Chief Examiner & Chief Moderator Report

T Level Technical Qualification in Science (Level 3) (603/6989/9)

Summer 2024 – Occupational Specialism (OS) (Laboratory Science)

Chief examiner and chief moderator report

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Assessment dates: **18 March 2024 to 24 May 2024**

Paper number: **P002428 & P002429 & P002430**

This report contains information in relation to the externally assessed component provided by the chief examiner and chief moderator, with an emphasis on the standard of student work within this assessment.

The report is written for providers, with the aim of highlighting how students have performed generally, as well as any areas where further development or guidance may be required to support preparation for future opportunities.

Key points:

- grade boundaries
- evidence creation
- responses to the assessment tasks
- administering the external assessment

It is important to note that students should not sit this external assessment until they have received the relevant teaching of the qualification in relation to this component.

Grade boundaries

Grade boundaries for the series are:

	Overall
Max	408
Distinction	307
Merit	227
Pass	148

Grade boundaries are the lowest mark with which a grade is achieved.

For further detail on how raw marks are scaled and the aggregation of the occupational specialist element, please refer to the qualification specification.

Overall, this series, there seemed to be a higher number of students answering the brief. Answers were more relevant to the task being asked. As a result, there were more students easily achieving the pass boundary. There is still only a small number of students reaching the distinction boundary due to not answering the questions to a high enough standard. For example, not giving strong enough arguments or justifications. There were also some specific challenging tasks/parts of questions that limited student achievement, and this will be discussed in the specific task section of the report.

Students were much better at organising their responses this year. For example, task 2 of assignment 1 was broken down into relevant headers and assignment 3 was broken down into clear tasks by nearly all students. More students seemed to have given full responses this year as there were few students who missed out parts of tasks.

There were some students that appeared to use Artificial Intelligence (AI). It is worth noting that not only are they penalised for this, but their answers were not as strong as the students that did not. It is also noted that there should be limited use of internet access to solely research the references provided in the brief.

External assessment

Evidence creation

There has been a huge improvement of evidence supplied by providers this series. Most students had the correct assignments uploaded as well as LIMS data in assignment 3. There were a few cases where the incorrect information had been uploaded. There were some students for which the LIMS data was sent as an image in the assignment rather than a separate Microsoft Excel document. The LIMS data on Excel is preferred as it allows the examiners to view calculations that may have been done through excel for example, mean and standard deviation calculations.

Responses to the Assessment Tasks

Assignment 1

Task 1

Generally, students were able to write the literature review to a descriptive or explanatory level. Some students were too vague when critiquing the literature or did not select the correct literature and this limited their marks. The students that achieved the highest marks were able to balance the strengths and weaknesses of the sources and suggest practical alterations to the literature for their specific SOP. Importantly, the students that did the best on this question were able to select relevant literature and give relevant critique. There is still a large number of students focusing on the year of publication and the website domain as a measure of reliability, rather than the guidance of the mark scheme for example, author, type of source, relevance of the literature.

Task 2

Breaking down task 2 into individual components:

There was a huge improvement in students' development of a hypothesis. Most students wrote a hypothesis that contained some relevant information. To achieve full marks students were required to give an overview of how the method would meet the brief and a brief explanation of the scientific theory such as, how a spectrometer/colorimeter can determine a concentration.

The list of equipment was poorly answered. Very few students achieved full marks here as most students missed the idea of needing to heat sulphuric acid such as with a Bunsen burner, which is mentioned in the mark scheme as a key piece of equipment. Students should ensure they are very prescriptive with their equipment list and consider all stages of the practical.

There was a significant improvement in students' response to safety considerations. Last series very few students included this but this series most students had a separate section solely to consider safety. On the whole this was well answered, and students considered all factors. Some student missed mentioning copper sulphate which is a crucial consideration due to its effect on the environment.

Students were able to write a sufficient method but many of them missed out on the highest marks as they failed to make alterations and simply copied from the literature. Some students chose the wrong method for example, electrolysis, which would not allow them to achieve sufficient results. Some students missed out essential steps such as the filtering of the mixture or the development of a calibration curve using serial dilutions.

The method section was varied in response level. Some students were able to explain the use of serial dilutions and the calibration curve very well and included the correct calculations. Other students did not find the link between the calibration curve and determining the concentration and then the mass of copper. As a result their methods of analysis section was weak or confusing.

