T-LEVELS | Institute for Apprenticeships & Technical Education

T Level Technical Qualification in Science

Core knowledge and understanding

Paper B

Mark scheme

V1.1: P001932
Post-standardisation
Summer 2023
603/6989/9

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 mark for each question.

Marking guidelines

General guidelines

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

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

Guidelines for using extended response marking grids

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

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

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

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

Application of extended response marking grids

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

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

Assessment objectives

This assessment requires students to:

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

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

Section A: Biology

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

1 **A pathology technician is using the Giemsa stain technique on a sample of sputum from a patient.**

Which one **of the following statements describes** one **purpose of the Giemsa stain technique?**

A To identify Gram-positive and Gram-negative bacteria
B To identify specific bacteria or parasites
C To give an image of the cytoplasmic components of an animal cell
D To stain viruses so they can be viewed under the light microscope

[1 mark]

AO1 = 1 mark

Award **one** mark:

B To identify specific bacteria or parasites (1).

2 **A virologist needs to examine the structure of the outer surface of a virus.**

Which one **of the following is the most appropriate type of microscope to examine the structure?**

A Compound microscope
B Light microscope
C Scanning electron microscope
D Transmission electron microscope

[1 mark]

AO1 = 1 mark

Award **one** mark:

C Scanning electron microscope (1).

3(a) **Two organisms have the following volumes:**

- organism A **volume = 62,000 cm^3**
- organism B **volume = 4.8 cm^3**

Explain why organism A **is most likely to require a specialised gaseous exchange surface.**

[2 marks]

AO2 = 2 marks

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

- as organism A has a much larger volume, its surface area / SA to volume / V ratio is likely to be much smaller than organism B (1). An organism with a small surface area / SA to volume / V ratio cannot exchange enough gases through its surface and therefore requires a specialised (gaseous) exchange surface (1).

Accept any other suitable response.

3(b) **Describe why these specialised gaseous exchange surfaces are often only one cell thick.**

[1 mark]

AO1 = 1 mark

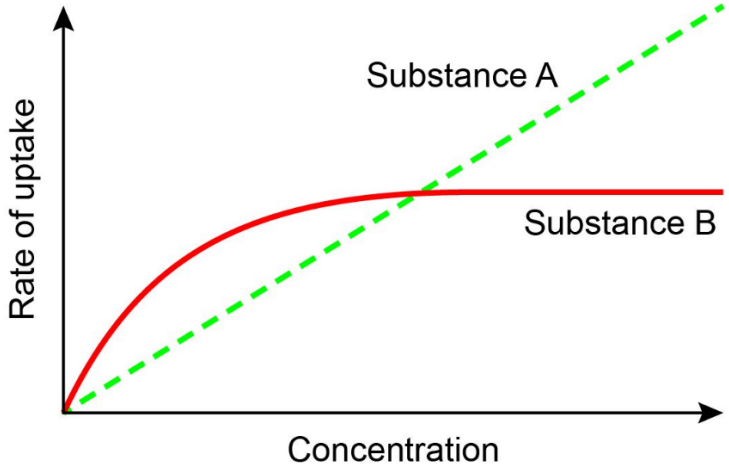
Award a maximum of **one** mark:

- reduces the diffusion pathway / ensures a short diffusion pathway (1)
- diffusion through a thin exchange surface / one cell thick exchange surface will be quick (1).

Accept any other suitable response.

3(c) **A scientist wanted to investigate the differences between simple diffusion and facilitated diffusion. They did this by measuring the concentration of** two **different substances in the same cell over a period of time. They calculated the rate of uptake and produced the graph shown in** Figure 1**.**

Figure 1: **A graph to show rate of uptake of two different substances into the same cell**



The scientist concluded that substance B moved into the cell by simple diffusion and substance A moved into the cell by facilitated diffusion.

Assess the scientist's conclusion.

[3 marks]

AO3 = 3 marks

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

- Substance A's line shows that rate of uptake increases as concentration increases, this is more likely to be simple diffusion (1)
- Substance B's line levels off / plateaus, this is likely to show that carrier proteins / facilitated diffusion channels are saturated / full / used which is more likely to be facilitated diffusion (1)
- Substance B's line could also show active transport was used; it could level off / plateau due to a lack of (ATP to provide) energy for the uptake of substance B (1)
- Substance B's line could also show co-transport; it could level off / plateau as the transport proteins are saturated / full / used (1)
- The scientist could be correct but further investigation into other factors that affect the rate of diffusion, for example diffusion distance / temperature, would be needed to make reliable conclusions (1).

Accept any other suitable response.

4(a) Figure 2: **Diagram of three amino acids joined together**

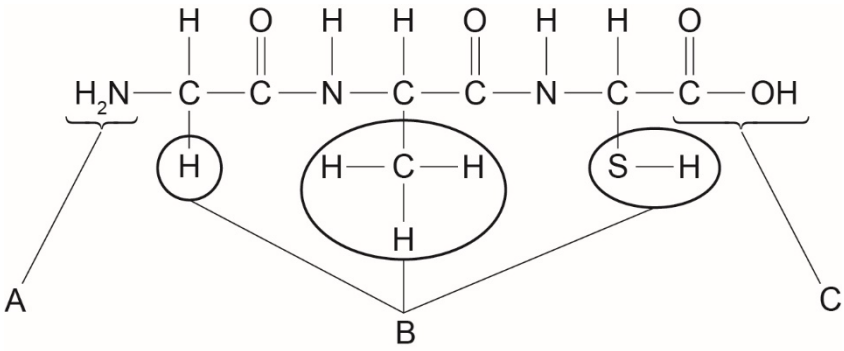


Figure 2 **represents a simple diagram of three amino acids which have been joined together during the formation of a larger polypeptide.**

Identify groups A, B **and** C.

[3 marks]

AO1 = 3 marks

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

- A – Amine (group) (1)
- B – R (group) (1)
- C – Carboxyl (group) (1).

4(b) **State the name of the reaction which occurs when amino acids join to form dipeptides and polypeptides.**

[1 mark]

AO1 = 1 mark

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

- condensation (reaction) (1).

5(a) Table 1 **shows the amount of energy available from three different respiratory substrates, expressed as kilojoules of energy per gram (kJg^{-1}) of substrate.**

Table 1: **Amount of energy from three different substrates**

Respiratory substrate	Energy value / kJg^{-1}
Carbohydrate	**15.8**
Lipid	**39.4**
Protein	**17**

A culture of bacteria was grown on an agar plate containing 12g of carbohydrate.

Calculate the maximum amount of energy available to the bacteria from this plate, show your working and include appropriate units.

[2 marks]

AO2 = 2 marks

Award **two** marks for correct answer with correct working and units.
Award **one** mark for correct answer with units but no working.
Award **zero** marks for correct answer with no working or units.

