T-LEVELS | Institute for Apprenticeships & Technical Education

T Level Technical Qualification in Health

Core knowledge and understanding

Paper B

Mark scheme

V1.1: Post-standardisation
P002371
14th December 2023
603/7066/X

NCFE CACHE

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 band-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 **Which of the following is synthesised in the integumentary system?**

A Antibody
B Antigen
C Vitamin C
D Vitamin D

[1 mark]

AO1 = 1 mark

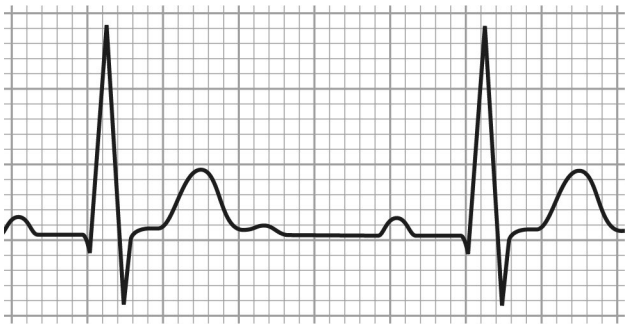
Award **one** mark for the correct identification, up to a maximum of **one** mark:

Answer

D Vitamin D

2 Figure 1 **shows the electrical activity of the heart taken from an electrocardiogram (ECG).**

Figure 1: **Part of a trace from an electrocardiogram**



(a)(i) **Work out how many heart beats are represented by the trace.**

[1 mark]

AO2 = 1 mark

Award a maximum of **one** mark for the correct number of beats, up to a maximum of **one** mark:

- 2 (beats).

(a)(ii) **State what would need to be added to** Figure 1 **to enable the heart rate to be worked out.**

[1 mark]

AO2 = 1 mark

Award a maximum of **one** mark for the correct statement, up to a maximum of **one** mark:

- a time scale.

2(b) **The same person runs on a treadmill for 10 minutes before a second ECG trace.**

Explain two **ways in which the trace would change.**

[4 marks]

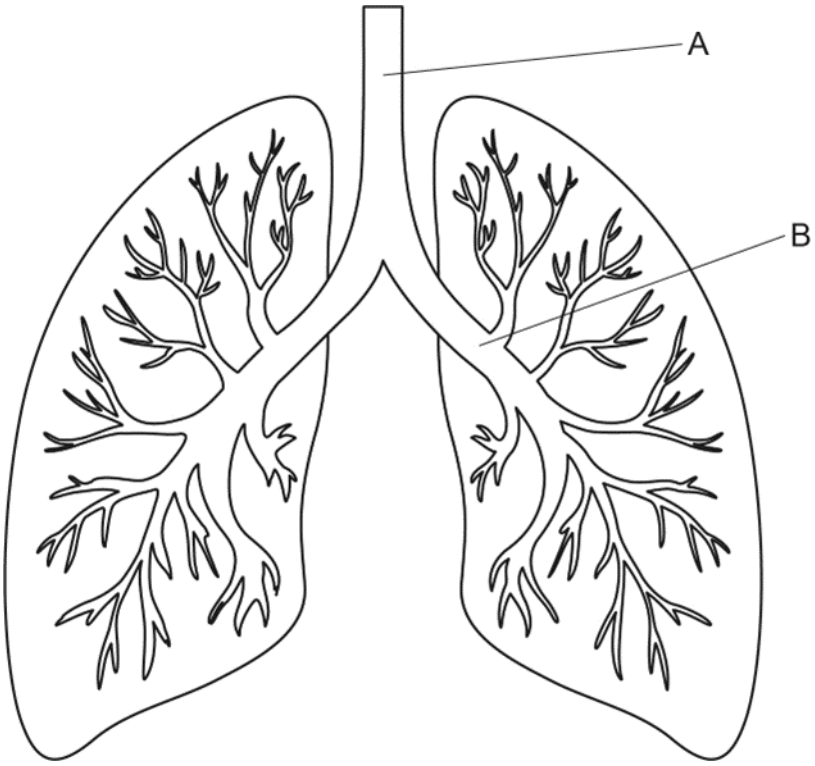
AO2 = 4 marks

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

- the peaks would be closer together / there would be more beats in the given time (1) as the heart would beat faster to increase the blood supply to the muscles (1)
- the height of the peaks would be greater (1) because the heart would beat with more force to increase the volume of blood pumped per beat / stroke volume (1).

Accept any other suitable response.

3 Figure 2: **Simplified components of the human respiratory system**



(a) **Identify components A and B.**

[2 marks]

AO1 = 2 marks

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

- A = trachea (1)
- B = bronchus/bronchi (1).

3(b)	**An individual has an accident which paralyses the intercostal muscles and diaphragm.** **Explain why the individual would not be able to breathe.**	[4 marks]

AO2 = 4 marks

Award up to **one** mark for each explanation point, up to a maximum of **four** marks:

- the intercostal muscles cannot contract (1) therefore, ribs cannot move up and out (1)
- the diaphragm cannot contract (1) therefore, it cannot flatten (1)
- therefore, the volume of the lungs cannot increase (1) meaning the pressure inside the lungs would not be reduced and air from the outside could not be drawn in (1).

4	**The average total blood volume of an adult is 5 litres. 0.1 litres of this total volume can be found in the lung capillaries.** **Calculate the percentage of total blood volume in the lung capillaries.**	[2 marks]

AO2 = 2 marks

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

- % of total blood volume in lung capillaries (0.1/5) x 100
- = 2(%).

NB: An answer of 2(%) with no working can be awarded two marks.

5	**A lecturer is working with a group of trainee paramedics discussing how to deal with blood loss at the scene of an accident.** **The lecturer states:** **'If an accident victim has serious bleeding and their blood pressure is falling, paramedics should immediately set up a sterile saline solution drip as this is a safe and potentially lifesaving procedure.'** **Saline solution is a sterile solution of salt and water.** **Discuss the lecturer's statement.** **Your response should include reasoned judgements and conclusions.** [6 marks]

AO3 = 6 marks

Award up to **one** mark for each discussion point, up to a maximum of **six** marks:

- the lecturer is correct because the sterile saline solution does not contain any antigens (1) so it cannot cause an immune response caused by antigens on the red blood cells (1) therefore this is a safe procedure to carry out if you do not know the person's blood type (1)
- the lecturer is correct as the patient has reduced blood flow to vital organs due to severe blood loss (1) they are at risk of blood pressure falling too low and are in danger of ischemia/going into shock (1), a saline solution drip will maintain blood pressure/blood volume preventing ischemia/going not shock until they reach the hospital and can be treated accordingly (1)
- the lecturer is correct as the saline solution is sterile, so it will not contain any microorganisms which could cause infection (1), if the paramedic takes care to keep everything sterile when setting up the drip there should not be a risk of infection (1) therefore a saline drip could save a patient's life without putting them in any further danger (1).