Overall, responses were much improved and much more relevant to the brief. The equipment list was the major factor that lowered students results in task 2.

Task 3

Students answered the risk assessment well in general. Many students were able to describe or explain a good breadth of risk well. Some students were using the old template compared to the new one provided by NCFE for this series. The major differentiation in results came through the understanding of hierarchy of risk with many students only showing some awareness.

The examiners looked for a wide range of major risk rather than sheer number such as copper sulphate, sulphuric acid, electrocution, sharps. Students that achieved most highly were able to explain the major risk very well rather than many risks (some irrelevant) in basic detail.

Moderated assignments

Assignment 2

Assignment 2 is internally assessed by Provider-appointed assessors and externally moderated by NCFE-appointed moderators. The assignment scenario for this series concerned the quantitative determination of copper content in the ash of Indian mustard seed. The practical work and analytical processing provided standard operating procedures that a laboratory may undertake to determine the quantity of copper. Students were tasked with determining the mass of copper within an ash sample using colorimetry in Part A, and determining the concentration of a sample solution of copper (II) ions using redox titration in Part B.

In task 1(a) of Part A, students were able to follow the standard operating procedure (SOP) to prepare a solution of the sample and serially dilute 0.5 mol dm^{-3} copper (II) sulphate solution to obtain colorimetry absorption data for a calibration graph. It was good to see that students were selecting and using personal protective equipment (PPE), handling chemicals and equipment safely and working in an organised workspace. Stoppers were almost always replaced after a container had been used and spillages cleared up swiftly. Assessors awarded most students these basic observation criteria, and this could clearly be observed in audio-visual evidence provided.

Although the SOP was relatively easy to follow, the most challenging parts were the serial dilution, requiring consistency and patience with the repetitive pipette work involved, and accuracy in making up solutions in volumetric flasks. The equipment that students used made a difference and was reflected in the data. Providers are strongly advised to resource assignment 2 as per the specified equipment list in the Provider Guide. This indicated pipettes or syringes could be provided, with most opting for the former. Some students had access to autopipettes, which made this activity easier for them. Whichever way students carried out their pipette work, it was generally observed to be handled well. Occasionally, a student was observed to revert to using a measuring cylinder, often to make up time. Some students appeared not to select, or have access to, $10cm^3$ volumetric flasks. A range of glassware was then observed in use, including much larger volumetric flasks but also boiling tubes and beakers. Often students would use a water wash bottle to top up volumetric flasks to the mark, but this clearly did not offer the control of a Pasteur pipette. Occasionally, students were then observed pipetting solution out of the flask having overfilled it.

These were areas that would often impact upon the accuracy of the work and absorption data collected. Assessors generally applied the criteria under effective performance of scientific techniques correctly, but there were instances where these had to be moderated. Colorimetry work was generally observed to be very good, with careful handling of the cuvette and zeroing before solution readings were taken. Poor practice was only very occasionally observed, such as the use of the same Pasteur pipette for every solution to fill the cuvette, and simply recording the reading three times. A few students appeared to have trouble in the set up and operation of the colorimeter that they were provided with, which indicated that further practice and familiarity with the equipment was needed during the course. In general, students were often observed working independently, with little, if any, input from supervisors.

In task 1(b) of Part A, students were expected to calculate a mean and create a calibration graph to determine the concentration of the sample. All students recorded their data in the table provided in the assignment. Data recorded was very reliable and accurately measured in almost all cases. Occasionally, students would forget to be consistent with the number of decimal places, notably with distilled water, which would just be recorded as zero. Anomalies for a specific concentration were extremely rare. However, although results tended to follow the trend in concentration, few students considered whether any mean may have been anomalous within the data set. The number of students that transferred and replicated data into a spreadsheet to manipulate was approximately equal to those that worked purely on paper. There were advantages and disadvantages to this. The results in a spreadsheet were typically presented in the same way as the template (which did not yield any marks) but this astutely could be used to accurately determine the mean and plot the graph. This is acceptable and is encouraged, but providers and students should be warned that a high level of proficiency is needed. Unfortunately, some students clearly ceded control over their data and its presentation to the spreadsheet software. Significant figures were often inappropriate or variable and units of concentration were frequently represented inaccurately. Means were always calculated by the software using the values provided – it was often fortunate then that the data was reliable, without anomalies. Graphs created using a spreadsheet were almost always weaker by comparison to graphs that had been hand drawn. This included:

- spreadsheet graphs that were far too small
- spreadsheet graphs that omitted a title and/or labelled axes, sometimes simply due to "cropping" of text boxes
- inappropriate bar charts and "dot-the-dot" graphs more commonly observed
- points plotted with such large circles that the accuracy of the plot could not be verified
- scales being incorrect, such as the concentration (x) axis being non-linear
- a lack of minor gridlines that meant that absorption/concentration readings taken would be very approximate.

