



T Level Technical Qualification in Health

Core knowledge and understanding

Paper B

Elements 12-13

Mark scheme

v1.2: Specimen assessment materials
June 2022
603/7066/X

Internal reference: HLTH-0019-01

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 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 levels-based descriptors and indicative content.

Each level 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 levels-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 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	In epidemiology, which one of the following best describes the difference between incidence and prevalence? A Prevalence calculates the decline in new cases and incidence focuses on the rise of existing cases. B Prevalence focuses on using smaller relevant data whereas incidence focuses on incidents creating data. C Prevalence is the analysis of existing cases and incidence analyses new cases. D Prevalence is the analysis of new cases and incidence analyses existing cases. [1 mark]
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AO1 = 1 mark

Award **one** mark for the following:

Answer C: Prevalence is the analysis of existing cases and incidence analyses new cases.

2	Identify the organelle responsible for energy release within cells and name this process. [2 marks]
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AO1 = 2 marks

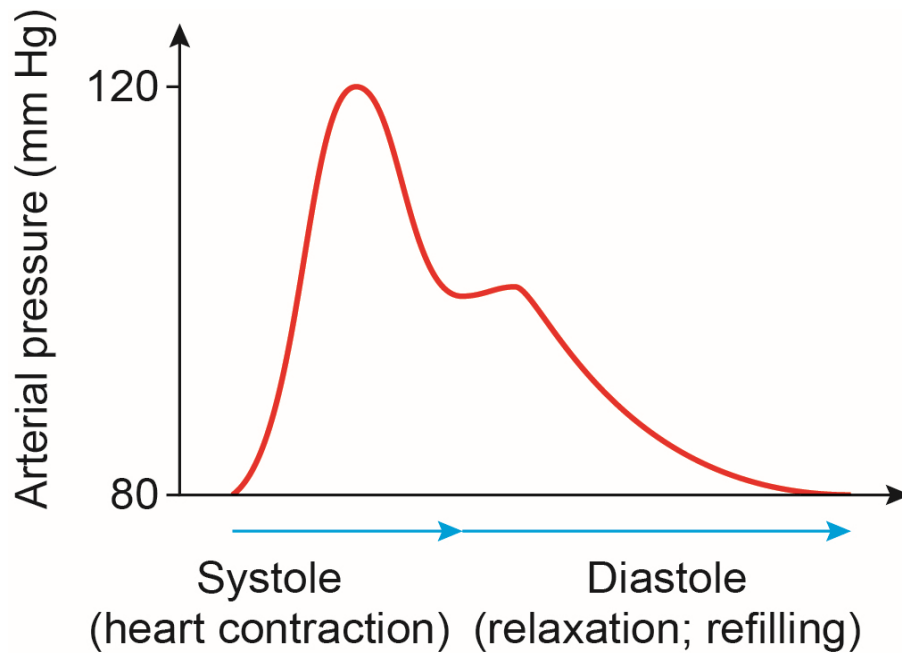
Award **one** mark for the following:

- mitochondria (1).

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

- respiration (1)
- aerobic respiration (1).

Figure 1. The graph shows the arterial blood pressure changing during a 55-year-old man's cardiac cycle



3

A student states that Figure 1 shows that in terms of their cardiovascular system, the 55-year-old man is healthy.

Give **three** pieces of information from the graph that support this statement.

Use approximate readings where required.

[3 marks]

AO2 = 3 marks

Award **one** mark for each of the following, up to a **maximum** of **three** marks:

- diastolic blood pressure is (approx.) 80 mm Hg (1)
- systolic blood pressure is (approx.) 120 mm Hg (1)
- a dichotic notch/second pulse (1).

Accept other appropriate responses.

4 An overweight 68-year-old male smoker exercises less than 30 minutes per week. On climbing stairs, he experiences chest pains, is out of breath and feels exhausted.

Give **two** examples of physiological factors that are causing him to experience these symptoms.

For **both** physiological factors, explain why it causes these symptoms.

[4 marks]

AO2 = 4 marks

Award **one** mark for each of the following physiological factors up to a maximum of 2 marks, and an additional mark for each explanation of why it causes the symptoms, up to a maximum of 2 marks, and up to a **maximum** of **four** marks in total:

- atherosclerosis/fatty deposits in arteries (1) reducing blood supply to the heart (1)
- physical activity increases the need for oxygen/blood (1) as less oxygen is available, it causes breathlessness/exhaustion (1)
- poor circulation (1) means that less oxygen is transported/lower blood oxygen levels (1)
- cardiovascular disease increases fluid on the lungs/pulmonary oedema/reduces blood oxygen levels (1) causing tiredness/exhaustion (as oxygen is needed to provide energy) (1)
- climbing stairs increases use of oxygen (1) which (the lower oxygen levels) will be experienced as exhaustion and feeling out of breath (1).

Accept other appropriate responses.

5 During the transcription process, DNA is transcribed into messenger RNA using a sequence of base pairs.

Identify the missing base to complete the pairs in the table below:

DNA	RNA
Adenine	
Cytosine	Guanine
Guanine	Cytosine
Thymine	Adenine

[1 mark]

AO1 = 1 mark

Award **one** mark for:

- Uracil (1).

6 Identify **one** of the two stages of the body's response to a soft tissue injury.

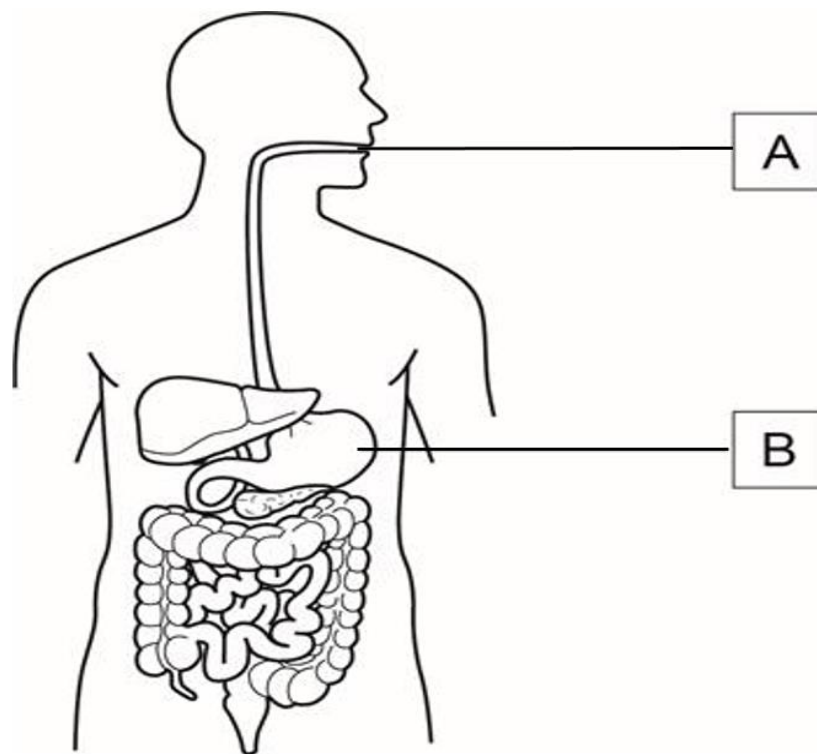
[1 mark]

AO1 = 1 mark

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

- involuntary inflammatory response (1)
- proliferation phase (1).

