



T Level Technical Qualification in Science

Core knowledge and understanding Paper A

Mark scheme

V1.1: P001926
Post-standardisation
Summer 2023
603/6989/9

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

The purpose of this mark scheme is to give you:

- examples and criteria of the types of response expected from a student
- information on how individual marks are to be awarded
- the allocated assessment objective(s) (AOs) and total 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 to 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 AOs, 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 AO can be found in the Qualification Specification.

Section A: Working within the science sector

This section is worth 25 marks, plus 3 marks for the quality of written communication (QWC) and use of specialist terminology.

1 Which one of the following states one purpose of a disciplinary policy?

- A Eliminates discrimination
- B Ensures consistent and fair treatment
- C Facilitates feedback to improve performance
- D Sets out rights and responsibilities

[1 mark]

AO1 = 1 mark

Answer

B Ensures consistent and fair treatment (1).

2 (a) As part of an audit by a regulatory body, a laboratory specialising in biological pathogen testing has been asked to supply their standard operating procedures (SOPs).

Give two reasons why SOPs are important in a workplace.

[2 marks]

AO1 = 2 marks

Answer

Award **one** mark for each reason why SOPs are important in a workplace, up to a maximum of **two** marks:

- SOPs help to maintain health and safety in the workplace (1)
- SOPs enable consistency of approach (1)
- SOPs help employers / employees to meet legal / organisational requirements (1)
- SOPs enable employers to demonstrate compliance for audit purposes (1)
- SOPs enable employers / employees to uphold professional standards (1).

Accept any other suitable response.

2 (b) For each of your reasons, explain how SOPs ensure the laboratory is working to the required standard.

[4 marks]

AO2 = 4 marks

Answer

Award **one** mark for each explanation given for how the stated reason would allow the regulator to ensure the company is working to the required standards, up to a maximum of **four** marks:

- (SOPs help to maintain health and safety in the workplace) to make sure all relevant health and safety information is included relating to the procedures carried out in the laboratory with biological pathogens (1), ensuring that employees are working at levels that maintain health and safety standards (1)
- (SOPs enable consistency of approach) to check SOPs are in place for the correct storage, handling and disposal of all biological pathogens for the procedure being audited (1), ensuring all staff are working to the exact same protocols each time they carry out the procedure (1)
- (SOPs help employers / employees to meet legal / organisational requirements) to check controls specified within SOPs are effective for the handling of biological pathogens in the laboratory for this procedure (1), to ensure regulatory controls for the handling of biological pathogens in the laboratory are being applied (1)
- (SOPs enable employers to demonstrate compliance for audit purposes) to ensure the organisation is following regulations / guidance (1) which will contribute to employee / wider public / customer safety and avoid fines / legal action from regulatory bodies (1)
- (SOPs enable employers / employees to uphold professional standards) to check the SOPs meet set standards (for example GMP / GLP / GCP) ensuring employees are safe and are working to agreed levels of compliance (for example GMP / GLP / GCP compliant) (1) and follows models of good practice within the laboratory (1).

Accept any other suitable response.

3 The management team of a research company is attending health and safety training.

The health and safety officer delivering the training states, “It is the responsibility of the laboratory staff to ensure they are working in a safe manner because training has been provided by the employer.”

Explain how the health and safety officer’s statement might be partially correct.

[2 marks]

AO2 = 2 marks

Answer

Award **one** mark for each explanation point about why this statement might be correct, up to a maximum of **two** marks:

- all individuals in the laboratory are aware of the SOPs (1) and if they choose not to follow them then any accidents that happen are their responsibility (1)
- staff training will have been provided to prevent accidents happening (1), it is the responsibility of individuals to ensure they are working in a manner that is safe when in the laboratory (1)
- employers and employees have a legal responsibility under the Health and Safety at work Act (1974) to ensure everyone is safe whilst at work (1); part of this responsibility includes regularly carrying out risk assessments, providing training in the correct procedures and best practice as well as producing and sharing SOPs (1)
- it is the employer's responsibility to provide the correct personal protective equipment (PPE) for each activity undertaken and this, if followed, will mean that accidents are prevented, and worker safety can be guaranteed (1); it might be beyond their control if some employees choose not to wear the PPE (1).

Accept any other suitable response.

4 **A buyer for a research company is assessing suppliers for a reagent that is required for a project. The project requires 200L of the reagent per month. The buyer has identified two suppliers, A and B, who can supply the reagent.**

Supplier B is significantly cheaper than A, and as a result the buyer is planning on ordering from supplier B.

A colleague suggests that supplier B would not be the best option as there would be waste product at the end of each month.

Table 1: Reagent supplier comparison

| Supplier | Cost per litre | Delivery size | Delivery cost | Lifespan of product | Total cost |
|----------|----------------|---------------|---------------|---------------------|---------------|
| A | £18 | 200L | £25 | 3 months | £3,625 |
| B | £5 | 500L | £1 | 1 month | £2,501 |

Discuss the research team member's statement showing reasoned judgements about which supplier the company should use.

[4 marks]

AO3 = 4 marks

Answer

Award **one** mark, for each discussion point that may have implications for the commercial success of the company, up to a maximum of **four** marks:

- Supplier B is the cheapest by a large margin, meaning this will save the company significant amounts of money on the consumables required and this will help towards the project being commercially successful due to decreased costs (1).
- However, the minimum volume that can be ordered is 500L and the lifespan is only 1 month, meaning 300L will need to be disposed of each month, and they will be paying for stock that they will not be using, meaning a large proportion of the money spent will be wasted (1).
- The disposal of this material may have its own associated costs that would reduce the cost benefit of supplier B, this may impact the commercial success of the project due to increased costs that have not been factored in (1).
- Purchasing excess material that is certain to be wasted has environmental implications that should prevent the company going with supplier B, this could have negative impacts on the company if it becomes known they are needlessly and knowingly disposing of large amounts of waste regularly (1).
- The materials are available from different suppliers with longer life spans, so there is no shortage of suppliers that would justify wasting the excess (1).
- Supplier B would require monthly deliveries, and any delay would have increased impacts should there be no available in-date materials on site, and could be more difficult to schedule, which could have impacts on the ability of the company to carry out the work to the planned timeline, impacting on their commercial performance (1).

