T Level Technical Qualification in Science

Core knowledge and understanding

Paper A

Mark scheme

v1.1: Specimen assessment materials
21 November 2023
603/6989/9

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

The purpose of this mark scheme is to give you:

- examples and criteria of the types of response expected from a student
- information on how individual marks are to be awarded
- the allocated assessment objective(s) (AOs) and total 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 marking grids have been designed to assess students' work holistically. They consist of bands-based descriptors and indicative content.

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

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

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

Application of extended response marking grids

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

When determining a mark, your decision should be based on the quality of the response in relation to the descriptors. You must also consider the relative weightings of the 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.

You are reminded that the indicative content provided under the marking grid is there as a guide, and therefore you must credit other suitable responses a student may produce. It is not a requirement either that students must cover all the indicative content to be awarded full marks.

Assessment objectives (AOs)

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 **When applying for a job to become a metrologist, an apprentice is sent a job description to help them decide whether the role is suitable for them.**

Which one **of the following would be included in a job description?**

[1 mark]

A **The benefits available for the role**

B **The responsibilities that would go with the role**

C **The salary for the role**

D **Who to send your application to when it is completed**

AO1 = 1 mark

Answer

B. The responsibilities that would go with the role (1).

2 **A former apprentice in a food manufacturing company is now qualified, but they are ambitious and looking for future promotion and opportunities for a job with more responsibilities.**

Give one **action they could take to improve their chances of progression in their current sector.**

[1 mark]

AO1 = 1 mark

Answer

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

- undertake a higher education programme (1)
- look for a degree apprenticeship (1)
- undertake some continuing professional development (CPD) (1)
- join a professional body (1)
- look for a scholarship opportunity (1).

Accept any other suitable response.

3 **A laboratory science student has done work experience in a testing lab, analysing samples and using statistics to calculate the significance of results.**

They then took part in client presentations to feed back the results and pitch for further work. After completing their training, they decide they would not like to work in a laboratory.

They state, 'All the jobs in science need me to work in a lab, so I will need to change career direction.'

Explain two **ways the student could still use the skills they have gained in their work experience outside the science sector.**

[4 marks]

AO2 = 4 marks

Answer

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

- the student could use the scientific knowledge from their training and the experience of client presentations they have to communicate to others about science (1) (for example, checking scientific articles for a journal) (1)
- as they have a good scientific knowledge and can communicate well (1), this could be used to explain science to children (for example, working in a museum) (1)
- they have been in the scientific workplace and analysing data (1), so could work in the background using results in a scientific organisation but not in the lab directly (for example, in administration or management) (1)
- there are public service jobs that would need scientific understanding and experience of following standard operating procedures (SOPs) or regulations like they did in the laboratory (1) (for example, civil servant working in the environment agency) (1).

Accept any other suitable response.

4 **For their whole first month in the job, a new biomedical scientist in a hospital lab has been analysing skin swabs from wounds and ulcers for bacterial contamination. The workload is very large and they are stressed by what they are being asked to do, finding it difficult to keep on top of everything.**

To reduce the amount of time taken to do each test, the scientist has stopped cleaning the bench thoroughly in between tests.

4 (a) **Explain** two **possible consequences of their actions. [4 marks]**

4 (b) **For** one **of your chosen consequences, explain how this might affect patients in the longer term. [3 marks]**

[7 marks]

AO2 = 4 marks
AO3 = 3 marks

Answer

AO2: Award up to **one** mark for **each** consequence of their actions and **one** mark for each reason, up to a maximum of **four** marks:

- there could be contamination or cross contamination of the samples (1), meaning patients may get the wrong results for their tests (1)
- decisions could be made about the patients' treatment (1), such as amputating a limb or major surgery (1)
- all tests could need to be repeated (1), leading to delays in treatment for patients (1)
- if contamination gets onto other items, it could go back to wards (1) and infection could be spread to other ill people in the hospital (1).

Accept any other suitable response.

AO3: Award up to **three** additional marks for an explanation of what any given consequence could lead to in the longer term:

- contamination / cross contamination of the samples – the patients could then be given treatment they do not need and get the worry and side effects of that treatment (1), or some patients might leave the hospital without having had treatments that they do need, or unknowingly spread any infections to others in or outside of the hospital (1)
- treatment such as amputating a limb or major surgery could be major and lead to unnecessary long-term trauma for that patient (1) or seriously affect their life afterwards, meaning they are unable to work or look after themselves (1)
- repeating tests will result in delays to their treatment and the patients could become more ill, or even be released without having been treated properly (1); it will also cost the hospital more time and money to repeat the tests and hospitals operate on tight budgets – some tests are expensive (1)

- infection spreading across the hospital could lead to outbreaks on other wards (1) to other ill or vulnerable groups of people like those having chemo or transplant surgery (immunosuppressed), for whom it can be fatal (1)
- allowing such practices can leave the hospital (and in some cases the staff themselves) open to lawsuits or inspections by regulatory bodies (1).

Accept any other suitable response.

5 **A trainer in a company that stores and manages radioactive waste is trying to produce a training session that covers the importance of standard operating procedures (SOPs) for all its employees – including cleaners, truck drivers and radioactive monitoring technicians.**

Evaluate the importance of staff training and of using SOPs in this workplace.

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

This is a band marked question.

Marking guidance

Band	Marks	Descriptor
3	7–9	**AO3 –** Evaluation of the proposed training and how the principles apply in this context 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. **AO2 –** Applied all **relevant** knowledge of the importance of SOPs to the given context and showed a **detailed,** functional understanding of the parts involved. **AO1 –** Knowledge and understanding of the importance of SOPs is **accurate** and **detailed**. The answer demonstrates **comprehensive** breadth and depth of understanding.
2	4–6	**AO3 –** Evaluation of the proposed training and how the 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.