Accept any other suitable response.

6 **An elderly patient in a hospital ward is recovering from a total hip replacement operation, carried out 12 hours ago.**

A student nurse who is monitoring the patient records the following physiological measurements, shown in Table 1.

Table 1: **Physiological measurements**

Blood pressure	**130/90 mmHg**
Heart rate	**105 BPM**
Temperature	**37.8°C**

In a discussion with their supervisor the student nurse suggests that the trauma of the operation has caused the patient's heart rate to increase. This is causing the blood pressure and body temperature to rise.

Using the information provided and your knowledge of factors which may affect physiological measurements, evaluate the student nurse's suggestion.

Your response should include reasoned judgements and conclusions.

[9 marks plus 3 for QWC]

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

Band	Mark	Descriptor
3	7–9	**AO3**: Evaluation of the student nurse's suggestion is **comprehensive, effective and relevant,** showing **logical** and **coherent** chains of reasoning throughout. Information provided is used to **effectively** inform conclusions that are **fully** supported with **rational and balanced** judgements. **AO2**: Applied all **relevant** knowledge of factors which may affect physiological measurements to the given context. **AO1**: A **wide** range of **relevant** knowledge and understanding of factors which may affect physiological measurements is present, which is **accurate** and evident. A **wide** range of **appropriate** technical terms are used consistently. The answer demonstrates **comprehensive** breadth and/or depth of understanding.
2	4–6	**AO3**: Evaluation of the student nurse's suggestion is in **most** parts **effective** and mostly **relevant**, showing in most parts **logical** and **coherent** chains of reasoning. Analysis of the information presented is in **most** parts **accurate**. Conclusions are supported by judgements that consider **most** of the **relevant** arguments. **AO2**: Applied **mostly relevant** knowledge of factors which may affect physiological measurements, to the given context.

		AO1: Knowledge and understanding of factors which may affect physiological measurements, is in **most** parts **clear** and in **most** parts **accurate**, although on **occasion** may lose focus. The answer demonstrates **reasonable** breadth and/or depth of understanding, with **occasional** inaccuracies and/or omissions.
1	1–3	**AO3**: Evaluation of the student nurse's suggestion is in **some** parts **effective** but at times may be of **little relevance**. **Brief** conclusions supported by judgements that consider only **basic** arguments and show **little relevance** to the question aims, are evident. **AO2**: Applied **limited** knowledge of factors which may affect physiological measurements, to the given context. **AO1**: Knowledge and understanding of factors which may affect physiological measurements, shows **some** but **limited accuracy, focus** and **relevance.** 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 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: Demonstration of knowledge of factors which may affect physiological measurements may include:

- the normal systolic blood pressure range is 90–120 (mmHg)
- the normal diastolic blood pressure range is 60–80 (mmHg)
- the normal heart rate range is 60–100 (BPM)
- the normal body temperature range is 36–37.2°C
- the pressure of the blood is created by the heart beating / cardiac cycle
- physiological measurements can vary with age
- injury or trauma will lead to an increased blood flow
- injury or trauma will lead to an increased metabolic rate
- the skin is a physical barrier which prevents causative agents entering the body
- inflammation is a normal part of reaction to trauma / injury
- inflammation is a normal reaction to infection / entry of causative agents into the body
- increased metabolic rate is part of inflammation
- increased blood flow is a part of inflammation.

AO2: Application of knowledge of factors which may affect physiological measurements, to the given context may include:

- a blood pressure of 130 / 90 (mmHg) is higher than the normal range
- a heart rate of 105 (BPM) is higher than the normal range
- a temperature of 37.8°C is higher than the normal range
- as the patient is elderly this could be the cause of the measurements being outside the normal range
- no information is given about the patient's physiological measurements before the operation
- no information is provided about the patient's weight which could affect the blood pressure
- the patient's normal heart rate and blood pressure may have been high before the operation
- the operation is an injury or trauma to the body, this is likely to cause an increase in blood flow and therefore heart rate
- the operation is an injury or trauma to the body, this is likely to cause an increase in metabolic rate and therefore temperature
- an increase in pain may cause the heart rate to increase
- the wound caused by the hip replacement operation could allow causative agents of infection to enter the body
- if causative agents of infection enter the body through the wound, this could cause inflammation leading to a rise in body temperature.

AO3: Evaluation of factors which may affect physiological measurements, to the given context may include:

- as the operation is a form of trauma or injury, it will cause an inflammatory response leading to an increase in heart rate and therefore blood pressure and an increase in metabolic rate and therefore temperature. This does support the student nurse's suggestion
- as no information is provided about the patient's pre-surgery physiological measurements it is possible that they have not risen as a result of the operation, they could have been higher than normal before the operation, this does not support the student nurse's suggestion
- as the operation creates a wound, it is possible that causative agents of infection have entered the body and this has led to an infection, the resultant inflammatory response caused by the infection would lead to an increase in body temperature. This does not support the student nurse's suggestion
- as the operation is a form of trauma or injury this will cause pain, the pain could lead to an increase in heart rate which will affect the patient's blood pressure, this does support the student nurse's suggestion.

Possible conclusions may include:

- as trauma / injury will cause an increase in heart rate and metabolic rate the student nurse's suggestion is reasonable, however the measurements need to be compared to measurements taken before the operation before the suggestion can be regarded as valid
- as infection resulting from trauma or injury could also cause the raised measurements, this would need investigating before the suggestion could be regarded as valid

Accept any other suitable response.