Accept any other suitable response.

| | |
|----------|--|
| 5 | <p>A scientific research company is looking to establish a new pharmaceutical research facility. As part of the work, a wide variety of flammable chemicals, acids, bases and toxic chemicals will need to be brought onto the site.</p> <p>A manager has suggested buying a single, large, metal cabinet in which all of the above chemicals could be stored in a separate storage room. They have stated that they are unsure about how to dispose of the chemicals and have said they are going to assume staff know how to deal with all chemicals.</p> <p>Focusing on the safe storage, use and disposal of the chemicals:</p> <p>Evaluate the manager's proposal and make any recommendations for additional safety measures that may be required.</p> <p>Your response should demonstrate reasoned judgements about the required processes that may be introduced.</p> <p style="text-align: right;">[12 marks, plus 3 marks for QWC]</p> |
|----------|--|

AO1 = 4 marks
AO2 = 4 marks
AO3 = 4 marks

QWC = 3 marks

This is a band-marked question.

| Band | Marks | Descriptor |
|------|-------|---|
| 4 | 10–12 | <p>AO3 Evaluation of the potential dangers and issues caused by dangerous chemicals and the mitigation of the associated risks, and how these key principles apply in this context, is comprehensive, effective and relevant, and complete showing detailed understanding and logical and coherent chains of reasoning throughout. Informed conclusions that are fully supported with rational and balanced reasoned judgements are evident.</p> <p>AO2 Applied all relevant knowledge of the potential risks (and how to mitigate them) to health and safety arising from the introduction of the chemicals to the given context and shows a detailed functional understanding of the problems that could arise.</p> <p>AO1 A wide range of relevant knowledge and understanding of the key principles of safe working and risk management that is accurate and detailed. The answer demonstrates comprehensive breadth and / or depth of understanding.</p> |
| 3 | 7–9 | <p>AO3 Evaluation of the potential dangers and issues caused by dangerous chemicals and the mitigation of the associated risks, and how these key principles apply in this context, is effective and relevant, though some minor key points may be omitted or insufficiently explained, showing mostly logical and coherent chains of reasoning. Conclusions supported by reasoned judgements that consider most of the relevant arguments are evident.</p> <p>AO2 Applied the majority of relevant knowledge of the potential risks (and how to mitigate them) to health and safety arising from the introduction of the chemicals to the context, showing functional understanding of how they can be applied in this scenario, though some minor points may be omitted or insufficiently explained.</p> <p>AO1 Knowledge and understanding of the key principles of safe working and risk management is in most parts clear and mostly accurate, although some minor elements may not be comprehensively explained. The answer demonstrates reasonable breadth and / or depth of understanding, with occasional inaccuracies and / or omissions.</p> |

| | | |
|---|-----|---|
| 2 | 4–6 | <p>AO3 Evaluation of the potential dangers and issues caused by dangerous chemicals and the mitigation of the associated risks, and how these key principles apply in this context, is in most parts effective and mostly relevant, showing mostly logical and coherent chains of reasoning. Conclusions supported by reasoned judgements that consider most of the relevant arguments are evident.</p> <p>AO2 Applied mostly relevant knowledge of the potential risks (and how to mitigate them) to health and safety arising from the introduction of the chemicals to the context, showing some functional understanding of how they can be applied in this scenario.</p> <p>AO1 Knowledge and understanding of the key principles of safe working and risk management 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.</p> |
| 1 | 1–3 | <p>AO3 Evaluation of the potential dangers and issues caused by dangerous chemicals and the mitigation of the associated risks, and how these key principles apply in this context, is in some parts effective and of some relevance, with some understanding and reasoning taking the form of generic statements with some development. Brief conclusions supported by reasoned judgements that consider only basic arguments and show little relevance to the question aims are evident.</p> <p>AO2 Applied limited knowledge of potential risks (and how to mitigate them) to health and safety arising from the introduction of the chemicals to the context and may show a lack of functional understanding of the diagnostic tools.</p> <p>AO1 Knowledge and understanding of the key principles of safe working and risk management shows some but very limited accuracy, focus and relevance. The answer is basic and shows limited breadth.</p> |
| | 0 | No creditworthy material. |

Indicative content

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

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

AO1: Demonstration of knowledge and understanding of what storage conditions and disposal routes to implement to ensure health and safety is maintained – answer identifies examples of the responsibilities of the manager, which may include:

- the manager has a responsibility to ensure their team is kept safe within the working environment
- the company has a responsibility to store / use / dispose of the chemicals safely
- different chemicals will need to be stored in different ways depending on their properties
- there are regulations that determine the safe storage of chemicals
- there should be a person / people in charge of health and safety within the company that can be asked for advice on use / storage / disposal of chemicals
- the company has a responsibility to produce / provide a risk assessment for each chemical.

AO2: Application of knowledge and understanding of what storage conditions and disposal routes to implement to ensure health and safety is maintained – answer links these factors to the scenario in question, which may include:

- the company and staff responsible for the safe use / storage / disposal of chemicals should refer to CLEAPSS / COSHH guidelines for instructions
- if the chemicals are not stored properly it could lead to:
 - cross-contamination of chemicals that should not be in contact with each other which could lead to a reaction that given off toxic gas / causes a fire / causes corrosion
 - breakdown of limited stability products if stored in a cabinet / cupboard near to a heat source or in strong light
 - products exceeding expiry dates / or difficult to locate if the cupboard isn't organised correctly and chemicals aren't rotated when new stock arrives
 - loss of samples or degradation of reagents not stored at the correct temperature (-20°C, -4°C, 4°C or room temperature), if all chemicals are stored in the same space / cupboard then the environment may not be suitable for all chemicals
 - risks to health and safety (for example, spread of infection, release of dangerous chemicals, or heavy items not stored at correct height) if all chemicals are stored in the same space / cupboard then the environment may not be suitable for all chemicals as some chemicals are better stored at ground level, for example, corrosive substances
 - financial loss (could be linked to any of the above bullets)
- risk assessments are important because they ensure the chemicals are stored / used / disposed of correctly by the employees; this ensures the company are keeping the employees safe and adhering to the regulations surrounding the chemicals
- the employees have a responsibility to ensure they are knowledgeable and confident in the use / storage / disposal of chemicals
- all colleagues should know how each type of chemical should be stored (for example, separately in locked, appropriately rated cabinets each for flammables, acids, alkalis and toxic chemicals)
- cabinets should be appropriate sizes for the volumes stored, and should be able to contain any spills without leaking
- a maximum amount of chemicals to be stored should be in place and noted in the risk assessment
- incorrectly storing chemicals, for example, storing certain chemicals together could be a hazard as they may react together if there is a spill; this could cause damage or injury

- the student might give specific suggestions for the following (credit any reasonable suggestion – they are not required to know specifics):
 - the number and variety of chemical cabinets that would be required and what would be stored in each (for example, metal versus plastic cabinets, locked versus open cabinets, separating the flammable chemicals from all other chemicals, storing away from heat, do not store corrosive chemicals high up, heavy chemicals stored at ground level)
 - training for staff to understand hazard labels and the storage methods for different chemical types
 - the types of disposal routes that will need to be introduced for the chemicals (for example, certain bins to be used, certain sinks to be used, pouring used product into special containers to be collected by special disposal companies)
- all colleagues are responsible for regular reviews / upkeep of the cabinets to ensure correct storage and that cabinets are not damaged / there are no spillages.

AO3: Evaluation of knowledge and understanding of what storage conditions and disposal routes to implement to ensure health and safety is maintained – answer evaluates how these factors could impact the laboratory, which may include:

- statement that the manager’s plan is inadequate plus a reasoned judgement, such as:
 - they could harm employees by not providing training / assuming they know what they are doing
 - they could cost the company money in fines if risk assessments are not provided
 - the chemicals are not in any way separated if stored within one large, metal cabinet as they could react together and cause an accident
 - they could cost the company money in fines if any environmental damage occurs in terms of incorrect disposal
 - they may lose their job or face disciplinary procedures if they are not adhering to company policy or government regulations
- the manager should provide / make sure the company provides risk assessments otherwise they could be responsible for accidents / damage that occurs
- training for staff should be provided to ensure that chemicals are correctly stored and disposed of to correct the manager’s proposal otherwise the manager / company could be fined / sued / closed down / dismissed
- disposal routes must be defined before the manager’s plan can be signed off to ensure there is no injury / danger for people who are not familiar with the specifics of each chemical, and to ensure there is no environmental impact
- multiple cabinets are required to ensure that chemicals of distinct kinds are kept separate, there may be a need for more than one of each depending on the volumes required for the work in the laboratory
- placement of the cabinets needs to be in areas that can be locked / are away from the general public or unauthorised personnel; there may also be other criteria, such as temperature, which need to be adhered to.