		AO2 – Applied **mostly relevant** knowledge of the importance of SOPs to the context, showing **some** functional understanding of how they can be applied in this scenario. **AO1 –** Knowledge and understanding of the importance of SOPs is in **most parts clear** and **mostly accurate**, although on occasion **may lose** focus. The answer demonstrates **reasonable** breadth and depth of understanding, with **occasional** inaccuracies and / or omissions.
1	1–3	**AO3 –** Evaluation of the proposed training and how the 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. **AO2 –** Applied **limited** knowledge of the importance of SOPs to the context and may show a **lack** of functional understanding of the components. **AO1 –** Knowledge and understanding of the importance of SOPs shows **some** but **limited** accuracy, focus and relevance. The answer is **basic** and shows **limited** breadth and depth of understanding, **with** inaccuracies and omissions.
	0	No creditworthy material.

Indicative content

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

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

AO1 – Demonstration of knowledge and understanding of the importance of SOPs may include:

- standard operating procedures (SOPs) are a set of sequential steps or instructions designed to standardise the approach to a process or action
- there are a variety of different reasons for following SOPs, and these may have a different level of importance depending on your role in the company; these should include the consequences of not following the SOPs to the health and safety of staff, visitors and the surrounding area

- all members of staff would need to have health and safety training as it is a risk to everyone if SOPs are not followed
- staff could be removed from a professional register if they are found not to be following SOPs as this could be unprofessional behaviour
- audits will be important at the company to demonstrate regulations are being followed
- if SOPs are not being obviously followed, then this will be spotted and could have major consequences for the company (they may not get further work if they do not meet the standards)
- all members of staff will need to keep records for audit purposes so should get this training.

AO2 – Application of knowledge of the importance of SOPs to the context may include:

- health and safety are probably the most important aspects of the training at a radioactive waste management facility
- not following SOPs could mean there is a leak of radioactive waste that could be dangerous to the wider public or wildlife
- if things like safety checks have not been completed properly, then leaks or problems might not be picked up in time to do something about them
- cleaners would need extra health and safety SOPs as they may come into contact with areas or items that could be contaminated
- truck drivers would need SOPs that describe what to do if there were major leaks as they may be transporting hazardous and radioactive materials off the site
- radioactive monitoring technicians have a very responsible role so would have SOPs and training that would detail what to do if they found a leak
- it is important that checks can be made on radioactive spread and that these have been done properly to safeguard the local area
- even cleaning or moving around the site could possibly spread radiation so all employees would need this training
- this industry is likely to be heavily regulated (by the environment agency)
- some of the more scientific / technical members of staff may have professional standards they need to abide by (this training could be different for them and not include all staff)
- some standards are checked regularly to show compliance (for example, ISO standards)
- some members of staff may have responsibility for an area (for example, data protection) so would probably need extra training and auditing for this role.

AO3 – Evaluation and reasoned judgements and conclusions of the proposed training and how the principles apply in this context may include:

- staff training is important to prevent accidents happening in the first place and this is especially important in the radioactive waste industry because of the severity of incidents if they do happen
- if you are working in a dangerous facility like this, you need to be able to trust that all employees are working consistently and that there are no ‘weak links’ that could cause contamination or endanger other people
- the consequences of losing professional registration could be that they can no longer work in their role in any industry, meaning there are less experienced members of staff at the company

- the consequences of not following SOPs in this case could be major, as radioactive waste could cause long-term conditions like cancer, or a major accident that could be fatal
- the regulations are likely to have heavy financial penalties if they are not met, which could ruin the company
- there are also likely to be legal repercussions if regulations are not met (for example, staff involved being sued).

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 the quality of written communication (QWC) and use of specialist terminology.

6 **Which of the following is a method for ensuring the results of an experiment are a true reflection of the actual effect being examined in a scientific setting?**

Select one **from the list below:**

[1 mark]

A **Standard deviation**

B **Tabulate raw data**

C **Using controlled variables**

D **Using Spearman's rank**

AO1 = 1 mark

Answer

C. Using controlled variables (1).

7 **A cosmetic formulation scientist works in the lab at the head office of a company, but also does most of the data inputting and report writing from an office behind the busy reception of the building. The office has two glass walls and two shiny, white reflective walls to give a clinical feel to make the brand seem 'scientific' to customers.**

The department are conducting a review after a leak of the data from a recent formulation of an eye cream resulted in their cream being copied by another brand.

Explain one **way the head of department can ensure information the scientist is working on cannot be accessed by unauthorised personnel.**

[2 marks]

AO2 = 2 marks

Answer

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

- turn the computer screen / desk away from the glass walls (1) so the screen is not visible from behind (1)
- log out / lock or switch off the computer when not at the workstation (1) so the data is not visible when the workstation is unattended (1)
- consider a privacy screen filter (1) so work cannot be viewed by any reflection from the walls (1)
- try to avoid accessing data when people are at reception (1) so the public cannot see sensitive information (1)
- work in another, more secure room (1) when sensitive information is being viewed (1).

Accept any other suitable response.

8 **The number of rare newts feeding at two different sites were counted to see if there was a difference between a protected area (site A) and an open site (site B) over a period of time. The results are shown in** Figure 1**.**

Number of newts at site A	12	8	22	13	15	16	10	8	16	17
Number of newts at site B	12	25	28	27	15	22	19	21	23	18

Figure 1: **Results of the newt count**

Suggest which statistical test you would use to determine if there was a significant difference between the numbers of newts feeding at the two sites.

Explain your choice.

[2 marks]

AO2 = 2 marks

Answer

Award **one** mark for correctly identifying which test to use, and **one** mark for a valid explanation of why, up to a maximum of **two** marks:

- they would use a t-test (1) because a t-test determines if there is a significant difference between the means of the two groups (in this case between the numbers of newts at two sites) (1).

Accept any other suitable response.

