NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

National Qualifications Framework Levels 1–3, 2007

Chemistry

National Moderator's Report

NATIONAL MODERATOR'S REPORT

General Guidance for Assessors of Achievement and Unit Standards

The purpose of external moderation is to provide reassurance that assessor judgments are at the national standard and are made on the basis of assessment materials that are fair and valid. All assessment materials are expected to:

- give the learner the opportunity to meet the requirements of the standard
- have an assessment schedule that gives evidence of appropriate learner responses and clear judgments at all levels.

The Ministry of Education contracted subject experts to write assessment resources for achievement standards. These are not pre-moderated. The intention is that they are modified to suit teaching programmes and learner needs. They do not provide "rules" but suggest different ways of assessing to the nationally registered standard.

General Overall Comment

It is recommended that assessors use the most recent version of the achievement standards.

The assessment activity must clearly state both the number and version of the standard as well as the time allowed to do the activity.

The majority of schools assessing against level two and level three achievement standards have used exemplars from the Te Kete Ipurangi (TKI) website. However, it must be noted that some exemplars require changes to be made to the activity used. If changes are not made the activity does not fairly assess the learner since *knowing the answers* limits the validity of the assessment activity.

Where the activity involves numerical data, assessors must be careful to supply data with sufficient accuracy to meet the requirements of the accuracy of answer that is expected.

AS 90169: Carry out a practical chemistry investigation with direction

Version 7 of the Generic Template available on the TKI website clearly outlines the requirements of an activity that meets the standard. A different format may be used, but the Generic Template indicates the level of direction that should be given.

The investigation is *with direction*. However, too much direction cannot be given. For example, an investigation on effect of concentration change on reaction rate, learners must make decisions on concentrations to use given only one solution to start with.

For achievement the conclusion may be an interpretation based on the processed data while for merit and excellence the conclusion must be valid and relate to the purpose. For example an investigation in which the purpose is to investigate reaction rate as a variable is altered, and has a conclusion which describes time taken with respect to the variable, is acceptable for achievement. Rate must be referred to for merit and excellence.

Excellence is based on the level of the evaluation of the investigation. Evaluation cannot be limited to such things as 'lack of careful use of equipment or measurement'.

Additional notes

In order to carry out a practical chemistry investigation a minimum of three values of the independent variable are required. In this case the experiment needs to be repeated to have sufficient data. Alternatively, a larger number of values of independent variable may be used. This is appropriate when it is not possible to repeat with the same conditions, eg when using different temperatures. If the data produced is to be graphed, it is preferable that five values are used if the graph is to be meaningful.

AS 90170: Process information to describe a use of chemistry knowledge with direction

There is only one criterion of this standard and the emphasis is on processing information.

The levels of achievement are based on *describe*, *explain* or *discuss* and these terms are defined in Explanatory Note 6. For all levels of achievement the report must be mostly in the learner's own words and references or sources of information must be stated.

Additional notes

Too much direction must not be given. The standard does not require the learner to find the information by research, although this is possible. At least 2 different sources of information must be used and these may be supplied by the assessor.

AS 90305: Carry out qualitative analysis

The standard is based on one criterion so that the theory and practical aspects involved are integrated.

The standard requires identification of ions, with supporting evidence to be provided by the learner. A suitable activity needs to contain

- a range of ions of different degree of difficulty
- sufficient ions involving complex ion formation
- a limited number of ions that do not precipitate or complex.

Achievement requires that learners are able to carry out the practical work and identify precipitates formed as the unknown ions in the solutions are determined.

Merit requires that learners can also write balanced equations for these precipitation reactions occurring. It is expected that the precipitation equations, for a majority of the ions, are correctly written to meet sufficiency. If two precipitations occur for one ion, then both must be correct if the ion is to be judged correct.

To achieve excellence, in addition to the requirements related to merit, learners must be able to identify and write balanced equations for complex ions that are formed in the analysis.

As for merit, the complex ion formation equations, a majority of these ions, must be correct. Where there is more than one such equation for an ion, both must be correct to make a judgement of excellence for the ion.

