T-LEVELS | Institute for Apprenticeships & Technical Education

T Level Technical Qualification in Science

Occupational specialism assessment (OSA)

Laboratory Sciences

Assignment 3

Mark scheme

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Assignment 3

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Task 1

Task 1: Evaluation of data

Band	Mark	Descriptor
4	7–8	The student has made a judgement on the reliability 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 reliability 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 reliability 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 reliability of the data which includes some valid references to the data.
1	1–2	The student has identified an assertion about the reliability 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 reliability of the data
- effective communication skills are demonstrated

Using information to evaluate:

- a balanced evaluation might consider the evidence for and against reliability in data, the uncertainty in data and evidence from both overall patterns and repeated measurements

Possible statements about reliability of data:

- Both the data sets from the main laboratory and the field laboratories shows three repeats have been carried out at each site / for each sample for each type of radiation; this allows for a judgement of reliability and also identification of anomalous results
- data from the field laboratories appears to be less reliable than data from the main laboratory as there are obvious differences between the readings collected at Date city and Date County origins.
- most readings are comparable for each type of radiation but there are some potential anomalies, this could be down to the random nature of radioactive decay
- examples of evaluative points based on the data obtained:
    - slight variance in data may reflect procedural error, for example within Date city/county origins
    - margin for error is not given

  - results are all standardised to a whole number ending in 0 or 5, this possibly reduces the reliability of the data as this suggests a low resolution of the equipment used but there is no information on resolution of equipment
- examples of evaluative points based on results of repeated measurements:
  - repeat measurements recorded in the main laboratory are consistent, whereas the field laboratory results are not consistent with the main laboratory results for Date city or Date County origins
  - there are several results that do not fit the patterns or trends for each reading taken in the field laboratories, which may provide evidence of the data being unreliable from field laboratories / being more reliable in the main laboratory

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

S3.10: 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 explained 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 explained 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 explained 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 within the Date city/county origin field laboratories
- identifies other likely source of error as random for outliers / anomalous results in the field laboratory data
- 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 Cs 134 and Cs 137 results is low, but there are four examples of anomalous results in the field laboratories data that do not fit the pattern / trend and this suggests random errors in these specific readings only
- in the field laboratory data, all Date city / Date County results are consistently around 200 Bq/kg lower than other readings for both Cs-134 and Cs-137. This suggests a systematic error in the field laboratories in the Date city / Date County origins. The main laboratory shows readings that are more comparable to other origins for each type of radiation, further suggesting that the error originates in the field laboratories.

Accept any other reasonable justification of the type of error identified.

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, (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 of errors

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
Hand-held, battery powered Geiger counters may be low on battery / need recharging	• Results in false reading / consistently low reading • False reading leads to false detection limit for spinach samples and therefore unreliable data
Faulty equipment.	• Systematic error in the Date city / Date County origins may point towards faulty equipment in the field laboratories here only. • Unlikely to be user error as the same team travelled around different sites and main laboratory. • The equipment may not have been calibrated prior to use, leading to consistently lower readings than expected in the Date city / Date County origins.
Correct method of use not followed, for example, standard operating procedure (SOP) is not followed.	• Unlikely as the same team travelled around sites and also worked in the main laboratory.
Contamination of sample.	• This would have been more likely had the issues in the data sets been in the main laboratory due to transporting samples.
Storage of sample.	• This would have been more likely had the issues in the data sets been in the main laboratory due to transporting samples.
Incorrect equipment.	• Unlikely as the same team travelled around sites and also worked in the main laboratory.
Transcription errors.	• A possibility for the random errors recorded due to working in various field laboratories and possible distractions that may not be present in the main laboratory.
Human error in taking a measurement.	• A possibility for the random errors recorded due to working in various field laboratories and possible distractions that may not be present in the main laboratory.
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: Devising a strategy for improving the sampling techniques

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.

Steps to identify sources of error:

- check for damage / fault / low battery in hand-held Geiger counter
- check if calibration and maintenance is being carried out in accordance with the manual for the hand-held Geiger counter
- carry out any required maintenance as per training or ensuring adequately trained colleagues carry out maintenance.
- 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 take the samples, for example samples kept at a certain temperature even in the field laboratories
- make sure a suitable protocol / SOP is in place for the collection and processing of samples from the field.
- ensure all dates and times of sample collection and temperature sample is stored at are recorded
- make sure there is a suitable protocol for storing and maintaining the hand-held Geiger counter and any other laboratory equipment
- field team must record calibration and maintenance detail in LIMS.
- arrange for training of staff for use and calibration of hand-held Geiger counter and / or other equipment.
- Introduce a system where a lab manager intermittently / randomly checks a scientist's readings to minimise transcription errors
- introduce a policy that ensures regular changing of batteries or a charging port for hand-held Geiger counters so that they remain charged all of the time
- Any other suitable suggestion

Content Mapping

K3.3 The factors that can contribute to data errors (random or systematic) in a laboratory:
K3.4 How to minimise errors in scientific tasks, by:
K3.5 The principles of good documentation practice (GDocP) to prevent data errors:
K3.6 How to report and correct recording errors:
S2.19 Complete relevant calculations on data obtained in the laboratory environment:
S2.20 Select appropriate statistical techniques to analyse and interpret results from scientific tasks:

S2.22 Use the results of calculations and statistical analysis to interpret and evaluate data from scientific tasks to:
S2.23 Present data in an appropriate format:

Task 5

Task 5: data processing

Criteria	Marks awarded
Calculation of means	1 mark for calculating means for Cs-134 data 1 mark for calculating means for Cs-137 data
Graph components	1 mark for suitable scale **and** title on X-axis 1 mark for suitable scale **and** title on Y-axis, including correct units 1 mark for plotting 7 or more mean points for Cs-134 correctly, within ± 1 small square 1 mark for plotting 7 or more mean points for Cs-137 correctly, within ± 1 small square 1 mark for drawing trend lines for Cs-134 and Cs-137, must be line of best fit and not joining the dots 1 mark for omitting anomalous results for 2014 from both trend lines
Line to show 150 counts per minute and explanation	1 mark for drawing a horizontal line at 150 counts per minute 1 mark for each explanatory point as follows, up to a maximum of 2 marks: • Cs-134 trend line has been below 150 counts per minute since 2018 • Cs-137 trend line has not yet fallen below 150 counts per minute • unless both counts per minute are below 150 count per minute, it is not safe for the spinach to be consumed • a total counts per minute covering both Cs-134 and Cs-137 might be more useful / reliable • there may be other types of radiation being emitted that need to be considered
Total	(11 marks)

Indicative content

- means calculated as follows:

Year	Cs-134	Cs-137
2011	1294	618
2012	976	611
2013	655	601
2014	740	615
2015	326	580
2016	242	569
2017	163	563
2018	123	547
2019	83	537
2020	65	527
2021	41	516

- X-axis title: Year
- Y-axis title and units: Count rate (counts per minute)

Content mapping

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

- determine trends
- 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
    - histogram
- organising data logically and coherently

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%

Document information

Owner: Head of Assessment Design