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 B: Ethics, data and managing personal information in the science sector

This section is worth 25 marks, plus 3 marks for quality of written communication (QWC) and use of specialist terminology.

- 6** Which one of the following is a form of quantitative data?
- A A case study looking at the feelings surrounding vaccines among different ethnic groups
 - B Follow-up notes written by a nurse about an examination of a patient
 - C The rate a specific bacterial infection spreads across a hospital
 - D Visual observations made of a laboratory animal's behaviour following a drug intervention
- [1 mark]

AO1 = 1 mark

Answer

C The rate a specific bacterial infection spreads across a hospital (1).

- 7** A senior metrologist wants the company they work for to deliver an ICT training course to all employees. They feel it will build confidence in using certain programs and free up their working day to concentrate on their own workload.

The course will cost a large amount of money, so the owner of the company wants some evidence that this will have a significant impact. To gather this evidence, the senior metrologist has had a small number of employees take a test assessing their ability to use the programs before and after the training.

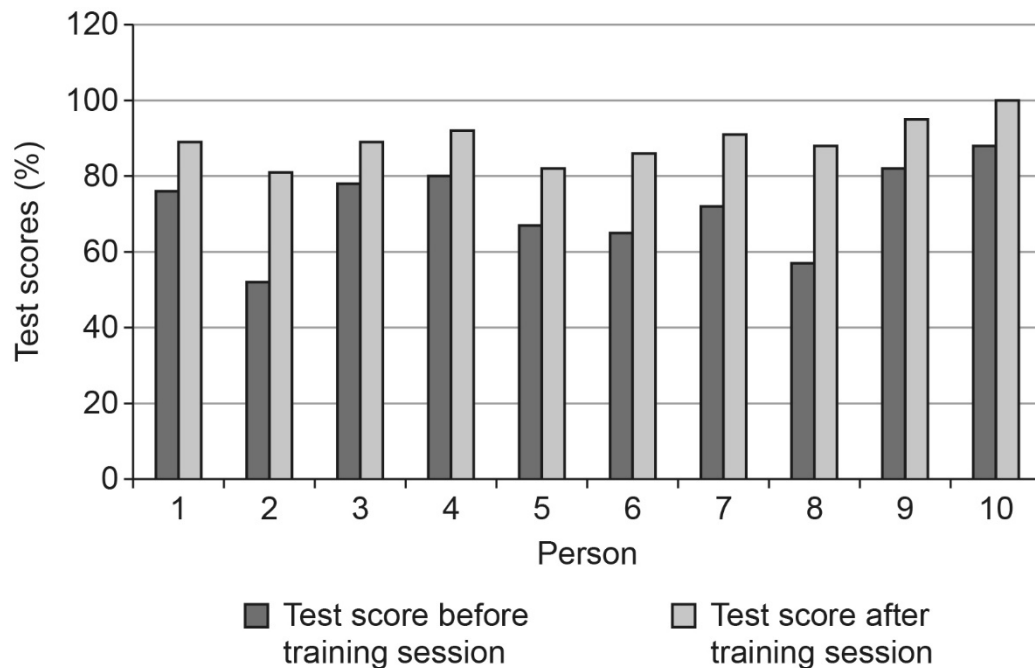
The senior metrologist gathers the data shown in Table 2 and Figure 1 and decides that the best statistical test to use would be the Chi-square test.

Table 2: Test scores before and after training

| Person | Test score before training session (%) | Test score after training session (%) | Difference in score (%) |
|--------|--|---------------------------------------|-------------------------|
| 1 | 76 | 89 | 13 |
| 2 | 52 | 81 | 29 |
| 3 | 78 | 89 | 11 |
| 4 | 80 | 92 | 12 |
| 5 | 67 | 82 | 15 |
| 6 | 65 | 86 | 21 |
| 7 | 72 | 91 | 19 |
| 8 | 57 | 88 | 31 |
| 9 | 82 | 95 | 13 |
| 10 | 88 | 100 | 12 |

| | | | |
|-------------|-------------|-------------|-------------|
| Mean | 71.7 | 89.3 | 17.6 |
|-------------|-------------|-------------|-------------|

Figure 1: Bar chart comparing test scores before and after training



(a) By comparing T-tests and Chi-square tests, give one reason why a T-test might be a more appropriate choice for this data.

[2 marks]

(b) Using Figure 1, suggest how useful the training would be for the company.

[4 marks]

AO2 = 2 marks

AO3 = 4 marks

Answer

a) Award **two** marks for a reason why a T-test is appropriate or why a Chi-square test is not appropriate:

- T-tests are used to determine if there is a significant difference between the means of two groups, which would be able to be applied here (1) because the data presents the same variable measured twice and these values are continuous quantitative variables for which a mean can be calculated (1)
- Chi-square tests are used to test the significance of the difference between observed and expected results, carrying out this test would not be useful here (1) because the data is not a categorical variable (for example, pass / fail), it would need to be manipulated before carrying out a Chi-square test (1).

Accept any other suitable response.

b) Award **one** mark for each suggestion of how useful the training would be, up to a maximum of **four** marks:

- all people taking the test after training improved their score; this suggests that the owner should pay for the training (1)
- most people only improved by 10–20%, depending on the cost of the course this may not be enough to be significant; this suggests that maybe the owner should not pay for the training (1)
- most people scored highly in the original test before training; this suggests that some in-house or basic training might be appropriate and cost significantly less money (1)
- the type of test is not specified so it is difficult to assess whether the training course was all useful or whether there were areas that were irrelevant to this company / team (1)
- it would depend on how frequently and how many of the staff members use the system the training is for as to whether it would be of use to the company to fund the training (1)
- 60% of those who took the test scored over 75% on the first go, so it might be of better use to aim the training at those who obtained a lower score (1).

Accept any other suitable response.

8 A scientist is performing a study on the biodiversity of species of mice within a local park. In order to correctly classify the species of mouse, the scientist must collect the mice.

Explain one way the scientist could ensure the collection of mice is in line with the key aims of ethical scientific practices.

[2 marks]

AO2 = 2 marks

Answer

Award **one** mark for the student identifying a consideration required, and **one** mark for an explanation of why it is required, up to a maximum of **two** marks:

To foster ethical research:

- capture mice in a way that does not injure them (1) as they will not survive in the wild if injured (1); the main aim of any study like this is to capture and classify without harming the animals (1)
- ensure food and water are in the trap (1) to make sure that mice trapped for any amount of time do not starve or die of thirst (1).

To encourage active reflection on the impact of their work:

- in order not to disrupt the biodiversity of the park (1), the same number of mice that are collected must be released unharmed to the same locations (1) otherwise the balance that has occurred naturally will be disrupted and may not recover (1).

Accept any other suitable response.

9 A quality control (QC) scientist at a pharmaceutical company has noticed that a certain department is producing work with repeated results that are out of line with expected results. They now need to plan an investigation to determine the potential sources of the errors, allowing them to minimise any future errors.