Figure 2. The human digestive system



7

There are many functions working together in the human digestive system, one of these is mechanical digestion.

Give **two** ways in which mechanical digestion breaks down food at point A.

Give **one** way in which mechanical digestion breaks down food at point B.

[3 marks]

AO2 = 3 marks

Award up to a **maximum** of **two** marks for a way in which mechanical digestion breaks down food at point A (award one mark per way), and up to **one** mark at point B.

Point A:

- teeth mechanically break food into smaller pieces (1)
- tongue will help chewing of food into a ball (bolus) (1)
- tongue will help move food to the throat and therefore stomach (1).

Point B:

- stomach muscles contract (peristalsis) (to aid digestion) (1).

Accept other appropriate responses.

8	<p>An amateur runner is planning to take part in a charity marathon.</p> <p>To help get a good race time, the runner is considering completing the race without stopping for any drinks. A friend advises against this as the weather will be hot during the marathon.</p> <p>Evaluate the friend's advice.</p> <p style="text-align: right;">[6 marks]</p>
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AO3 = 6 marks

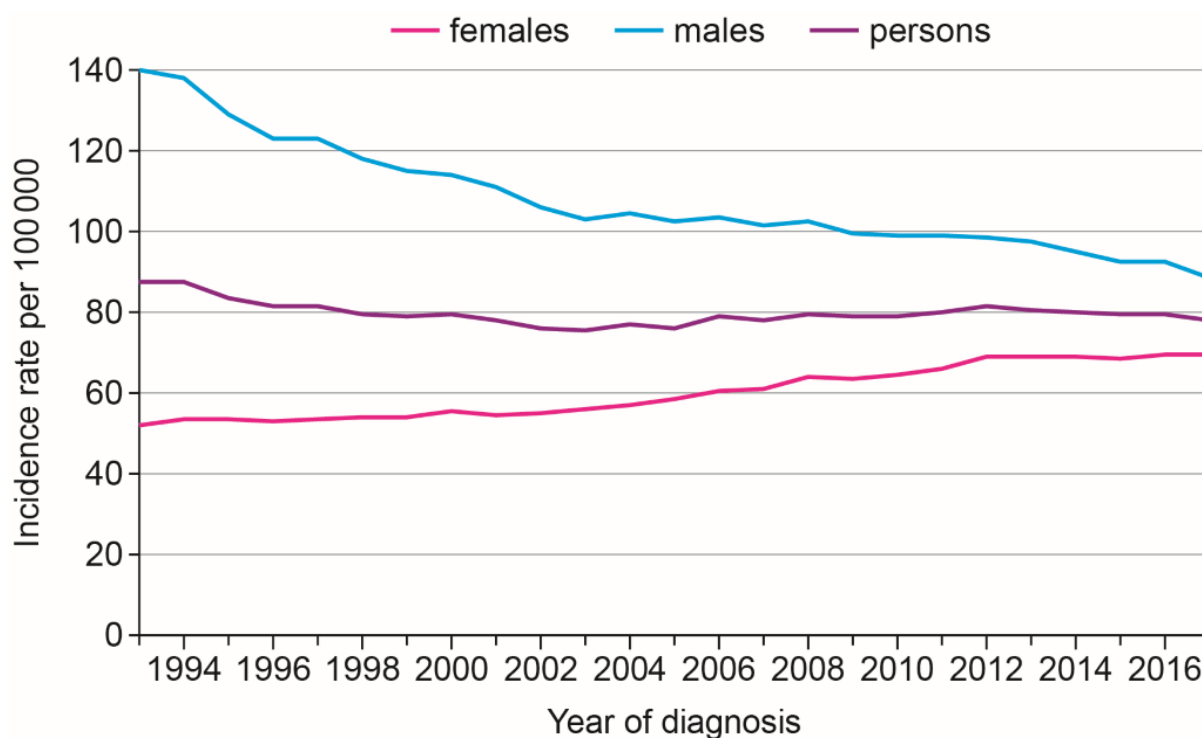
Award **one** mark for each valid evaluative point, up to a **maximum** of **six** marks.

Answers should reflect the importance of following the advice and stopping for drinks because of increased fluid loss/heat production and can include:

- (sustained) running will increase fluid loss due to increased respiratory rate (as expired water vapour), sweating due to the hot weather and heat produced (by the muscles) during (prolonged) exercise, these fluids will need to be replaced to prevent dehydration (1)
- prolonged exercise in hot weather risks the body not being able to compensate without drinks. Increased thirst sensation (caused by raised ADH levels) should not be ignored, water is vital to ensure waste products can be expelled and to ensure the body can function appropriately (1)
- drinks are essential to stop the body overheating. Overheating can affect enzyme behaviour and alter electrolyte levels, impairing normal cellular behaviour (such as neurones, cardiac cells, muscles) (1)
- water is necessary to prevent cramps which can slow down your marathon time or cause other injuries so drink breaks are important to ensure that you can maintain a stable pace throughout the race and ensure your body is working effectively (1)
- loading up on water prior to the race can cause other problems such as increased urination which will affect your ability to maintain pace but also puts unnecessary pressure on your body and can increase stress (1)
- electrolytes must be replaced when running so it is vital to take in fluids containing electrolytes, this can prevent other health conditions such as confusion, exhaustion and seizures, failure to replace electrolytes when undertaking high intensity exercise can be extremely dangerous (1)

Accept other appropriate responses.

Figure 3. Lung cancer incidence statistics in the UK 1993–2017



9

A scientist claims that smoking habits have changed, and that there will be a reduction in the number of cases of lung cancer in the UK by 2030.

Evaluate this statement using the information in Figure 3.

Your answer should demonstrate:

- the use, and limits of, epidemiology as a method
- reasoned judgements and conclusions about the impact of health promotion.

[9 marks plus 3 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 graph and statement is comprehensive, effective and relevant to the use of epidemiology and health promotion, showing logical and coherent chains of reasoning throughout.</p> <p>Informed conclusions that are fully supported with rational and balanced judgements that consider the impact of health promotion are evident.</p> <p>AO2: Applied relevant knowledge of data and health promotion required to support more positive trends.</p>

Band	Mark	Descriptor
		<p>AO1: A wide range of relevant knowledge and understanding of epidemiology, 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>
2	4–6	<p>AO3: Evaluation of the graph and statement is in most parts effective and in most parts relevant to the use of epidemiology, showing in most parts logical and coherent chains of reasoning.</p> <p>Conclusions supported by judgements that consider a range of the relevant arguments are evident.</p> <p>AO2: Applied mostly relevant knowledge of data and health promotion required to support more positive trends to the given context.</p> <p>AO1: Knowledge and understanding of epidemiology and health promotion 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>
1	1–3	<p>AO3: Evaluation of the graph and statement is in some parts effective and have some limited relevance to the use of epidemiology with some reasoning taking the form of generic statements that include some development.</p> <p>Brief conclusions supported by judgements that consider only basic arguments and show little relevance to the question aims are evident.</p> <p>AO2: Applied limited knowledge of data and health promotion required to support more positive trends.</p> <p>AO1: Knowledge and understanding of epidemiology and health promotion show 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 will be implicit through the level of analysis and reasoned judgements and conclusions that the student provides.