Sufficiency is dependent on the actual ions used. A majority of ions must be correctly identified. For an ion to be considered correct, identification of all precipitates that are formed during the analysis of the ion are required, eg in identifying the presence of Zn^{2+} ions, the precipitates formed by reaction with aqueous sodium hydroxide and ammonia solutions must be identified. It cannot be assumed that the precipitates formed are the same.

The degree of difficulty, as well as the total number of ions, needs to be considered when designing the assessment activity, eg more then one coloured species in a limited number makes an easier task and more correct ions would be expected. If only two substances are used, both cations and anions need to be determined and all would be expected to be correct for excellence, and this would mean all four ions should form precipitates and at least two form complex ions.

Additional notes

The unknown ions in solution need to be carefully selected to ensure ample opportunity for the learner to provide evidence as required.

Some ions, eg Zn^{2+}, as an unknown require tests and observations plus four different equations (precipitation of $Zn(OH)_2$ with both sodium hydroxide and ammonia solutions) if the judgement is at the level of achievement or merit, plus complex ion formation of $[Zn(OH)_4]^{2-}$, $[Zn(NH_3)_4]^{2+}$ if the judgement is at the level of excellence.

Too many unknown ions from Na^+, NH_4^+, NO_3^- or CO_3^{2-} in an activity limits the opportunity for the learner to demonstrate evidence of ability to write precipitation and complex ion formation equations.

Chlorides of non-amphoteric metal ions, eg $MgCl_2$, are difficult to determine since the addition of ammonia solution to prove the presence of the chloride ion will precipitate the metal hydroxide.

A suitable activity would contain 8 ions, 7 that form precipitates (5 correct for achievement or merit) and 5 of which form complex ions (6 correct for achievement).

A flow chart procedure is provided with the activity available on the TKI website but it is not essential that this is the procedure provided.

The assessment schedule supplied with the activity for moderation purposes must specify the actual ions used. If it is an either/or situation the actual ion must be supplied in the evidence of the assessment schedule, not evidence for both.

In an activity it may be useful to include an additional column in the table to name the precipitates formed. This would allow learners who can carry out the procedure and identify precipitates, but not write correct formulae, an opportunity to achieve.

AS 90306: Carry out an acid–base volumetric analysis

The evidence statements prepared must include
- the expected titre for the analysis
- the calculated concentration of the solution.

For achievement, *a minor error is allowed but the solution must be a sensible one*. A minor error is an arithmetic error rather than an error associated with the chemistry involved. For example, the mole ratio applied incorrectly is a chemistry error, not a minor error.

For excellence, *the final answer must have correct units and an appropriate number of significant figures*. This means the standard solution provided must be supplied with 3 significant figures if this is to be the required accuracy of the unknown solution.
Also, in order to ensure understanding of the calculations involved, it is advisable to use a standard concentration of values other than ones such as 0.100 mol L^{-1}, eg the standard solution may be given a value such as 0.112 mol L^{-1}.

Where an additional written problem is provided, this should contain a wide enough range of titres to allow learners to make a selection of concordant titres meeting the requirements of all levels of achievement.

Additional notes

Data gained from the analysis must be recorded in a way that can easily be interpreted. Initial and final burette readings are required, as well as the titre used. Without this it is not possible to check the correctness of the subtractions of volumes involved. It is not usual practice to refill the burette to the zero marking for each titration.

Learners reading a burette to only an accuracy of 0.1 mL may be disadvantaged when it comes to the accuracy of average titre. Reading a burette to a higher level of accuracy, eg to 0.05 mL or 0.02 mL, is expected.

For the purposes of moderation the volume, as determined by the assessor, must be supplied with the material submitted.

AS 90763: Solve simple quantitative chemical problems

The judgement made is based on the complexity of the problem solved, with an increasing number of steps involved at the higher levels of achievement.

A suitable activity will include
- a range of types of problems
- problems with varying numbers of steps
- data which requires understanding of units and significant figures.

For excellence, *answers to calculations must demonstrate correct units and appropriate use of significant figures*. In order to make this judgement, the data given in the questions must be consistent with accuracy of data required. A learner achieving at excellence would be expected to have all answers to questions recorded appropriately, not just the questions leading to excellence opportunity.

Determining a molar mass is not considered *solving a simple quantitative problem*.

Additional notes

The explanatory notes 2, 3 and 4 clearly state the types of problem that are required to enable the learner to show evidence for each level of achievement.

