T-LEVELS | Institute for Apprenticeships & Technical Education

T Level Technical Qualification in Science

Occupational specialism assessment (OSA)

Laboratory Sciences

Assignment 2 - Part A

Mark scheme

SAM

v1.2: Specimen assessment materials
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Contents

Task 1(a)

Task 1(a) – assessor observation checklist

Criteria	**Assessor check**	**Marks awarded**	**Essential criteria** (All essential criteria must be awarded to pass)
Safe handling of chemical agents during task		1	Yes
Safe storage and disposal of chemical agents		1	Yes
Well organised workstation to facilitate the completion of the task		1	Yes
Safe handling of equipment during task		1	Yes
Use of appropriate PPE in preparation and completion of the task		1	Yes
Performed scientific techniques effectively: • measuring • observing • use equipment correctly (manual dexterity)		1 mark for completing technique effectively and 1 mark for completing techniques accurately (maximum 6 marks) **Guidance** Assessor must check accuracy of recorded measurements and observations on at least 2 occasions during the task	Yes
Total awarded*		11 marks	

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Task 1(a) – Following the SOP

Band	Mark	Descriptor The student has:
4	10–12	The student has demonstrated autonomy and judgement in following the multi-step standard operating procedure (SOP), carrying out all instructions in full and carrying out the task logically and in a time-efficient manner to produce accurate results.
3	7–9	The student has followed the multi-step standard operating procedure (SOP), carrying out most instructions in full, with only occasional minor omissions or errors, for example, stoppers not replaced immediately, instructions on air bubbles, mixing or wait time not accurately followed and carried out the task in the correct order of steps to produce accurate results.
2	4–6	The student has followed the multi-step standard operating procedure (SOP) to produce results, but in some areas attention to detail is lacking. Carried out all major steps in the correct order, although there may be some errors or omissions within some of the steps, for example, mistakes in volumes or equipment used, parts of steps carried out in the wrong order, indicator added at start of titration.
1	1–3	The student has followed parts of the multi-step standard operating procedure (SOP) correctly to produce results, carrying out most of the major steps, but may omit a key step and complete some of the steps in the wrong order, compromising the validity of results.
0	0	No creditworthy material as described in bands 4 to 1.

Indicative content

Following the SOP correctly would include, for example:

- following instructions for use of BOD or similar stoppered bottles
- following instructions for which equipment to use to measure volumes
- solutions A and B added in correct order without introducing air bubbles to sample
- sulfuric acid added after wait time and after transfer to larger flask
- titration begun immediately after sulfuric acid added and mixed
- starch indicator only added when near to end point

Highly effective application of practical scientific and mathematics skills would include (but is not limited to):

- measuring, for example, confident measurement of volumes of reagents demonstrating good practice to enable accurate measurements
- correct use of pipette and measuring cylinder, for example, read at eye level, base of meniscus used, no bubbles in pipette column, pipette is not overfilled
- manual dexterity, for example, accurate and efficient transfer of liquids (when pouring or avoiding bubbles in BOD bottles) or skilful and safe handling of glassware (note that other titration skills are covered below)
- observing, for example, suitable approach to end point determination

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- adds starch indicator when pale straw colour is achieved, recognises end point, and does not progress beyond this point
- analysing:
    - calculates mean titre from concordant results
    - uses information provided to calculate dissolved oxygen content in mg/l
    - correct and complete use of units

Effective techniques and skills for carrying out titration includes (but is not limited to):

- burette rinsed with solution to be titrated
- funnel used for filling and then removed
- equipment used safely, for example in filling, positioning, and storing burette
- burette filled and adjusted to appropriate point
- jet space in burette tip is filled with solution and air bubbles removed
- reading taken from base of meniscus, at eye level and accurate measurements taken
- correct use of burette tap, and manipulation to achieve start and end points of titration
- swirling of the mixture while adding solution cautiously from burette
- solution added dropwise from burette when close to the end point
- results obtained are within an approximate expected range and concordancy

Content mapping:

K1.1: How health, safety and environmental practices apply to laboratory settings:

- safely performing the procedure
- completing the procedure

K1.13: How to perform calculations for acid-base titrations based on mean titres, using n = cV and mass = n/Mr

K1.22: The oxidation and reduction process

K1.47: When scientific and mathematical skills may be applied when completing scientific tasks:

- measuring:
    - volume using a burette
- manual dexterity:
    - when using a pipette
- observing:
    - colour changes at titration end point
- analysing:
    - calculations

K1.49: The purpose of:

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- analysing substances and chemical environments to confirm composition and/or quantity of materials

K1.50: Why the following techniques are used:

- titration, for example, purity analysis
- purity analysis and determining concentration

K1.53: The purpose of the following environmental laboratory techniques:

- biochemical oxygen demand (BOD) to determine the amount of dissolved oxygen needed by microorganisms in a water sample

K1.63: The principles of producing reliable and verifiable results:

- recording in a clear and unambiguous way, such as the use of tables, indelible ink, not using sticky notes or loose papers and ensuring that writing is legible
- using appropriate units, notation, and correct number of significant figures

K1.67: The purpose and importance of SOPs within the laboratory environment

S1.68: Work safely in a laboratory when performing specific scientific techniques

S1.69: Comply with relevant health and safety legislation and regulations, including COSHH and biosafety containment levels, when handling and disposing of solids, liquids, and gases relevant for the scientific technique being performed