The QC scientist states, “Checking record keeping is the most important place to start our investigation, because then we can see which employees are not following company policy.”

Discuss the advantages and disadvantages of the QC scientist’s plan.

Your answer should include a reasoned judgement on whether the QC scientist’s plan will identify the root cause of the problem.

[4 marks]

AO2 = 4 marks

Answer

Award **one** mark for a discussion of the advantages of the chosen approach:

- checking record keeping will identify gaps in the record keeping that may lead to errors (1)
- checking record keeping would identify any employees that consistently had poor record keeping, which may lead to errors (1).

Award **one** mark for a discussion of the disadvantages of the chosen approach:

- if the source of the errors is not due to record keeping, then this will not identify the cause of the errors and will not prevent them (1)
- the focus on employees not following company policy may not be appropriate, if the standard operating procedures (SOPs) or policies are incorrect in the first place these could be the cause of the errors themselves (1)
- the focus on employees could be perceived as placing the blame on the employees rather than attempting to assist in preventing the errors, which may cause grievances with the employees (1).

Award up to **two** marks for a discussion of the conclusions about the statement:

- the approach is only likely to find the source of the error if it is due to record keeping, as it appears to be a whole department producing errors this may be unlikely (1)

- if the whole department has poor record keeping this is likely to be the fault of the processes in place from the employer rather than due to individual employees (1)
- checking the records may be important but it would be unlikely to be the most important and likely cause of error (1); a better initial first step would be talking to members of staff in the department to discuss where they think the errors are arising from, and from there decide what specific elements need to be examined (1).

Accept any other suitable response.

10 A research scientist has just started a new job in an animal testing laboratory and is having lunch with friends. A friend does not like the idea of testing on animals.

The research scientist states, “As long as animal experimentation is beneficial to humans, it should be allowed to be carried out, and all employees of the animal testing laboratory follow ethical scientific practices as outlined in ‘Rigour, Respect, Responsibility: A Universal Ethical Code for Scientists 2007.’”

Considering the key aims of this code of practice and the need for integrity in a scientific setting, evaluate the research scientist's statement.

Your response should include reasoned judgements and conclusions about the validity of the statement.

[12 marks, plus 3 marks for QWC]

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

This is a band-marked question.

| Band | Marks | Descriptor |
|------|-------|--|
| 4 | 10–12 | <p>AO3 Evaluation of the scientist’s statement in relation to following ‘Rigour, Respect, Responsibility: A Universal Ethical Code for Scientists 2007’ and how integrity is demonstrated in this scientific setting, is comprehensive, effective and relevant, and complete showing detailed understanding and logical and coherent chains of reasoning throughout. Informed conclusions that are fully supported with rational and balanced reasoned judgements are evident.</p> <p>AO2 Applied all relevant knowledge of the ethical principles in science and the need for integrity in a scientific setting to animal testing. Shows a detailed functional understanding of the problems that could arise.</p> <p>AO1 A wide range of relevant knowledge and understanding of ethical principles and how the scientist can demonstrate integrity in their workplace, which is accurate and detailed, is given. The answer</p> |

| | | |
|---|-----|--|
| | | demonstrates comprehensive breadth and / or depth of understanding. |
| 3 | 7–9 | <p>AO3 Evaluation of the scientist’s statement in relation to following ‘Rigour, Respect, Responsibility: A Universal Ethical Code for Scientists 2007’ and how integrity is demonstrated in this scientific setting, is effective and relevant, though some minor key points may be omitted or insufficiently explained, showing mostly logical and coherent chains of reasoning. Conclusions supported by reasoned judgements that consider most of the relevant arguments are evident.</p> <p>AO2 Applied the majority of relevant knowledge of the ethical principles in science and the need for integrity in a scientific setting to animal testing, showing functional understanding of how they can be applied in this scenario, though some minor points may be omitted or insufficiently explained.</p> <p>AO1 Knowledge and understanding of ethical principles and how the scientist can demonstrate integrity in their workplace, is in most parts clear and accurate, although some minor elements may not be comprehensively explained. The answer demonstrates reasonable breadth and / or depth of understanding, with occasional inaccuracies and / or omissions.</p> |
| 2 | 4–6 | <p>AO3 Evaluation of the scientist’s statement in relation to following ‘Rigour, Respect, Responsibility: A Universal Ethical Code for Scientists 2007’ and how integrity is demonstrated in this scientific setting, is in most parts effective and mostly relevant, showing mostly logical and coherent chains of reasoning. Conclusions supported by reasoned judgements that consider some of the relevant arguments are evident.</p> <p>AO2 Applied little but some knowledge of the ethical principles in science and the need for integrity in a scientific setting to animal testing, showing some functional understanding of how they can be applied in this scenario.</p> <p>AO1 Knowledge and understanding of ethical principles and how the scientist can demonstrate integrity in their workplace is in some parts clear and with some but limited accuracy, although on occasion may lose focus. The answer demonstrates reasonable breadth and / or depth of understanding, with occasional inaccuracies and / or omissions.</p> |

| | | |
|---|-----|--|
| 1 | 1–3 | <p>AO3 Evaluation of the scientist’s statement in relation to following ‘Rigour, Respect, Responsibility: A Universal Ethical Code for Scientists 2007’ and how integrity is demonstrated in this scientific setting, is in some parts effective and of some relevance, with some understanding and reasoning taking the form of generic statements with some development. Brief conclusions supported by reasoned judgements that consider only basic arguments and show little relevance to the question aims are evident.</p> <p>AO2 Applied limited knowledge of the ethical principles in science and the need for integrity in a scientific setting to animal testing may show a lack of functional understanding of the diagnostic tools.</p> <p>AO1 Knowledge and understanding of ethical principles and how the scientist can demonstrate integrity in their workplace shows some but limited accuracy, focus and relevance. The answer is basic and shows limited breadth.</p> |
| | 0 | No creditworthy material. |

Indicative content

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

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

AO1: Demonstration of knowledge and understanding of ethical principles and how the scientist can demonstrate integrity in their workplace – answer identifies examples of these codes and practices, which may include:

- The key aims of ethical scientific practices as outlined in ‘Rigour, Respect, Responsibility: A Universal Ethical Code for Scientists 2007’:
 - to foster ethical research
 - to encourage active reflection among scientists on the implications and impact of their work
 - to support communication between scientists and the public on complex and challenging issues
- How to demonstrate integrity in a scientific setting:
 - maintaining high quality ethical and professional standards, for example, objectivity, clarity, reproducibility
 - following organisational codes of practice
 - following regulatory guidance
 - aspiring to excel, not just meet the minimum standards
- codes of practice exist that govern the use of animals in research

- The purpose of codes of practice within organisations is to define how employees can remain compliant with policies or legislation.

AO2: Application of knowledge of the ethical principles in science and the need for integrity in a scientific setting to animal testing – answer links these factors to the scenario in question, which may include:

- in adhering to Rigour, Respect, Responsibility: A Universal Ethical Code for Scientists 2007 scientists:
 - demonstrate adherence to the law and ensure animals in the laboratory are treated as humanely as possible
 - foster ethical research by only testing on animals when absolutely necessary, for example, testing drugs that may save human lives
 - encourage active reflection among scientists by challenging others when carrying out animal testing, for example, ensuring colleagues have considered all other ways to carry out research that does not need to use animals
 - support communication between scientists and the public by being open and honest about the research with the others, allowing the integrity of the testing to be challenged if needed
- scientists must work in accordance with the relevant laws, there will be laws that cover the use of animals in testing and this will need to be followed to demonstrate integrity in the scientific setting
- integrity includes aiming to maintain high-quality ethical and professional standards.

