MRI in order to evaluate the statement, which is limited and may show a lack of functional understanding.</p> <p>AO1 - Knowledge and understanding of the properties of electromagnetic radiation shows some but limited accuracy, focus and relevance.</p> <p>The answer is basic and shows limited breadth and / or depth of understanding of medical imaging, with inaccuracies and omissions.</p>
	0	No creditworthy material.

Indicative content

Examiners are reminded that 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.

AO1 and AO2 may be implicit through the level of analysis and reasoned judgements and conclusions that the student provides.

AO1 Knowledge and understanding of properties of electromagnetic radiation and medical imaging may include:

- x-rays are used in imaging bone
- radio waves are used for communication as well as in MRI
- an MRI uses electromagnets
- ionising radiation is dangerous as it can damage cells.

AO2 Discussion and comparison of imaging modalities may include:

- the CT scan delivers a relatively small amount of energy compared to the MRI scan as indicated by the results in table 3
- table 3 shows that the CT scan uses ionising X-rays, and so may ionise the tissue they interact with, causing damage – the radio waves are lower energy, and so may not ionise atoms they interact with, so would not cause damage
- table 3 suggests that a higher amount of energy is transferred by radio waves so they may still interact with tissues, leading to heating
- furthermore, table 3 suggests that the CT scan occurs over a much smaller timeframe than that of MRI scans, meaning that the rate of energy delivery may still be high
- ionising radiation is specifically dangerous for foetuses (this is relevant to the given scenario as the pelvis is being imaged).

AO3 conclusions may include:

- the radiographer’s statement is incorrect as the type of wave used in CT scans is more damaging than MRI scans as x-rays are ionising
- in this particular scenario, the pelvis is being scanned, therefore, CT scans should be avoided if the patient is pregnant or trying to conceive
- table 3 suggests that MRI scans delivers more total energy, but due to the lower energy of the individual waves it will cause less damage to tissue, and so is safer than CT, which uses ionising x-rays
- table 3 also suggests that CT scans are much quicker than MRIs, and so may be more useful in emergency settings and when the patient cannot stay still for long
- whilst table 3 suggests that energy transfer is larger for MRI scans than CT scans, the total energy transmitted is not the best measure to determine the safety of an imaging technique, as MRI energy transfer is greater than a CTs, although it is safer
- in this particular scenario, the pelvis is being scanned, therefore, CT scans should be avoided if the patient is pregnant or trying to conceive.

Accept other appropriate responses.

Quality of written communication (QWC) = 3 marks

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. Or

	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.
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SAMPLE

Section D: Biology, chemistry and physics

Total for this section: 18 marks plus 6 marks for quality of written communication (QWC)

19 Scientists are discussing the health impacts of high levels of radioactivity on the general population.

Details of three isotopes that emit radiation to form new elements known as decay products are shown in Table 4 below.

Radioactive isotope	Plutonium-241	Iodine-131	Caesium-137
Type of radiation emitted	Beta	Gamma and beta	Gamma and beta
Half-life	14 years	8 days	30 years
Decay product	Americium-241	Xenon-131	Barium-137
Half-life of decay product	432 years	Stable	3 minutes
Type of radiation emitted by decay product	Alpha	None	Beta

Table 4: The most significant isotopes released

One scientist state that if samples of the three original radioactive isotopes were found in the air, then:

- iodine-131 poses the greatest danger to the health of the general public in the short term (4 weeks)**
- caesium-137 poses the greatest danger over a period of 20 years**
- plutonium-241 may account for the greatest risk to health over the longest period.**

Using the information in Table 4 and your knowledge of radiation, evaluate the scientist's statement.

[9 marks, plus 3 marks for QWC]

AO1 = 3 marks
AO2 = 3 marks
AO3 = 3 marks
QWC = 3 marks

Band	Mark	Descriptor
3	7–9	AO3 - Evaluation of the extent to which the information provided supports the conclusions is comprehensive , effective , and relevant , showing detailed understanding and logical and coherent chains of reasoning throughout.