9 **Whilst writing an article for a science journal on integrity in the science industry, a science journalist starts by explaining that it is important for employees to follow organisational codes of practice in the workplace.**

Outline two **other ways an employee can show integrity in the science industry.**

[2 marks]

AO1 = 2 marks

Answer

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

- they should follow regulatory guidance (1)
- they should show high quality ethical standards (1)
- they should show high quality professional standards (1)
- they should aspire to excel, not just meet minimum standards (1).

Accept any other suitable response.

10 **An environmental scientist is monitoring the health of a pond in the grounds of a stately home. The site is having landscaping work carried out and the scientist has been instructed to share their data with the landscaping team. The readings were taken weekly across the month of March and are shown in** Figure 2**.**

Variable	**Week 1**	**Week 2**	**Week 3**	**Week 4**
Temperature (°C)	1.0	1.3	2.8	2.0
Pond species observed in sample	Pond skater (2) Water boatmen (3) Tench (6)	Diving beetle (1) Pond skater (2) Tench (2)	Water midge (4) Pond skater (5) Water flea (2) Tench (2) Carp (1)	Water boatmen (1) Water flea (5) Pond skater (2) Tench (4)

Figure 2: **Results of the environmental survey**

The scientist is considering the following options for sharing the data with the landscaping team:

- **bar chart**
- **box and whisker plot**
- **line graph.**

Using Figure 2**, discuss the most appropriate option for displaying** each **variable.**

[4 marks]

AO2 = 2 marks
AO3 = 2 marks

Answer

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

Temperature:
- the data here is continuous (AO2 1)
- the data is just one data point (not a spread) (AO2 1).

Pond species:
- the data here is categoric (AO2 1).

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

Temperature:
- the most appropriate is a line graph if data is continuous and only one value (AO3 1)
- there is no mean or spread of data to show with a box and whisker plot (AO3 1)
- the data is not categoric so a bar chart would not be appropriate (AO3 1).

Pond species:
- a bar chart would be most appropriate to show categoric data (AO3 1).

Accept any other suitable response.

11 **A firm doing calibration and testing of measurement equipment for the building industry has just appointed a new managing director. They have a meeting with all employees on their first day and say that they are not going to be too nice because 'mean bosses get better results'.**

The union representative has issues with this as they feel it shows a lack of respect in the workplace and they are worried about the effect on staff in the firm.

11 (a) **Give** two **reasons why respect is important in the workplace.**

[2 marks]

AO1 = 2 marks

Answer

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

- it would help improve equality and diversity in the workplace (1)
- it would reduce conflict and stress in the workplace (1)
- it could make productivity higher (1)
- it could improve employee job satisfaction (1)
- it may mean that employees are more loyal to their boss (1)
- it may mean there is more loyalty to each other (meaning a better team spirit) (1).

Accept any other suitable response.

11 (b) **Discuss the possible consequences of lack of respect in the workplace to this business.**

[3 marks]

AO3 = 3 marks

Answer

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

- a lack of respect and being mean might reduce productivity as staff will not feel valued and appreciated, and may not take as much pride in their work (1)
- if managers are not respectful then staff are unlikely to be either, and they will pick up on this culture, leading to people not working well in teams and possibly some social issues between staff members (1)
- they may work harder and have higher productivity because they are scared but will maybe look to leave as they are unhappy in their work (1)
- staff may leave and this means new staff need to be recruited and trained, so a high turnover for human resources (HR) to deal with which is expensive for the company in the long run as advertising and recruitment are costly (1)

- if staff are mean, there may be a lot of workplace conflict, and this could reduce collaboration and teamwork which could mean things take longer to get done or are of a worse quality (1)
- if staff do not feel loyal to the company, they may not recommend it to others or appear proud when talking about it (reducing the company reputation) (1)
- if staff are not being supportive and kind to each other, this may impact on equality and diversity in the workforce and could result in legal action (1).

Accept any other suitable response.

12 **In a quality control laboratory for a clothes dye manufacturer, all data from a team of two part-time technicians is currently recorded in lab notebooks. The notebooks are then kept in a storeroom after 1 year. The two members of staff work different days of the week and so need to be able to easily share their data between them.**

The manager is currently looking at whether to switch to an electronic laboratory information management system (LIMS) and has made the following recommendations to the company leadership team:

'I think we should continue using lab notebooks as we can more easily share data and notebooks are not able to be wiped. Plus, they are much cheaper.'

Evaluate the manager's recommendations, considering the advantages and disadvantages of electronic and paper-based systems.

Your response should demonstrate reasoned judgements and conclusions.

[9 marks, plus 3 marks for QWC]

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

This is a band marked question.

Marking guidance

Band	Marks	Descriptor
3	7–9	**AO3 –** Evaluation of the manager's proposed actions and how the advantages and disadvantages apply in this context 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. **AO2 –** Applied all **relevant** knowledge of the advantages and disadvantages of LIMS and paper-based systems to the given context and showed a **detailed,** functional understanding of the diagnostic tools involved. **AO1 –** Knowledge and understanding of the advantages and disadvantages of LIMS and paper-based systems is **accurate** and **detailed**. The answer demonstrates **comprehensive** breadth and / or depth of understanding.
2	4–6	**AO3 –** Evaluation of the manager's proposed actions and how the advantages and disadvantages 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. **AO2 –** Applied **mostly relevant** knowledge of the advantages and disadvantages of LIMS and paper-based systems to the given context, showing **some** functional understanding of how they can be applied in this scenario. **AO1 –** Knowledge and understanding of the advantages and disadvantages of LIMS and paper-based systems 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	1–3	**AO3 –** Evaluation of the manager's proposed actions and how these advantages and disadvantages 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.