AO3: Evaluation of the scientist’s statement in relation to following ‘Rigour, Respect, Responsibility: A Universal Ethical Code for Scientists 2007’ and how integrity is demonstrated in this scientific setting – answer evaluates how these codes and practices are able to be used in animal testing, which may include:

- animal testing is permitted in scientific settings, without animal testing, we would have many preventable human deaths during drug trials / many people suffering with treatable diseases; this supports the research scientist’s statement
- human volunteers would arguably be better than animal testing and also reduce the need for animal testing, however, the regulations surrounding human testing are much stricter than those around animal testing
- animals are living things and deserve to be treated with respect; many people refuse to use drugs / products that have been tested on animals, and so this does not support the statement
- some of the laws are subjective, for example, the decision on what is necessary in terms of animal testing.

Students may make other valid and well-reasoned responses that can be credited:

- unrestricted use of animals in research would not be ethical / would not show integrity, as this may also negatively impact public perception, for example, if the work is not deemed worthy of using animals, such as cosmetic testing
- research must be able to justify its importance, especially in terms of the use of animals; not all potential animal research would meet these thresholds, and some would be out of scope with ethical codes and laws

- a general agreement exists that animal use in research should be reduced and replaced in any capacity that it can be, for example, using cell culture or simulated models instead of animals.

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: Health and safety in the science sector

This section is worth 25 marks, plus 3 marks for quality of written communication (QWC) and use of specialist terminology.

| |
|---|
| <p>11 Choose the correct definition of a category three biohazard:</p> <p>A Can cause human disease and may be a hazard to employees, unlikely to spread to the wider population and there are usually effective vaccines or other treatments available</p> <p>B Can cause human disease and may be a serious hazard to employees, it may spread to the wider population but there are usually effective vaccines or other treatments available</p> <p>C Causes severe human disease and is a serious hazard to employees, it is likely to spread to the wider population and there are usually no effective vaccines or other treatments available</p> <p>D Is unlikely to cause human disease or be a hazard to employees, unlikely to spread to the wider population so no treatments needed</p> <p style="text-align: right;">[1 mark]</p> |
|---|

AO1 = 1 mark

Answer

B Can cause human disease and may be a serious hazard to employees, it may spread to the wider population but there are usually effective vaccines or other treatments available (1).

| |
|---|
| <p>12 A piece of machinery in a chemical plant gives off 90 decibels of noise on a consistent basis.</p> <p>Identify two steps the employer could undertake to ensure the protection of their employees working with the machinery.</p> <p style="text-align: right;">[2 marks]</p> |
|---|

AO1 = 2 marks

Answer

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

- generating and ensuring compliance with risk assessments
- providing personal protective equipment (PPE) such as ear defenders
- providing regular hearing checks for employees
- ensure that no one is exposed to the noise of the machine unless necessary (for example, do not have any other equipment near it).

Accept any other suitable response.

13 A physics research building is using a piece of equipment that generates a high intensity electromagnetic field.

Outline two requirements for minimising the risk to employees.

[2 marks]

AO1 = 2 marks

Answer

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

- limit exposure to electromagnetic fields
- implement action plans to ensure employees are not exposed to unsafe levels
- provide relevant training
- provide health monitoring
- have appropriate risk assessments in place.

Accept any other suitable response.

14 (a) A research laboratory is planning to begin a new project carrying out research on an airborne category two biohazard.

The laboratory manager has suggested that in order to ensure the scientists and others carrying out work in the area are safe, the following protocols need to be implemented.

They have suggested that these protocols will be sufficient for any category two biohazards worked on in the laboratory:

- **personal protective equipment (PPE) including gloves and lab coats must be worn at all times**
- **all work should be carried out in a fume cupboard fitted with a HEPA filter**
- **all contaminated waste will have its own specified labelled waste stream and will be incinerated.**

Explain how two elements of the above protocols will protect the scientists performing the work on category two biohazards.

[4 marks]

AO2 = 4 marks

Answer

Award **one** mark for each part of an explanation of how a protocol step will protect scientists, up to maximum of **four** marks:

- Gloves will reduce the risk of any pathogen / biohazard coming into contact with the scientist's hands, reducing the likelihood it will find an infection route into the scientist through the skin (1). Lab coats prevent the transfer of biohazard / pathogens onto clothes that may be worn outside of the laboratory environment and taken home (1)
- The microbiological fume cupboard will reduce the risk of contamination to the area outside the cupboard by providing a flow of air preventing escape of aerosols and the HEPA filter will prevent any pathogen / biohazard being released through the air vent (1), which the laboratory staff may inhale and, therefore, prevents a direct route to infecting them with the pathogens / biohazard (1)
- The specific waste route will ensure that all contaminated material is clearly identifiable and unlikely to get mixed in with other waste from the laboratory, which could lead to accidental release into the wider laboratory or the environment (1). Incineration will prevent release into the wider environment because the high temperatures destroy all living organisms including pathogens / biohazard (1).

Accept any other suitable response.

14 (b) Discuss whether the manager's protocols will be sufficient to fully protect scientists working in the laboratory.

[4 marks]

AO3 = 4 marks

Answer

Award **one** mark for each discussion of each point given for how this method mitigates the associated risk, up to a maximum of **four** marks.

PPE:

- positive aspects – gloves and lab coats would be the minimal level of protection that would protect the scientist (1)
- negative aspects – as the pathogen / biohazard is airborne it would also be important to wear safety goggles to prevent transmission into the eyes (1), it may also be necessary to wear PPE that would prevent inhalation of the pathogen / biohazard, such as a mask or respirator (1), however, proper use of a safety cabinet may mean this is not necessary (1).

Fume cupboard:

- positive aspects – the fume cupboard will prevent release of the pathogen / biohazard into the laboratory environment, and so should mean that the scientist is not exposed to it (1)
- negative aspects – there are no details given about the class rating of the cupboard (1), the cupboard would need to be at least a class two safety cabinet to protect both the environment in the cabinet and the user outside of it (1); a class one fume cupboard would

prevent release of the pathogen / biohazard into the laboratory but not prevent contamination from the laboratory into the cupboard, which may be sufficient (1).

Waste:

- positive aspects – labelling and a specific waste stream will ensure that all contaminated waste is disposed of in a way that will prevent its release into the wider environment (1)
- negative aspects – specified waste streams are aimed more at protecting the wider environment outside of the laboratory rather than those working on the pathogen / biohazard (1), it is likely further elements will need to be incorporated into the waste disposal to protect those in the laboratory (for example ensuring the pathogen / biohazard is killed before placing it into waste, keeping waste in a protected area) (1).

Accept any other suitable response.

15 An accident has occurred in a chemical manufacturing facility.

A report states:

- an employee has been injured by a chemical spill
- the employee has severe chemical burns across 15% of their body
- the employee was not wearing appropriate PPE
- it is thought the spill was caused by overfilling a container
- all documentation, including Control of Substances Hazardous to Health (COSHH) forms and standard operating procedures (SOPs) are correct and up to date.

