T-LEVELS | Institute for Apprenticeships & Technical Education

T Level Technical Qualification in Science

Occupational specialism assessment (OSA)

Laboratory Sciences

Assignment 3

Mark scheme

v1.1: Specimen assessment materials
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Contents

Task 1

Task 1: accuracy of data

Band	Mark	Descriptor
4	7–8	The student has made a judgement on the accuracy of the data which is justified by a balanced evaluation and which reflects on the relative strengths and weaknesses of the data and data sources. A balanced evaluation considers the evidence for and against inaccuracy in data, the uncertainty in data and evidence from both overall patterns and repeated measurements.
3	5–6	The student has made a judgement on the accuracy of the data which is supported by a relevant explanation of some of the strengths and weaknesses of the data and data sources.
2	3–4	The student has described their opinion on the accuracy of the data which includes some valid references to the data.
1	1–2	The student has identified an assertion about the accuracy of the data supported by general or common-sense statements or reasons (rather than occupational knowledge in context).
0	0	No creditworthy material as described in bands 4 to 1.

Indicative content

Judgement: where a coherent and logical statement is made about the accuracy of the data. Effective communication skills are demonstrated.

Using information to evaluate: a balanced evaluation might consider the evidence for and against inaccuracy in data, the uncertainty in data and evidence from both overall patterns and repeated measurements.

Uncertainty: there is not enough data to be certain if the probe is faulty or not - more comparative data and checks are required to be certain.

Examples of evaluative points based on the data obtained:

- inaccuracy suggested by comparing pH results from the 2 probes identifying earlier concordance and later disagreement
- inaccuracy suggested by underlying trend of slightly increasing pH (initially in both probes, later only in lab probe) compared to drop in field pH in later weeks
- sudden large drop in field pH may indicate inaccurate data due to damage or appearance of fault

Examples of evaluative points based on results of repeated measurements:

- repeat measurements from the same lake show good agreement which may suggest the data is accurate - probe is not faulty
- standard deviation values are low, which may suggest the data is accurate/probe is not faulty

Content mapping

K3.3: The factors that can contribute to data errors (random or systematic) in a laboratory

- contamination of samples or equipment
- incorrect sample storage
- working outside acceptable tolerances
- incorrect laboratory equipment used, for example, using the wrong sized pipette
- inadequate training, for example, use of the equipment or procedure
- equipment not set up properly or used incorrectly
- method not followed, for example, standing operating procedure not followed
- transcription errors

S3.10: Recognise when equipment is likely to be damaged or cause injury due to malfunction

S3.13: Identify when a random or systematic error has occurred in scientific tasks:

- gathering and interpreting data efficiently and in an appropriate format, for example, chart or graph
- comparing results against previous data

Task 2

Task 2: identification of errors

Band	Mark	Descriptor
3	5–6	The student has identified different types of error and to explain whether they are random or **systematic**. Commented on all errors, and explanations are evidence-based.
2	3–4	The student has identified different types of error and to explain whether they are random or systematic. Commented on some errors with some reference to relevant evidence.
1	1–2	The student has identified some errors and explain whether they are random or **systematic**, with no reference to evidence.
0	0	No creditworthy material as described in bands 3 to 1.

Indicative content

Identifying types of error:

- identifies the likely main source of error as systematic error
- identifies the difference between random and systematic errors, for example, random are unpredictable errors that vary from one result to another while systematic show a similar value or proportion of error with every result

Using data to explain errors:

- similarity between the repeat samples suggests that variability of pH results is low, hence there is little evidence for random errors
- deviation between field and lab pH probes is unidirectional and consistent at around 0.8 pH units which suggests systematic error

Content mapping

K3.3: The factors that can contribute to data errors (random or systematic) in a laboratory:

- contamination of samples or equipment
- incorrect sample storage
- working outside acceptable tolerances
- incorrect laboratory equipment used, for example, using the wrong sized pipette
- inadequate training, for example, use of the equipment or procedure
- equipment not set up properly or used incorrectly
- method not followed, for example, standard operating procedure not followed
- transcription errors

S3.14: Address non-routine problems with samples and instrumentation in a scientific task:

- identify the error
- quantify the error to determine if this is within accepted tolerance
- remove or minimise the sources of error
- record the source of error and the action taken

Task 3

Task 3: identification of causes

Band	Mark	Descriptor
4	7–8	The student has identified all potential causes (sources) of error, providing a comprehensive justification for each cause (source).
3	5–6	The student has identified most potential causes (sources) of error, providing a logical explanation for each cause (source).
2	3–4	The student has identified some potential causes (sources) of error, providing a relevant description of each cause (source).
1	1–2	The student has listed few potential causes (sources) of error.
0	0	No creditworthy material as described in bands 4 to 1.

Indicative content

Source of error	Justification
Equipment not set up properly, for example: • incorrect or no calibration • stated buffer problems	Likely to be because there is no record of calibration in LIMS for field pH. Could be incorrect range of buffers used to calibrate, contaminated buffer or old buffer used, only one buffer may be used - should be 2, for example, pH4 and 7.
Faulty equipment, damage to probe or membrane, incorrect storage of probe.	Likely because data shows a systematic error/similar amount of error with each result which is often due to faults with equipment.
Correct method of use not followed, for example, standard operating procedure (SOP) is not followed.	Likely because there is no reference to a standard operating procedure (SOP) in the field notes on the LIMS.
Contamination of sample.	Unlikely because these are field measurements/measured in a lake - all lakes show same error.
Storage of sample.	Not possible because samples are not stored.
Incorrect equipment.	Not likely - field pH probe should be appropriate.