First mark:
Carbohydrate = 12 x 15.8 = 189.6 (1)

Second mark:
189.6 kJ (1)

5(b)	**Calculate the** percentage **of energy that would be provided by carbohydrate, if 3g of protein was added to the plate in question 5a.** **[2 marks]**

AO2 = 2 marks

Award **one** mark for calculating the total energy now available from the plate:

189.6 + (3 x17) = 240.6 (kJ) (1)

Award **one** mark for calculating the percentage:

(189.6 / 240.6) x 100 = 78.8%

Award **two** marks for correct answer without the use of the percentage symbol.

5(c)	**Give** one **function of carbohydrates and** one **function of lipids, other than as a respiratory substrate.** [2 marks]

AO1 = 2 marks

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

Carbohydrates
- energy storage, for example, starch / glycogen (1)
- structural, for example, cellulose (1).

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

Lipids
- energy storage (1)
- insulation (1)
- provide flexibility in plasma / cell membranes (1)
- provide transport mechanisms in cell membranes (1).

Accept any other suitable response.

5(d) **'Lipids are a better source of energy for respiration than carbohydrates'.**

Use the information above and your knowledge of the structure and properties of carbohydrates and lipids to discuss the validity of this statement.

[3 marks]

AO3 = 3 marks

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

- as lipids have more available energy / contain a higher amount of energy (per gram) than carbohydrates, this supports the statement (1)
- although lipids contain a higher amount of energy (per gram) than carbohydrates, they may need to be digested before they can be used for respiration, making them more difficult to use. This does not support the statement (1)
- lipids are insoluble in water, this will make them more difficult to transport to the sites of respiration, which does not support the statement (1)
- if the carbohydrates are monosaccharides / simple sugars, as these are soluble in water, they are easier to transport to the sites of respiration. This does not support the statement (1)
- if the carbohydrate is in the form of complex polysaccharides this would require digestion before transport to the site of respiration, making it more difficult to use. This does support the statement (1).

Accept any other suitable response.

6(a) **Describe what happens to the number of chromosomes per nuclei in** one **complete cycle of mitosis and** one **complete cycle of meiosis.**

[2 marks]

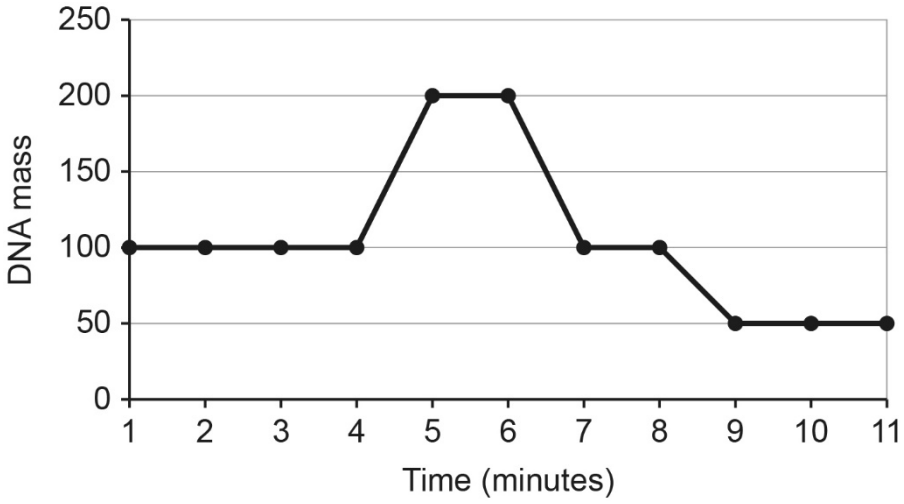
AO1 = 2 marks

AO1: Award **one** mark for each description up to a maximum of **two** marks:

- in mitosis the number of chromosomes in each daughter nuclei is the same at the end of cell division as at the beginning (1)
- in meiosis the number of chromosomes in each daughter nuclei is halved by the end of the process compared to the beginning (1).

6(b) Figure 3 **shows the changes in DNA mass during one complete cell cycle in a human.**

Figure 3: **Change in DNA mass during cell division over time**



Explain whether Figure 3 **represents meiosis or mitosis.**

[2 marks]

AO2 = 2 marks

AO2: Award **one** mark for correctly identifying meiosis and **one** mark for a correct reason:

Type of cell division

- meiosis (1).

Reason

- the graph shows that the mass of DNA at the start of the cell cycle is 100 in each cell and at the end it is 50 (1)

or

- if the graph represented mitosis the mass of DNA at the end of the cell cycle would still be 100 (1).

Accept any other suitable response.

6(c) **Give the reason for the change in DNA mass between 4 and 6 minutes in** Figure 4 **based on this type of cell division.**

[1 mark]

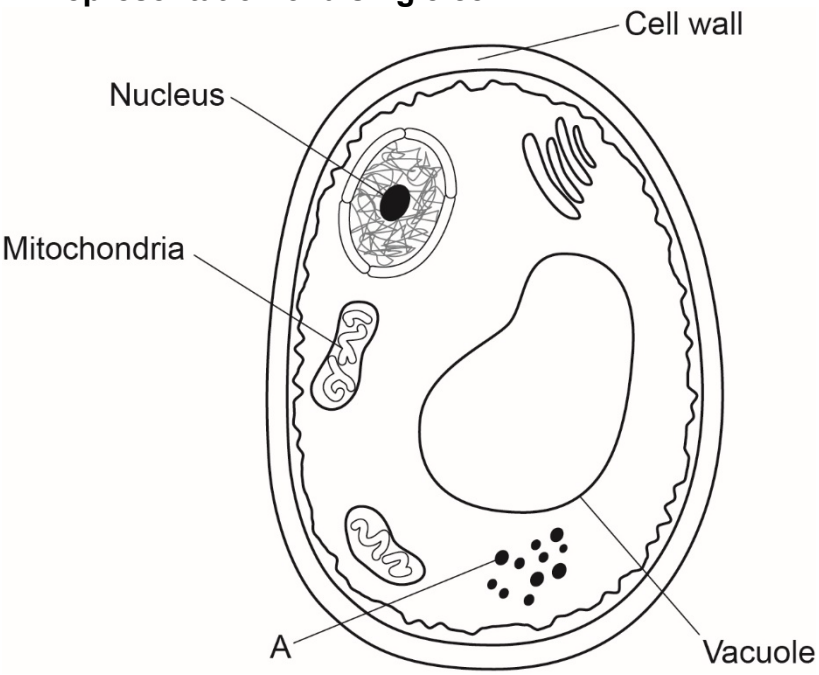
AO2 = 1 mark

Award a maximum of **one** mark for **either** of the organs shown below:

- DNA mass doubles as the chromosomes replicate ahead of meiosis 1 (1).