As a result of the accident, the health and safety (H&S) officer has decided to run a course on the correct protocols for cleaning up chemical spills. Other than this no other steps have been taken. The H&S officer is not aware if they have complied with all the required legislation and company policies but thinks this will be enough.

Evaluate how effective the response of the H&S officer is in terms of complying with legislation and regulations, and in preventing similar incidents occurring in future.

Your response must include reasoned judgements and conclusions.

[12 marks, plus 3 marks for QWC]

AO1 = 4 marks

AO2 = 4 marks

AO3 = 4 marks

QWC = 3 marks

This is a band-marked question.

| Band | Marks | Descriptor |
|------|-------|--|
| 4 | 10–12 | <p>AO3 Evaluation of the H&S officer’s response to the accident is comprehensive, effective and relevant, and complete showing detailed understanding and logical and coherent chains of reasoning throughout. Informed conclusions that are fully supported with rational and balanced reasoned judgements are evident.</p> <p>AO2 Applied all relevant knowledge of how the relevant legislation and regulations apply in the context, how effective the response is for minimising future risks and complying with the relevant regulations and legislation, and whether any further detail is required, with the answer showing a detailed functional understanding of the problems that could arise.</p> <p>AO1 A wide range of relevant knowledge and understanding of relevant legislation and regulations, their implementation and how they would manage risk, which is accurate and detailed, is given. The answer demonstrates comprehensive breadth and / or depth of understanding.</p> |
| 3 | 7–9 | <p>AO3 Evaluation of the H&S officer’s response to the accident is effective and relevant, though some minor key points may be omitted or insufficiently explained, showing mostly logical and coherent chains of reasoning. Conclusions supported by reasoned judgements that consider most of the relevant arguments are evident.</p> <p>AO2 Applied the majority of relevant knowledge of how the relevant legislation and regulations apply in the context, how effective the response is for minimising future risks and complying with the relevant regulations and legislation, and whether any further detail is required, with the answer showing functional understanding of how they can be applied in this scenario, though some minor points may be omitted or insufficiently explained.</p> <p>AO1 Knowledge and understanding of relevant legislation and regulations, their implementation and how they would manage risk, is in most parts clear and mostly accurate, although some minor elements may not be comprehensively explained. The answer demonstrates reasonable breadth and / or depth of understanding, with occasional inaccuracies and / or omissions.</p> |
| 2 | 4–6 | <p>AO3 Evaluation of the H&S officer’s response to the accident is effective and relevant is in some parts effective and of some relevance, showing mostly logical and coherent chains of reasoning. Conclusions supported by reasoned judgements that consider some relevant arguments are evident.</p> |

| | | |
|---|-----|---|
| | | <p>AO2 Applied some relevant knowledge of how the relevant legislation and regulations apply in the context, how effective the response is for minimising future risks and complying with the relevant regulations and legislation, and whether any further detail is required, with the answer showing some functional understanding of how they can be applied in this scenario.</p> <p>AO1 Knowledge and understanding of relevant legislation and regulations, their implementation and how they would manage risk, is in some parts clear and sometimes accurate. The answer demonstrates reasonable breadth and / or depth of understanding, with occasional inaccuracies and / or omissions.</p> |
| 1 | 1–3 | <p>AO3 Evaluation of the H&S officer’s response to the accident is very limited in effectiveness and relevance, with some understanding and reasoning taking the form of generic statements with some development. Brief conclusions supported by reasoned judgements that consider only basic arguments and show little relevance to the question aims are evident.</p> <p>AO2 Applied limited knowledge of how the relevant legislation and regulations apply in the context, how effective the response is for minimising future risks and complying with the relevant regulations and legislation, and whether any further detail is required, with the answer showing a lack of functional understanding of the diagnostic tools.</p> <p>AO1 Knowledge and understanding of relevant legislation and regulations, their implementation and how they would manage risk, shows some but very limited accuracy, focus and relevance. The answer is basic and shows limited breadth.</p> |
| | 0 | No creditworthy material. |

Indicative content

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

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

AO1: Demonstration of knowledge and understanding of how effective the response of the H&S officer is in terms of complying with legislation and regulations – answer identifies examples of these factors, which may include:

- the company has to follow specific regulations, for example:
 - Health and Safety at Work etc. Act 1974

- Control of Substances Hazardous to Health (COSHH) Regulations 1994 and subsequent amendments 2002
- The Personal Protective Equipment at Work Regulations 1992
- The Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 2013 (RIDDOR)
- the company has a responsibility to follow organisational policies and SOPs, including site-specific emergency procedures
- the company should have policies in place to deal with situations that can occur in a health or science environment that could cause harm to self or others (for example, spillage of hazardous material)
- the employees have a responsibility to follow organisational health and safety procedures
- the company has responsibility to provide regular and up-to-date training for all employees.

AO2: Application of knowledge and understanding of how effective the response of the H&S officer is in terms of complying with legislation and regulations – answer links these factors to the scenario in question, which may include:

- the purpose of the following legislation and regulations in the health and science sector:
 - Health and Safety at Work etc. Act 1974 defines an employer's responsibility to its employees, with rules in place to ensure the health of employees
 - Control of Substances Hazardous to Health (COSHH) Regulations 1994 and subsequent amendments 2002 outlines requirements for how dangerous substances should be used and controlled, with the forms in this case being in place correctly
 - The Personal Protective Equipment at Work Regulations 1992 defines an employer's responsibility to provide correct PPE, the employee in this case was not wearing correct PPE, which is relevant to this regulation
- The Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 2013 (RIDDOR) outlines the employer's responsibility to report serious incidents of a defined type to the Health and Safety Executive (HSE), the burns to the employee would need to be reported to the HSE in this case
- the proper procedures were in place in regard to SOPs; however, they were likely not followed, resulting in injury to the employee
- the employer has a responsibility to provide a safe workplace – harm was caused to the employee due to incorrect PPE and clean up, so this element was not correctly in place at the time
- the employee has a responsibility to follow organisational health and safety procedures; the employee failed to correctly wear PPE when dealing with the incident. The H&S officer is also not following the correct procedures in his response
- the employer / company has a responsibility to report issues / accidents / incidents as appropriate – this accident will need to be reported to the HSE under RIDDOR, the H&S officer has no plan in place for doing this
- good practice involves debriefing and reflecting on the root causes to prevent the situation from recurring; the H&S officer is to reissue training, but this will only be effective if the proper procedures are implemented.

AO3: Evaluation of knowledge and understanding of how effective the response of the H&S officer is in terms of complying with legislation and regulations – answer evaluates how these factors could prevent future events, which may include:

- no evidence that the Health and Safety at Work etc. Act 1974 was not followed, so maybe training of staff as suggested will be enough to prevent future accidents
- the report states that the correct paperwork was in place to cover the Control of Substances Hazardous to Health (COSHH) Regulations 1994 and subsequent amendments 2002, so again no evidence that these were not followed, and no response required from the employer
- the employee in this case was not wearing correct PPE, which is relevant to The Personal Protective Equipment at Work Regulations 1992, proper training in the use of PPE would therefore be of benefit, with the proposed training covering this
- the burns to the employee would need to be reported to the HSE to ensure compliance with the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 2013 (RIDDOR) – the H&S officer in this case has made no mention of reporting the accident, which would be a breach of the regulations and would need to be rectified
- the proper procedures were in place regarding SOPs; however, they were likely not followed, resulting in injury to the employee and, as a result, training in the proper procedures would be beneficial in this situation
- overall, the H&S officer will need to issue training as suggested, but a review of current practice would be of use to ensure the procedures in place are of the correct standard and are adhered to by employees
- foster a ‘speak-up’ culture so all employees are confident to encourage others to follow the rules and regulations put in place by the employer.