The student is able to study and analyse the pattern of incidence of disease, consider changes in habits and anticipate changes in trends.

AO1 Knowledge and understanding of the limits and use of epidemiology may include:

- graph shows trends over 25 years – lung cancer is more prevalent in older people and develops over decades
- likely to show impact of smoking/lifestyle habits over several decades, for example, from people born approx. 1930–1960 (accept 1910–1975)
- graph shows a downward trend/reduction in the incidence of lung cancer in the male population of the UK
- graph shows an upward trend/increase in the incidence of lung cancer in the female population of the UK
- the overall number has only moderately decreased from approximately 90 to 75 cases per 100,000
- the overall number was lowest both in early 2000s and in 2017, meaning there was an increase for around 10 years
- as popularity of smoking rose in females in 1960s and 1970s, there has been an ongoing increase in lung cancer incidence in females, but this is still lower than males
- data is for the whole population of the UK and does not differentiate between socio-economic class, ethnicity, education or age.

AO2 Application of knowledge and understanding of the impact of health promotion may include:

- difficult to measure how health promotion changes lung cancer incidence
- changes in behaviours by the population are multiple and difficult to have any confidence that a single health promotion has reduced the incidence in males
- the time between health promotion and observing changes is many decades, making it difficult to understand what is successful and what is not
- banning of smoking indoors in the UK may reduce smoking habits
- increase in vaping seems to be reducing use of tobacco
- increase in vaping may reduce incidence of lung cancer but this is unknown; some lab reports (student does not need to say mice but should not say human studies) have shown lung cancer causation
- banning of tobacco advertising may reduce incidence
- clear health warnings mandatory on tobacco products may reduce incidence
- reduction in the number of people smoking in films/television may reduce incidence
- NHS stop smoking campaigns may reduce incidence
- increased use of nicotine patches may reduce incidence.

AO3 Evaluation of statement may include:

- graph shows incidence but statement refers to numbers. UK population continues to rise (approx. 10 million in last 20 years) therefore incidence could decrease but numbers could go up
- statement predicts a decrease in the next 10 years which is likely to be based on health promotion/public smoking practices in around 1970s–1990s
- graph shows whole population for all four countries and health promotion may vary between the countries, making predictions harder
- graph does not show age of incidence, making health promotion harder to predict changes

- based on current graph trends, there is likely to be an increase in the incidence in female lung cancer but a reduction in the incidence of male lung cancer and overall total incidence number; this assumes that there are no changes in trends.

Reasoned judgements/conclusions may include:

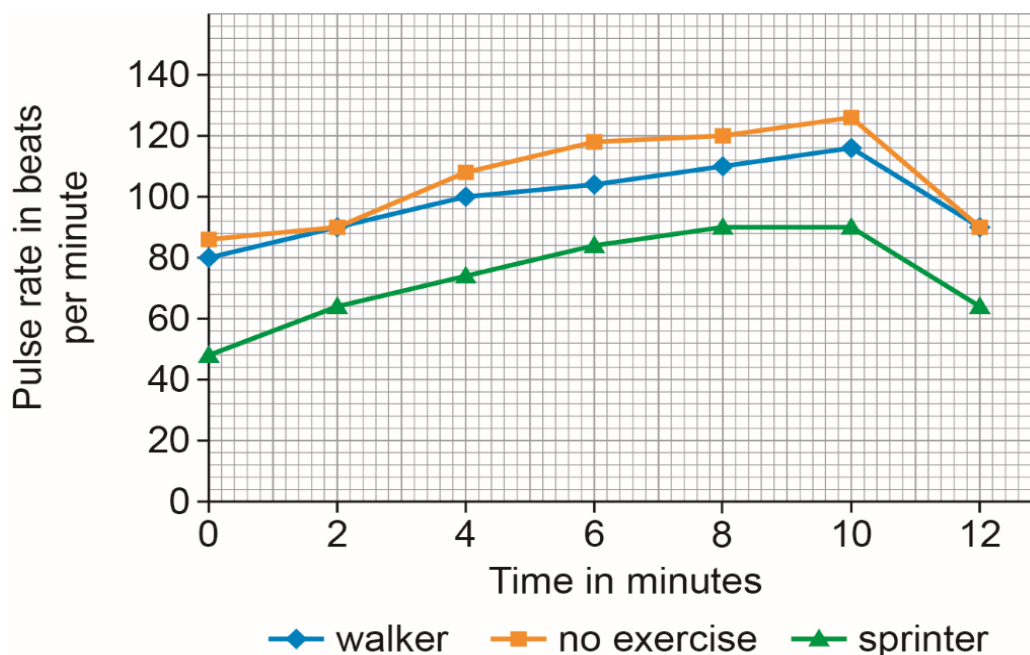
- the overall incidence of lung cancer in the UK has gone down and up, therefore it is too difficult to predict the number of cases in 10 years
- the health promotion during the last 20 years is very unlikely to impact on incidence in the next 10 years
- the health promotion during the last 30 years is not likely to impact on incidence in the next 10 years
- number of cases is likely to go up in the next 10 years as the population continues to increase and people live for longer.

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.

Figure 4: The effects of exercise on heart rate



10

Figure 4 shows the recorded heart rates of three different people with different fitness levels during a 10 minute brisk walk that is followed by a 2 minute period of rest.

Hafsa says she thinks that sprinting is the best form of exercise as it makes your muscles work harder. However, Ahmed strongly disagrees, saying he believes that regular walking with a dog is much better.

Do you agree with Hafsa or Ahmed? Justify your answer using the information in the graph and with reference to the homeostatic response.

[12 marks plus 3 for QWC]

AO1 = 4 marks

AO2 = 4 marks

AO3 = 4 marks

QWC = 3

Band	Mark	Descriptor
4	10–12	<p>AO3: Evaluation of the arguments is comprehensive, effective and relevant, showing logical and coherent chains of reasoning throughout. Analysis of the data relating to homeostatic mechanisms of the heart rate and breathing rate is used to effectively inform conclusions that are fully supported with rational and balanced judgements.</p> <p>AO2: Applied all relevant knowledge of homeostatic mechanisms relating to heart rate and breathing rate to the given context.</p> <p>AO1: A wide range of relevant knowledge and understanding of the homeostatic mechanisms, 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</p>

		understanding.
3	7–9	<p>AO3: Evaluation of the arguments is in most parts effective and mostly relevant, showing in most parts logical and coherent chains of reasoning. Analysis of the data relating to homeostatic mechanisms of heart rate and breathing rate is in most parts accurate. Conclusions are supported by judgements that consider most of the relevant arguments.</p> <p>AO2: Applied mostly relevant knowledge of homeostatic mechanisms relating to heart rate and breathing rate to the given context</p> <p>AO1: Knowledge and understanding of the homeostatic mechanisms 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 arguments is in some parts effective and of little relevance. Brief conclusions supported by judgements that consider only basic arguments and show little relevance to the question aims are evident.</p> <p>AO2: Applied limited knowledge of homeostatic mechanisms relating to heart rate and breathing rate to the given context.</p> <p>AO1: Knowledge and understanding of the homeostatic mechanisms show 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 arguments is minimal and very limited in effectiveness and relevance. Conclusions are tenuous and mostly unsupported and have very little relevance to the question.</p> <p>AO2: Applied very limited knowledge of homeostatic mechanisms relating to heart rate and breathing rate to the given context.</p> <p>AO1: Knowledge and understanding of homeostatic mechanisms 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 Knowledge and understanding of the role of homeostatic mechanisms may include:

- regulates body temperature
- regulates blood sugar (glucose levels)

- regulates the amount of waters and minerals in the body
- removes metabolic waste.