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 **There are** two **forms of glucose:**

- **D glucose which occurs naturally in a wide range of foods and is a constituent of all polysaccharides**
- **L glucose which must be produced in a laboratory.**

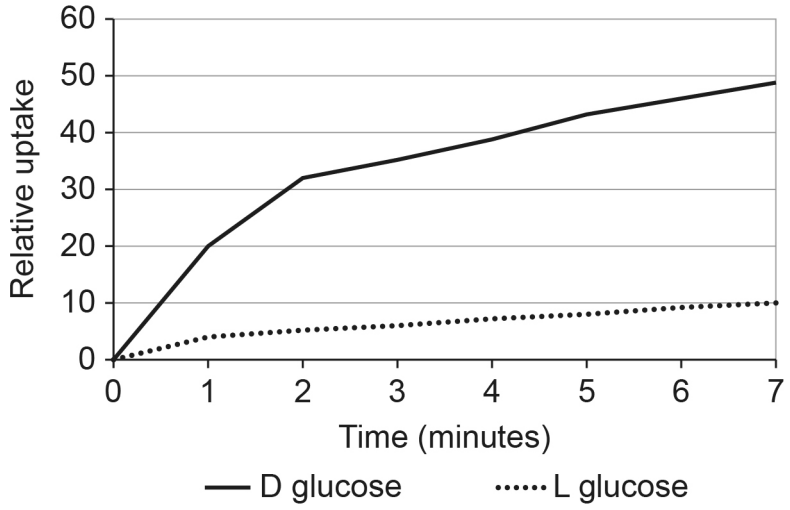
D glucose and L glucose have exactly the same taste, but the human body cannot metabolise L glucose and use it for energy.

A trial is being carried out to investigate if L glucose could be used as a healthy artificial sweetener by type 2 diabetics. The sweetener would help reduce their blood glucose levels but would allow them to eat sweet tasting foods.

Two volunteers each fasted for 6 hours, they then drank 100 ml of either 5% D glucose solution or 5% L glucose solution.

The relative rate that each type of glucose was absorbed into the blood stream is shown in Figure 3.

Figure 3: **Rate each type of glucose was absorbed**



Using the information provided and your knowledge of

- **absorption of glucose from the gut**
- **control of blood glucose levels**
- **role of glucose in the body.**

Discuss the potential use of L glucose as a healthy artificial sweetener for type 2 diabetics.

Your response should include reasoned judgements and conclusions.

[12 marks plus 3 for QWC]

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

Band	Mark	Descriptor
4	10–12	**AO3**: Discussion of the potential use of L glucose as a healthy artificial sweetener for type 2 diabetics is **comprehensive, effective and relevant,** showing **logical** and **coherent** chains of reasoning throughout. Information provided is used to **effectively** inform conclusions that are **fully** supported with **rational and balanced** judgements. **AO2**: Applied all **relevant** knowledge of the control of blood glucose level and the role of glucose and absorption from the gut to the given context. **AO1**: A **wide** range of **relevant** knowledge and understanding of the control of blood glucose levels and the role of glucose and absorption from the gut, which is **accurate** is evident. A **wide** range of **appropriate** technical terms are used consistently. The answer demonstrates **comprehensive** breadth and/or depth of understanding.
3	7–9	**AO3**: Discussion of the potential use of L glucose as a healthy artificial sweetener for type 2 diabetics is in **most** parts **effective** and mostly **relevant**, showing in most parts **logical** and **coherent** chains of reasoning. The information provided is in **most** parts used to effectively inform conclusions which are supported by judgements that consider **most** of the **relevant** arguments. **AO2**: Applied **mostly relevant** knowledge of the control of blood glucose levels and the role of glucose and absorption from the gut to the given context. **AO1**: Knowledge and understanding, of the control of blood glucose levels and the role of glucose and absorption from the gut is in **most** parts **clear** and in **most** parts **accurate**, although on **occasion** may lose focus. The answer demonstrates **reasonable** breadth and/or depth of understanding, with **occasional** inaccuracies and/or omissions.
2	4–6	**AO3**: Discussion of the potential use of L glucose as a healthy artificial sweetener for type 2 diabetics, is in **some** parts **effective** but at times may be of **little relevance**. **Brief** conclusions supported by judgements that consider only **basic** arguments and show **little relevance** to the question aims, are evident. **AO2**: Applied **limited** knowledge of the control of blood glucose levels and the role of glucose and absorption from the gut to the given context. **AO1**: Knowledge and understanding of the control of blood glucose levels and the role of glucose and absorption from the gut shows **some** but **limited accuracy, focus** and **relevance.** The answer is **basic** and shows **limited** breadth and/or depth of understanding, with inaccuracies and omissions.
1	1–3	**AO3**: Discussion of the potential use of L glucose as a healthy artificial sweetener for type 2 diabetics is **minimal** and **very limited** in

		effectiveness and **relevance**. Conclusions are **tenuous** and **mostly unsupported** and have **very little** relevance to the question. **AO2**: Applied **very limited** knowledge of the control of blood glucose levels and the role of glucose and absorption from the gut to the given context. **AO1:** Knowledge and understanding of the control of blood glucose levels and the role of glucose and absorption from the gut shows **very minimal accuracy, focus** and **relevance**. The answer has **isolated** points, showing **very minimal** breadth and/or depth of understanding, with **significant** inaccuracies and omissions.
	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: Demonstration of knowledge of the control of blood glucose levels and the role of glucose and absorption from the gut may include:

- glucose is absorbed into the blood from the gut / small intestine
- glucose is present in many foods and is also released as a product of digestion of more complex carbohydrates (maltose, starch)
- glucose will be released into the blood due to the action of glucagon when blood glucose levels are low
- glucose is one of the main energy sources of the body
- glucose is absorbed by cells and metabolised / broken down (in respiration) to release energy
- blood glucose levels must be maintained between an upper and a lower limit
- if blood glucose levels move above or below these limits this can cause severe damage to the body
- glucose levels are controlled by the actions of insulin and glucagon
- the pancreas secretes insulin and glucagon in response to changing blood glucose levels
- in type 2 diabetics the body becomes resistant to insulin and the cells cannot absorb glucose
- if the cells cannot absorb glucose from the blood it remains in the blood and blood glucose levels can rise to dangerous levels
- polysaccharides such as starch can be broken down in the gut to release D glucose.

AO2: Application of knowledge of the control of blood glucose levels and the role of glucose and absorption from the gut to the given context may include:

- the graph shows that the rate of D glucose absorption is around five times higher than that of L glucose during the time shown

- the use of L glucose instead of D glucose, would not stop D glucose production by the digestion of polysaccharides / starch from the diet entering the blood
- the graph shows that the rate of D glucose absorption starts to slow down after the first 2 minutes
- the graph shows that although the rate of D glucose slows after 2 minutes, it remains much higher than the rate for L glucose.
- the lower rate of L glucose uptake suggests more L glucose may remain in the gut
- the graph and the information provided, does not consider any glucose released into the blood by the action of glucagon
- the sample size was only two people
- the measurement of uptake of each form of glucose only took place over 7 minutes
- there is no information provided to indicate if changing L glucose levels can lead to insulin or glucagon secretion
- there is no information provided to show how L glucose is tolerated by the body
- the volunteers fasted, therefore there should be little or no food in their small intestine.