7(a) Figure 4 **is a diagrammatic representation of a single cell.**

Figure 4: **Representation of a single cell**



(i) Identify the structure labelled as 'A' in the diagram.

[1 mark]

(ii) State the function of structure A.

[1 mark]

AO1= 2 marks

7a(i) AO1: Award **one** mark:

- ribosomes.

7a(ii) AO1: Award a maximum of **one** mark:

- protein synthesis (1)
- translation (1).

7(b) **Give** one **feature from** Figure 4 **that proves this cell is a eukaryote** and **state its function.**

[2 marks]

AO1 = 1 mark
AO2 = 1 mark

Award a maximum of **one** mark (AO2) for giving the feature and **one** mark (AO1) for stating its function:

Feature:

- mitochondria (1)
- (membrane-bound) nucleus (1)
- Golgi apparatus / body (1).

Do not accept ribosomes / small ribosomes as no scale is provided.

Function:

- mitochondria – site of respiration (1)
- nucleus – contains genetic material / chromosomes / DNA (1)
- Golgi apparatus – protein processing / transport (1).

7(c) **A student makes the conclusion that** Figure 4 **represents a single plant cell from a plant root.**

Discuss the extent to which this conclusion can be supported.
Your response must demonstrate reasoned judgements and conclusions.

[3 marks]

AO3 = 3 marks

Award **one** AO3 mark for each correct evaluative point up to a maximum of **three** marks:

- as the cell has a cell wall and a (permanent) vacuole, both of which are found in plant cells, this supports the statement (1)
- if the cell was from a plant root, there would be no need for chloroplasts as the root does not receive light, this supports the statement (1)
- if the cell was from inside the stem of the plant, there would be no need for chloroplasts as it would not receive sunlight, this does not support the statement (1)
- there may be other types of eukaryotic cell (in addition to plants) that do have cell walls / vacuoles but no chloroplasts, this does not support the statement (1).

Accept any other suitable response.

8	**All antibodies are proteins, which have a variable region. The shape of this variable region is complementary to the shape of the antigen.** **The shape of the variable region is vital for the correct functioning of the antibody.** **'For antibodies to function, the R groups of the amino acids are more important than the amine or carboxyl groups, as antibodies are proteins, and the R group is responsible for the tertiary structure of proteins.'** **Evaluate this statement.** **Your response should demonstrate reasoned judgements and conclusions.** [12 marks plus 3 marks for QWC]

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

Level	Marks	Descriptor
Level 4	10-12	**AO3:** Evaluation of the statement in relation to knowledge of R, amine and carboxyl groups and tertiary structure of proteins, **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 **all relevant** knowledge of R, amine and carboxyl groups and tertiary structure of proteins **effectively** showing a **detailed** functional understanding. This is **effectively** linked to the context provided. **AO1:** A **wide** range of relevant knowledge and understanding of R, amine and carboxyl groups and tertiary structure of proteins is demonstrated, which is **accurate** and **detailed**. A **wide** range of **appropriate** technical terms are used.
Level 3	7-9	**AO3:** Evaluation of the statement in relation to knowledge of R, amine and carboxyl groups and tertiary structure of proteins, is in **most** parts effective and **mostly** relevant, showing **mostly** logical and coherent chains of reasoning. Makes conclusions **mostly** supported by reasoned judgements that consider **most** of the relevant arguments. **AO2:** Applied **mostly** relevant knowledge of R, amine and carboxyl groups and tertiary structure of proteins showing **some** functional understanding. This linked **mostly** effectively to the context provided.

		AO1: Knowledge and understanding of R, amine and carboxyl groups and tertiary structure of proteins, is in **most** parts clear and **mostly** accurate, although on **occasion** may lose focus.
Level 2	4-6	**AO3:** Evaluation of the statement in relation to knowledge of R, amine and carboxyl groups and tertiary structure of proteins, 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 **little** but some **knowledge** of R, amine and carboxyl groups and tertiary structure of proteins, but this is **limited** and **may** show a **lack** of functional understanding. Linking to the context is **attempted** but **not** always clear. **AO1:** Knowledge and understanding of how R, amine and carboxyl groups and tertiary structure of proteins shows **some** but **limited** accuracy, focus and relevance.
Level 1	1-3	**AO3:** Evaluation of the statement in relation to R, amine and carboxyl groups and tertiary structure of proteins is **minimal** and **very limited** in effectiveness and relevance. Gave **brief** conclusions supported by judgements that consider only **basic** arguments and show **little** relevance to the question aims. **AO2:** Applied limited knowledge of R, amine and carboxyl groups and tertiary structure of proteins, showing a very limited functional understanding. Linking to the context, is **not** attempted or **inappropriate**. **AO1:** Knowledge and understanding of R, amine and carboxyl groups and tertiary structure of proteins, shows **very minimal** accuracy, focus and relevance.
	0	No creditworthy material.

Indicative Content

AO1:

- the R group is a variable group present in all amino acids
- the R group can exist in 20 different forms
- proteins are made up of many amino acids
- the carboxyl group of 1 amino acid reacts with the amine group of another amino acid to form a peptide bond
- peptide bonds link amino acids together to form polypeptides
- the R group of a specific amino acid can form bonds with the R group of another specific amino acid
- antibodies counteract / destroy / neutralise the antigen which has triggered their production
- antigens are found on the surface of all cells and viruses and can trigger an immune response.

AO2:

- the type and position of the R groups will determine the tertiary structure of the protein
- the tertiary structure of the protein will determine the shape of the variable region
- if the tertiary structure of the amino acid changes, this changes the shape of the antibody / variable region of the antibody
- if the shape of the antibody / variable region of the antibody changes and is not complimentary to the antigen, the antibody will not function
- the carboxyl and amine groups link the amino acids together which forms the primary structure of the protein
- the primary structure of the protein is vital for the formation of the tertiary structure.

AO3:

- as the R group of one specific amino acid can form bonds with the R group of another specific amino acid to form the tertiary structure, without the R groups there would be no bonds and no tertiary structure (as no ionic bonds and disulfide bridges can form)
- as the tertiary structure determines the shape of the antibody / variable region of the antibody, if there were no R groups and therefore no tertiary structure, there would be no variable region of the antibody, so no complimentary shape to fit the antigen
- as the carboxyl group of one amino acid reacts with the amine group of another to link the amino acids via a peptide bond, without these groups there would be no peptide bonds
- as peptide bonds are required to link many amino acids together to form the primary protein structure, without the carboxyl and amine groups, there would be no primary structure
- as the primary structure is the level of structure on which all other levels of structure are formed, without the primary structure there would be no tertiary structure
- although the R groups do determine the tertiary structure which determines the shape of the antibody / variable region of the antibody, without the carboxyl and amine groups there would be no tertiary structure, therefore they are equally important.

Accept any other suitable response.