AO2 Application of knowledge and understanding of homeostatic mechanisms relating to heart rate and breathing may include:

- during exercise, our bodies need more oxygen
- our breathing rate increases to supply the oxygen
- the heart beats faster to take oxygen to where it is needed
- energy is needed for the muscles to work
- oxygen is needed for the release of energy
- once exercise stops, the body no longer needs the additional oxygen supply
- the breathing rate decreases
- the heart rate reduces as the demand for oxygen falls
- the more muscle activity to support the level of exercise, the more carbon dioxide that is produced
- increased carbon dioxide levels will quickly be detected and promptly cause an increase in heart rate
- the heart rate begins to increase so that the blood can move around the body quicker
- breathing rate increases so that more oxygen can be inhaled
- increased blood flow distributes more oxygen to where it is needed
- negative feedback mechanisms help to control heart rate and breathing rate
- the heart rate adjusts as the baroreceptors, which recognise when the blood vessels become stretched, send impulses to the cardiovascular centre
- action potentials/sympathetic stimulation are initiated to adjust the heart rate
- walking places less demand on muscles compared to sprinting so will consume less oxygen, produce less carbon dioxide, and have a less stimulating effect on the cardiovascular system as the demand to provide oxygen and remove carbon dioxide is less.

AO3 Evaluation of the role of homeostatic mechanisms in the control of heart rate and breathing may include:

The response must formulate comparisons, examples of which may include:

Sprinting:

- high intensity activities such as sprinting involve several muscle groups working at a high rate, which elevates your heart rate
- the heart muscle becomes stronger and more efficient at beating
- the stronger the heart becomes, the more forceful the contractions
- the more forceful contractions mean less heartbeats are needed to transport the same amount of blood
- as exercise begins, the body's need for energy increases and the muscles demand more oxygen
- in a sprinter, the heart is pumping more efficiently and delivering oxygen in the blood, therefore the demand for oxygen is lower. Breathing rate would also be lower.

Walking:

- walking offers a moderate to good level of intensity, using full body muscle groups working at a moderately elevated rate, and offers a moderate raise in heart rate
- walking offers the individual the ability to work the whole body over a longer period without placing too high of a demand on muscles and organ systems to work under increased pressure
- the heart increases in strength at a stable pace over a period of time without increasing the risk of severe body responses or injury
- due to the moderate nature of walking, the body can supply oxygen to muscle groups with ease
- walking offers less risks to the muscle and organ systems as there is a moderate demand on the body
- as a gentle exercise, walking places a lower demand on the heart by requiring a slower rate of demand to increase output
- when walking, the heart contractions become increased at a gradual rate and can supply blood to the body effectively without causing unnecessary strain on the heart.

Note: Links must be made between the homeostatic response and the data provided.

Reasoned judgements or conclusions may include:

- sprinting is a high intensity activity which, over time, improves cardiovascular fitness
- sprinting tends to use type IIx muscle fibres which are fast twitching. However, sprinters are highly likely to improve muscle conditioning and cardiovascular fitness through a range of exercises including medium and long distance training
- sprinters' training is likely to involve a controlled diet and regular exercise. This will ensure a good cardiovascular fitness and a healthy BMI. This helps to reduce their resting heart rate, and improve cardiovascular efficiency and blood oxygen capacity/aerobic fitness/ VO_2 max so that their bodies have to work less, compared to somebody less fit, when exercising
- higher cardiovascular fitness will also support a quicker recovery rate when exercise is stopped so that the heart rate returns to normal in less time compared to somebody that is not as fit
- due to the effectiveness of the heartbeat, more blood is pumped around the body with each contraction. This means that the sprinter has a lower resting heart rate than the walker and the individual who does not exercise. This continues throughout the exercise
- the reasons above do not support Ahmed's view as a dog walker is less likely to have a higher cardiovascular fitness and the graph supports that they have a higher resting rate that takes longer to recover following low demand exercise.

Accept other appropriate responses.

Note: Reasoned judgements may be awarded as part of the analysis or within the conclusions.

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)

11 Which **one** of the following does the pH scale measure?

- A** Hydrogen atoms
- B** Hydrogen compounds
- C** Hydrogen ions
- D** Hydrogen neutrons

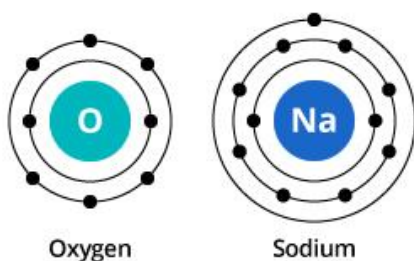
[1 mark]

AO1 = 1 mark

Award **one** mark for:

C: Hydrogen ions.

12 **Figure 5. The electron arrangement of oxygen and sodium**



12 Choose which **one** of the following represents the electron arrangement of sodium (Na)

- A.** $1s^2 2s^2 2p^6 3s^1$
- B.** $1s^2 2s^2 2p^4$
- C.** $1s^2 2s^2 2p^6 2d^1$
- D.** $1s^2 2s^2 3s^2 2p^5$

[1 mark]

AO2 = 1 mark

Award **one** mark for:

A $1s^2 2s^2 2p^6 3s^1$

- Q 13** A scientist places 5g of iron fillings into a beaker containing 100ml of 0.1M hydrochloric acid.
(a) 5g of iron are also placed into a beaker containing 100ml of distilled water.
The scientist observes the reaction that occurs in both beakers for 24 hours.
Compare the experimental observations that the scientist will make for each beaker.

[2 marks]

AO2 =2 marks

Mark Scheme

Award **one** mark each, up to a maximum of two, for:

- The beaker containing 0.1M HCl will rapidly bubble, while the beaker containing water will not bubble (1)
- The iron in the beaker containing 0.1M HCl will form green rust/iron chloride, while the iron in the beaker containing water will form orange rust/iron oxide (1)
- The iron in the beaker containing 0.1M HCl will appear to dissolve rapidly, while the iron/rust in the water beaker will not dissolve significantly (1)

- Q 13** A 100ml solution of 0.1M methanoic acid (with the formula CHOOH) is prepared and placed in a beaker.
(b) This is measured to have a pH of 2.38, and the hydrogen ion (H^+) concentration is calculated to be 0.004M (4mM).
A second beaker is prepared containing 100ml of 0.1M HCl solution.
5g of iron fillings are then placed in each beaker.
Using your knowledge of acids and bases, explain which beaker will react more rapidly.

[3 marks]

AO2= 3 marks

B1.37

Mark Scheme

Award up to **one** mark each up to **three** marks (AO2) for

- The methanoic acid is a weak acid, as it does not completely dissociate (1 AO2)
- As HCl is a strong acid, 0.1M HCl will therefore have a lower pH than the methanoic acid (AO2)
- The beaker containing HCl will react more rapidly as the acid is stronger (1 AO2)

Q 14 A scientist is investigating a sample of a white, crystalline substance, and attempting to determine its chemical composition.