AO3: Discussion of the potential use of L glucose as a healthy artificial sweetener for type 2 diabetics may include:

- as L glucose is soluble and tastes exactly the same as D glucose, it could be used as an artificial sweetener
- as L glucose appears to be absorbed more slowly than D glucose, most of it may never enter the blood, therefore it is less likely to make blood glucose levels rise, even in type 2 diabetics, making it useful as a healthy artificial sweetener
- as L glucose cannot be metabolised / broken down, it will not be converted to fat and stored, making it useful as a healthy artificial sweetener
- as there is no information provided regarding whether L glucose will stimulate insulin / glucagon secretion, we do not know how it may affect diabetics
- as the graph suggests that more L glucose will be left in the small intestine, this may cause more water to remain in the small intestine, which could cause diarrhoea
- as the sample size used in the investigation was only two people the results may not be valid
- as the uptake was only measured over 7 minutes, a clear indication of the update of the two forms of glucose will not be given
- as fasting would lower blood glucose, this may cause glucose to be released into the blood due to the action of glucagon, however this should be the case for both the volunteers
- as the volunteers had fasted for 6 hours, the results should not be affected by absorption of glucose that may have already been present in the small intestine
- as L glucose needs to be manufactured and does not readily occur naturally, it may be too expensive to use as a sweetener.

Possible conclusions may include:

- due to the slower absorption of L glucose, and as it tastes the same as D glucose, it may be useful as an artificial sweetener for type 2 diabetics, however a much larger sample is required to make sure that these results are valid
- due to the slower absorption of L glucose, and as it tastes the same as D glucose, it may be useful as an artificial sweetener for type 2 diabetics, however further studies are required into how the body tolerates / possible side effects of L glucose, and whether it causes a homeostatic response.

Accept any other suitable response.

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.
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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	**Which one of the following is the property which allows a metal to be drawn into thin strips?** A **Conductive** B **Ductile** C **Malleable** D **Sonorous** [1 mark]

AO1 = 1 mark

Award **one** mark for the correct identification, up to a maximum of **one** mark:

B Ductile

9	**Which one of the following gives the products of an acid-base reaction?** A **Salt and hydrogen only** B **Salt and hydrogen peroxide only** C **Salt and water only** D **Salt, oxygen and water only** [1 mark]

AO1 = 1 mark

Award **one** mark for the correct identification, up to a maximum of **one** mark:

C Salt and water only

10 **A team of chemists is developing a new pain relief drug which can be used in a similar way to ibuprofen and paracetamol. They are interested in the acidity levels of the different drugs as this can affect how effective they are for patients. The table below shows the associated pH values of ibuprofen, paracetamol, and the new drug.**

Table 2**: pH values of paracetamol, ibuprofen and the new drug when in solution.**

Drug	pH
Paracetamol	**6**
Ibuprofen	**3**
New drug	**4**

(a) **Compare the hydrogen ion concentration of the drugs when in solution in** Table 2**. You should provide** two **comparisons.**

[2 marks]

AO2 = 2 marks

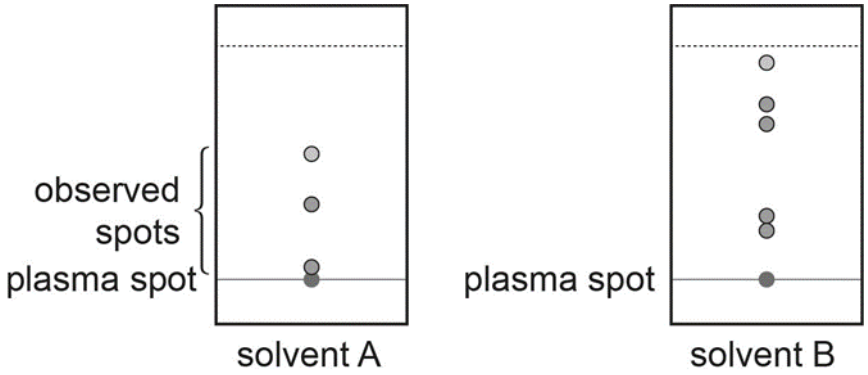
Award **one** mark for each comparison point, up to a maximum of **two** marks:

- hydrogen ion concentration is 1000 times higher in ibuprofen than paracetamol (1)
- hydrogen ion concentration is 10 times higher in Ibuprofen than the new drug (1)
- hydrogen ion concentration is 100 times higher in the new drug than paracetamol (1).

Accept any other suitable response.

Another team of chemists are interested in the products released into the bloodstream as ibuprofen is broken down by the body. They obtain a blood plasma sample from a patient currently taking ibuprofen.

Figure 4: **thin layer chromatography (TLC) chromatograms of a plasma sample in two different solvents.**



(b) **Explain the results shown on** each **chromatogram in** Figure 4.

[4 marks]

AO2 = 4 marks

Award **one** mark for each explanation point, up to a maximum of **four** marks:

- the chromatogram using solvent A shows three separate spots (1) this tells us that the plasma sample has three separate products which could be from the breakdown of ibuprofen (1)
- the chromatogram using solvent B shows five separate spots (1) this tells us that the plasma sample has five separate products which could be from the breakdown of ibuprofen (1)
- solvent B appears to be more polar than that of solvent A (1) as the spots have travelled further up the stationary phase (1).

Accept any other suitable response.

11 **A dentist has agreed to replace the two lower front teeth of a 24 year old patient. The dentist has decided to use dental implants. An apprentice working with the dentist, has been researching possible materials to use. They focus on two main materials: titanium metal and a ceramic named zirconia.**

The apprentice discovers that zirconia implants tend to have a slightly higher resistance to bacterial infection than titanium and they can be coloured to meet the patient's needs.

Table 3: **A comparison between titanium and zirconia.**

	Titanium	Zirconia
Average life span of implant	**20–30 years**	**15 –20 years**
Success rate after 1 year	**95.8%**	**90.9%**

The apprentice suggests that zirconia implants may be the most appropriate to use as the implants are at the front of the mouth.

Using Table 3 **and your knowledge of ceramics, assess the apprentice's suggestion.**

[3 marks]

AO3 = 3 marks

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

- the apprentice could be correct because zirconia implants can be coloured to meet the patient's needs which would be important as the implants are at the front of the mouth (1) and zirconia implants are less likely to lead to a bacterial infection meaning they are less likely to need further medical intervention (1) reducing the need for them to be replaced despite the lower average life span (1)
- the apprentice could be incorrect as titanium has a longer life span which might be more beneficial as this may reduce the need for replacements in the future (1) and titanium has a higher success rate which reduces the chance that they will need to be replaced after 1 year (1) reducing the need to return to the dentist at extra cost (1).