QWC mark scheme

Mark	Descriptor
3	The answer is clearly expressed and well structured. The rules of grammar are used with effective control of meaning overall. A wide range of appropriate technical terms are used effectively.
2	The answer is generally clearly expressed and sufficiently structured. The rules of grammar are used with general control of meaning overall. A good range of appropriate technical terms are used effectively.
1	The answer lacks some clarity and is generally poorly structured. The rules of grammar are used with some control of meaning and any errors do not significantly hinder the overall meaning. A limited range of appropriate technical terms are used effectively.

Mark	Descriptor
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: 27 marks plus 3 marks for QWC and use of specialist terminology

9 Reacting hydrochloric acid and sodium hydroxide produces a salt and water.

Which of the following is the name of the salt produced in this acid-base reaction?

A Calcium chloride
B Sodium chloride
C Sodium sulfate
D Zinc hydroxide

[1 mark]

AO1 = 1 mark

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

B: Sodium chloride (1).

10(a) Potassium (K) reacts violently in water (H_2O) and oxygen (O_2).

The unbalanced chemical equations are shown below:

$$\mathbf{K + H_2O \rightarrow KOH + H_2}$$
$$\mathbf{K + O_2 \rightarrow K_2O}$$

Give the balanced equation for the reaction of potassium with water.

[1 mark]

AO2 = 1 mark

Award **one** mark for any of the following correct equations, up to a maximum of **one** mark:

$K + H_2O \rightarrow KOH + {}^1/_2 H_2$ (1)
or,
$2K + 2H_2O \rightarrow 2KOH + H_2$ (1)

Accept any response that provides these equations with the correct balancing ratios.

10(b) Give the balanced equations for the reaction of potassium with oxygen.

[1 mark]

AO2 = 1 mark

Award **one** mark for any of the following correct equations, up to a maximum of **one** mark:

$2K + {}^{1}/_{2}O_2 \rightarrow K_2O$ (1)
or,
$4K + O_2 \rightarrow 2K_2O$ (1)

Accept any response that provides these equations with the correct balancing ratios.

10(c) A scientist is trying to find out the quickest way to produce a large volume of hydrogen gas. They carry out the same reaction using two different metals and record the rate of each reaction in Table 2**.**

Table 2: **Results from scientists' preliminary investigation, where gs^{-1} is grams per second.**

Metal	Rate of reaction (gs^{-1})
Potassium($^{39}_{19}K$)	**0.23**
Caesium($^{133}_{55}Cs$)	**0.35**

The scientist then concludes that the best metal to use would be caesium.

Evaluate the scientist's initial conclusion.

Your evaluation must include reference to the electronic configuration and reactivity of the metals.

[3 marks]

AO3 = 3 marks

Award **one** AO3 mark for each correct evaluative point, up to a maximum of **three** marks:

- based on these observations it could be concluded that the scientist may be correct in terms of rates of reaction which is higher for caesium (1)
- the amount of electrons shells increases between potassium and caesium which makes caesium more reactive than potassium which supports the scientist's conclusion (1)
- caesium is more reactive than potassium because the outer electron is less tightly bound by the nucleus in caesium compared to potassium, making it more reactive which supports the scientist's initial conclusion (1)

- it would be worth experimenting with other metals with different electronic configuration as they may have a higher reaction rate, this does not support the scientists original conclusion (1).

Accept any other suitable response.

11(a) Consider the following reaction:

$$\mathbf{A + B + C \rightarrow D + E + B}$$

Scientists obtain the following data in Table 3 **for this reaction.**

Table *3*: **Data obtained from reaction.**

Conditions	Rate (gs^{-1})
Without reagent B at 25 °C	0.00561
Without reagent B at 35 °C	0.00667
With reagent B at 25 °C	0.00788

Using the information provided above, explain the role of reagent known as B **in this reaction.**

[2 marks]

AO2 = 2 marks

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

- reagent B is a catalyst (1) as it increases the rate of reaction without being permanently chemically changed (1).

Accept any other suitable response.

11(b) Scientists then conduct the following timed experiments on this reaction without reagent B **at an increased temperature of 70°C.**

They obtain the following kinetic data.

Table 4: **Mass of A+B+C after 120 seconds.**

Time (seconds)	Mass of 'A+B+C' (grams)
0	**6.7**
120	**5.3**

Calculate the rate of reaction in gs^{-1} (grams per second). Show your working and give your answer to two significant figures.

[2 marks]

AO2 = 2 marks

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

- correctly calculating the rate as: (6.7 – 5.3) / 120 = 1.4 / 120 = 0.0116666… (1)
- correctly achieving the answer of 0.012 gs^{-1} (1).

11(c) **An industry is interested in using reagent** B **for this reaction for large scale production of substance D.**

Using the data provided in Table 3**, describe** one **advantage of using reagent** B **in an industrial reaction.**

Ensure your answers are different to what you have provided in question 11a.

[2 marks]

AO2 = 2 mark

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

Either:

- table 3 suggests that using reagent B would decrease industrial turnaround times for the reaction (1)
- this is because the associated rate is higher than that of the same reaction at 25°C (1)

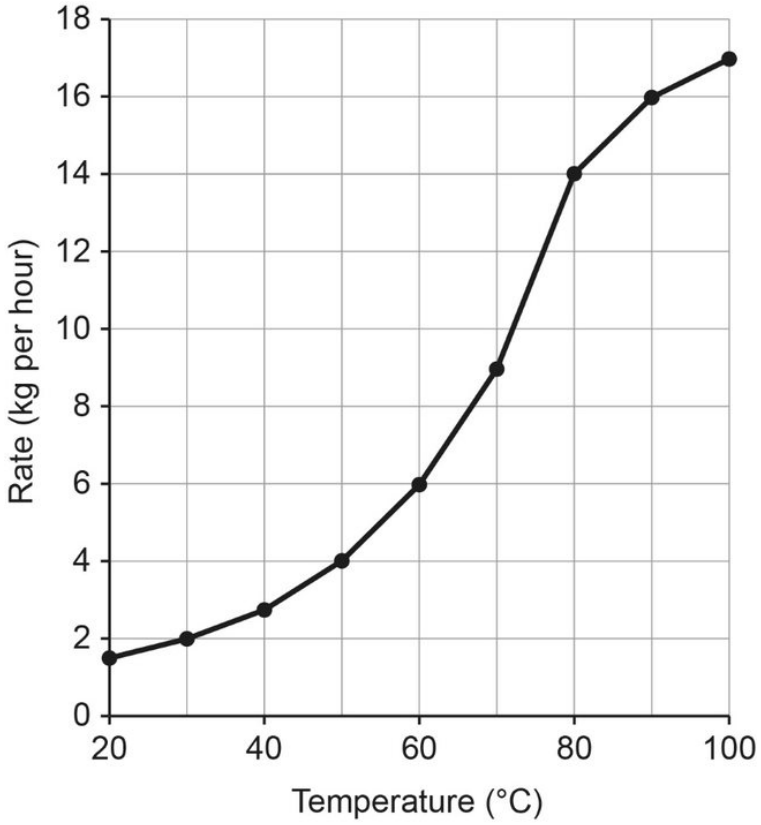
or:

- table 3 suggests using reagent B could reduce production and energy costs (1)
- this is because whilst the data in table 2 suggests that 35 °C produces a larger reaction rate than that of 25 °C, reagent B still provided a larger reaction rate without the need for increased temperatures (1).