The scientist has access to the following techniques:

- Thin layer chromatography
- Gas chromatography
- Mass spectrometry

Using your knowledge of chemical analysis techniques, suggest how these methods might be used to determine the chemical composition of the substance.

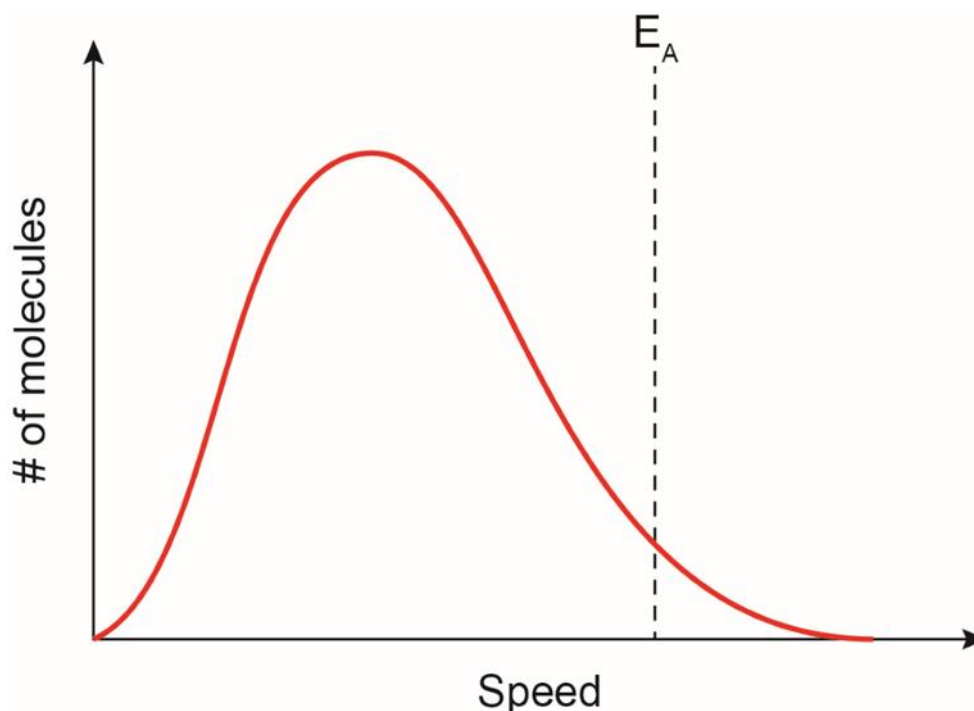
[4 marks]

AO3 = 4 marks

Mark Scheme

Award up to **four** marks for

- Thin layer chromatography is useful to determine the different components of a mixture, and so it could be used to separate, and determine the number of, individual components of the substance. However, this would not be suitable for determining the precise chemical composition of the substance (1).
- Gas chromatography can be used only if the substance is volatile and can be vapourised, so this may not be suitable for this sample (1).
- Mass spectrometry could be used to determine the elements and compounds present in the substance based upon weight but may be challenging to interpret in a mixture with many components. It may not be the most effective method to use (unless the analyte is known to be chemically pure) (1).
- Thin layer chromatography can be non-destructive, and so performing mass spectrometry on the individual components isolated by chromatography would be able to identify them each separately, so this would be a suitable approach (1).
- Using multiple techniques together may not be possible if there is only limited amounts of analyte available, so a combined approach may not be suitable (1)



15

The graph shows how the molecular energy is distributed, where E_A is the activation energy the molecule needs to break or form bonds.

Three different jars contain identical gasses. Each jar is heated to a different temperature – 30 °C, 80 °C and 300 °C.

Using the principles of collision theory, explain how the curve helps us to understand how temperature can affect any rates of chemical reactions in the different jars.

Your response should demonstrate:

- concepts of activation energy
- conclusions of changes to molecular energy distribution and the rates of chemical reactions when changing temperature.

[9 marks plus 3 for QWC]

AO1 = 3 marks

AO2 = 3 marks

AO3 = 3 marks

QWC = 3 marks

Band	Mark	Descriptor
3	7–9	<p>AO3: Explanation of the curve in relation to reactions of gasses colliding and the exchanges of energies between the particles at different temperatures is comprehensive, effective and relevant, showing detailed, logical and coherent chains of reasoning throughout. Informed conclusions that are fully supported with rational and balanced judgements are evident.</p> <p>AO2: Applied all relevant knowledge of how the reactions may collide and</p>

		<p>the need for a certain amount of energy to the given context, showing detailed functional understanding of the diagnostic tools in terms of waves, radiation and electromagnetism.</p> <p>AO1: A wide range of relevant knowledge and understanding of the collision theory of reaction rates, 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>
2	4–6	<p>AO3: Explanation of the curve in relation to reactions of gasses colliding and the exchanges of energies between the particles at different temperatures is in most parts effective and mostly relevant, showing mostly logical and coherent chains of reasoning. Conclusions supported by judgements that consider most of the relevant arguments are evident.</p> <p>AO2: Applied mostly relevant knowledge of how the reactions may collide and the need for a certain amount of energy, showing some functional understanding of the diagnostic tools in terms of at least two elements from waves, radiation and electromagnetism.</p> <p>AO1: Knowledge and understanding of the collision theory of reaction rates 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, with occasional inaccuracies and/or omissions.</p>
1	1–3	<p>AO3: Explanation of the curve in relation to reactions of gasses colliding and the exchanges of energies between the particles at different temperatures is in some parts effective and of some relevance. Brief conclusions supported by judgements that consider only basic arguments and show little relevance to the question aims are evident.</p> <p>AO2: Applied limited knowledge of how the reactions may collide and the need for a certain amount of energy, showing a lack of functional understanding of the diagnostic tools.</p> <p>AO1: Knowledge and understanding of the collision theory of reaction rates show 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 will be implicit through the level of analysis and reasoned judgements and conclusions that the student provides.

AO1 Knowledge and understanding of the collision theory of reaction rates may include:

- two species are atoms and molecules
- two species (atoms and molecules) must collide for a reaction to occur
- when two species come into contact/collide, they may react
- not all collisions cause a reaction
- to get a reaction between the particles, a certain amount of energy is required
- a collision with too little energy will not produce a reaction
- species colliding with less energy than activation energy will not react but bounce apart.

AO2 Application of knowledge of how the reactions may collide and the need for a certain amount of energy may include:

- activation energy is the minimum amount of energy required for a reaction to occur where atoms within the reactants rearrange to form products
- any chemical reaction results in the breaking of some bonds and creating of new bonds
- within any system where particles are present, they will have a wide range of energies which can be shown on a graph. The colliding particles must have enough energy for the collision to be successful or effective in producing a reaction
- the rate of a reaction will depend on the number of successful collisions between two species. The more successful collisions there are, the faster the rate of reaction
- when a catalyst is used, the activation energy is reduced; this will make more of the collisions successful at a set temperature
- a catalyst increases the rate of reaction by lowering the minimum energy required for successful collisions.

