T-LEVELS | Institute for Apprenticeships & Technical Education

T Level Technical Qualification in Science

Occupational specialism assessment (OSA)

Laboratory Sciences

Assignment 3 - Distinction

Guide standard exemplification materials

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Contents

Introduction

The material within this document relates to the Laboratory Sciences occupational specialism sample assessment. These exemplification materials are designed to give providers and students an indication of what would be expected for the lowest level of attainment required to achieve a pass or distinction grade.

The examiner commentary is provided to detail the judgements examiners will undertake when examining the student work. This is not intended to replace the information within the qualification specification and providers must refer to this for the content.

In assignment 3, the student must review the results and analyse them, and review errors.

After each live assessment series, authentic student evidence will be published with examiner commentary across the range of achievement.

Scenario

You are a laboratory scientist working for a company that specialises in environmental monitoring. The company has a contract for the monitoring of water quality, including the pH in a group of lakes used for recreation.

A fieldwork team uses a field pH meter at the lakes as part of their weekly on-site analysis. The pH probe must be calibrated before use. Recently, the fieldwork team have commented that pH values at sampling sites seem to be low for the time of year.

These low values may reflect true environmental values, but there is a possibility that the field pH meter is producing inaccurate data.

Each month a batch of samples from the same sites are returned to the laboratory for full chemical analysis. The pH is measured in the lab using a bench pH meter. All pH values are recorded on the laboratory information management system (LIMS).

As a laboratory scientist for the company, you have been asked to investigate the low pH values. It is possible to access the pH data from both the bench and field pH probes using the LIMS. This data is provided for your use in this task. A summary of the data (means and standard deviations) is also provided.

Task 1

Using the information provided, comment on the accuracy of the data obtained from the field pH meter.

Evaluate whether recent low field pH values reflect true conditions in the lakes or are due to inaccurate readings produced by the field pH probe.

Use the LIMS data and data summary to inform your judgement.

(8 marks)

(30 mins)

Student evidence - task 1

Samples from 3 lakes were taken on a weekly basis from 11/04/2020 through to 02/05/2020. The pH of each sample was measured using a field pH meter on a weekly basis, and the same samples from 11/04/2020 and 02/05/2020 (but not the dates in between) were also measured using a calibrated lab pH probe. The pH recorded on the 11/04/2020 with the field pH meter gives consistent results with little variation at all sites, with a mean pH of 6.13 for Ingle, 6.27 for Salby and 6.3 for Kerra, compared with mean lab pH measurements of 6.17, 6.27 and 6.27 for each lake respectively, indicating that both the field pH meter and the lab pH meter returned highly similar results on this date, thus these readings are likely to be accurate.

However, the next time that a lab pH meter was used, on the 02/05/2020, the field pH meter returned mean pH readings of 5.63 (Ingle), 5.77 (Salby) and 5.8 (Kerra), compared with the lab based pH probe results of 6.47 (Ingle), 6.57 (Salby) and 6.56 (Kerra), suggesting that one of the probes may potentially be returning inaccurate results. As the lab pH probe is recorded as being calibrated between pH 4 and 7, it is likely that this probe is returning accurate results (though it could be malfunctioning). If the field pH meter is giving an accurate reading this needs to be determined as low pH in the lakes could be damaging to wildlife. The lab probe returns a mean pH for all sites of 6.2 on the 11/04/20 and a similar result of 6.5 on the 02/05/20 may support that the pH levels remain consistent in the lakes and that the low reading is a result of inaccuracies in the field pH meter. The field pH meter does not seem to be routinely calibrated and checked which also suggests that it is more likely that it is the field pH meter giving inaccurate results.

Also suggestive of a malfunction in the field pH meter is the fact that all of the samples from all 3 lakes appear to consistently drop by ~0.4 pH units between the 18/04/2020 and the 02/05/2020. As these samples are all taken from separate lakes it would probably be unlikely that the pH of all of the lakes would be uniformly reduced, though this could occur if all lakes were, for example, exposed to runoff from the same source of environmental damage (for example a single factory).

The fact that the lab pH meter is calibrated while the field one is not, and that the field probe is returning similarly reduced values for all the lakes on the 02/05/20 would suggest that it is most likely a fault in the field pH probe, suggesting that this probe is giving inaccurate pH measurements, though further checks, for example measuring a solution with a known concentration on both probes, would be required to confirm this.