Accept any other suitable response.

11(d) **Scientists conduct an initial investigation of the industrial reaction, without the use of reagent** B**, using different temperatures. They obtain the graph shown in** Figure 5**.**

Figure 5: **Graph to show how temperature affects rate of reaction when not using reagent B**



A scientist states: 'Based on the graph, temperatures of greater than 100°C are needed in order to acquire the highest rate of reaction and therefore make the most amount of money.'

With reference to activation energy, discuss the scientist's statement.

[3 marks]

AO3 = 3 marks

Award **one** mark for each correct statement, up to a maximum of **three** marks:

- beyond temperatures of 80°C the rate begins to reach a threshold / maximum point where the rate begins to level off so increasing the temperature beyond 100°C may have little effect and therefore not be cost effective (1)
- it is likely that the most efficient temperature is around 80°C. This is because the rate of reaction is 14kg / hr. Increasing the temperature to 100°C would cost more but only raise the rate of reaction to 17kg / hr (1)

- at temperatures less than 80°C there is not enough heat / thermal energy to supply the majority of reactants with enough energy to overcome the activation energy and this support the scientist's claim that higher temperatures are required (1)
- the scientist is incorrect as Reagent B has not been used. Using Reagent B will reduce the activation energy and mean higher rates of reaction can be achieved at lower temperatures, making this more cost effective (1)
- the scientist's statement is not correct, as data for temperatures over 100°C have not been recorded / tested. Therefore, the scientist has no evidence to support their statement (1).

N.B. a maximum of two marks can be awarded without reference to activation energy.

Accept any other suitable response.

12 **A manufacturing company that produces cooking utensils is investigating which material is best suited to use within the food industry.**

Prior to the investigation, they have produced utensils using metal but are now considering using a high-density polymer instead.

Give three **reasons why the company might choose to use the high-density polymer.**

[3 marks]

AO2 = 3 marks

Award **one** AO2 mark for each correct reason, up to a maximum of **three** marks:

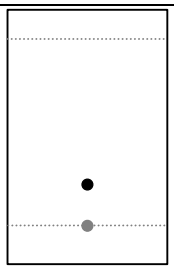
- polymers are chemically unreactive and therefore will not impact on food safety (1)
- metals have a high thermal conductivity which increase the risk of burns (1)
- high density polymer will have the required strength to be used in cooking (1).

Accept any other suitable response.

13 **An agriculture company is interested in the purity of a particular food ingredient. This is to ensure that the necessary quality assurance standards can be met.**

Initially, scientists conduct a thin layer chromatography (TLC) analysis of the ingredient using three different solvents. Figure 9 **shows the scientists' results:**

Figure 6: **Chromatograms of scientists initial TLC analysis**



solvent: hexane

solvent: petroleum ether

solvent: toluene

The scientists conclude that the ingredient is pure and therefore do not need to carry out further tests.

Using your knowledge of chromatography and analytical techniques, evaluate the scientists' conclusions.

Your answer should include reasoned judgements and conclusions.

[9 marks plus 3 marks for QWC]

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

Level	Marks	Descriptor
Level 3	7-9	**AO3:** Evaluation of the chromatograms 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 how each chromatogram is analysed. Shows a detailed **functional understanding** of the scientific methodology involved. **AO1**: Demonstrates a wide range of **relevant knowledge** and understanding of chromatograms which is accurate and detailed. The answer demonstrates **comprehensive** breadth and / or depth of understanding.
Level 2	4-6	**AO3:** Evaluation of the chromatograms 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 how each chromatogram is analysed is in **most parts appropriate**, showing **some functional understanding** of the scientific methodology involved. **AO1:** Knowledge and understanding of chromatograms in this context are in **most parts clear** and **mostly accurate**, although on occasion may lose focus
Level 1	1-3	**AO3:** Evaluation of the chromatograms 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 how each chromatogram is analysed and may show a **lack of functional understanding** of the scientific methodology involved. **AO1**: Knowledge and understanding of chromatograms in this context show some but **limited accuracy**, focus and relevance.
	0	No creditworthy material

Indicative Content

AO1:

- the TLC is comprised of a stationary phase (a thin absorbent material such as silica or alumina on glass) and a mobile phase (the sample dissolved in a solvent which is then carried up the stationary phase)
- the chromatogram is developed after passing the mobile phase through the stationary phase
- developed single spots indicate purity. The more spots the less pure the sample
- TLC provides useful information such as Rf values, these indicate affinity for solvent
- high Rf values indicate larger affinity for solvent
- this information can be used to separate the components of a mixture either via column chromatography which utilises gravity filtration, or high-performance liquid chromatography (HPLC) which uses high pressure to separate sample mixtures
- an alternative to TLC could be the use of mass spectrometry.

AO2:

- the exact / specific methods of how each TLC was developed is not mentioned within the question. Without this information it becomes difficult to compare each chromatogram.
- all samples appear to have one spot. However, in toluene the spot only travelled halfway up the chromatogram. This spot is beginning to separate suggesting the ingredient is not pure
- based on this, toluene is the most effective solvent and hexane is the least effective. However, only three solvents were used
- no details of the type of stationary phase used were provided. Additionally, no solvent front or R_f values are reported
- in a qualitative analysis, the scientist's conclusion would be reasonable.

AO3:

- in a qualitative context the scientists conclusion would appear reasonable. However, there is missing information such as the methods used. A quantitative analysis would be impossible as no R_f values or times each TLC was run for is shown
- based on the chromatograms alone it would appear the sample is pure. However, only three solvents were tested. Other solvents may have produced different results
- toluene showed a spot which was beginning to show some form of separation, suggesting the ingredient is not pure which does not support the scientist's conclusion, meaning further analysis should be carried out such as HLPC
- as no details of solvent front and R_f values were provided, scientists could run the TLC analysis for longer to see if separations occur
- scientists could also use combinations of different solvents

- as no details of stationary phase were provided scientists could also change the stationary phase to check for separation and purity.

Accept any other suitable response.