		AO2 – Applied **limited** knowledge of the advantages and disadvantages of LIMS and paper-based systems to the given context and may show a **lack** of functional understanding of the diagnostic tools. **AO1 –** Knowledge and understanding of the advantages and disadvantages of LIMS and paper-based systems 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 and AO2 will be implicit through the level of evaluation and the reasoned judgements and conclusions that the student provides.

AO1 – Demonstration of knowledge and understanding of the advantages and disadvantages of LIMS and paper-based systems may include:

Lab notebooks:

- lab notebooks cannot be wiped by electronic failure, but they can be altered, and changes not tracked
- there is less likely to be an issue that would halt work as a lab notebook will not be brought down by any technology failure
- lab notebooks are easy to use and would not need any new training.

LIMS system:

- the lab may not have a current internet connection so that may need to be put into the lab before starting (and adds to the cost)
- the LIMS system is a bit more complicated so may need training on its use
- LIMS systems are more expensive, not only to buy at the start, but for licences they would need to keep using them
- LIMS systems would be able to do a lot more, like analysing the data.

AO2 – Application of knowledge and understanding of advantages and disadvantages of LIMS and paper-based systems in context may include:

Lab notebooks:

- although the lab notebooks can be shared by the two technicians, they could also be accessed by anyone else in the organisation
- if a technician put the lab notebook somewhere unexpected (for example, a locked drawer), it may not be able to be accessed by the second technician
- although the lab notebooks cannot be wiped, they could easily be damaged during work in the lab
- the lab is unlikely to do any work where a computer was not appropriate or available (would all be in the lab in the manufacturing building)
- the technicians already use lab notebooks so they would not need to be trained on how to use them.

LIMS system:

- if anyone were to hack the system, they could steal the data, although that is not likely to be an issue with clothes dyes as they would have less sensitive data than other organisations
- reports could more easily be made from the data to track the dye quality and spot any issues in the process and manufacture
- if a technician were to work from home, they could access the data from there

- as the data could be stored in the 'cloud', there would be less likelihood of damage if something was spilt
- as two technicians are working on the data, errors in the data may not be spotted if they do not look at each other's work
- the LIMS system would require maintenance and there may not be anyone in the organisation who can do this
- if the team were to change, it would be a lot easier to see who had inputted what data as they would all have separate logins.

AO3 – Evaluation / reasoned judgements / conclusions of the manager's proposed actions and how the advantages and disadvantages apply in context may include:

- the manager is right – it would be a lot more expensive, but could bring efficiencies that could mean any problems are spotted earlier and production does not need to be stopped (which would save money)
- although a lab notebook is cheaper, you would need to keep buying and storing them for years, so this cost should be included in any calculations
- it is probably not true that it is easier to share data as lab notebooks could be lost and would not be able to be taken home
- lab notebooks cannot be wiped but you could remove pages without there being a trail that this has happened (a computer system would store changes)
- overall, the LIMS systems are probably more efficient and would allow data to be shared between two people and tracked more easily
- lab notebooks would not have any other functions, so if data is to be analysed, an LIMS system would allow this to happen more easily
- data can also be displayed for others to use it in an LIMS system, and this would be a major advantage for managers.

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 the quality of written communication (QWC) and use of specialist terminology.

13 **A chemical company has a set of material safety data sheets for all the chemicals it uses.**

Identify the purpose of material safety data sheets:

[1 mark]

A **To allow chemicals to be ordered and restocked in time for their next use**

B **To allow risk assessments to be done in line with Control of Substances Hazardous to Health Regulations 2022 (COSHH)**

C **To comply with regulations around moving and handling**

D **To make sure disposal records are kept for a number of years**

AO1 = 1 mark

Answer

B. To allow risk assessments to be done in line with Control of Substances Hazardous to Health (COSHH) regulations (1).

14 **A case study from the health and safety executive detailed a workplace accident.**

Prior to the accident, a worker was using highly flammable cellulose thinners in an open-topped container to wash paint-spraying equipment.

14 (a) **Give** two **items of personal protective equipment (PPE) you could wear when using flammable substances.**

[2 marks]

AO1 = 2 marks

Answer

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

- safety glasses (1)

- protective gloves (1)
- appropriate footwear for working in the lab (1)
- protective apron or clothing (1).

Accept any other suitable response including (but not essential) flame retardant items.

14 (b) **In the incident being examined by the health and safety executive, while working with the flammable substance the employee knocked the container over, splashing the thinners over their trouser leg and canvas shoe.**

They then went into a nearby room to clean themselves, but the room happened to contain drying ovens. These ignited the flammable vapours coming from the thinners, which set their trouser leg and shoe on fire, causing serious burns to their leg and foot.

Suggest three **actions the employer must take in response to the accident with regards to the Dangerous Substances and Explosive Atmospheres Regulations 2002.**

[3 marks]

AO2 = 3 marks

Answer

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

- the employer should decide if cellulose thinners need to be used in this case and provide a non-flammable alternative if not (1)
- the employer should provide a written risk assessment for the thinners if they are to be used (1)
- open containers should not be used for flammable substances and a more suitable alternative may need to be found (1)
- the quantity of thinners to be used should be assessed and the lowest possible amount used (1)
- the employer needs to provide appropriate training on the use of flammable substances (1)
- remedial measures need to be in place in case of fire, such as fire blankets and fire extinguishers to put fire out quickly (1)
- PPE should be in place, if needed, to protect workers and lessen the effects of any spillage (1)
- signage should be in place in any room that could cause a fire hazard if being used near flammable substances (1)
- workers should not be using flammable substances alone in case of injury or accident (1).

Accept any other suitable response.

15 **A containment level 2 laboratory handles a hazard category 2 biohazard and their procedures for the storage and use of the biohazard they handle include:**

- **1 hour training course at start of employment**
- **biological agents must be stored securely in a biosafety cabinet**
- **only authorised personnel have keys to access the storage unit**
- **a chart is signed when the biological agents are used, or the cabinet accessed.**

Evaluate these measures to determine their effectiveness in ensuring the biohazards are safely stored and accounted for at all times.