AO3 Explanation of the curve (in relation to reactions of gasses colliding and the exchanges of energies between the particles at different temperatures) may include:

- the distribution only applies to gasses, but conclusions can be drawn and applied to liquids also
- for any reactions to occur, particles must collide with energies which are equal or greater
- the average speed of a molecule in the gas is actually located a bit to the left of the peak
- the total area under the entire curve is equal to the total number of molecules; however, the activation energy line shows which molecules have sufficient energy to react
- the activation energy cannot be altered
- changing temperature leads to changes to molecular energy distribution and chemical reactions

- there are a majority of particles which do not have enough energy to react which will be represented under the larger curve. At a constant temperature, the shape of the curve will not change
- in order to speed up the reaction, one of two things must happen – either change the shape of the curve or move the activation energy further left so that at any one time, there are enough particles with enough energy to react
- with an increase in the heat of the molecules, the peak of the curve will shift to the right since the average molecular speed will increase
- as the graph will shift to the right, the height of the graph will decrease in order to maintain the same total area under the curve
- thus, more molecules will be found to the right of E_A and have sufficient energy to react
- the curve is limited to predicting that the higher the temperature, the higher the number of reactions
- the different temperatures are not uniform, but the distribution curve is non-linear so changes in rates of reaction are not linear against temperature and would not be able to be used to make predictions; measurements would be needed.

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 C: Physics

Total for this section: 20 marks plus 3 marks for quality of written communication (QWC)

16 In electro surgery, a generator converts mains alternating current to a radio frequency.

Select the correct frequency that the generator would convert the current to.

- A** 50 Hz
- B** 100 Hz
- C** 500 Hz
- D** 1000 kHz

[1 mark]

AO1 = 1 mark

Award **one** mark for the following:

A 50 Hz

17 **Figure 6. Drug label for Iodine-131**

Drug name: Radioiodine (Iodine-131)

Atomic properties:

- Neutrons 78
- Protons 53
- Isotope mass 130.906 u
- Excess energy 971 keV
- Physical half-life 8 days 0 hours
- Biological half-life 66 days
- Biological half-life in hyperthyroidism 38 days

17 (a)

$$\frac{1}{T_{\text{effective}}} = \frac{1}{T_{\text{physical}}} + \frac{1}{T_{\text{biological}}}$$

Use the formula above to calculate the effective half-life of Iodine-131 in a person without hyperthyroidism.

Show your workings. Give your final answer to 1 decimal place.

[3 marks]

AO1 = 1 marks

AO2 = 2 marks

Award **one** mark for extrapolating correct data from drug label in formula:

- physical = 8 days and biological = 66 days (1 AO1).

Award **one** mark for the process of using formulae:

- $1/(8 \times 24 \times 60 \times 60) + 1 / (66 \times 24 \times 60 \times 60) = 1.622 \times 10^{-6}$
Effective half-life = $\sqrt{1.622 \times 10^{-6}}$
= $0.00127 \times 60 \text{ sec} \times 60 \text{ min}$ (1 AO2).

Award **one** mark for correct answer:

- = 4.6 hours (1 AO2).

Note: One mark can be awarded for follow through (FT) error if incorrect answer matches incorrect numbers used in the correct formulae.

17 (b) A pregnant woman with thyroid cancer is considering radioiodine treatment (Iodine-131).

Analyse the risk to the woman of **not** taking radioiodine.

[3 marks]

AO3 = 3 marks

Award **one** mark for any of the following, up to a **maximum** of **three** marks:

- if the woman avoids taking Iodine-131 it would reduce the risk of harm to the unborn baby but it may mean that the thyroid cancer develops and the woman has a lower risk of recovery in the longer-term (1)
- not treating the cancer could affect the normal development of the baby (due to the cancer affecting her physiologically) as the woman's body may not be able to support the development of the baby due to the cancer (1)
- if the woman does not commence Iodine-131 treatment she may have to have her thyroid removed to eliminate the cancer, this could lead to other health impacts which may impact her longer-term (1)

Accept any other suitable response.

18 (a) Ultrasound waves are generated at a frequency of 15MHz (15,000,000Hz). While performing a scan, these waves pass through 2 different tissues; muscle and fat.

Using the wave equation $v=f\lambda$ calculate the wavelength of the sound waves in each tissue, given that the wave speed in each is:

- Muscle: $V_{Muscle} = 1600 \text{ ms}^{-1}$
- Fat: $V_{Fat} = 1450 \text{ ms}^{-1}$

Assume that the frequency remains constant. Give the answer to 3 significant figures.

[2 marks]

AO2 = 2 marks

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

- $V_{Muscle} = f \lambda_{Muscle}$

Therefore $\lambda_{Muscle} = \frac{V_{Muscle}}{f} = \frac{1600}{15,000,000} = 0.000107\text{m} (=0.107\text{mm})$

- $V_{Fat} = f \lambda_{Fat}$

Therefore $\lambda_{Fat} = \frac{V_{Fat}}{f} = \frac{1450}{15,000,000} = 0.0000967\text{m} (=0.0967\text{mm})$

Award for correct answer only (CAO).

18 (b) Ultrasounds are often used to create images inside the body for monitoring an existing condition or to diagnose a condition.

Explain **two** limitations of using an ultrasound to diagnose a condition. **[2 marks]**

AO2 = 2 marks

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

- Ultrasound images are not as detailed as those from CT or MRI scans (1)Ultrasound cannot tell whether a tumour is cancer (1)
- Ultrasound cannot be used to diagnose conditions on the entire body as sound waves do not travel well through bone or air (1)

Accept any other suitable response

19	<p>A pregnant woman is involved in a road traffic collision. She is unconscious when she is admitted to the local emergency department.</p> <p>The staff consider the options, including using an X-ray machine and the MRI scanner.</p> <p>Evaluate the use of these diagnostic tools to investigate the extent of her injuries.</p> <p>Your response should demonstrate:</p> <ul style="list-style-type: none"> the usefulness of the tools for this patient reasoned judgements about the benefits and risks of the different tools in this situation. <p style="text-align: right;">[9 marks plus 3 for QWC]</p>
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AO1 = 3 marks
AO2 = 3 marks
AO3 = 3 marks
QWC = 3 marks

Band	Mark	Descriptor
3	7–9	<p>AO3: Evaluation of the use, limitations and risks of the diagnostic tools is comprehensive, effective and relevant, showing detailed logical and coherent chains of reasoning throughout. Informed conclusions that are fully supported with rational and balanced judgements are evident.</p> <p>AO2: Applied all relevant knowledge of the diagnostic tools in terms of waves, radiation and electromagnetism.</p> <p>AO1: A wide range of relevant knowledge and understanding of the physics around diagnostic tools, 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>
2	4–6	<p>AO3: Evaluation of the use, limitations and risks of the diagnostic tools is in most parts effective and mostly relevant, showing mostly logical and coherent chains of reasoning. Conclusions supported by judgements that consider most of the relevant arguments are evident.</p> <p>AO2: Applied mostly relevant knowledge of the diagnostic tools in terms of at least two elements from waves, radiation and electromagnetism.</p> <p>AO1: Knowledge and understanding of the physics around diagnostic tools 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, with occasional inaccuracies and/or omissions.</p>
1	1–3	<p>AO3: Evaluation of the use, limitations and risks of the diagnostic tools is in some parts effective and of some relevance, with some understanding and reasoning taking the form of generic statements with some development. Brief conclusions supported by judgements that consider only basic arguments and show little relevance to the question aims are evident.</p>

Band	Mark	Descriptor
		<p>AO2: Applied limited knowledge of the diagnostic tools to the given context.</p> <p>AO1: Knowledge and understanding of the physics around diagnostic tools show 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 will be implicit through the level of analysis and reasoned judgements and conclusions that the student provides.