In addition, only students with near perfect data could rely upon the software to provide a straight best fit line, and where data indicated a curve, students lacked the skills to be able to modify this. Most students were also unable to even attempt to take an accurate reading from their graph, as it only existed in an electronic form. Some students resorted to superimposing tie lines onto the graph. This is acceptable but again appeared to be very difficult to achieve well, mainly due to in built issues of graph size, scale, and lack of minor gridlines, but also because the size of the lines used and "movement" on the spreadsheet. Having realised the difficulty created for themselves, some students simply ignored the graph altogether, instead concocting a formula to convert the absorption into a concentration.

In task 1(a) of Part B, students demonstrated again that they worked safely, with basics of PPE, handling of resources and organisation easily corroborated by video or photographic evidence. Pipette work was again an area of strength for students, possibly due to the extensive use of this in the previous task. Preparation of the burette was more variable, however. Good practice was frequently observed, such as washing and rinsing the burette, clearing the jet of air bubbles, and zeroing the first reading. Bad practice included not using a funnel, filling the burette above head height and filling the burette whilst the conical flask was directly beneath it. The redox titration itself proved to be challenging for most students. The instruction to add potassium iodide until in excess was often not accomplished fully, which created dilemmas for students such as when to add the starch solution and observing the colour change at the end point. It was rare to see a straw colour solution, which was the cue as the point for the addition of the starch indicator. Whilst these issues are understandable and can be attributable to being an unfamiliar titration, titration work that was observed was only adequate in the main. Good points tended to be reading of the burette at eye level, good burette tap manipulation and control of the addition of sodium thiosulfate solution, and the achievement of concordant titres. However, some common weaknesses that would impact upon the accuracy included:

- slow or awkward swirling of the conical flask to mix the solutions
- addition of the sodium thiosulfate solution being too rapid on approach to the end point, and sometimes not even dropwise
- drops of the titrant or the analyte solution stuck to the sides of the conical flask not being washed back into the mixture

- readings from the burette rarely being measured and recorded to two decimal places.

In task 1(b) of Part B, students were expected to present their results and carry out a calculation to find the mass of copper in the solution provided. As this was a much simpler data set than for Part A, students should have found this easier to present. However, clarity in tables could often have been stronger, such as units for volume and initial/final readings. As noted previously, an inconsistent number of significant figures was another common error. Many students obtained concordant titres and there would seem to be good recognition of this. A few students failed to indicate that these were the values used in the mean calculated, however. Calculations were generally carried out well, but often only as far as the mass of copper within 25cm^3 rather than 250cm^3.

Assignment 3

Task 1

Students seemed to understand the requirements of the brief better than they did last year and include more relevant points in their answer. Most students were able to select the obvious sources of reliability including, repeats and the anomalous results. The more able students also included other indicative content including the use of 2/3 decimal places.

Task 2

Most students were able to explain random error, and some were able to select all or some of the anomalous data results. There were still some students who did not refer to data for this task. Very few students gave reasoning for random error.

Task 3

This question was generally well answered. The students were able to include many sources of error. The differentiators were those who were able to explain this error well and correctly identify whether sources of error were likely or unlikely.

Task 4

The students answered this question relatively well. They improved on last year and were able to correctly provide methods that would identify and remove error. This was mostly done at a generic level. Those who achieved highest on this question were able to make it relevant to the brief specifically for example, a mention of TG (Unreliable Data), and were able to form interdependencies.

Task 5

Students found this task difficult. There was a large amount of data for students to process and some were not able to do this. As a result, the students dropped marks in their calculation of the mean, standard deviation and profits in particular. Most students were able to gain credit for their significant figures, explanation of site, plant choices and the T-test.

Administering the external assessment

The external assessment is invigilated and must be conducted in line with our Regulations for the Conduct of External Assessment.

Students must be given the resources to complete the assessment, and these are highlighted within the Qualification Specific Instructions for Delivery (QSID).