Your response should demonstrate reasoned judgements and conclusions.

[3 marks]

AO3 = 3 marks

Answer

Award **one** mark for **each** reasoned explanation about the effectiveness of the procedure, up to a maximum of **three** marks:

- it is important that there is training on the regulations and that this is in place at the staff induction so that they are being considered from their first day on the job (1)
- 1 hour may not be long enough to fully understand the regulations and their procedures and some staff may need more specific training depending on their role (1)
- there probably should be regular training updates during employment, as some staff might work there a long time and need to have the information refreshed or updated (1)
- the biohazards should be kept in a locked cupboard, and they are, which means it is difficult to get access and only one specific person will hold a key which prevents unauthorised people getting access (1)
- the cupboard should be placed somewhere harder to get to that not all staff may have access to (for example, not in the corridor as everyone will be walking past it and people may be less vigilant as to who is accessing it) (1)
- it is good that only limited people have access to a key, so they (and others) are aware if anyone else is accessing the cupboard (and biohazards) (1)
- the chart should be signed when a biohazard is accessed, but this should also be countersigned by someone else so they cannot just remove the biohazards without authorisation (1)
- the biohazards should also be signed into the lab when they arrive, so all stock is accounted for (1)
- the biohazards should be signed out of the lab when they are to be properly disposed of (for example, if they are out of date) as this will prevent them just being discarded in a bin where anyone else could pick them out of the bin (1).

Accept any other suitable response.

16 **A toxic chemical spill from a plastics factory was discovered when the local environment agency did a random ground water check in a neighbouring area. The spill is the company's first offence; it was an accident and no one was seriously harmed, so their chief executive thinks they will only receive a fine.**

Discuss the other possible consequences of breaching environmental legislation.

Your response should demonstrate reasoned judgements and a conclusion determining the most probable outcome for the company.

[7 marks]

AO2 = 4 marks
AO3 = 3 marks

Answer

AO2: Award **one** mark for **each** possible consequence, up to a maximum of **four** marks:

- the company are likely to be fined as this will possibly stop them doing it in the future (1)
- the fine is likely as they did not report this themselves and it was detected later (1)
- as the chemicals have got into ground water, they are likely to have a clean-up order that means they will remove the chemicals to stop further contamination or run off (1)
- the chief executive is unlikely to gain a prison sentence as the chemicals were only released by accident and this was not a deliberate act (1)
- they will have some damage to their reputation as the chemicals were found in ground water which could have been drunk by wildlife or found its way into water supplies (1)
- they are likely to only be given an enforcement order as the chemicals were found in ground water (1)
- their business is unlikely to be closed as they did stop the leak, and this is their first offence (1)
- if anyone is found to have been injured as a result of this spillage, the consequences will be more severe (1).

AO3: Award **one** mark for **each** discussion point of the most probable outcome for the company, up to a maximum of **three** marks:

- the most likely outcome will be a fine, as the chief executive thought, as this is a first offence and it was an accident (1), but there will also probably be a clean-up order where they will have to pay for any remedial action (1) to protect the local area and prevent any injury to the local population or aquatic life / wildlife (1). There may possibly be damage to the company's reputation (1) as this spillage was avoidable had they followed their own internal procedures properly (1) and it should not have happened. They may also have to work with the local community to build trust and make assurances that this was a one-off incident (1).

Accept any other suitable response.

17	**A jewellery design company has ordered some nitric acid to use for etching patterns onto metal necklaces and earrings. They estimate using 100 cm^3 of the acid a day and currently employ five designers.** **Moderately concentrated nitric acid is corrosive and can cause severe skin burns and eye damage.** **Using your knowledge of the Health and Safety Executive's 5 Steps to Risk Assessment, discuss the elements the company will need to consider when carrying out their risk assessment for this chemical and the importance of adhering to the 5 steps in a workplace.** **Your response should demonstrate reasoned judgements.** [9 marks, plus 3 marks for QWC]

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

This is a band marked question.

Marking guidance

Band	Marks	Descriptor
3	7–9	**AO3 –** Discussion of the parts of an effective risk assessment and how the key principles apply in this context is **comprehensive**, **effective**, and **relevant**, showing **detailed** understanding and **logical** and **coherent** chains of reasoning throughout. **AO2 –** Applied all **relevant** knowledge of the Health and Safety Executive's 5 Steps to Risk Assessment to the given context and shows a **detailed** functional understanding of the control measures involved. **AO1 –** Knowledge and understanding of the Health and Safety Executive's 5 Steps to Risk Assessment is **accurate** and **detailed**. The answer demonstrates **comprehensive** breadth and / or depth of understanding.
2	4–6	**AO3 –** Discussion of the risk assessment 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. **AO2 –** Applied **mostly relevant** knowledge of the Health and Safety Executive's 5 Steps to Risk Assessment to the context, showing **some** functional understanding of how they can be applied in this scenario.

		AO1 – Knowledge and understanding of the Health and Safety Executive's 5 Steps to Risk Assessment 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	1–3	**AO3 –** Discussion of the Health and Safety Executive's 5 Steps to Risk Assessment and how these 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. **AO2 –** Applied **limited** knowledge of the Health and Safety Executive's 5 Steps to Risk Assessment to the context and may show a **lack** of functional understanding of the diagnostic tools. **AO1 –** Knowledge and understanding of the Health and Safety Executive's 5 Steps to Risk Assessment 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 and AO2 will be implicit through the level of evaluation and reasoned judgements that the student provides.