Accept any other suitable response.

12 **Health scientists are interested in developing a new type of polymer to use as drug packaging. They would like to use polypropene but need to produce it before they can test how suitable it is as drug packaging.**

The team of scientists carry out a reaction which produces polypropene. They use two different temperatures and also try using a catalyst. The data from this experiment are shown in Table 4.

Table 4: **Data from scientists' experiments**

Temperature (°C)	Was a catalyst used?	Rate of reaction (grams per second)	The percentage of polypropene in the final product (%)
30	**No**	**1.1**	**57**
60	**No**	**1.5**	**40**
30	**Yes**	**3.0**	**78**

One of the scientists concludes they are happy that an addition of a catalyst produces the best results.

With reference to collision theory and factors affecting rate of reaction, evaluate the scientist's conclusion.

Your answer should include reasoned judgements and conclusions.

[9 marks plus 3 for QWC]

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

Band	Mark	Descriptor
3	7–9	**AO3:** Evaluation of the scientist's conclusion 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. **AO2:** Applied **relevant** knowledge of collision theory and factors affecting rate of reaction using the data provided. Shows a **detailed** functional understanding of the scientific methodology involved. **AO1**: Demonstrates a **wide** range of relevant knowledge and understanding of collision theory and factors affecting rate of reaction which is accurate and detailed. The answer demonstrates **comprehensive** breadth and/or depth of understanding.

2	4–6	**AO3:** Evaluation of the scientist's conclusion is in **most parts effective** and **mostly relevant**, showing mostly **logical** and **coherent** chains of reasoning. Given conclusions supported by reasoned judgements that consider **most** of the relevant arguments. **AO2**: Applied relevant knowledge of collision theory and factors affecting rate of reaction using the data provided is in **most parts** appropriate, showing **some** functional understanding of the scientific methodology involved. **AO1:** Knowledge and understanding of collision theory and factors affecting rate of reaction are in **most parts** clear and **mostly accurate**, although on occasion may lose focus.
1	1–3	**AO3:** Evaluation of the scientist's conclusion 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. **AO2:** Applied **limited** knowledge of collision theory and factors affecting rate of reaction using the data provided and may show **insufficient** functional understanding of the scientific methodology involved. **AO1**: Knowledge and understanding of collision theory and factors affecting rate of reaction in this context shows **limited** accuracy, focus and relevance.
	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: Demonstration of knowledge regarding collision theory and factors affecting rate of reaction may include:

- collision theory states that for a reaction to occur molecules must:
  - collide
  - collide with enough energy to break and reform bonds
  - be in the correct spatial orientation

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

AO2: Application of knowledge of collision theory and factors affecting rate of reaction using the data may include:

- there is a greater percentage of polypropene produced at 30°C than 60°C
- 30°C has a slower rate of reaction than 60°C, this agrees with the principles of collision theory
- 30°C with the catalyst has the highest rate of reaction and highest percentage of polypropene produced, this is expected as a catalyst increases the rate of reaction
- we might expect a higher percentage of polypropene produced with a higher rate of reaction, but the data for 60°C doesn't show this. This could be an anomalous result
- the experiment has not been repeated
- the scientists only investigated two temperatures
- the scientists have only investigated one catalyst
- there is no information given on concentrations used in the initial reaction
- there is no information given on control measures.

AO3: Evaluation of collision theory and factors affecting rate of reaction using the data may include:

- the scientist is correct that using 30°C and a catalyst would be the best option to use, when looking at the data collected
- the scientist should consider repeating the investigation at least three times so they can identify any anomalous results and ensure the results are valid
- the scientist should consider investigating temperatures other than 30°C and 60°C, temperatures, between 30°C and 60°C might have a faster rate of reaction and a higher percentage of polypropene produced
- the scientist should consider investigating an alternative catalyst as this could produce an even higher rate of reaction / percentage of polypropene than the catalyst used initially
- the scientist could consider changing other variables in their investigation, for example, concentration of reactants.

Possible conclusions may include:

- although the scientist's conclusion is correct using the data they have collected, their investigation could be improved by investigating different factors which will lead to a more valid conclusion.

Accept any other suitable response.

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 **Which of the following is a property of mains electricity in the UK?**

A **Direct current**
B **Constant current of 50A**
C **Frequency of 60Hz**
D **Voltage of 230V**

[1 mark]

AO1 = 1 mark

Award **one** mark for the correct identification, up to a maximum of **one** mark:

D Voltage of 230V

14 **Some radioactive isotopes have very high count-rates.**

Define the term "count-rate".

[1 mark]

AO1 = 1 mark

Award **one** mark for the correct definition, up to a maximum of **one** mark:

- count-rate is the number of decays recorded each second.

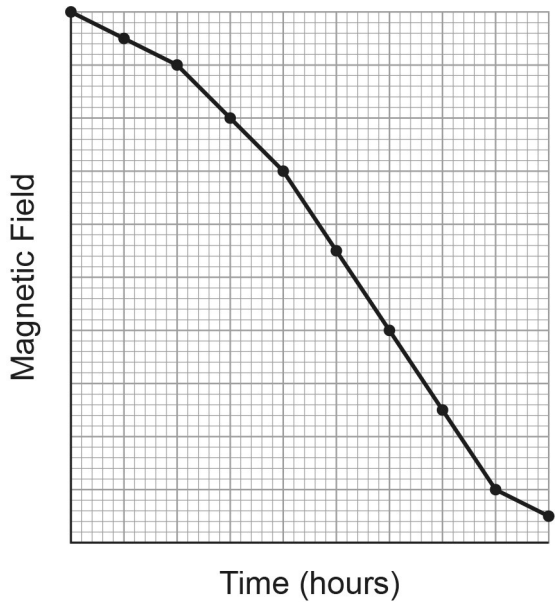
Accept any other suitable response.

15 **Electromagnets are commonly used in diagnostics such as magnetic resonance imaging (MRI).**

A scientist is developing a new type of electromagnet. They begin by taking an iron bar and placing it inside a coiled wire. Then a current is passed through the coil.

The scientist records the magnetic field strength of the bar over a few hours and plots the following graph shown in Figure 5**.**

Figure 5: **Magnetic field strength after applied current**



The scientist concludes the current through the wire decreases over time.

Use the information from Figure 5 **to explain the scientist's conclusion.**

[2 marks]

AO2 = 2 marks

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

- as time increases, the strength of the magnet decreases (1) which suggests the current in the wire is decreasing as this would reduce the strength of field produced by the conducting wire (1).