QWC mark scheme

Mark	Descriptor
3	The answer is clearly expressed and well structured. The rules of grammar are used with effective control of meaning overall. A wide range of appropriate technical terms are used effectively.
2	The answer is generally clearly expressed and sufficiently structured. The rules of grammar are used with general control of meaning overall. A good range of appropriate technical terms are used effectively.
1	The answer lacks some clarity and is generally poorly structured. The rules of grammar are used with some control of meaning and any errors do not significantly hinder the overall meaning. A limited range of appropriate technical terms are used effectively.
0	There is no answer written or none of the material presented is creditworthy. **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: 18 marks plus 3 marks for quality of written communication (QWC) and use of specialist terminology

14 Which of the following is the correct definition of the half-life of a radioactive element?

A The length of time taken for half of a population of living organisms to die
B The length of time taken for an unstable nucleus to split in half
C The length of time taken for half the unstable nuclei in a sample to decay
D The length of time taken for the weight of the sample to halve

[1 mark]

AO1 = 1 mark

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

C The length of time taken for half the unstable nuclei in a sample to decay (1).

15(a) A town obtains its electricity supply from a coal-powered power plant. Electricity at the plant is generated by steam turbines that spin a magnet inside a coil of wire.

It generates electricity at a voltage of 230V and 50Hz.

To supply enough electricity during peak times, an engineer plans to increase the turbine speed to meet this demand.

Using your knowledge of electromagnetic induction, suggest how increasing the frequency of the turbine's rotation would affect the properties of the electricity being generated.

[2 marks]

AO2 = 2 mark

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

- the peak voltage would increase, as the magnet would be spinning through coil of wire faster (1)
- the frequency of the alternating current would also increase, as the direction of the magnetic field would be changing more rapidly as the turbine / magnet spins faster (1).

Accept any other suitable response.

15(b) **An alternative generator is also available, that produces electricity at a voltage of 330V and 60Hz.**

The engineer suggests that this can be used to provide additional power directly into the network if needed.

Using your knowledge of the requirements and properties of mains electricity, evaluate this plan.

Your answer should include reasoned judgements and conclusions.

[3 marks]

AO3 = 3 marks

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

- the electricity is of a higher frequency or voltage, it may not be suitable for powering devices that are plugged into the mains, and so this is not a suitable way to produce additional electricity (1)
- there is no information on whether the voltage generated by the alternative generator can be changed meaning it may not be suitable to provide additional power directly into the network (1)
- the electricity produced may need be altered using a transformer to ensure that it is at a suitable voltage to supply to homes, and this will require additional steps/expense (1)
- a transformer would not be able to change the frequency of the electricity, so this may cause issues with certain electrical devices (1).

Accept any other suitable response.

16 **Sonar waves are transmitted through water with a wavelength of 0.75 m and a frequency of 2.1 kHz.**

The equation used to calculate wave speed is:

$v = f\lambda$

Calculate the speed of these waves through water.

Show your working and include the correct units in your answer.

1 kHz = 1000 Hz

[3 marks]

AO2 = 3 marks

Award **one** mark for correctly converting kHz into Hz:

- 2.1 kHz = 2100 Hz.

Award **one** mark for the correct calculation using the equation:

- v= 2100 x 0.75 (1).

Award **one** mark for giving the correct answer in m/s:

- v = 1.575 x 10^3 m / s = 1575 m / s (1).

Accept alternative correct answers in standard form.
Accept alternative correct answers in km / s or ms^{-1}.

17(a) Give three **properties of alpha particles.**

[3 marks]

AO1 = 3 marks

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

- alpha particles are positively charged / have a charge of 2+ (1)
- alpha particles are highly ionising (1)
- alpha particles are weakly penetrating (or correct reference to range in air/stopped by paper) (1)
- alpha particles are relatively heavy compared to beta and gamma radiation (1)
- alpha particles are relatively slow compared to beta and gamma radiation (1).

Accept any other suitable response.

17(b) A scientist is performing an experiment using a source of gamma radiation.

For safety reasons, the scientist decides to perform the experiment inside an airtight containment cabinet, where they are always shielded from the sample by 5mm of plastic.

The experiment will last 3 hours, during which time the scientist plans to wear standard personal protective equipment (PPE). This consists of a standard laboratory coat and safety goggles, along with a device to monitor levels of radiation exposure.

The laboratory manager states that the planned safety measures are not robust enough and need improving.

Using your knowledge of gamma radiation and its properties, justify the laboratory manager's statement.

Your answer should include reasoned judgments and conclusions.

[6 marks]

Band	Mark	Descriptor
3	**5–6**	**AO3** Justification of the statement in relation to the properties of gamma radiation and the planned safety measures is **comprehensive**, **effective**, and **relevant**, showing **detailed** understanding and **logical** and **coherent** chains of reasoning throughout. There are **effectively** informed judgements that are **fully** supported and **rational**. **AO2** Application of knowledge of the implications of prolonged exposure to gamma radiation linked to safety measures is **highly appropriate** and shows a **detailed** functional understanding. **AO1** There is a **wide** range of relevant knowledge and understanding of gamma radiation and safety measures that should be used that is **accurate** and **detailed**. The answer demonstrates **comprehensive** breadth and / or depth of understanding.
2	**3–4**	**AO3** Justification of the statement in relation to the properties of gamma radiation and the planned safety measures 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 the implications of prolonged exposure to gamma radiation linked to safety measures is in **most** parts appropriate, showing **some** functional understanding. **AO1** Knowledge and understanding of gamma radiation and safety measures that should be used is in **most** parts **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	**1–2**	**AO3** Justification of the statement in relation to the properties of gamma radiation and the planned safety measures 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 the implications of prolonged exposure to gamma radiation linked to safety measures is **limited** and may show a lack of functional understanding. **AO1** Knowledge and understanding of gamma radiation and safety measures that should be used 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 creditworthy material

AO1 = 2 marks
AO2 = 2 marks
AO3 = 2 marks

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 the properties of gamma radiation and general laboratory safety may include:

- gamma radiation is highly penetrating
- gamma radiation is weakly ionising
- gamma rays can cause damage to cells and tissues that they come into contact with
- standard PPE should always be worn when in a laboratory
- standard PPE may not always be enough to reduce risk depending on the investigation taking place
- certain equipment, such as radioactive sources, may need more specialised PPE and safety equipment.

AO2: Application of knowledge of the implications of prolonged exposure to gamma radiation linked to safety measures may include:

- the airtight containment cabinet will not fully block gamma radiation, and so will not provide protection against gamma radiation
- the airtight cabinet would prevent accidental inhalation of airborne / vapourised radioactive particles
- the lab coat and goggles will provide minimal protection against radiation risks, alternative PPE is required when working with radioactive sources
- gamma radiation is only weakly ionising, but over a long experiment there could be a high dose / level of exposure, leading to greater risk of damage
- the radiation monitor will be useful to alert the scientist if the cumulative dose reaches too high levels during the experiment.