Source of error	Justification
Transcription errors.	Unlikely to give repeated consistent unidirectional errors.
Human error in taking a measurement.	Unlikely because this would usually cause random errors.
Any other valid error.	Valid justification.

Content mapping

K3.4: How to minimise errors in scientific tasks

S3.13: Identify when a random or systematic error has occurred in scientific tasks:

- gathering and interpreting data efficiently and in an appropriate format, for example, chart or graph
- comparing results against previous data

S3.15: Take steps to minimise errors in scientific tasks following continuous improvement techniques

Task 4

Task 4: improvement strategy

Band	Mark	Descriptor
4	7–8	The student has devised a workable and realistic strategy to enable the improvement of techniques and the minimisation of errors. This strategy will: • support the mitigation or elimination of all errors • cover all relevant steps and elements (damage, maintenance, and calibration) • identify dependencies and inter-connections
3	5–6	The student has devised a plan to enable the improvement of most techniques and the minimisation of most errors. This plan will: • support the mitigation or elimination of most errors • cover most relevant steps and elements (damage, maintenance, and calibration) • present the steps as separate and stand-alone
2	3–4	The student described a series of steps which enable the improvement of some techniques and the minimisation of some errors. These steps will: • support the mitigation or elimination of some errors • cover some steps or elements (damage, maintenance, and calibration)
1	1–2	The student has listed some general steps to enable some progress towards the improvement of some techniques or the minimisation of some errors. Suggestions are common sense or general assertions that do not rely on occupational knowledge in context.
0	0	No creditworthy material as described in bands 4 to 1.

Indicative content

Steps to identify sources of error:

- check for damage to probe and meter
- check if calibration and maintenance is being carried out in accordance with the manual for pH meter
- carry out any required maintenance, for example, membrane replacement or cleaning
- recalibrate the meter according to manual instructions and compare measurements again with lab probe
- check that buffers used for calibration are in-date/working
- check that 2-point calibration uses correct buffer range compared to data values, for example, buffers of pH4 and 7 may be more appropriate than pH7 and 9 for the data provided

- record the cause of and extent of error and actions taken in the relevant maintenance logbook/LIMS

Actions to improve techniques:

- review current practices with the field team that make the measurements
- make sure a suitable protocol/SOP is in place for calibration and use of the pH meter
- this should include regular checks against the lab pH meter
- make sure there is a suitable protocol for storing and maintaining the probe
- field team must record calibration and maintenance detail in LIMS - this instruction should be included in the SOP
- arrange for training of staff for use and calibration of pH meter

Content mapping

K3.4: How to minimise errors in scientific tasks

S3.15: Take steps to minimise errors in scientific tasks following continuous improvement techniques

Task 5

Task 5: calculation method

Criteria	Marks awarded
Means calculated	1 mark for correct calculation method. 1 mark for each correct mean value (**maximum 2 marks**). 1 mark for presenting values to a suitable number of significant figures.
Standard deviations correctly calculated	1 mark for correct calculation method. 1 mark for each correct SD value (**maximum 2 marks**). 1 mark for presenting values to a suitable number of significant figures.
T-test identified as correct test	1 mark for identifying T-test.
Explanation of why T-test identified	1 mark for each relevant reason given in explanation. (**maximum 2 marks**)
Total	11 marks

Indicative content

1) Mean for field pH = 6.3 and laboratory pH = 6.4. Standard deviation for field pH = 0.976 and laboratory pH = 0.124. Allow values reported to either 2 or 3 significant figures.
2) T-test (or student's T-test) is identified (or other suitable test named) - do not credit Chi-squared test, do not credit T-test if another invalid test is also named.

Account of how the T test is used may include these key points in explanation:

- it tests for a significant difference between 2 means/means and standard deviations are used to calculate a T value
- critical value is determined using sample size/degrees of freedom/critical value is read from a table of values
- critical value at P = 0.05 is used/explains choice of probability level
- calculated value is compared to the critical value (read from the table)
- if the calculated T value is greater than the critical value (from the table) the null hypothesis is rejected
- if the calculated T value is greater than the critical value (from the table) the difference between the 2 means is significant, accept the alternative hypothesis that there is a significant difference between the measurements taken with the field and lab pH meter

Content mapping

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

- appropriate statistical techniques to determine the validity of the results
- mean
- standard deviation
- chi-square test
- t-test

S2.20: Select appropriate statistical techniques to analyse and interpret results from scientific tasks

S2.21: Process results, using statistical software

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

- assess statistical validity
- draw conclusions

S2.23: Present data in an appropriate format:

- using appropriate statistical techniques, including the use of data from laboratory information management systems (LIMS)
- in a clear and unambiguous way, taking into account the level and experience of the audience and the purpose
- using technical language correctly, and using graphics and other tools to aid understanding
- using digital technology competently and confidently to produce, design and create charts and graphs:
    - line graphs
    - pie charts
    - bar chart
    - results tables

S2.24: Use relevant information from online databases to review scientific tasks

S2.28: Review and modify a scientific method to improve the task

Performance objective grid

Task	PO1	PO2	PO3	Total
1	0	0	8	8
2	0	0	6	6
3	0	0	8	8
4	0	0	8	8
5	0	0	11	11
Total marks	0	0	41	41
% Weighting	0%	0%	100%	100%

Skill	PO1	PO2	PO3
Field pH task		☐	☐

Document information

The T Level Technical Qualification is a qualification approved and managed by the Institute for Apprenticeships and Technical Education.

Owner: Head of Assessment Design

Change History Record

Version	Description of change	Approval	Date of Issue
v1.0	Post approval, updated for publication.		January 2021
v1.1	NCFE rebrand.		September 2021