AO1 Knowledge and understanding of the physics around diagnostic tools. Physics may include:

- X-rays and MRI are diagnostic tools that generate an image of the underlying tissues in the body by using ionising radiation and non-ionising radiation, respectfully
- X-ray machines generate the X-rays that pass through the body and, depending what structures they meet, will determine how much X-ray is detected by the receiver
- MRI scanners use electromagnetism to spin protons on their axis in a uniform fashion and then use radio waves to disturb this uniformity so that the scanner can then look to detect these changes to generate images depending on the density of the protons.

AO2 Functional understanding of the use of diagnostic tools may include:

- X-ray machines can give information quickly to help with the diagnosis and therefore prompt treatment for the patient, reducing further harm
- as there has been a road traffic collision, it is likely that bone damage could be involved and the X-ray can help determine this type of injury
- the scenario does not include any information to suggest that there is bone injury
- X-rays are quick so if the patient becomes conscious and moves, it is unlikely to interfere in the image OR that it could easily be taken again, although that increases the exposure to radiation
- the scenario does not include any information about the type of injury but that the patient is unconscious, so there must be a significant injury to cause this and investigation is needed
- the loss of consciousness is unlikely to be due to broken bones which the X-ray would detect, whereas the MRI scan would show soft tissue injury, for example, brain and spinal cord injury
- during an MRI, if the patient moves/regains consciousness, then the image will be lost and it could be distressing to the patient as they would be inside the MRI chamber which is

restrictive.

AO3 Evaluation of the use of diagnostic tools to investigate the extent of any injuries (including reasoned judgements about the benefits and risks of the different tools) may include:

- as the patient is unconscious, then a whole body inspection would be needed for the MRI, to ensure that they had no metal piercings, and this would take time and be difficult to manoeuvre the person depending on the patient's injuries. Any metal implants would be unknown
- there is no information about friends/relatives to give further information and the patient is unconscious so unable to give informed consent. There are additional risks as the patient history is unknown
- the noisy and slow process of taking an MRI is an increased problem for claustrophobic people
- the patient could be sedated to keep them still for the MRI scanner but that may present a risk to the pregnancy
- both tools have benefits and risks and one is not a better tool as they look at different tissues. However, the MRI will give no bone detail and the X-ray image will generate less information compared to an MRI and makes 2D images that are limited to shadows
- her pregnancy is likely to mean that X-rays could not be used unless, by not having an X-ray, it would become life-threatening
- the patient cannot give consent if they are unconscious and there are risks with the X-ray that may not be in the patient's best interest
- therefore, the use of MRI would be preferable following a full body check for metal piercings.

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 D: Biology, chemistry and physics

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

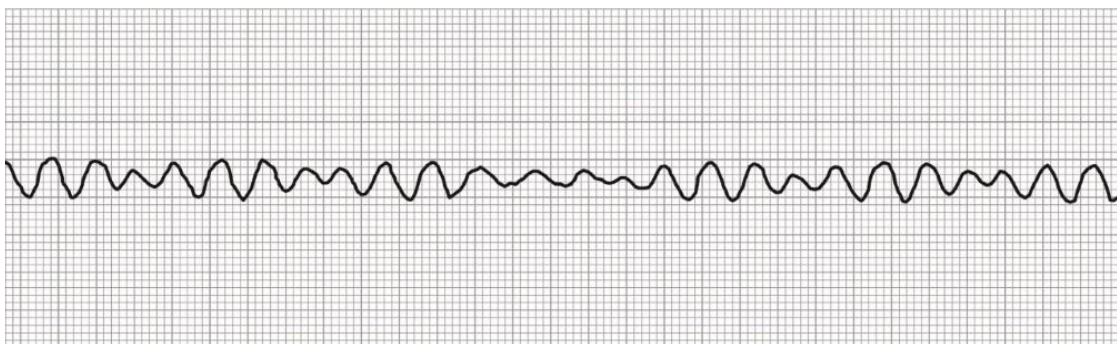
Figure 7. ECG 1 – normal ECG



Figure 8. ECG 2 – atrial fibrillation



Figure 9. ECG 3 – ventricular fibrillation



- 20** Figures 9, 10 and 11 show different electrocardiograms (ECGs). The first is a typical healthy ECG, the second indicates the person has atrial fibrillation (AF) and the third is of somebody in ventricular fibrillation (VF). Fibrillation describes rapid and irregular contractions of the cardiac muscle fibres that are not synchronised.

“Atrial fibrillation is not usually life-threatening whereas ventricular fibrillation is.”

Evaluate the above statement.

Your response should demonstrate:

- interpretation of ECGs in terms of cardiac electrical activity
- consideration of the mechanical cardiac function in the different conditions.

[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 normal ECG is comprehensive, effective and relevant, showing detailed, logical and coherent chains of reasoning throughout. Informed conclusions that are fully supported with rational and balanced judgements that relate to how the ECG can be interpreted through biochemical changes are evident.</p> <p>AO2: Applied all relevant knowledge of the cellular level of ECG mechanics.</p> <p>AO1: Knowledge and understanding of the anatomy, physiology, biochemistry and electrocardiogram is clear and fully accurate with sustained focus.</p> <p>The answer demonstrates comprehensive breadth and/or depth of understanding of the properties and interaction of gamma radiation and the impact on the body systems.</p>
2	4–6	<p>AO3: Evaluation of the normal ECG is in most parts effective and mostly relevant, showing mostly logical and coherent chains of reasoning. Conclusions supported by judgements that consider most of the relevant arguments related to how the ECG can be interpreted through biochemical changes are evident.</p> <p>AO2: Applied mostly relevant knowledge of the cellular level of ECG mechanics to the given context. There may be a few errors.</p> <p>AO1: Knowledge and understanding of the anatomy, physiology, biochemistry and electrocardiogram is mostly clear and generally 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 normal ECG 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>Brief conclusions supported by judgements that consider only basic arguments and show little relevance to the question aims are evident.</p> <p>AO2: Applied limited knowledge of the cellular level of ECG mechanics to the given context.</p> <p>AO1: Knowledge and understanding of the anatomy, physiology, biochemistry and electrocardiogram shows some but limited accuracy, focus and relevance.</p>

Band	Mark	Descriptor
		The answer is basic and shows limited breadth and/or depth of understanding, with inaccuracies and omissions.
	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 will be implicit through the level of evaluation and considerations that the student provides.

AO1 Knowledge and understanding of the anatomy, physiology, biochemistry and the electrocardiogram may include:

- normal ECG – the heart is beating in a regular, steady rhythm; a normal range is between 60–100 beats per minute
- atrial fibrillation – an abnormal, fast and irregular heartbeat (arrhythmia)
- ventricular fibrillation – life-threatening abnormal heart rhythm; a cause for cardiac arrest
- P wave is associated with atrial contraction
- QRS complex associated with ventricular contraction
- T wave associated with ventricular resting.