Band	Mark	Descriptor
		<p>AO2 - Applied all relevant knowledge of radiation and its effects, and interpretation of data. Application is highly appropriate and shows a detailed functional understanding.</p> <p>AO1 - A wide range of relevant knowledge and understanding of radiation and its effects and data interpretation was demonstrated. A wide range of appropriate technical terms are used.</p>
2	4–6	<p>AO3 - Evaluation of the extent to which the information provided supports the conclusions is in most parts effective and mostly relevant, showing mostly logical and coherent chains of reasoning.</p> <p>AO2 - Applied mostly relevant knowledge of radiation and its effects and interpretation of data. Application is in most parts appropriate, showing some functional understanding.</p> <p>AO1 - Knowledge and understanding of radiation and its effects and interpretation of data is in most parts clear and mostly accurate, although on occasion may lose focus. A range of mostly appropriate technical terms used.</p>
1	1–3	<p>AO3 - Evaluation of the extent to which the information provided supports the conclusions is in some parts effective and of some relevance, with some understanding and reasoning taking the form of generic statements with some development.</p> <p>AO2 - Applied limited knowledge of radiation and its effects and interpretation of data. Application may show a lack of functional understanding.</p> <p>AO1 - Knowledge and understanding of radiation and its effects and interpretation of data shows some but limited accuracy, focus and relevance. A limited range of appropriate technical terms are used.</p>
	0	No creditworthy material.

Indicative content

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AO1 and AO2 may be implicit through the level of evaluation and considerations that the student provides.

AO1 Knowledge and understanding of radiation, its effects and the interpretation of data may include:

- alpha radiation is highly ionising / has highest ionisation
- alpha radiation has low penetration / has lowest penetration

- alpha radiation has low range, about 1 to 2 cm of air / has lowest range
- beta radiation is medium ionising
- beta radiation is medium penetrating
- beta radiation has a range of up to 15 cm of air
- gamma radiation is low ionising / has lowest ionisation
- gamma radiation has high penetration / highest penetration
- gamma radiation has high range, many kilometres of air / has highest range
- ionising radiation can remove electrons from atoms
- all forms of radiation can cause burns through excitation of atoms in cells
- half-life is the time taken for half the unstable nuclei in a sample to decay.

AO2 Application of knowledge and understanding of radiation, its effects and the interpretation of data may include:

- plutonium-241 emits beta radiation which has medium penetrating and ionising power
- plutonium has a half-life of 14 years meaning it will take that amount of time for half the unstable nuclei to decay
- americium-241, which is formed by plutonium, has a half-life of 432 years and emits alpha radiation which has high penetrating and ionising power
- alpha radiation is extremely dangerous if ingested / inhaled
- iodine-131 emits gamma as well as beta radiation; beta radiation has medium penetrating and ionising power
- iodine 131 has a half-life of 8 days meaning it would take that amount of time for half the unstable nuclei to decay; it also suggests iodine-131 would emit radiation rapidly due to its fast rate of decay / short half-life
- xenon-131 which is formed from iodine-131 emitting radiation is stable and therefore does not emit any radiation
- caesium-137 also emits gamma and beta radiation
- caesium-137 has a half-life of 30 years meaning it will take a long amount of time for half the unstable nuclei to decay, therefore caesium-137 would still be present after 20 years in significant amounts
- the radiation emitted by all 3 radioactive isotopes would be likely to get into the bodies if samples were found in the air
- if ionising radiation removes electrons from atoms in DNA, this can change the DNA, leading to cancer
- if ionising radiation causes changes in gametes, this can lead to birth defects.

AO3 Evaluation of the statement may include:

On this data, evaluations could include:

- In the short term, gamma radiation would be emitted from iodine-131 and caesium-137 / 2 of the radioactive isotopes, which is able to penetrate deep into the bodies of people in the area.
- In the short term, beta radiation would also be emitted from iodine-131 and caesium-137 / 2 of the radioactive isotopes, which has medium penetration and ionising power so would cause damage if the samples were inhaled / ingested.