Task 2

Using the information provided, comment on the type of errors in the data obtained from the field pH meter.

Explain the evidence for any random or systematic errors. Use the LIMS data and data summary to inform your explanation.

(6 marks)

(30 mins)

Student evidence - task 2

There a 2 main types of error possible here: random and systemic. Random would be the result of unknown and unpredictable changes that would impact the results each time (such as variations in noise), while systemic errors usually arise from faults in the instruments or ways in which they are used. As the LIMs data consistently giving readings within 0.1 pH units of each other for each sample from each lake, with a low and consistent standard deviation, this would be suggestive of a systemic error in the field pH meter rather than a random error. The fact that all of the results obtained after the 25/04/2020 are all reduced - and reduced by a similar amount in each lake and each repeat sample - would also be suggestive of a systemic error in the pH meter or its use.

Task 3

Identify factors that could cause data errors in measurements made with a field pH meter.

Justify which factors are likely to cause the data errors measured.

Use the information provided, as well as your own knowledge, to help you.

(8 marks)

(30 mins)

Student evidence - task 3

There are several potential factors that could be contributing, or causing alone, the errors seen in the field pH probe. As there is no record of calibration for the field probe (while this is specifically recorded for the lab probe) it is likely that this probe is not being calibrated at all. This could result in a slow drift of the accuracy of the probe, since we see a sudden drop in pH values it may not be solely the result of this. Even if the field probe is being calibrated it is possible that problems with the calibration could be contributing to the errors, for example if the wrong pH buffers are being used to calibrate (for example, if using a pH 6 buffer instead of pH 7). Not calibrating correctly would result in incorrect measurements being obtained on that particular day, and so it is possible that a contamination of the buffer previously used to calibrate the field pH meter occurred on the 25/04/2020.

It is also possible that the operator is using the probe incorrectly, as there is no reference to an SOP or instructions on how to properly use the probe. Readings that are similar to the lab probe were obtained with the field probe prior to 25/04/2020 this would only be the likely source of error if a new person was using the probe from this date and was, for example, not properly submerging the probe.

It could also be that incorrect maintenance and storage of the lab pH probe (for example, not storing the probe in the correct buffer, crack in the probe) has damaged its ability to obtain accurate readings between the 18 and 25 April, resulting in a drop in the pH obtained by the field probe from the 25 April.

As all lakes seem to be showing a drop in the pH it is unlikely that contamination would be the cause of the drops in pH in the sample, especially as the lab probe recorded a result more in line with the original measurements on the 2 May. The drop is consistent across all lakes also suggests that it is not the result of errors in the recording of the data from the probe by the user.

Task 4

Describe the steps that should be taken to find out what is causing the error in the field pH meter.

You should also describe the actions that should be taken to improve techniques for using the field pH meter in order to minimise future errors.

Use the information provided, as well as your own knowledge, to help you.

(8 marks)

(30 mins)

Student evidence - task 4

The initial step would be to confirm that the field probe is functioning incorrectly. This could be done by measuring a sample with a known pH of around the same range expected in the lakes (for example, a buffer with a known pH of 6). If this confirms that there is a problem with the field probe, then steps should be taken to determine what the source of the problem is. The probe should be inspected for damage, and any damaged parts replaced, and the maintenance and storage procedures should be checked to ensure that the probe is correctly cared for and, if not, procedures should be implemented. The field probe should also be properly calibrated using the correct buffers and this should be maintained as part of the maintenance procedures. In order to ensure that the probe is used correctly in the future a SOP should be written and users should be trained in the correct use of the field probe before they use it to measure samples. Proper training should prevent errors caused by incorrect usage, storage, and calibration, and allow users to identify any damage to the field pH meter.

Task 5

The field pH meter was recalibrated. The pH of a series of samples were then measured using both the field pH meter and laboratory pH meter. This data is provided in the LIMS for your use in this task.

a) Use the LIMS data to calculate the mean and standard deviation for the field and lab pH meters. You should use the spreadsheet to carry out your calculations.

b) Explain how a named statistical technique could be used to test if there is a significant difference between the 2 sets of measurements.

The formula and calculations are not required.