Accept any other suitable response.

16 **One use of ultrasound is to provide images of organs which can be used to guide surgeons during surgery.**

A sonographer is conducting an ultrasound image of a patient's kidney. They use a high-speed sound wave with a velocity of 1560m/s and a wavelength of 0.00039m.

Using the following equation to help you, calculate the frequency of this sound wave. You must show your working and provide the correct unit for frequency.

$$\boldsymbol{v = f\lambda}$$

[4 marks]

AO2 = 4 marks

Award **one** mark for correct use and rearrangement of the equation, up to a maximum of **one** mark:

$f = \frac{v}{\lambda}$

Award **one** mark for correctly substituting the values provided, up to a maximum of **one** mark:

$f = \frac{1560}{0.00039}$

Award **one** mark for correctly calculating the frequency, up to a maximum of **one** mark:

- $f = 4{,}000{,}000.$

Award **one** mark for providing the correct unit for frequency, up to a maximum of **one** mark:

- Hz/Hertz (1).

NB: accept an equivalent answer, for example, 4 MHz or 4 x 10^6 Hz.

17 **A trainee is assisting a GP with a 15 year old patient suffering with a facial wart. The GP is worried about scarring if the wart is removed by surgery.**

The trainee decides to research complementary therapies. They find a study which used microwaves to cure a verruca in a 41 year old male.

The study reported that the verruca was fully healed after 3 weeks, two treatments were required and no scarring on the foot was present afterwards.

They think, as a verruca is type of wart, the same treatment could be considered for their patient.

Using the information above, assess the use of microwaves as a treatment for facial warts.

[3 marks]

AO3 = 3 marks

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

- the treatment shows promise as the main concern was facial scarring and the study reported no scarring (1) however, the study only had a sample size of one patient (1), the patient with the wart might react very differently to microwave treatment compared to the study patient (1)
- the patient in the study is an adult and can therefore consent to new / novel / potentially dangerous treatments using microwaves (1) the patient with a facial wart is young and is not able to consent to this (1) the trainee would have to discuss the option with a parent / carer / guardian (1)
- the study was only carried out on the foot of the patient, the skin on the feet is thicker / tougher than the skin on the face (1), additionally the skin of the 15 year old patient will still be developing / be even more delicate due to their age (1) the patient may not want to risk trying a new microwave treatment on the face as any problems / potential scarring / redness may be very visible (1).

Accept any other suitable response.

18 **Radioisotopes are commonly used to treat bone cancers and are absorbed by bone cells. Each isotope emits energy destroying neighbouring cancerous cells.**

A team of healthcare scientists is investigating three different radioisotopes for bone cancer treatments.

These are:

- **Radium-223 (^{223}Ra)**
- **Strontium-89 (^{89}Sr)**
- **Iodine-131 (^{131}I).**

The scientists are provided with the following data shown in Table 5.

Table 5: **Preliminary data of the radioisotopes studied.**

Radioisotope	Ionising radiation emitted	Half-life (days)
^{223}Ra	**alpha**	**11.4**
^{89}Sr	**beta**	**50.5**
^{131}I	**beta and gamma**	**8**

A scientist suggests that ^{89}Sr is too dangerous to use because it has the longest half-life.

With reference to your knowledge of ionising radiation, radioactive decay and half-life, discuss the scientist's suggestion.

Your answer must include reasoned judgements and conclusions.

[9 marks plus 3 for QWC]

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

Band	Mark	Descriptor
3	7–9	**AO3**: Discussion of the scientist's suggestion is **comprehensive**, **effective** and **relevant**, showing detailed understanding and logical and **coherent** chains of reasoning throughout. Effectively informed judgements and conclusions that are **fully supported** and **rational** are evident. **AO2:** Application of knowledge of ionising radiation, radioactive decay and half-life using the data provided is **highly appropriate** and shows a detailed functional understanding.

		AO1: There is a wide range of **relevant knowledge** and understanding of ionising radiation, radioactive decay and half-life, that is **accurate** and **detailed**. The answer demonstrates **comprehensive** breadth and/or depth of understanding.
2	4–6	**AO3:** Discussion of the scientist's suggestion is in **most parts effective** and **mostly relevant**, showing mostly logical and coherent chains of reasoning throughout. There are **mostly accurate** judgements and **mostly rational** and balanced conclusions are evident. **AO2:** Application of knowledge of ionising radiation, radioactive decay and half-life using the data provided is in **most parts appropriate**, showing some functional understanding. **AO1:** Knowledge and understanding of the properties of ionising radiation, radioactive decay and half-life is in **most part clear** and **mostly accurate**, although on occasion may lose focus. The answer demonstrates **reasonable** breadth and / or depth of understanding with occasional inaccuracies and / or omissions.
1	1–3	**AO3:** Discussion of the scientist's suggestion 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**, and conclusions will have **limited** rationality and balance. **AO2:** Application of knowledge of ionising radiation, radioactive decay and half-life using the data provided is **limited** and may show a lack of functional understanding. **AO1:** Knowledge and understanding of ionising radiation, radioactive decay and half-life shows some but **limited** accuracy, focus and relevance. The answer is **basic** and shows **limited** breadth and / or depth of understanding with inaccuracies and omissions.
0	0	No credit worthy material

Indicative content

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

AO1: Demonstration of knowledge regarding ionising radiation, radioactive decay and half-life may include:

- the types and properties of ionising radiation:
  - alpha:
    - high ionising but low penetrating power
    - range is 1 to 2 centimetres of air

        - consists of 2 neutrons and 2 protons and is equivalent to a helium nucleus
    - beta:
        - medium ionising and penetrating power
        - range is approximately 15 centimetres of air
        - a high-speed electron ejected from the nucleus as a neutron turns into a proton
    - gamma:
        - low ionising and high penetrating power
        - range is many kilometres of air
        - electromagnetic radiation from the nucleus
- half-life – the time taken for half the unstable nuclei in a sample to decay
- ionisation – by causing electrons to break apart from atoms or molecules.

AO2: Application of knowledge of ionising radiation, radioactive decay and half-life using the data provided may include:

- Radium-223 emits alpha radiation, which is highly ionising but has low penetrating power, it is extremely dangerous once inside the body as it is heavy / large and will do a lot of damage to (healthy) cells
- Radium-223 has a half-life of 11.4 days, it will decay slower than iodine-131 but faster than strontium-89
- Strontium-89 emits beta radiation which is medium ionising and has medium penetrating power. This means it will damage cells it comes into contact with but can escape the body. Beta radiation is less dangerous inside the body than alpha.
- Strontium-89 has the longest half-life, it will decay slower than radium-223 and iodine-131
- Iodine-131 emits beta and gamma radiation, both are less damaging inside the body than alpha and can escape the body once inside
- Iodine-131 has the shortest half-life of 8 days, it will decay faster than both strontium-89 and radium-223.