- This supports the scientist’s statement as iodine-131 has the shortest half-life and therefore will emit more beta radiation within the first 4 weeks.
- The levels of gamma radiation would fall dramatically after this time as the iodine-131 decays and forms stable xenon-131
- However, as Caesium-137 will still be present, there will still be gamma radiation which could still cause damage to the body, meaning it will be dangerous over a period of 30 years, which is its half-life, and this does not support the scientist’s statement
- Caesium-137 also forms barium-147 which emits beta and has a half-life of 3 minutes, further supporting the conclusion that caesium-137 is dangerous
- Plutonium-241 has a half-life of 14 years so is dangerous over that period as it also emits beta radiation which will cause damage if inhaled / ingested
- Plutonium-241 forms americium-241 which has a half-life of 432 years and emits alpha radiation that has high penetrating and ionising power which can cause considerable damage if inhaled / ingested. Therefore, it is americium-241 which causes the greatest risk to health over the longest period. However, as it is formed from plutonium-241, this may support the scientist’s conclusion.

Accept other appropriate responses.

Quality of written communication (QWC) = 3 marks

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. Or 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.

20

Humans cannot produce all the essential amino acids needed to make proteins. Therefore, in order to make proteins needed for healthy growth and repair, we need to ensure that these amino acids are present in our diet.

A protein of plant origin and a protein of animal origin have been investigated to find out which amino acids they contained.

Scientists used a protease called pepsin, which is found in the stomach, to breakdown the protein using the following technique:

1. Used a blender to liquidise 10 grams of plant protein in 100ml of distilled water.
2. Added 10ml of the liquidised protein to a boiling tube.
3. Added 1ml of pepsin solution to the boiling tube.
4. Incubated the boiling tube at 37 °C for 15 minutes.
5. Analysed the liquid from the boiling tube using thin layer chromatography to identify any amino acids present.
6. Repeated steps 1 to 5 with the animal protein.

The results are summarised in Table 5.

	Protein of plant origin	Protein of animal origin
Total number of different amino acids present	9	8

Table 5: Results from outlined amino acid extraction experiment

A dietician made the following conclusion based on the results:

- more of the protein of plant origin should be present in our diet than the protein of animal origin, as it contains a greater range of amino acids.

Evaluate the dietician's statement.

[9 marks, plus 3 marks for QWC]

AO1 = 3 marks

AO2 = 3 marks

AO3 = 3 marks

QWC = 3 marks

Band	Mark	Descriptor
3	7–9	<p>AO3 - Evaluation of the extent to which the information provided supports the conclusions is comprehensive, effective, and relevant, showing detailed understanding and logical and coherent chains of reasoning throughout.</p> <p>AO2 - Applied all relevant knowledge of paper chromatography and the stomach effectively. Application is highly appropriate and shows a detailed functional understanding.</p> <p>AO1 - A wide range of relevant knowledge and understanding of chromatography and the stomach was demonstrated. A wide range of appropriate technical terms are used.</p>
2	4–6	<p>AO3 - Evaluation of the extent to which the information provided supports the conclusions is in most parts effective and mostly relevant, showing mostly logical and coherent chains of reasoning.</p> <p>AO2 - Applied mostly relevant knowledge of paper chromatography and the stomach mostly effectively. Application is in most parts appropriate, showing some functional understanding.</p> <p>AO1 - Knowledge and understanding of paper chromatography and the stomach is in most parts clear and mostly accurate, although on occasion may lose focus. A range of mostly appropriate technical terms used.</p>
1	1–3	<p>AO3 - Evaluation of the extent to which the information provided supports the conclusions is in some parts effective and of some relevance, with some understanding and reasoning taking the form of generic statements with some development.</p> <p>AO2 - Applied limited knowledge of paper chromatography and the stomach and with limited effect. Application may show a lack of functional understanding.</p> <p>AO1 - Knowledge and understanding of paper chromatography and the stomach shows some but limited accuracy, focus and relevance. A limited range of appropriate technical terms are used.</p>
	0	No creditworthy material.

Indicative content

Examiners are reminded that the 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.

AO1 and AO2 may be implicit through the level of evaluation that the student provides.