AO2 Application of knowledge and understanding of the cellular level of ECG mechanics. Interpretation of the ECGs may include:

- the ventricles will depolarise/contract when the atrioventricular node (AVN) is stimulated
- the normal ECG shows the P wave (atrial depolarisation), QRS complex (ventricular depolarisation) and T wave (ventricular repolarisation)
- the AF ECG shows chaotic activity during atrial depolarisation but normal QRS and T waves, and there is an abnormal rhythm. There are multiple electrical signals being generated. These signals are random, chaotic or disorganised
- AF ECG has an irregular/abnormal rhythm
- the abnormal rhythm in AF is due to the irregular/chaotic stimulation of the atrioventricular node
- the VF ECG shows very little electrical activity that is random and chaotic. There is no rhythm or pattern
- in AF and VF, the sinoatrial node (SAN) no longer maintains the regular beat/rhythm of the heart whereas it does in the normal ECG
- in AF, the AVN causes an abnormal rhythm as it is controlled by the chaotic and unorganised atrial electrical activity.

AO3 Evaluation with considerations of cardiac mechanics may include:

- the normal and AF ECGs show normal ventricular contraction, meaning that there is a cardiac output to supply the body
- fibrillating atria in AF do not effectively contract but it is not life-limiting as most (around 70%) blood will pass straight through the atria into the ventricles (as there is a low pressure in the ventricles)
- as there is normal ventricular contraction in AF, the heart will be able to support life
- in VF, the QRS complex is not present but there is chaotic/random electrical activity across the ventricles
- in VF, this disorganisation of ventricular contraction significantly reduces the pressure the ventricles can create to circulate blood, as the blood pressure in the arteries is too high
- this loss of cardiac output in VF will not support life.

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.

21	<p>A patient with breast cancer has been referred for external-beam radiation therapy. They have been advised that the radiation will hopefully reduce the development of the cancer.</p> <p>Evaluate the benefits and risks of using therapeutic radiation for the patient.</p> <p>Your response should demonstrate:</p> <ul style="list-style-type: none"> the principles of the mechanism of therapeutic radiation considerations about the impact on normal function of the cardiac, respiratory or digestive system. <p style="text-align: right;">[9 marks plus 3 for QWC]</p>
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AO1 = 3 marks

AO2 = 3 marks

AO3 = 3 marks

QWC = 3 marks

Band	Mark	Descriptor
3	7–9	<p>AO3: Evaluation of the benefits and risks of radiation is comprehensive, effective and relevant, showing detailed, logical and coherent chains of reasoning throughout on the properties and interaction of gamma radiation and its therapeutic use in the treatment of breast cancer. Informed considerations that are fully supported with rational and balanced judgements are evident.</p> <p>AO2: Applied all relevant knowledge of the risks of radiation and its therapeutic use to the given context, for example, for the treatment of breast cancer.</p> <p>AO1: Knowledge and understanding of the properties and interaction of gamma radiation and the impact on the body systems is clear and fully accurate with sustained focus.</p> <p>The answer demonstrates comprehensive breadth and/or depth of understanding of the properties and interaction of gamma radiation and the impact on the body systems.</p>
2	4–6	<p>AO3: Evaluation of the benefits and risks of radiation is in most parts effective and mostly relevant, showing mostly logical and coherent chains of reasoning. Considerations supported by judgements that consider most of the relevant arguments are evident.</p> <p>AO2: Applied all relevant knowledge of the risks of radiation and its therapeutic use to the given context, for example, for the treatment of breast cancer. There may be a few errors.</p> <p>AO1: Knowledge and understanding of the properties and interaction of gamma radiation and the impact on the body systems is mostly clear and generally 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 benefits and risks of radiation is in some parts effective and of some relevance, with some reasoning taking the form of generic statements with some development on the properties and interaction of gamma radiation and its therapeutic use in the treatment of breast cancer. Brief considerations supported by judgements that consider only basic arguments and show little relevance to the question aims are evident.</p>

Band	Mark	Descriptor
		<p>AO2: Applied limited knowledge of the risks of radiation and its therapeutic use to the given context, for example, in the treatment of breast cancer.</p> <p>AO1: Knowledge and understanding of the properties and interaction of gamma radiation and the impact on the body systems 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 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 will be implicit through the level of evaluation that the student provides.

AO1 The mechanism of radiation in radiation therapy may include:

- tungsten is bombarded with electrons which are attracted to the nuclear field. The attraction causes a deceleration in kinetic energy which is converted into photons which can be used to damage the cancer cells
- the radiation beam therapy aims directly at the cancer
- the beams penetrate deep into the body
- cell DNA becomes damaged and the cancer cells stop dividing
- cells die, they are broken down and removed by the body
- this takes place over a prolonged period of time.

AO2 Application of knowledge and understanding of the risks of radiation may include:

- it can affect the surrounding organs such as the heart, lungs or oesophagus
- radiation therapy involves gamma rays which are emitted from the decay of radioactive isotopes, for example, caesium or cobalt
- gamma rays transfer all of their energy to the area targeted once they interact with it
- gamma rays also kill normal body cells outside of the targeted cancerous area
- damage to the heart has an impact on the circulation of blood around the body
- damage to the lungs has an impact on the respiratory system and the transport of respiratory gasses
- damage to the oesophagus has an impact on the digestive system and nutrition.

AO3 Evaluation of role of radiation in radiation therapy may include:

- individuals are more likely to develop lung cancer, leukaemia, oesophageal cancer and heart disease as the radiation is directed towards breast/chest/thorax/mediastinum
- heart disease can lead to problems with blood circulation and transport of oxygen and carbon dioxide. The heart muscle may not work effectively. Impact on lifestyle with impeded cardiac output/heart function
- lung disease reduces the efficiency of gaseous exchange. Blood oxygen levels reduce. Lung capacity becomes reduced. Impact on life choices with reduced oxygenation
- oesophageal inflammation makes swallowing painful, thus impacting upon the digestive system and nutrition. Impact on eating, nutrition, socialisation.

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	2					2
3		3				3
4		4				4
5	1					1
6	1					1
7		3				3
8			6			6
9	3	3	3		3	12
10	4	4	4		3	15
Total	12	17	13		6	48
Totals required	10–13	16–19	12–15		6	48
Kil	5					

Section B

Question Number	AO1	AO2	AO3	Maths	QWC	Total
11	1					1
12	1					1
13		5				5
14			4			4
15	3	3	3		3	12
Total	5	8	7		3	23
Totals required	5–6	8–9	6–7		3	23
Kil	2					

Section C

Question Number	AO1	AO2	AO3	Maths	QWC	Total
16	1			(1)		1
17 (a)	1	2		(3)		3
17 (b)			3			3
18 (a)		2		(2)		2
18 (b)		2				2
19	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
20	3	3	3		3	12
21	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				(6)	18	118

Document information

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Owner: Head of Assessment Design

Change History Record

Version	Description of change	Approval	Date of Issue
v1.0	Published.		2020
v1.1	NCFE rebrand.		September 2021
v1.2	ODSR_H_164, ODSR_H_174, ODSR_H_176 – Q12, Q13, Q14, Q16, and Q18 amends.	May 2022	June 2022