AO3: Discussion of ionising radiation, radioactive decay and half-life using the data provided may include:

- the scientist is correct in saying a long half-life poses more danger than a shorter half-life would as the radioisotope would remain in the patient's body for longer than necessary but this does not mean it is the most dangerous as the type of radiation emitted is very important too
- the scientist needs to consider that even though radium-223 has a shorter half-life than strontium-89 it emits alpha radiation. This is extremely dangerous once inside a person's body as it is relatively large and highly ionising. This will damage more cells that strontium-89, including healthy cells
- the scientist should consider using iodine-131 rather than strontium-89 as they both emit beta radiation but the iodine-131 has a shorter half-life. This means that the radioisotope would decay faster and the patient would not need to isolate for as long as with strontium-89
- consideration would need to be given to the amount of gamma radiation emitted by iodine-131 as this might damage cells due to its high penetrating power. This means the gamma radiation would not remain in the area intended and would be able to spread across the body / out of the body and harm other organs / cells or other people close to the patient.

Accept any other suitable response.

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)

19 **A 20 year old man requires an investigation of a possible tumour in the testes. His medical records show that he has had metal plates inserted into the left side of his pelvis.**

The aim of the investigation is to produce a detailed image of the size and extent of the possible tumour, its blood supply and relationship with the surrounding tissue. This will then be used to plan suitable treatment.

Evaluate the use of the following diagnostic techniques in this situation:

- **MRI**
- **X-ray**
- **Ultrasound.**

Your response should include reasoned judgements and conclusions.

[9 marks plus 3 for QWC]

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

Band	Mark	Descriptor
3	7–9	**AO3 –** Evaluation of the diagnostic techniques in this situation is **comprehensive**, **effective** and **relevant**, showing **logical** and **coherent** chains of reasoning throughout that are **fully** supported with **rational** and **balanced** judgements. **AO2 – All relevant** knowledge of the diagnostic techniques and their potential effect on sperm production is applied **effectively** to the given context. **AO1 –** A **wide** range of relevant knowledge and understanding of diagnostic techniques and their potential effect on sperm production is evident. A **wide** range of **appropriate** technical terms are used. The answer demonstrates **comprehensive** breadth and or depth of understanding.
2	4–6	**AO3 –** Evaluation of the diagnostic techniques in this situation, is in **most** parts **effective** and **mostly relevant**, showing in **most** parts **logical** and **coherent** chains of reasoning, which are **mostly** supported with rational and balanced judgements. **AO2 – Most of the** relevant knowledge of the diagnostic techniques and their potential effect on sperm production are applied **mostly effectively** to the given context, although on occasions there **may** be a lack of clarity.

		AO1 – Knowledge and understanding of the diagnostic techniques and their potential effect on sperm production is in **most** parts **clear** and in **most** parts **accurate**, although on **occasion** may lose focus. The answer demonstrates **reasonable** breadth and/or depth of understanding, with occasional inaccuracies and/or omissions.
1	1–3	**AO3 –** Evaluation of the diagnostic techniques in this situation is in **some** parts **effective** but may **at times** have **little relevance**. **Brief** conclusions supported by judgements that consider only **basic** arguments and show **tenuous** relevance to the question aims are evident. **AO2 – Limited** knowledge of the diagnostic techniques and their potential effect on sperm production, is **applied** to the given context. **AO1 –** Knowledge and understanding of diagnostic techniques and their potential effect on sperm production, shows **some** but **limited accuracy, focus** and **relevance.** 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 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: Demonstration of knowledge of diagnostic techniques and their potential effect on sperm production may include:

- testes are the site of sperm production
- during sperm production DNA will be constantly replicating
- DNA can change spontaneously leading to variation / mutation
- the pelvis is close to the testes
- MRI uses a very strong magnetic field
- MRI is not ionising
- MRI can image both bones and soft tissue
- MRI can provide a very precise image
- X-rays are a form of ionising radiation
- X-rays are mostly used to image bones
- X-rays pass through the body
- ionising radiation can kill cells
- ionising radiation can alter DNA
- ultrasound passes high frequency sound waves into the body and analyses the echo
- ultrasound is not ionising.

AO2: Application of knowledge of the diagnostic techniques and their potential effect on sperm production, to the given context may include:

- the man is 20 and therefore may want to have children in the future
- X-rays are likely to affect the testes due to their proximity / closeness to the potential tumour
- MRI scans and ultrasound should not affect the testes despite being close to the potential tumour
- no detail is provided about the type of metal used for the plates inserted into the pelvis
- steel plates maybe affected / dislodged by the MRI
- an MRI scan is likely to produce the most detailed image of the potential tumour as it is soft tissue.

AO3: Evaluation of the diagnostic techniques and their potential effect on sperm production, to the given context may include:

- the ionising radiation of X-rays could kill the sperm producing cells, leading to sterility or low sperm count thus preventing fathering children in the future, therefore ultrasound may be a better choice in this situation
- the ionising radiation of X-rays could lead to sperm production in which the DNA has been changed, this could have serious consequences for a child conceived with this sperm, therefore ultrasound may be a better choice in this situation
- due to the proximity / closeness of the potential tumour to the testes it is unlikely to be possible to shield the testes from the ionising radiation, therefore ultrasound may be a better choice in this situation
- as X-rays are mainly used for imaging bones, they are less likely to be suitable for producing a detailed image of the potential tumour, therefore ultrasound may be a better choice in this situation
- if the metal used in the plates in the pelvis is steel, an assessment will need to be made of the risk posed by the MRI against the advantages the detailed MRI image will give in planning treatment, or the use of one of the other diagnostic techniques should be considered
- if the metal used is nonmagnetic, for example, titanium the plates will not be affected by the MRI, therefore it could be used in this situation
- MRI machines are expensive and less available than the X-rays and ultrasound, therefore the patient may be required to wait longer for an appointment. This could cause problems as the potential tumour could grow, or the use of one of the other diagnostic techniques could be considered
- as ultrasound is not ionising or involving a magnetic field, it should not cause any damage to the testes or the metal plates, whereas both X-rays and MRI scans could
- ultrasound can provide a clear image, but it is not likely to be sufficient for the requirements of the investigation, therefore one of the other diagnostic techniques needs to be considered.