AO3: Justification of the statement in relation to the properties of gamma radiation and the planned safety measures may include:

- thicker shielding (or lead shielding), or doing the experiment from another room entirely, would be much safer than using the cabinet suggested as it would reduce exposure to gamma radiation
- additional PPE such as a lead apron would provide further protection as it would reduce the dose of gamma radiation

- the experiment duration, or at least the time spent using the radioactive sample, should be kept to a minimum to reduce the exposure to the gamma radiation
- additional considerations may be needed if multiple experiments are performed over a longer period as this would increase exposure to / dose of gamma radiation
- using a monitor to measure the dose of radiation that would be delivered without the scientist in the room first would be a good way to manage the risk better as dose of radiation received could be accurately calculated before risking the health of the scientist
- the safety of the experiment can be improved by only handling the radioactive materials when they are needed, and not leaving them in the working area whilst it is not being actively used, reducing unnecessary exposure to gamma radiation
- additional workflow changes should be considered, such as working with colleagues to reduce individual exposure.

Overall conclusion could be:

- the lab manager is correct that the planned safety measures should be improved, there are many options for increasing the protection offered to the scientist that are easy to implement
- the lab manager is partially responsible for the safety of their team and should work with the scientist to improve the safety measures suggested
- the scientist in charge of the investigation should have produced a valid risk assessment, and had this approved, before carrying out the investigation to ensure their own safety and that of their colleagues.

Accept any other suitable response.

Section D: Scientific concepts

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

18 **Biological washing powders contain enzymes which can break down the biological materials that cause stains on clothing.**

For optimum effectiveness, biological washing powders should not be used at temperatures over 40°C.

Use your knowledge of the effect of temperature on enzyme structure to explain why.

[2 marks]

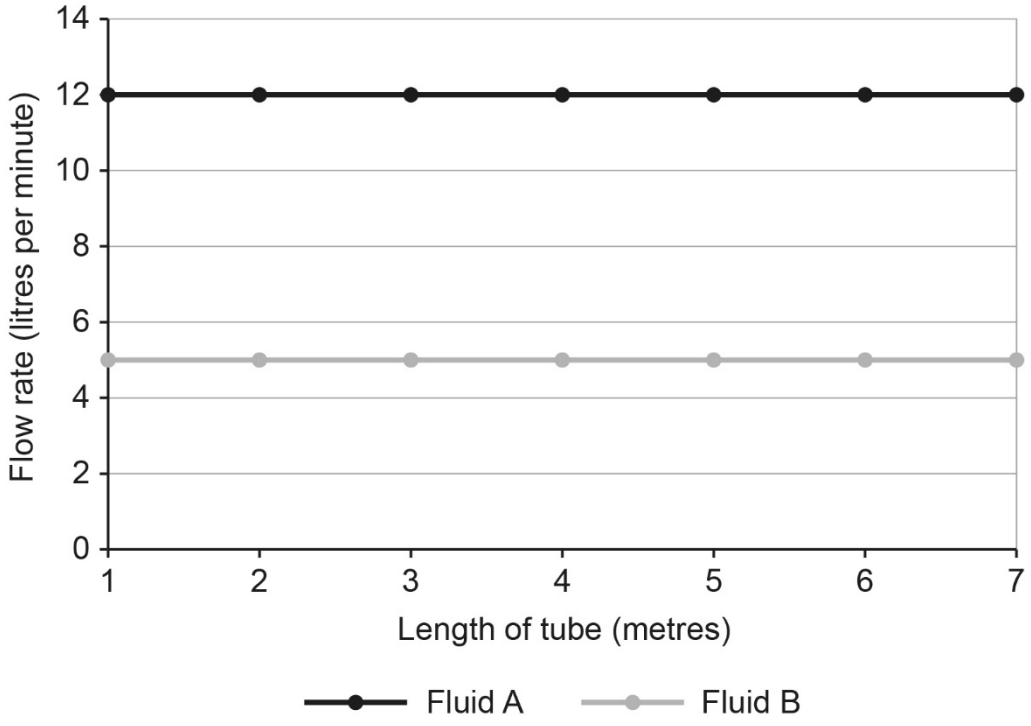
AO2 = 2 marks

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

- if the temperature rises above 40°C, the shape of the active site changes / enzyme to denature (1) meaning there will be no successful collisions between the enzyme and the molecules of the stain, and the stain will not be broken down (1).

Accept any other suitable response.

19(a) Figure 7: I**nformation about two different fluids flowing through the same tube at different times**



Explain the type of flow rate shown on the graph.

[2 marks]

AO2 = 2 marks

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

- the type of flow rate is volumetric flow rate (1) as volumetric flow rate is defined as the volume of liquid flowing per minute, and the units for flow rate are given as litres per minute (1).

19(b) (i) **In relation to liquids, define the term 'viscosity'.**

[1 mark]

(ii) **Assuming the same pump is used to create the flow of each fluid, explain which fluid is likely to have the highest viscosity.**

[2 marks]

AO1 = 1 mark
AO2 = 2 marks

19b(i) Award **one** AO1 mark for the correct definition:

- a measure of resistance (internal friction) of a fluid (1).

19b(ii) Award **a maximum of two (2)** AO2 marks:

- fluid B (is likely to have the highest viscosity) (1) as viscosity increases, flow rate decreases and fluid B has the lowest flow rate (1).

Accept any other suitable response.

19(c) A student states that increasing flow rate would cause turbulent flow, as the friction between the tube walls and the parts of the fluid in contact with the tube walls would increase.

(i) Define the term 'turbulent flow'.

[1 mark]

(ii) Evaluate the validity of the student's statement.

[3 marks]

AO1 = 1 mark
AO3 = 3 marks

19c(i) Award **one** AO1 mark for the correct definition:

- when different parts of the fluid have a different velocity (1).

19c(ii) Award **one** AO3 mark for an appropriate evaluative point, up to a maximum of **three** marks:

- if the parts of the liquid in contact with the tube walls did slow down (due to friction), then these would be flowing more slowly than the parts of the fluid not in contact with the tube walls, therefore flow would be turbulent, this supports the validity of the statement (1)
- however, if the student's statement is correct, the same would apply at slower flow rates as well, but to a lesser extent, this does not support the statement (1)
- as there is no information on whether the flow is steady or turbulent in the graph, the flow could already be turbulent, this does not support the statement (1)
- if the fluid had a viscosity of zero the parts of the liquid in contact with the tube walls would not slow down therefore the flow would not become turbulent (1).

Accept any other suitable response.

20 **Invertase is an enzyme which breaks down sucrose into glucose and fructose. It is used in the food industry as fructose is much sweeter than sucrose and can therefore be used in smaller amounts.**

A student investigated the rate of sucrose breakdown with two different arrangements of invertase. The student wanted to measure the concentrations of the three sugars after each process and detect if enzymes were present in the product.