AO1 – Demonstration of knowledge of the Health and Safety Executive's 5 Steps to Risk Assessment:

- the Health and Safety Executive's 5 Steps to Risk Assessment are:
  - identifying the hazard
  - deciding who might be harmed and how
  - evaluating the risks and deciding on precautions
  - recording findings and implementing them (including completing documentation)
  - reviewing the assessment and updating if necessary.
- the assessment is reviewed every year and after any accident has been recorded
- changes are made if anyone is injured due to the procedures or equipment used
- all equipment provided is documented and spare items are kept for new staff or if items are damaged.

AO2 – Application of each of the Health and Safety Executive's 5 Steps to Risk Assessment to the scenario:

- (step 1) identifying the hazard:
  - the nitric acid is corrosive, and the burns can be severe.
- (step 2) deciding who might be harmed and how:
  - the designers could be harmed when painting the designs onto the necklaces
  - the staff in the stockroom could be harmed if the containers are spilt or damaged
  - could cause severe burns to the skin of the designer or stock person (probably on hands or legs)
  - the nitric acid could cause burns to the eyes if it splashes from the necklaces
  - cleaners could be burnt whilst they are cleaning up at the end of the day and if they are not aware acid has been used.
- (step 3) evaluating the risks and deciding on precautions:
  - if the nitric acid is being used by designers, they may have little or no science training and will not be used to working with chemicals; this may mean accidents are more likely to happen and they will need training
  - eye damage can be severe and could result in loss of sight for an affected person
  - the designers are likely to be sat down as they will need to be doing close working
  - the designers are likely to have their face close to the item as they are making small patterns on an object
  - it is important to have small quantities out on desks, rather than large stock bottles
  - they will need to wear splash resistant goggles as they are working close to the object
  - as they are handling the necklaces, they should wear gloves that are chemically resistant
  - they may possibly need aprons that are chemically resistant if they are sitting down
  - spill kits to neutralise the acid should be on benches or close by.
- (step 4) recording findings and implementing them (including completing documentation):
  - there is a written risk assessment kept in the office and given to all staff making the necklaces.

- (step 5) reviewing your assessment and updating if necessary:
  - it is important to regularly review the precautions that have been put in place to minimise risk to ensure they are still effective.

AO3 – Discussion of the importance of following the Health and Safety Executive's 5 Steps to Risk Assessment in this situation:

- the possible consequences of not following the steps could be serious injury to employees' eyes; this could be life changing (for example, loss of sight)
- employees could have serious burns that may need to be treated in hospital (for example, by skin grafts), and have permanent pain or scars
- the company may also have to pay out thousands of pounds and have to close if they were sued for not providing a risk assessment in this case
- they could face an investigation by the Health and Safety Executive and face criminal charges for not providing a risk assessment.

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 the quality of written communication (QWC) and use of specialist terminology.

18 **An electrician is called in to carry out a portable appliance test (PAT) on the electrical items in a laboratory for safety. As part of the test, they check the insulation around the live parts of a hot plate to make sure its resistance is high enough to stop the user being electrocuted.**

Choose the piece of equipment they would be most likely to use:

[1 mark]

A **An analytical balance**

B **A multimeter**

C **A pH meter**

D **A thermometer**

AO1 = 1 mark

Answer

B. A multimeter (1).

19 **A student is measuring 15 cm^3 of sodium hydroxide solution in order to further dilute it.**

Identify one **piece of suitable equipment they could use to measure this volume of liquid.**

[1 mark]

AO1 = 1 mark

Answer

Award **one** mark for a suitable piece of equipment, up to a maximum of **one** mark:

- measuring cylinder (1)
- graduated pipette (1)
- volumetric pipette (1).

Accept any other suitable response.

20 **The chief executive officer (CEO) of an international scientific company is considering whether to apply for accreditation of the International Organization for Standardization (ISO) standards in scientific settings for their brand-new testing laboratory in the UK.**

The CEO states, 'We won't be able to do any testing for other countries if we do not have accreditation.'

20 (a) **Explain** one **other benefit to the new laboratory business in gaining the accreditation.**

[2 marks]

AO2 = 2 marks

Answer

Award **one** mark for the benefit, up to a maximum of **two** marks for relevant reason:

- it will show that a new laboratory has the proven competency to do the testing needed (1) when it is not yet a proven business (1)
- it will mean the results of the testing they do is accepted by other organisations they may be working with (1), making them part of a recognised community already (1)
- it makes it clear what they are aiming at, in terms of competence to carry out tests (1) and any new staff will have external standards to work towards (1)
- being an accredited laboratory will allow customers to have trust in their service (1), even though they are a new service without a track record (1).

Accept any other suitable response.

20 (b) **Evaluate the CEO's statement.**

Your response should demonstrate reasoned judgements and conclusions about the validity of the CEO's statement.

[3 marks]

AO3 = 3 marks

Answer

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

- the CEO is incorrect as they would be able to do the work in other countries (1), but would need extra test reports to meet any country's standards separately (1); this could cost more money in the long run if they had to do this every time they carry out tests for a company in another country rather than a one-off 3 yearly accreditation renewal (1)
- if they get the accreditation, they will only need one set of test reports and they could be accepted by any country (1)

- this extra layer of work would cost time and will be more work for the staff, not just once but every 3 years when it is due to be renewed, and mean there are less staff available for the day-to-day operations of the business, meaning less time for international work (1)
- international companies may be more likely to use an accredited lab in another country, as they would be reassured by the standards (1).

Accept any other suitable response.