Possible conclusions may include:

- possible tumour is in the testes and ionising radiation could damage sperm production, combined with the fact that X-rays do no provide clear images of soft tissues, means that X-rays are not suitable in this situation
- as ultrasound will not affect the metal plates and will not damage sperm production it can be used safely but is unlikely to provide a clear image of the potential tumour
- an MRI scan will provide the most detailed image of the possible tumour and therefore would be the best diagnostic technique to use, providing that the assessment of the likelihood of damage to the metal plates is minimal
- other diagnostic techniques may need to be considered, (for example, biopsies) as all of the three diagnostic techniques mentioned may not be suitable.

Accept any other suitable response.

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	**It is essential to sterilise materials used in medicine. Inadequate sterilisation could lead to the presence of pathogens which could enter the body and cause disease.** **High temperatures or chemical agents are often used to sterilise materials; however, they cannot be used with temperature sensitive products intended for human consumption, as they could damage the product or leave traces of toxic chemicals behind.** **During a discussion on infection control, a trainee health worker states:** **'Ionising radiation could be used to sterilise these products, and gamma rays would be much more suitable than alpha or beta radiation at preventing contamination with causative agents of infection.'** **Using the information provided and your knowledge of the properties and effects of the different forms of ionising radiation, evaluate this statement.** **Your response should include reasoned judgements and conclusions.** [9 marks plus 3 for QWC]

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

Band	Marks	Descriptor
3	7–9	**AO3 –** Evaluation of the statement is **comprehensive**, **effective** and **relevant**, showing **logical** and **coherent** chains of reasoning throughout that are **fully** supported with **rational** and **balanced** judgements. **AO2 – All relevant** knowledge of the different forms of radiation and their properties and effects, is applied **effectively** to the given context. **AO1 –** A **wide** range of relevant knowledge and understanding of different forms of radiation and their properties and effects is evident. A **wide** range of **appropriate** technical terms are used. The answer demonstrates **comprehensive** breadth and / or depth of understanding.
2	4–6	**AO3 –** Evaluation of the statement, is in **most** parts **effective** and **mostly relevant**, showing in **most** parts **logical** and **coherent** chains of reasoning, which are **mostly** supported with rational and balanced judgements. **AO2 – Most of the** relevant knowledge of the different forms of radiation and their properties and effects, are applied mostly **effectively** to the given context, although on occasions there **may** be a lack of clarity. **AO1 –** Knowledge and understanding of the different forms of radiation and their properties and effects is in **most** parts **clear** and in **most** parts **accurate**, although on **occasion** may lose focus. The answer demonstrates **reasonable** breadth and / or depth of understanding, with occasional inaccuracies and / or omissions.

1	1–3	**AO3 –** Evaluation of the statement is in **some** parts **effective** but may **at times** have **little relevance**. **Brief** conclusions supported by judgements that consider only **basic** arguments and show **tenuous** relevance to the question aims are evident. **AO2 – Limited** knowledge of the different forms of radiation and their properties and effects, is **applied** to the given context. **AO1 –** Knowledge and understanding of the different forms of radiation and their properties and effects, shows **some** but **limited accuracy, focus** and **relevance.** 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 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: Demonstration of knowledge of the different forms of radiation and their properties and effects may include:

- all forms of ionising radiation can remove electrons from materials they irradiate
- gamma radiation is a form of ionising radiation
- gamma radiation is highly penetrating
- gamma radiation does not contaminate the product being sterilised
- alpha radiation is ionising
- alpha radiation has low penetration
- beta radiation is ionising
- beta radiation has medium penetration
- causative agents of infection include:
  - bacteria
  - viruses
  - fungi
  - prions
  - protoctists
  - parasites.

AO2: Application of knowledge of the different forms of radiation and their properties and effects, to the given context may include:

- ionising radiation can kill microbes in the products by damaging their DNA / removing electrons from their DNA
- gamma radiation will penetrate / pass through the product being sterilised as it is highly penetrating, reaching all parts of the product

- gamma radiation will be able to pass through the packaging of the product
- alpha radiation will not be able to enter the product as it has very low penetration
- beta radiation may be able to enter the product but will not pass all the way through and will not reach all parts of the product
- as ionising radiation can remove electrons from materials, it could change the nature of the product
- using ionising radiation, does not involve raising the temperature of the product therefore it will not be damaged by high temperatures.

AO3: Evaluation of the different forms of radiation and their properties and effects, to the given context may include:

- as gamma radiation can pass completely through the product it can reach all parts, alpha and beta could not do this, therefore gamma is much more suitable than alpha or beta radiation in this situation
- as gamma radiation is ionising and can pass completely through the product, it can kill microbes present throughout the product and therefore completely sterilise it, therefore it is much more suitable than alpha and beta radiation in this situation
- as gamma radiation can pass through the packaging of the product, the product can be packaged before sterilisation, this eliminates the chances of contamination during the packaging process. Alpha and beta radiation cannot do this, therefore gamma radiation is much more suitable in this situation
- as any ionising radiation could change the nature of the product, tests would have to be carried out to ensure the product was still fully functional after irradiation
- if ionising radiation is likely to change the nature of the product, gamma radiation is likely to be the most suitable form of radiation, as it is the least ionising therefore least likely to change the nature of the product.

Possible conclusions may include:

- as gamma radiation is the only form of ionising radiation which can reach all parts of the product being sterilised, the statement that it is the only form of ionising radiation suitable is correct
- as gamma rays are a form of ionising radiation and can remove electrons from materials, it is possible that it could alter / damage the product which may no longer be viable / do its job. Therefore, it is possible that all forms of ionising radiation are unsuitable
- if gamma rays are unsuitable, then other forms of sterilisation may need to be considered.

Accept any other suitable response.

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

Section B

Question Number	AO1	AO2	AO3	Maths	QWC	Total
8	1					1
9	1					1
10 (a)		2				2
10 (b)		4				4
11			3			3
12	3	3	3		3	12
Total	**5**	**9**	**6**		**3**	**23**
Totals required	**5–6**	**8–9**	**6–7**		**3**	**23**
Kil	**2**					

Section C

Question Number	AO1	AO2	AO3	Maths	QWC	Total
13	1					1
14	1					1
15		2				2
16		4		4		4
17			3			3
18	3	3	3		3	12
Total	**5**	**9**	**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
	6	**6**	**6**		**6**	**24**
Totals required	**4–6**	**4–6**	**4–6**		**6**	**24**
Kil	**0**					
Total marks				**6**	**18**	**118**

Document information

Owner: Head of Assessment Design