S1.71: Use appropriate PPE when performing scientific tasks, for example, suitable eye protection and gloves

S1.75: Apply a range of science and mathematical skills when performing practical scientific techniques

S1.77: Use the following practical scientific techniques to analyse substances:

- acid base and redox titration
- preparation of serial dilutions
- colorimetry
- selecting the appropriate filter
- zeroing the colorimeter using a cuvette containing the solvent only
- measuring the absorbance of a cuvette with test solution

S1.85: Demonstrate practical technical competence in the use of equipment:

- taking accurate measurements
- correctly manipulating the equipment
- using equipment safely and for intended purpose

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Task 1(b)

Task 1(b) – Calculating results

Band	Mark	Descriptor The student has:
4	10–12	The student has used relevant and appropriate methods to calculate mean titre and dissolved oxygen, presenting a complete, identifiable, and relevant set of results which is fit for purpose and supports analysis and further investigation, including the following elements: • in clear tabular format and logical structure • to appropriate significant figures • with appropriate units and notation • suitable number of repeats for all samples • calculations are complete, clear, and accurate with no calculation errors • records allow data to be easily verified
3	7–9	The student has used relevant and appropriate methods to calculate mean titre and dissolved oxygen, presenting an identifiable and relevant set of results which is fit for purpose and supports analysis and further investigation, including the following elements: • in tabular format and organised structure • to appropriate significant figures • appropriate units and notation with minimal error • suitable number of repeats for most samples • calculations are complete and accurate, with occasional minor errors • records allow data to be verified, although may include minor lapses in clarity, for example, result changed or deleted without explanation
2	4–6	The student has used some relevant methods to calculate mean titre and dissolved oxygen, presenting a set of results which includes some data to support further analysis. Results are recorded with some structure, although is incomplete and sometimes unclear, or unnecessary data is used. Work includes the following elements: • some organisation • some appropriate significant figures • inconsistent use of appropriate units and notation • suitable number of repeats for some samples • calculations are partially correct but may contain several minor errors or single major error

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Band	Mark	Descriptor The student has:
1	1–3	The student has calculated mean titre and dissolved oxygen, presenting a set of results which includes some but limited data to support further analysis. Data is recorded with little attempt at a coherent structure, is incomplete, and sometimes unclear or unnecessary data is used. Work includes the following elements: • little evidence of attempt to structure results • inconsistent use of appropriate significant figures • inconsistent use of appropriate units and notation • repeats carried out for some samples but not based around identification of concordant results • calculations have some aspects that are correct but may follow an incorrect approach, be limited in extent, or contain major errors
0	0	No creditworthy material as described in bands 4 to 1.

Indicative content

The student will produce tables with clear labels and units in the headings. Means should be placed at the right-hand side of the table. All tables should have clearly ruled lines and columns with no units in each row or column, these should only be found in the headings of each table. The tables headings should explain what the column or row represents.

The calculation of the means will be accurate with clearly set out calculations and each step will be mathematically accurate and to the correct significant figures, ideally 3sf. Students may present their calculation below the table, such as the calculation of the titre means. Ideally the readings should be to 0.05ml.

Students may include the reaction of Manganese with oxygen, followed by iodine with an ionic equation.

The calculation steps will be easy to follow and there will be no omissions. Students may avoid rounding up the data until the final step.

Students will use the volume of water sample (0.25 dm3) and the thiosulphate titration volume to calculate the dissolved oxygen concentration of the sample in mg per dm3.

Students may relate the concentration of dissolved oxygen in the wastewater sample to BOD and comment on its impact on the environment.

Content Mapping:

S1.87: Produce data from scientific techniques, which are reliable and verifiable, by:

- recording data and records in a clear and unambiguous way:

S2.19: Complete relevant calculations on data obtained in the laboratory environment:

S2.22: Use the results of calculations and statistical analysis to interpret and evaluate data from scientific tasks

S2.23: Present data in an appropriate format

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K1.63: The principles of producing reliable and verifiable results:

- recording in a clear and unambiguous way (for example, use of tables, indelible ink, not using sticky notes or loose papers, ensuring writing is legible)
- using appropriate units, notation and correct number of significant figures
- critically reviewing data obtained (for example, identifying any anomalous results)
- repeating investigations and referencing why any action was taken, where appropriate

K2.6: How the following considerations inform data processing and subsequent analysis of the results in laboratory environment:

- regulatory requirements (for example, validation, conformity to known analytical standards)
- relevant calculations (for example, magnification and Rf values)
- conversion of units (for example, consistent use of units across different data sets)
- appropriate statistical techniques to determine the validity or significance of the results (for example, standard deviation, p value, uncertainty values)
- customer requirements for the presentation of data (for example, graphs)
- using laboratory control charts and trend charts (for example, to confirm equipment and/or protocols are within tolerance)

K2.7: How to establish the validity of results against standards and controls:

- using certified reference material (CRMs)

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Performance outcome grid

Task	PO1	PO2	PO3	Total
1(a)	23	0	0	23
1(b)	12	0	0	12
Total marks	35	0	0	35
% Weighting	100%	0%	0%	100%

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Version	Description of change	Approval	Date of Issue
v1.0	Post approval, updated for publication.		January 2021
v1.1	NCFE rebrand		September 2021
v1.2	Sample added as a watermark	November 2023	20 November 2023

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