21	**A school has ordered a cylinder of hydrogen to use in a series of new experiments. The school science technician needs to find an appropriate area to store the cylinder. They are considering putting it in a locked outside store that is currently empty or in a locked cupboard adjoining a classroom in the school building.** **Using your knowledge of compressed gases, discuss factors that need to be taken into consideration when making this decision.** **Your response should demonstrate reasoned judgements and a conclusion about the best storage facility to use.** [4 marks]

AO2 = 4 marks

Answer

Award **one** mark for **each** reasoned explanation about the effectiveness of the procedure, up to a maximum of **four** marks:

- they should check the temperature in the two rooms (1)
- they should then consider any heat sources in those places (for example, radiator or window facing south) (1)
- they should avoid any chemicals being kept in a room (for example, oxidising agents or flammable cupboard) (1)
- how is the cylinder to be stored? (for example, is it on a trolley, a rack, or clipped to the wall?) (1)
- they should take into account any other non-chemicals kept in the room (for example, flammable materials like paper or sources of ignition) (1)
- the places where the cylinder is to be used should be assessed (for example, if the store is a distance away from the laboratories) (1)
- the ventilation in the room should be assessed; it would be better to have some ventilation such as a vent (1)
- the security of the room is important (for example, could students get into the room as it is left open during the day, or are they allowed to get pens out of the room?) (1)
- what the store is made out of (for example, an outside store could be wooden and the inside one a bricked room) (1).

Accept any other suitable response.

22 **A food scientist has set up a pilot plant to start producing a new flavour of sauce. Part of the checks on the sauce are to make sure there is low bacterial contamination in the jars of sauce after 6 months. They have decided to test some samples of sauce on nutrient agar plates using aseptic techniques, after first thoroughly preparing the room and surfaces, plus washing hands and wearing personal protective equipment (PPE).**

They have detailed the following steps in handling the equipment:

- **flame a wire loop in a Bunsen flame**
- **take off the lid of the sauce and place top down**
- **dip the loop into the sauce**
- **spread thinly on the agar plate.**

The lead food scientist has said: 'These measures will not be enough to provide accurate results due to the limited measures taken to reduce contamination. There are other procedures that would help to reduce the possibility of contamination further.'

To what extent is their statement justified about the steps taken to the reduce the chances of contamination affecting the results?

Your response should demonstrate reasoned judgements and conclusions about the effectiveness of the measures and any suggested improvements.

[5 marks]

AO3 = 5 marks

Award **one** mark for **each** reasoned argument about the effectiveness of the aseptic techniques given, up to a maximum of **four** marks:

Judgements about effectiveness:

- flaming the wire loop is important to decontaminate / reduce bacteria on this equipment before starting the procedure, but this needs to be done each time to ensure the loop is sterile for each different sauce sample taken (1)
- if the transfer of the sauce is done as quickly as possible, it will minimise exposure to the air; even though this is not listed in the instructions, it would also reduce the risk of contamination (1)
- when the bottle of sauce has the lid removed, it should be placed out of the way on a sterile surface; this will again reduce the risk of transferring any contaminants to the agar (if not held whilst transferring the sauce) (1)
- it can be assumed that they are using sterile nutrient agar and sterile Petri dishes, so these are not contaminated before use (1)
- spreading thinly on the agar plate is not going to affect any contamination issues but there could be inconsistencies if the viscosity of the sauces differs from jar to jar, meaning different amounts of sauce could be placed on each plate (1)
- washing hands and wearing PPE is an appropriate measure but it does not mention wearing sterile gloves which could be more effective in terms of contamination from the

skin, hands or under the nails, but poses an additional risk near the naked flame of the Bunsen burner so is not recommended in this case (1).

Suggestions:

- they should use a suitable control plate in the process to check the sterility of the plate / agar as there may be contaminants already on the plate or in the agar; without this control measure, it would not be clear if the plates were clear to begin with (1)
- they should flame the neck of the bottle as by not flaming the neck of the bottle of sauce, there could be a risk of contamination from the surface inside the bottle (1)
- the bottle should be held at an angle to reduce contamination from the sides of the bottle, and enabling them to reach the sauce without touching the sides (1)
- the technique should be done in a down flow cabinet or next to where the Bunsen burner is to reduce air contamination, but it would need to be quite close to the Bunsen for this to be effective at reducing contamination (1).

Award **one** mark for a conclusion about the effectiveness of the aseptic techniques given for a justified conclusion as to the efficacy of the steps taken – this can be either in favour of the lead food scientist's comments or can disagree with their statement wholly or in part.

Note: Accept suggested improvements and reasons but do not allow a description of a step alone, without sufficient reasoning why that step is needed or effective.

Accept any other suitable response.

23 **A scientific laboratory (with three full-time laboratory technicians) is asked to test 5,000 patient urine samples for traces of protein for a research study. They will use a small quantity of biuret reagent (irritant to skin and eyes) for each test and have 8 weeks to complete the study.**

	Volume of reagent needed per sample (cm^3)	Number of samples that can be processed each day	Patient information	Equipment required
For each laboratory technician	5	100	Patient number (details not recorded)	5 cm^3 digital pipette and disposable tips Sample vial
Laboratory manager checks	5	10	Patient number (details not recorded)	5 cm^3 digital pipette and disposable tips Sample vial

Figure 3: **Shows the staff, their capacity and the required equipment and reagents**

	Using the information in Figure 3 **and your knowledge of experimental design and planning, discuss the steps the laboratory manager must take in planning the work and the need to follow each step.** [9 marks, plus 3 marks for QWC]

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

This is a band marked question.

Marking guidance

Band	Marks	Descriptor
3	7–9	**AO3 –** Discussion of the parts of an effective experimental design and how the key principles apply in this context is **comprehensive**, **effective** and **relevant**, showing **detailed** understanding and **logical** and **coherent** chains of reasoning throughout. **AO2 –** Applied all **relevant** knowledge of the factors to consider when planning and designing an experiment to the given context, showing a **detailed** functional understanding of the control measures involved. **AO1 –** Knowledge and understanding of the factors to consider when planning and designing an experiment is **accurate** and **detailed**. The answer demonstrates **comprehensive** breadth and / or depth of understanding.
2	4–6	**AO3 –** Discussion of the experiment design 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. **AO2 –** Applied **mostly relevant** knowledge of the factors to consider when planning and designing an experiment to the context, showing **some** functional understanding of how they can be applied in this scenario. **AO1 –** Knowledge and understanding of the factors to consider when planning and designing an experiment 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	1–3	**AO3 –** Discussion of how the factors to consider during experiment design 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.

