NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

# Assessment Report

# Scholarship, 2007

# Chemistry

## COMMENTARY

As in previous years, a large percentage (approximately 19%) of the Level 3 chemistry cohort for 2007 sat this examination. Successful candidates were very well prepared and had an excellent grasp of the chemistry required at this level. They were able to write clear, concise answers, indicating the depth of their understanding of the concepts. They were also able to retrieve data that was presented in an unfamiliar form and use it to solve problems or explain given scenarios. However, a large number of candidates, many of whom were competent in the calculation questions, showed in their written answers a lack of understanding of the most fundamental of chemistry concepts.

This year, the number of questions was reduced to five in order to allow more time for candidates to plan their answers. Many camdidates wrote too much in answer to the early questions and so did not have time to complete the later ones. The "write-on" nature of the examination should have provided a guide as to the amount of writing / working expected for each answer. Candidates who had planned their answers so as to cover all the essential ideas in a logical sequence would have had sufficient space without needing extra pages.

When preparing candidates for the Scholarship examination, teachers should encourage practice at writing clear, concise discussions using the application of chemical principles and concepts which are linked to specific examples. It is often only in these discussions that student misconceptions become obvious, and these need sorting before the examination.

Most candidates showed good understanding of:

- calculations involving aqueous solutions (solubility and pH)
- quantitative calculations involving back titrations
- equilibrium principles
- links between intermolecular bonding and the physical properties of different compounds
- isomerism in organic chemistry.

Many candidates had difficulty with:

- explaining and correcting misconceptions about chemical reactions and atomic structure
- using the correct number of significant figures in their answers
- discussing the similarities and differences between two graphs – there was a tendency to just describe the similarities and differences without accounting for them
- interpreting a graph to access the data needed to answer a question
- recognising the relationship between the pH of a buffer solution and the nature of the particles present in the solution.

**The best performing candidates most commonly demonstrated the following skills and / or knowledge**:

- wrote logical and coherent responses, showing some evidence of planning, and linked their knowledge of chemistry directly to the context of the question asked
- correctly used chemical vocabulary and defined terms when necessary
- read and interpreted questions correctly
- wrote answers that were supported by balanced equations and / or correct formulae

- presented accurate calculations, showing working clearly and using significant figures appropriately
- showed an accurate and detailed understanding of chemical concepts especially in answers relating to atomic properties and intermolecular forces
- understood the reasons for steps taken in practical laboratory work
- applied knowledge in unfamiliar settings
- were familiar with all the Level 3 and related Level 2 Achievement Standards

**In Question One:**

- identified the errors in the statements given, provided a correct reason / explanation for the observations and used the example given to illustrate or discuss the misconception
- recognised that "atoms gaining full electron shells" is not the reason that chemical reactions occur and provided an alternative explanation
- recognised the limitations of the "octet rule"
- related the strength of the attractive force between an electron and the nucleus of an atom to the distance between the charges, the size of the nuclear charge, and the degree of shielding
- correctly calculated the heats of combustion, recognising the extended 3–D lattice structure of solid $SiO_2$
- recognised the role of activation energy in the spontaneity of a chemical reaction.

**In Question Two:**

- in part (a) used 0.01% of $Fe^{2+}$ in their answer
- in part (b) identified the stress applied to the system at the given points and related the stress to the changes in concentrations as recorded in the graph.

**In Question Three:**

- identified the correct isomer by taking into account ALL the data given
- wrote a coherent comprehensive account of the reasons for their choices at each step
- in part (b), recognised the polar nature of glucose and the non–polar nature of hexane
- wrote a comprehensive discussion linking ALL the data to the structure of the molecules and the strength of the related intermolecular forces.

**In Question Four:**

- correctly calculated the two pH values
- used the calculated pH values to sketch the second titration curve and recognised that after the equivalence point, both graphs will be the same
- discussed the similarities and differences between the two curves, relating these to the species present at relevant points on the graphs
- recognised that the pH of a buffer solution is related to the relative strengths of the acid and its conjugate base.

**In Question Five:**

- recognised that this was a back titration
- gave the answer to the appropriate number of significant figures
- linked reasons for using a back titration to the example given
- used the graph to access the reduction potential data for the range of pH values required
- discussed the species present at the different pH values by either comparing the reduction potential of the various species present OR determining the spontaneity of the reactions between the vanadium species and water or oxygen.

**Candidates who did NOT achieve scholarship lacked some or all of the skills and knowledge above and in addition they:**

- were unprepared for the lack of scaffolding in the questions
- misunderstood what was required from the questions and how to use the data that was given
- were unable to organise their time to attempt all the questions
- appeared to have large gaps in their knowledge and left out all questions on one topic, eg organic chemistry, aqueous chemistry, or calculations related to an investigation
- showed misconceptions in their understanding of chemical principles, particularly in relation to why chemical reactions occur and the forces between the nucleus of an atom and its valence electrons
- stated facts without linking them to the question asked
- used chemical jargon without explaining the meaning of the words, hence it was not apparent that they understood the underlying concepts, eg effective nuclear charge, van der Waals forces
- did not explain their ideas clearly or concisely.

**In Question One:**

- did not recognise that both reactants and products in the example given already had stable outer shell electron arrangements
- were unable to account for why reactions occur when both reactants and products already had stable electron arrangements
- assumed that the statement about electrons sharing the attractive force of the nucleus was true or partly true
- did not relate their answers to the examples given
- thought that when electrons completed the "octet", they became harder to remove
- used terms such as "shielding" and "effective nuclear charge" without showing that they knew what they meant.
- did not correctly calculate heats of combustion from the data given.

**In Question Two:**

- in part (a), calculated the solubility of the salts without taking into account concentrations of $Ni^{2+}$ and $Fe^{3+}$ present in solution
- failed to give a pH range
- in part (b), suggested more than one possible stress at some of the given points
- in their discussion, failed to relate the applied stress to the concentration changes of the species present as indicated by the graph.

**In Question Three:**

- had the alcohol group in the wrong position on the molecule because they did not recognise the stereoisomers present in compound **C**
- did not draw a cyclic compound for compound **G**
- either did not write a justification or wrote a very limited justification for their choices at each step
- in part (b), assumed glucose to be non–polar
- assumed that the hydrogen bonding in propan–2–ol was weaker than in methanol
- considered only some of the data in their discussion.

**In Question Four:**

- did not use the correct concentration for $OBr^-$ in the calculation of pH at equivalence point
- did not recognise that both the graphs are the same after equivalence point
- described the differences in the graphs rather than discussed them
- discussed the relative acidity of $CH_3COOH$ and HOBr rather than comparing the relative strength of each acid and its conjugate base.

**In Question Five**

- did not have the correct molar ratio because they did not balance the equation before attempting the calculation
- did not link reasons for back titrations to the data given, eg commented that a back titration was used because the titre values would otherwise be too small
- attributed error to poor technique
- did not recognise which species could be oxidised by another species, ie would consider a reaction where both species would need to be reduced.