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 D: Scientific methodology, equipment and techniques

This section is worth 25 marks, plus 3 marks for quality of written communication (QWC) and use of specialist terminology.

- 16** Which one of the following would be an example of a negative control when preparing microbiological plates?
- A Adding a known quantity of bacteria to the plate in combination with the unknown sample
 - B Adding an equivalent volume of pure water instead of sample to the plate
 - C Adding an unknown quantity of bacteria to the plate in combination with the unknown sample
 - D Ensuring the plate is incubated overnight at room temperature

[1 mark]

AO1 = 1 mark

Answer

B Adding an equivalent volume of pure water instead of sample to the plate (1).

- 17 (a)** A laboratory technician is preparing for an experiment in which animal cells will be cultured. They are preparing a cell culture medium that needs to be autoclaved.

Describe how an autoclave will sterilise a cell culture medium.

[1 mark]

AO1 = 1 mark

Answer

Award **one** mark for accurate description

- autoclaves work by heating medium under high pressure to kill microorganisms.

Accept any other suitable response.

17 (b) Name one piece of equipment that could be used to accurately measure and transfer the culture medium to an agar plate.

[1 mark]

AO1 = 1 mark

Answer

Award **one** mark for naming the correct piece of equipment:

- digital pipette.

Accept syringe or a named brand of pipette, for example Gilson pipette.

18 An apprentice is working with a substance known to be corrosive and that can potentially release harmful gas.

Explain one appropriate technique the apprentice should employ when working with this substance.

[2 marks]

AO2 = 2 marks

Answer

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

- The apprentice should refer to the appropriate safety data sheets as they contain the necessary information to carry out risk assessments (1). This is to ensure that risk assessments are followed / updated so the apprentice can work with the substance safely (1)
- The apprentice should apply containment controls / use a fume cupboard (1). This is to ensure that the apprentice does not inhale / come into contact with any harmful gas if it is released (1).

NB Any reference to use of personal protective equipment (PPE) needs to be specifically related to the scenario; generic responses should not be credited.

Accept any other suitable response.

19 A laboratory technician is making up 1M sodium hydroxide solution. They add 40g of solid sodium hydroxide to 0.5L of water in a volumetric flask and stir. Once the solid sodium hydroxide is dissolved, they dilute to 1L. This solution should have a pH of 13.

However, the pH meter shows the solution has a pH of 12.

Discuss how the technician could confirm that the inconsistencies in the pH are due to something other than the balance or the pH meter.

[4 marks]

AO3 = 4 marks

Answer

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

- the technician should confirm that both pieces of equipment are functioning correctly (1) by carrying out a physical / sight check / calibration (1)
- the technician can calibrate the pH meter against standard pH buffers of a known pH (1)
- the technician can calibrate the balance using a standard set of masses (1)
- the technician could use a different balance / pH meter and remake the sodium hydroxide solution (1)
- the technician could ask a colleague to double check their work to ensure they are using the equipment correctly (1).

Accept any other suitable response.

20 A researcher is finding it difficult to focus their light microscope. They are viewing a Gram-stained sample using a x100 objective lens and immersion oil.

Describe two things the researcher should check to ensure they are correctly using the microscope to view the sample.

[2 marks]

AO2 = 2 marks

Answer

Award **one** mark for each description of something the researcher should check to ensure they are using the microscope correctly, up to a maximum of **two** marks:

- ensure the Gram stain has been prepared correctly by viewing with lower powered objective lenses first (1)
- ensure there is no coverslip on the sample as immersion oil should be placed directly onto the sample to ensure a clear view (1)

- ensure oil has been correctly applied to the sample and that the stage has been raised so the oil completely covers the objective lens, this will ensure that the light is able to be correctly focused by the lens / increase the resolution giving a clearer image (1).

Accept any other suitable response.

21 A reagent manufacturing laboratory is seeking International Organisation for Standardisation (ISO) accreditation. They have only ever sold their products to a limited number of companies in their area and the director is wondering if seeking accreditation would be a good use of time and money.

Explain how ISO accreditation will help them when selling their products locally and abroad.

[2 marks]

AO2 = 2 marks

Answer

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

- getting accredited with and working to ISO standards will ensure that their reagent is certified as being made in a manner that will meet internationally expected standards (1), increasing confidence for the purchasers from overseas (1)
- ISO accreditation is an internationally recognised accreditation, it means that any testing done on the products in the country of origin will be accepted as valid abroad (1), allowing them to sell their reagent in those countries without any further testing requirements (1)
- ISO accreditation enables the option for working collaboratively with other ISO accredited companies (1), which may improve their product / gain further recognition in the field (1)
- ISO accreditation will increase the market available to the company (1), potentially improving sales and positively impacting on commercial performance (1).

Accept any other suitable response.

22 Pharm Ltd. are looking to start a new project focused on the purification of a drug. They have contracted JJS and Co. to help them get the new project started.

The experimental plans for the work to be undertaken need to be agreed by both companies. Pharm Ltd. have a current process they are using and want JJS and Co. to perform the same process to ensure the drug can be purified at different sites.

The current outline for the stages of the work is as follows:

- 1. specify the overall objective of the work**
- 2. define the scope of the experiments to be carried out**
- 3. agree a budget for the cost of the work**
- 4. transfer the protocol over and confirm it works on site**
- 5. carry out the work.**

Points 1–3 will be established in an initial meeting and the work will then be carried out before any further contact between the two companies.

Evaluate the company's plan.

Your response should demonstrate reasoned judgements about the steps outlined and conclusions about the effectiveness and reliability of the plan.

[12 marks, plus 3 marks for QWC]

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

This is a band-marked question.

| Band | Marks | Descriptor |
|-------------|--------------|--|
| 4 | 10–12 | <p>AO3 Evaluation of the steps laid out in relation to how well they will allow for the successful completion of the project is comprehensive, effective and relevant, showing detailed understanding and logical and coherent chains of reasoning throughout. Informed conclusions that are fully supported with rational and balanced reasoned judgements are evident.</p> <p>AO2 Applied all relevant knowledge of the steps required to agree the scope of a project with a client and carry it out as defined and shows a detailed functional understanding.</p> <p>AO1 A wide range of relevant knowledge and understanding of the steps required to carry out the work set by the client, which is accurate and detailed. A wide range of appropriate technical terms are used.</p> |