		AO2 – Applied **limited** knowledge of the factors to consider when planning and designing an experiment to the context and may show a **lack** of functional understanding of the diagnostic tools. **AO1 –** Knowledge and understanding of the factors to consider when planning and designing an experiment 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 and AO2 will be implicit through the level of evaluation and reasoned judgements that the student provides.

AO1 – Demonstration of knowledge of the steps taken when planning and undertaking scientific experiments:

- the steps that need to be carried out are managing time efficiently, ensuring sufficient resources, minimising errors, and addressing ethical considerations
- manage time:
  - the lab manager would need to make sure there is enough time planned for the tests (the number that could be done at maximum capacity here is 12 000, so this allows for absence and retests to be done if required)
  - support staff would be needed to check samples in and ship out samples to be stored in case of further checks.
- manage resources:
  - there would need to be enough computers, so each technician and supervisor has one to use to log results.
- minimise errors:
  - labelling and recording samples should be double checked and electronic, to ensure results can be quickly and clearly recorded
  - workspaces should be kept clear of other samples being tested to avoid contamination or incorrect recording
  - disposable tips on the pipettes should be used to ensure there is no contamination between samples
  - control samples should be used to make sure the reagent is being checked and is reliable
  - pipettes should be checked and serviced, if required, before use
  - standard operating procedures (SOPs) should be written to ensure the process is done in the same way each time to minimise errors.
- ethical considerations:
  - laboratory manager may need to justify the necessity of the experiment
  - laboratory manager would need to carry out the investigations in line with relevant organisational codes of practice as well as any relevant regulatory guidance.

AO2 – Application of knowledge and understanding of the factors to consider when planning and designing an experiment to the context:

- manage time:
  - technicians who are working flat out may be more likely to make mistakes and so they should not be working at maximum capacity for 2 months
  - the number of checks should be sufficient to ensure the quality of the testing (here, one-tenth of the tests can be double checked with time left over, if needed, to help with extra tests that come in on certain days, so is sufficient).
- manage resources:
  - enough biuret reagent needs to be ordered in case of wastage around the inside of funnels and pipettes and in case of spillage (in this case, the minimum needed of 5,500 cm^3 would not be enough – around 10 000 cm^3 would ensure enough for rechecks and wastage)
  - disposable pipette tips and sample vials should be bought in excess of the 5,500 needed in case of contamination; these could be used for other tasks so excess would not be wasted.
- minimise errors:
  - as the biuret reagent is an irritant, technicians should have a risk assessment for the chemicals used (for example, eye protection and possibly gloves to be used, depending on whether the technician is making up the reagent or just using it)
  - urine is a bodily fluid and so a risk assessment should take place to ensure droplet or aerosol contamination does not occur to the technician (for example, use of laminar flow cabinet, gloves and eye protection)
  - storage of samples and chemicals should be considered to ensure technicians are not lifting large bottles to decant.
- ethical considerations:
  - as patients have signed up to the research study, which is subject to regulation, there should be no ethical issues here (these details should be checked in advance to ensure this is the case).

AO3 – Discussion of the need to follow each step when planning and undertaking scientific experiments in the workplace:

- manage time:
  - steps for using time effectively need to happen; otherwise, they may not meet their order time or may end up paying extra staff who are not needed, costing the company money.
- manage resources:
  - they will need to manage resources or the project may not be able to start or finish on time, meaning there are delays to the project
  - if the project is held up by not having resources, this may mean companies do not order again as the company is unreliable.
- minimise errors:
  - they should plan to minimise errors or work may need to be repeated, holding up the project
  - if errors are detected after the work has been completed, this may result in reputational damage to the company

  - errors that cause staff to be injured could mean they are off work and not able to be part of future projects.
- ethical considerations:
  - ethical procedures need to be in place for lab standards to be met and the lab to have accreditation; if the lab is not accredited, it will lose a lot of its business and may need to close.

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	1					1
3		4				4
4 (a)		4				4
4 (b)			3			3
5	4	4	4		3	15
Total	**6**	**12**	**7**		**3**	**28**
Totals required	**5–10 marks**	**8–14 marks**	**5–12 marks**	**0**	**3**	**28**
Kil	**1**					

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				2
8		2				2
9	2					2
10		2	2			4
11 (a)	2					2
11 (b)			3			3
12	3	3	3		3	12
Total	**8**	**9**	**8**	**0**	**3**	**28**
Totals required	**5–10 marks**	**8–14 marks**	**5–12 marks**	**0**	**3**	**28**
Kil	**2**					

Section C
Health and safety in the science sector

Question Number	AO1	AO2	AO3	Maths	QWC	Total
13	1					1
14 (a)	2					2
14 (b)		3				3
15			3			3
16		4	3			7
17	3	3	3		3	12
Total	**6**	**10**	**9**	**0**	**3**	**28**
Totals required	**5–10 marks**	**8–14 marks**	**5–12 marks**	**0**	**3**	**28**
Kil	**1**					

Section D
Scientific methodology, equipment and techniques

Question Number	AO1	AO2	AO3	Maths	QWC	Total
18	1					1
19	1					1
20 (a)		2				2
20 (b)			3			3
21		4				4
22			5			5
23	3	3	3		3	12
Total	**5**	**9**	**11**	**0**	**3**	**28**
Totals required	**5–10 marks**	**8–14 marks**	**5–12 marks**	**0**	**3**	**28**
Kil	**2**					

Document information

Owner: Head of Assessment Design

Change History Record

Version	Description of change	Approval	Date of Issue
v1.0	Additional specimen assessment materials		November 2022
v1.1	Sample added as a watermark	November 2023	21 November 2023