The procedure is described below:

Arrangement A

- **1ml of 1% invertase suspension was added to 100ml of 5% sucrose solution in a beaker**
- **the beaker was stirred constantly**
- **after 20 minutes, a sample was taken from the beaker and the concentration of any substance present was measured using gas chromatography.**

Arrangement B

- **invertase was immobilised by attaching the enzyme to small inert beads**
- **1ml of a 1% suspension of these beads was added to 100ml of 50% sucrose solution in a beaker**
- **the beaker was incubated at 40˚C and stirred constantly**
- **after 20 minutes, the contents of the beaker were passed through a filter which retained the beads**
- **a sample of the filtrate was taken, and the concentration of any substance present was measured using gas chromatography.**

Table 5: **Results of** Arrangements A **and** B

	Arrangement A - Relative concentration of substances in arbitrary units	**Arrangement B - Relative concentration of substances in arbitrary units**
Sucrose	**12**	**32**
Glucose	**44**	**34**
Fructose	**44**	**34**
Protein	**0**	**0**

A student studying the results concluded:

- Arrangement A **is better for fructose production as there is a higher relative concentration of fructose in arbitrary units.**
- Arrangement B **may have reduced the ability of invertase to break down sucrose.**

Using your knowledge of gas chromatography and enzyme action, evaluate the reliability of the student's methods and their conclusions.

Your response should include reasoned judgements and conclusions.

[9 marks plus 3 marks for QWC]

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

Level	Marks	Descriptor
Level 3	7 - 9	**AO3:** Evaluation of the student's method and conclusions 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 gas chromatography and enzyme action is applied **effectively** to the given context. **AO1:** A **wide** range of relevant knowledge and understanding of gas chromatography and enzyme action is evident. A **wide** range of **appropriate** technical terms are used. The answer demonstrates **comprehensive** breadth and/or depth of understanding.
Level 2	4 - 6	**AO3:** Evaluation of the student's method and conclusions, 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 gas chromatography and enzyme action is applied mostly **effectively** to the given context, although on occasions there **may** be a lack of clarity. **AO1:** Knowledge and understanding of gas chromatography and enzyme action 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.
Level 1	1 - 3	**AO3:** Evaluation of the student's method and conclusions 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 gas chromatography and enzyme action is **applied** to the given context. **AO1:** Knowledge and understanding of gas chromatography and enzyme action 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

AO1:

- enzymes have an active site which is complementary to the shape of the substrate / region of the substrate
- for an enzyme to break down its substrate, the substrate must collide with the active site
- gas chromatography is a mechanism which can be used to separate the different components of a mixture
- gas chromatography requires the components in a mixture to be vapourised
- gas chromatography can be used to measure the concentration of components in a mixture
- enzymes are proteins.
- enzymes have an optimum pH and temperature
- high temperatures can cause enzymes to denature.

AO2:

- the breakdown of sucrose is significantly higher in A than B
- the amount of protein present in A and B is zero
- the beaker was kept at room temperature and there is no reference to the optimum temperature
- room temperature is likely to be lower than optimum for enzyme action based on the incomplete breakdown of sucrose
- separation and identification of proteins would not be possible using gas chromatography as they cannot be vaporised
- the investigation was not repeated
- the enzyme was removed from the product in B / the product in A still contained the enzyme
- a 1% suspension of beads with enzyme attached, will not contain the same amount of enzyme as a 1% suspension of enzyme.

AO3:

- as the breakdown of sucrose / concentration of fructose was significantly higher in A than B, this does support the first conclusion
- as the breakdown of sucrose / concentration of fructose was significantly lower in B than A, this does suggest that the arrangement in B, may reduce the action of invertase
- however, we do not know the temperature for arrangement A, the results may have been different if the optimum temperature for the enzyme had been used, this does not support the first statement
- as Arrangement B involved attaching the enzyme to inert beads, if some of the enzyme was attached to the bead at the active site, this would reduce the level of enzyme action, this supports the second statement
- as gas chromatography would not be suitable for separation and identification of protein, they should have used another method to detect invertase
- as the investigation was not repeated, this reduces the validity of the results and therefore the validity of the conclusions
- although A produced a higher concentration of fructose, the enzyme must still have been present in the product, meaning the reaction could have continued after the 20 minutes

- although B produced a lower yield of fructose, the enzyme was retained in the filter and could be used again, this would make Arrangement B more efficient than A as the amount of enzyme present in each arrangement is different, the results are not valid.

Accept any other suitable response.

QWC mark scheme

Mark	Descriptor
3	The answer is clearly expressed and well structured. The rules of grammar are used with effective control of meaning overall. A wide range of appropriate technical terms are used effectively.
2	The answer is generally clearly expressed and sufficiently structured. The rules of grammar are used with general control of meaning overall. A good range of appropriate technical terms are used effectively.
1	The answer lacks some clarity and is generally poorly structured. The rules of grammar are used with some control of meaning and any errors do not significantly hinder the overall meaning. A limited range of appropriate technical terms are used effectively.
0	There is no answer written or none of the material presented is creditworthy. **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.

Assessment Objective Grid

Question	AO1	AO2	AO3	QWC	Maths	Total
Section A						
1	1*					1
2	1*					1
3a		2				2
3b	1					1
3c			3			3
4a	3					3
4b	1*					1
5a		2			2	2
5b		2			2	2
5c	2*					2
5d			3			3
6a	2*					2
6b		2				2
6c		1				1
7a	2					2
7b	1	1				2
7c			3			3
8	4	4	4	3		15
Total	18	14	13	3	4	48
Kil*	7					
	17-22	11-16	11-16			45+3

Question	AO1	AO2	AO3	QWC	Maths	Total
Section B						
9	1*					1
10(a)		1				1
10(b)		1				1
10(c)			3			3
11(a)		2				2
11(b)		2			2	2
11(c)		2				2
11(d)			3			3
12		3				3
13	3	3	3	3		12
Total	4	14	9	3	2	30
Kil*	1					

	3-7	11-16	6-11			27+3

Question	AO1	AO2	AO3	QWC	Maths	Total
Section C						
14	1*					1
15(a)		2				2
15(b)			3			3
16		3			3	3
17(a)	3					3
17(b)	2	2	2			6
Total	6	7	5	0	3	18
Kil*	1					
	3-7	3-7	3-7			18

Question	AO1	AO2	AO3	QWC	Maths	Total
Section D						
18		2				2
19a		2				2
19b	1*	2				3
19c	1*		3			4
20	3	3	3	3		12
Total	5	9	6	3		23
Kil*	2					
Kil Total	11					
	3-7	6-11	6-11	9		20+3
Total	**33**	**44**	**33**		**(9)**	**119**

Document information

Owner: Head of Assessment Design