(11 marks)
(1 hour)

Student evidence - task 5

a)

Sample number	pH measured with field pH probe	pH measured with laboratory pH probe
1	6.4	6.3
2	6.3	6.4
3	6.3	6.4
4	6.3	6.2
5	6.2	6.1
6	6.3	6.4
7	6.2	6.2
8	6.4	6.5
9	6.3	6.4
10	6.5	6.5
11	6.4	6.4
12	6.4	6.5
13	6.3	6.3

14	6.5	6.5
15	6.2	6.3
Mean	6.33	6.36
Standard deviation	0.0976	0.1242

b)

A T test could be used to test whether the differences in the results obtained by the 2 probes are statistically significant. The T test compares the means of 2 samples to determine whether they are significantly different, with the standard deviations being used to calculate a T value. This T value is then compared against a critical value (P) that is determined using the sample size. A P value of less than 0.05 is usually considered to be statistically significant, which means there is a 5% or less chance that the difference is a result of random chance. Thus a P value of less than 0.05 is used to indicate that the differences between 2 populations are statistically significant.

Examiner commentary

The student presents a detailed and correct analysis of multiple pieces of evidence from the LIMs system to suggest potential sources of error based on the information provided and their own knowledge. These are presented in a logical and precise manor. The student identifies a range of relevant information from the provided data and uses this to infer and make judgements on the potential sources of error, presenting their analysis in a coherent manner.

The student correctly explains the 2 types of error and is able to accurately relate this to the potential errors that could be occurring based off of the LIMs data, using their own extensive knowledge and understanding to assess the types of error contained within. The student identifies a range of potential factors that may be contributing to the discordance between the results, showing a good understanding of the principles of the technique. The student offers up valid and decisive methods for mitigating the likelihood of errors reoccurring using their own extensive knowledge to suggest mitigating valid procedures. The student is able to correctly and accurately determine the means and standard deviations of the results and correctly identifies, from their own knowledge, suitable statistical tests, explaining in full how these would be applied.

Grade descriptors

The performance outcomes form the basis of the overall grading descriptors for pass and distinction grades.

These grading descriptors have been developed to reflect the appropriate level of demand for students of other level 3 qualifications, the threshold competence requirements of the role and have been validated with employers within the sector to describe achievement appropriate to the role.

Pass	The evidence is logical but displays minimal relevant knowledge or understanding in response to the demands of the brief.
	The student makes some use of relevant knowledge and understanding of how it informs practices of the sector and demonstrates a limited understanding of skills or approaches associated with the laboratory sciences sector.
	The student makes adequate use of facts/theories/approaches/concepts and attempts to demonstrate breadth and depth of knowledge and understanding of the different aspects of the task.
	The student is able to identify some information from appropriate sources and makes use of appropriate information/appraise relevancy of information and can combine information to make decisions.
	The student makes only select judgements/takes appropriate action/seeks clarification with guidance and is able to make limited progress towards solving non-routine problems in real life situations.
	The student demonstrates skills and knowledge of the relevant concepts and techniques reflected in a laboratory science setting and generally applies this across different contexts.
	The student shows adequate understanding of unstructured problems that have not been seen before, using limited knowledge to find solutions to problems and make justification for strategies for solving problems, explaining their reasoning.
Distinction	The evidence is precise, logical and provides a detailed and informative response to the demands of the brief.
	The student makes extensive use of relevant knowledge and has extensive understanding of the principles and practices of the sector and demonstrates an understanding of the different approaches/skills associated with the laboratory science sector.
	The student makes decisive use of facts/theories/approaches/concepts, demonstrating extensive breadth and depth of knowledge and understanding and selects highly appropriate skills//tasks/techniques/methods.
	The student is able to comprehensively identify information from a range of suitable sources and makes exceptional use of appropriate information/appraises relevancy of information and can combine information to make coherent decisions.
	The student makes well founded judgements/takes appropriate action/seeks clarification and

	guidance and is able to use that to reflect on real life situations in a laboratory science role.
	The student demonstrates extensive knowledge of relevant concepts and techniques reflected in a laboratory science role and precisely applies this across a variety of contexts and tackles unstructured problems that have not been seen before, using their knowledge to analyse and find suitable solutions to the problems.
	The student can thoroughly examine data/information in context and apply appropriate analysis in confirming or refuting conclusions and carrying out further work to justify strategies for solving problems, giving concise explanations for their reasoning.

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

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v1.0	Published final version.		June 2021
v1.1	NCFE rebrand		September 2021