The activity should contain different types of problem rather than repeated examples of the same kind.

A fair assessment activity will be one that is previously unseen by the learner since problems can be easily ‘remembered’. When using activities on the TKI website, changing masses, amounts or concentrations stated in the questions is required.

AS 90694: Carry out an extended practical investigation involving quantitative analysis

Evidence and judgement statements must contain detail relating to the requirements of Explanatory Notes 5, 6 and 7 of the standard. Key aspects of these include

- investigating a possible trend
- developing a procedure
- keeping a log book
- recording and processing data
- making a valid conclusion
- making critical evaluation.

The investigation must be individual and each learner is required to decide their own purpose.

The samples available on the TKI website illustrate how an assessment schedule can be formed from the Generic Template.

Additional notes

Material sent in for moderation must include the report and log book, as well as a clear indication of expected evidence and how judgements will be made. This may be through annotated examples of student work to indicate the expected standard and judgements made, or expected evidence and judgements for a particular investigation such as is available with the exemplars.

The analytical method used may be provided. However, the procedure used is developed by the learner. This includes how the samples are collected and prepared, and variable controlled. Usually the method supplied will require modification, particularly with respect to volumes and dilutions of solutions used.

Learners must determine any standard solutions that are required, and they must standardise these solutions. For excellence, the description of the method must show a clear understanding of the overall analytical technique. An analysis in which “differences” between a blank and actual titre values are used does not need a standard solution if the same solution is always used.

The report should not contain 'everything'. It should include the method used, a summary of data and a sample to indicate how the data has been processed. The raw data will be available in the log book. The log book will also contain the detail related to the making and standardising of solutions.

For excellence, a valid conclusion can only be reached by repeating experimental work. The experiment must be repeated for at least one new sample of the material involved to check whether the procedure used is reliable. It may be that a valid conclusion cannot be made as the repeated experimental work may produce different results. However, the procedure must include steps to determine whether reliable results are achieved.

The intent of the standard is that learners are doing an investigation rather than a series of experiments. This means that merely analysing 4 or 5 juices for Vitamin C content does not meet the requirements of the standard. To meet the requirements of a possible trend, a second variable is introduced. A possible trend must be considered with the purpose, although the conclusion may be that there is no trend.

AS 90695: Determine the concentration of an oxidant or reductant by titration

The evidence statements prepared must include
- the expected titre for the analysis
- the calculated concentration of the solution
- the calculated composition of the solution.

Concentration refers to the solution actually being analysed. Composition requires one further step to be carried out.

For achievement, *a minor error is allowed but the solution must be a sensible one.* A minor error is an arithmetic error rather than an error associated with the chemistry involved, eg the mole ratio applied incorrectly is a chemistry error, not a minor error.

For excellence, *the final answer must have correct units and an appropriate number of significant figures*. This means the standard solution provided must be supplied with 3 significant figures if this is to be the required accuracy of the unknown solution.

Also, in order to ensure understanding of the calculations involved, it is advisable to use a standard concentration of values other than ones such as 0.100 mol L^{-1}, eg the standard solution may be given a value such as 0.112 mol L^{-1}.

For merit and excellence, *determination of the composition of the sample will involve one mathematical conversion between the concentration of the solution analysed and the composition of the sample.* A conversion from mol L^{-1} to g L^{-1} is often used to meet this requirement although other conversions are possible.

Additional notes

Data gained from the analysis must be recorded in a way that can easily be interpreted. Initial and final burette readings are required, as well as the titre used. Without this it is not possible to check the correctness of the subtractions of volumes involved. It is not usual practice to refill the burette to the zero marking for each titration.

Learners reading a burette to only an accuracy of 0.1 mL may be disadvantaged when it comes to the accuracy of average titre. Reading a burette to a higher level of accuracy, eg to 0.05 mL or 0.02 mL, is expected.

Unit standards

Where unit standards are being used it must be recognised that all elements must be gained to achieve the unit standard with evidence of performance criteria within each element being met.

The assessment schedule must clearly show the expected evidence and judgement statements.

The range statements in unit standards need to be considered carefully. Depending on the position in the standard, range statements have different implications.

While there are many dated activities for unit standards, these activities were not moderated and often need modification to be used as a suitable activity.