| | | |
|---|-----|---|
| 3 | 7–9 | <p>AO3 Evaluation of the steps laid out in relation to how well they will allow for the successful completion of the project is effective and relevant, though some minor key points may be omitted or insufficiently explained, showing mostly logical and coherent chains of reasoning. Conclusions supported by reasoned judgements that consider most of the relevant arguments are evident.</p> <p>AO2 Applied the majority of relevant knowledge of the steps required to agree the scope of a project with a client and carry it out as defined, with the answer showing functional understanding of how they can be applied in this scenario, though some minor points may be omitted or insufficiently explained.</p> <p>AO1 Knowledge and understanding of the steps required to carry out the work set by the client is in most parts clear and accurate, although some minor elements may not be comprehensively explained. The answer demonstrates reasonable breadth and / or depth of understanding, with occasional inaccuracies and / or omissions.</p> |
| 2 | 4–6 | <p>AO3 Evaluation of the steps laid out in relation to how well the steps will allow for the successful completion of the project is in most parts effective and mostly relevant, showing mostly logical and coherent chains of reasoning. Conclusions supported by reasoned judgements that consider most of the relevant arguments are evident.</p> <p>AO2 Applied mostly relevant knowledge of the steps required to agree the scope of a project with a client and carry it out as defined, in the given context, with the answer showing some functional understanding of how they can be applied in this scenario.</p> <p>AO1 Knowledge and understanding of the steps required to carry out the work set by the client 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.</p> |
| 1 | 1–3 | <p>AO3 Evaluation of the steps laid out in relation to how well the steps will allow for the successful completion of the project is in some parts effective and of some relevance, with some understanding and reasoning taking the form of generic statements with some development. Brief conclusions supported by reasoned judgements that consider only basic arguments and show little relevance to the question aims are evident.</p> |

| | | |
|--|---|---|
| | | <p>AO2 Applied limited knowledge of the steps required to agree the scope of a project with a client and carry it out as defined, to the given context, with the answer showing a lack of functional understanding of the diagnostic tools.</p> <p>AO1 Knowledge and understanding of the steps required to carry out the work set by the client shows some but limited accuracy, focus and relevance. The answer is basic and shows limited breadth.</p> |
| | 0 | No creditworthy material. |

Indicative content

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

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

AO1: Demonstration of knowledge and understanding of the steps required when carrying out work for a company – answer identifies examples of these steps, which may include:

- it is good practice to:
 - define timescales
 - set a budget prior to work commencing
 - be clear about scale (for example, number of replicates and sample size)
 - be open and honest, and specify objectives
- any brief / research questions should be answered
- language that all present in meetings can understand
- the most appropriate way of presenting data should be agreed (for example, visualisations and infographics)
- transparency and honesty needed when highlighting the commercial / business benefits for the customer / client.

AO2: Application of knowledge and understanding of the steps required when carrying out work for a company and how closely the plan follows these steps – answer links these factors to the scenario in question, which may include:

- no overall timescale has been put in place to cover the work – this could lead to disappointment and / or contracts not being met
- objectives are needed to ensure the process can be carried out across different sites
- the client organisation has not answered any brief / research questions, which could lead to misunderstanding and / or the product not being fit for purpose

- neither organisation has agreed on the most appropriate way of presenting data, for example, visualisations and infographics – depending on the vision of each organisation, this could be vastly different and lead to a dissatisfied client organisation
- neither organisation has specified what they expect to gain from this venture – this could lead to dissatisfaction or a product that is not fit for purpose
- customers of the client organisation may not agree with the views / beliefs of the research organisation and boycott the use of the product.

AO3: Evaluation of their knowledge and understanding of the steps required when carrying out work for a company and how effective and reliable the plan is – answer evaluates how these factors could impact the company, which may include:

- credit reasoned suggestions as to how the methodology could be improved:
 - as no timescale has been agreed, this would need to be discussed to ensure the work is completed in an agreed timeframe that is both acceptable for the client and practicable for the company performing the work
 - a budget has been agreed between the two companies, but if any changes are made this may need to be re-examined; planning an interim meeting after samples have been made, to discuss further cost, might be beneficial
 - scope of the work has been agreed so this part of the requirements is correctly covered
 - objectives for the work have been defined, which will allow for the work to be performed
- as the companies have not decided on how to provide / display / feedback results, there should be further details put into the proposal that will cover the reporting of the results to the client, defining when and how these results will be provided
- regular meetings between the organisations would improve communication and reduce the chance of either organisation being unhappy with any aspect of the work.

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

Section A Working within the science sector

| Question Number | AO1 | AO2 | AO3 | Maths | QWC | Total |
|------------------------|-------------------|-------------------|-------------------|----------|----------|-----------|
| 1 | 1* | | | | | 1 |
| 2 (a) | 2* | | | | | 2 |
| 2 (b) | | 4 | | | | 4 |
| 3 | | 2 | | | | 2 |
| 4 | | | 4 | | | 4 |
| 5 | 4 | 4 | 4 | | 3 | 15 |
| Total | 7 | 10 | 8 | 0 | 3 | 28 |
| Totals required | 5–10 marks | 8–14 marks | 5–12 marks | 0 | 3 | 28 |
| Kil* | 3 | | | | | |

Section B

Ethics, data and managing personal information in the science sector

| Question Number | AO1 | AO2 | AO3 | Maths | QWC | Total |
|------------------------|-------------------|-------------------|-------------------|----------|----------|-----------|
| 6 | 1* | | | | | 1 |
| 7 | | 2 | 4 | | | 6 |
| 8 | | 2 | | | | 2 |
| 9 | | 4 | | | | 4 |
| 10 | 4 | 4 | 4 | | 3 | 15 |
| Total | 5 | 12 | 8 | 0 | 3 | 28 |
| Totals required | 5–10 marks | 8–14 marks | 5–12 marks | 0 | 3 | 28 |
| Kil* | 1 | | | | | |

Section C
Health and safety in the science sector

| Question Number | AO1 | AO2 | AO3 | Maths | QWC | Total |
|------------------------|-------------------|-------------------|-------------------|----------|----------|-----------|
| 11 | 1* | | | | | 1 |
| 12 | 2 | | | | | 2 |
| 13 | 2* | | | | | 2 |
| 14 (a) | | 4 | | | | 4 |
| 14 (b) | | | 4 | | | 4 |
| 15 | 4 | 4 | 4 | | 3 | 15 |
| Total | 9 | 8 | 8 | 0 | 3 | 28 |
| Totals required | 5–10 marks | 8–14 marks | 5–12 marks | 0 | 3 | 28 |
| Kil* | 3 | | | | | |

Section D
Scientific methodology, equipment and techniques

| Question Number | AO1 | AO2 | AO3 | Maths | QWC | Total |
|------------------------|-------------------|-------------------|-------------------|----------|----------|-----------|
| 16 | 1* | | | | | 1 |
| 17 (a) | 1 | | | | | 1 |
| 17 (b) | 1* | | | | | 1 |
| 18 | | 2 | | | | 2 |
| 19 | | | 4 | | | 4 |
| 20 | | 2 | | | | 2 |
| 21 | | 2 | | | | 2 |
| 22 | 4 | 4 | 4 | | 3 | 15 |
| Total | 7 | 10 | 8 | 0 | 3 | 28 |
| Totals required | 5–10 marks | 8–14 marks | 5–12 marks | 0 | 3 | 28 |
| Kil* | 2 | | | | | |
| | 28 | 40 | 32 | | | |

Document information

All the material in this document is © NCFE.

'T-LEVELS' is a registered trade mark of the Department for Education.

'T Level' is a registered trade mark of the Institute for Apprenticeships and Technical Education.

'Institute for Apprenticeships & Technical Education' and logo are registered trade marks of the Institute for Apprenticeships and Technical Education.

Owner: Head of Assessment Design