AO1 Knowledge and understanding of paper chromatography and the stomach may include:

- proteins are made up amino acids, which are the small molecules (monomers) from which all proteins are made
- proteases break down proteins into the amino acids that they are made from
- there are 20 amino acids that are common in all organisms, each differs by the side chain R
- the stomach has an acidic pH
- the stomach is at a temperature of 37 °C
- thin layer chromatography can be used to detect the number of components in a sample
- thin layer chromatography separates substances based on their affinity for a mobile phase (solvent) or stationary phase (on a coated plate).

AO2 Application of knowledge and understanding of paper chromatography and the stomach may include:

- pepsin will break down the plant and animal proteins into the amino acids from which they are made
- based on the data provided we can say that the plant-based mixture contained one more amino acid to that of the animal-based protein
- there is no information provided on the types of amino acids identified in each protein
- whilst the boiling tubes were incubated at a suitable temperature for pepsin activity, the data in the given scenario lacks the following information:
 - the pH of the boiling tubes, which is important as pepsin works in the stomach which is acidic
 - whether the investigation was repeated
 - whether different amounts of time were used for incubation time
- different amino acids in each solution would then be separated and detected by the thin layer chromatography - however, there may be some limitations such as, different amino acids could have a similar affinity for the mobile or stationary phase, meaning they cannot be separated and identified on the coated plate (especially if the chromatogram was not run for long enough).

AO3 Evaluation and justification of the statement may include:

- the results appear to show that the plant protein contains a greater range of amino acids than the animal protein and this does support the conclusion.
- however, based on the information provided and the data available this conclusion is rather weak because:
 - no evidence is provided on which amino acids are most beneficial in the diet, or on the types of amino acids identified, therefore, the statement cannot be supported
 - the chromatogram does not give quantitative information on how much of each amino acid is present, therefore, there could be tiny amounts of some of the amino acids in the plant protein and much more of the some of the amino acid in the animal protein
 - pairs of amino acids would be left in each boiling tube, even if breakdown is complete; this means the results are not valid, as one or more of these amino acids could be another type (which has not been identified)

- no information is provided on how long the chromatogram was run; it is possible that amino acids with similar affinities for the mobile or stationary phase would not separate and therefore not be identified, making the results invalid
- the pH was not stated therefore may have not been suitable for pepsin activity, meaning many amino acids would not be released and would not appear on the chromatogram, making the results invalid
- the boiling tubes were only incubated for 15 minutes; this may not have been sufficient for complete breakdown of the proteins making the results invalid
- it is not clear if the investigation was repeated, and therefore, it is not transparent that the differences between the two proteins are significant; furthermore, the results must be repeatable to hold any validity.

Accept other appropriate responses.

Quality of written communication (QWC) = 3 marks

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. Or 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 A

Question Number	AO1	AO2	AO3	Maths	QWC	Total
1	1					1
2 (a)	1					1
2 (b)		2				2
2 (c)		2		2		2
3 (a)	1					1
3 (b)			3			3
4			5			5
5 (a)		4				4
5 (b)		2				2
6	3	3	3		3	12
7	4	4	4		3	15
Total	10	17	15	2	6	48
Totals required	10–13	16–19	12–15		6	48
Kil	1					

Section B

Question Number	AO1	AO2	AO3	Maths	QWC	Total
8	1					1
9a	1					1
9b	1					1
9c		2				2
10a		2				2
10b		2				2
11			3			3
12	3	3	3		3	12
Total	6	9	6		3	24
Totals required	5–6	8–9	6–7		3	24
Kil	1					

Section C

Question Number	AO1	AO2	AO3	Maths	QWC	Total
13	1					1
14			3			3
15	1					1
16		2		2		2
17		4		4		4
18	3	3	3		3	12
Total	5	9	6	6	3	23
Totals required	5–6	8–9	6–7		3	23
Kil	1					

Section D

Question Number	AO1	AO2	AO3	Maths	QWC	Total
19	3	3	3		3	12
20	3	3	3		3	12
Total	6	6	6		6	24
Totals required	4–6	4–6	4-6		6	24
Kil	0					
Total marks				(7)	18	118

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Owner: Head of Assessment Design

Change History Record

Version	Description of change	Approval	Date of Issue
v1.0	Additional specimen assessment materials		November 2022
v1.2	Sample added as a watermark	November 2023	22 November 2023