2025 NCEA Assessment Report

Subject:	Chemistry
Level:	3
Achievement standard(s):	91390, 91391, 91392

General commentary

Achievement of each standard depended on candidates applying their understanding rather than simply recalling facts. At the Excellence level, critical thinking was required to interpret information and use concepts accurately in unfamiliar contexts. It is important that candidates read questions carefully to fully understand the intent of each question rather than assuming that certain questions will be asked and providing rote-learned responses.

Each examination included three questions, of which candidates were required to respond to all three.

Report on individual achievement standard(s)

Achievement standard 91390: Demonstrate understanding of thermochemical principles and the properties of particles and substances

Assessment

Question One focused on drawing Lewis structures and naming shapes, explaining the polarity of a molecule, justifying differing bond angles, and using entropy changes to justify the spontaneous nature of a reaction. Question Two covered *s, p, d* notation, explaining differences in ionic radii, justifying differences in enthalpy of vaporisation values with reference to the strength of the intermolecular forces present, and calculating the enthalpy change of a reaction using Hess' Law. Question Three required candidates to use enthalpy data to calculate the enthalpy of formation of ammonia, justify trends in ionisation energy and atomic radii, and use information from a calorimetry experiment to calculate the mass of calcium chloride dissolved.

The questions covered the requirements of the 2025 assessment specifications to demonstrate understanding of thermochemical principles and the properties of particles and substances.

Commentary

Most candidates attempted the majority of questions. In particular, candidates were confident to apply their knowledge to questions concerning the shape and polarity of molecules.

Many candidates struggled to clearly link their understanding of entropy to the spontaneity of a chemical reaction. Candidates who performed well recognised the significant impact of the loss of two moles of gas on entropy, while others focused more on the loss of a solid reactant.

Candidates needed to make it clear that intermolecular forces exist between molecules, rather than within a molecule. Furthermore, candidates needed to link the strength of temporary dipole forces to the size of the electron cloud.

Many candidates did not refer to the effect of repulsion between energy levels (shielding) in their explanations of periodic trends.

Grade awarding

Candidates who were awarded **Achievement** commonly:

- drew Lewis structures
- named molecular shapes
- recognised the number of regions of electron density around an atom
- identified electron geometry or bond angles in a molecule
- recognised entropy increases with an increase in disorder
- recognised how entropy could decrease in the system or increase in the surroundings
- wrote electron configurations using *s*, *p*, *d* notation
- recognised that intermolecular forces exist between molecules
- identified hydrogen bonding as the strongest type of intermolecular attraction
- partially applied Hess' Law to an enthalpy change calculation
- identified a factor affecting a periodic trend.

Candidates who were awarded **Achievement with Merit** commonly:

- justified the polarity of a molecule
- explained aspects of the entropy changes in the system or surroundings
- applied Hess' Law to an enthalpy change calculation
- compared the strength of intermolecular forces between molecules
- explained the effect of the size of the electron cloud on the strength of temporary dipole forces
- related the strength of hydrogen bonding to the electronegativity difference of an H–F bond
- completed a calorimetric calculation with a minor error
- explained differences in ionic radii
- linked the decrease in atomic radius across a period to the increasing number of protons
- calculated an enthalpy of formation using the data provided.

Candidates who were awarded **Achievement with Excellence** commonly:

- justified the spontaneity of a reaction based on the entropy changes of the system and the surroundings
- explained the differences in standard enthalpy of vaporisation data by comprehensively comparing the strength of intermolecular forces between molecules
- justified periodic trends in terms of the number of energy levels, nuclear charge, repulsion from inner energy levels, and the electrostatic attraction between the nucleus and valence electrons
- calculated the mass of a solid dissolved in a calorimetry experiment
- completed all calculations with appropriate units and significant figures.

Candidates who were awarded **Not Achieved** commonly:

- showed little understanding of factors affecting entropy or the strength of intermolecular forces
- stated periodic trends but did not describe factors affecting the trends
- could not perform any correct steps of enthalpy calculations.

Achievement standard 91391: Demonstrate understanding of the properties of organic compounds

Assessment

Question One focused on optical isomerism, devising a reaction scheme, and explaining how heating under reflux and distillation could be used to obtain the organic products from oxidation of butan-1-ol. Question Two required candidates to name and draw structural formulae of organic molecules, including drawing enantiomers, justify the steps involved in positively identifying three unknown organic liquids, and determine the structural formulae of organic compounds based on provided observations, properties, and reactions. Question Three covered explaining the condensation reaction used to form dipeptides, explaining the hydrolysis of a polyester, and using provided properties to draw and justify structural formulae.

The questions covered the requirements of the 2025 assessment specifications to demonstrate understanding of the properties of organic compounds.

Commentary

Candidates generally showed confidence with identifying functional groups, naming compounds, and recognising common reaction types. However, extended responses that required candidates to justify outcomes, link reaction conditions to products, or complete multi-step reaction pathways were more challenging.

Across the paper, candidates who achieved higher grades were able to clearly link structures, properties, and reactions. Weaker responses often demonstrated partial understanding that lacked sufficient explanation, contained structural inaccuracies, or did not fully address the intent of the question.

Grade awarding

Candidates who were awarded **Achievement** commonly:

- identified functional groups and basic reaction types
- identified asymmetric carbon atoms or recognised that enantiomers rotate plane-polarised light
- explained how distillation can purify organic compounds
- completed some steps in reaction schemes
- recognised observations for common chemical tests to identify organic functional groups
- drew some structural formulae with correct bonding and functional group placement
- used some evidence to identify or eliminate compounds.

Candidates who were awarded **Achievement with Merit** commonly:

- completed most steps of multi-step reaction schemes
- explained distillation and heating under reflux with reference to boiling points or how the position of the condenser affects the removal or retention of organic products
- partially justified the order of distinguishing tests for three organic compounds
- explained types of reactions in context
- determined the structural formula of an organic compound from a molecular formula, properties, and reaction observations
- drew accurate structural formulae, including correct bonding and functional group placement.

Candidates who were awarded **Achievement with Excellence** commonly:

- provided comprehensive, logically sequenced responses that fully addressed the intent of the question
- completed complex multi-step reaction pathways, clearly identifying reagents and organic products
- integrated explanations of structural formulae, functional groups, and reaction conditions to justify observed outcomes in context
- distinguished between distillation and heating under reflux, including the role and position of the condenser and the impact on the formation of organic products
- justified identification or elimination of organic compounds using multiple pieces of evidence.

Candidates who were awarded **Not Achieved** commonly:

- gave responses that were too brief or unclear to demonstrate understanding of the standard

- struggled to recognise functional groups
- drew structural formulae with incorrect bonding or misplaced functional groups
- could not provide at least one step of a reaction scheme.

Achievement standard 91392: Demonstrate understanding of equilibrium principles in aqueous systems

Assessment

Question One focused on solubility equilibria, including calculating a solubility product, explaining the effect of complex ion formation and the addition of an acid on the solubility of a sparingly soluble solid, and predicting precipitation. Question Two covered identifying species in solution, explaining how a buffer functions, calculating the mass of an acidic salt required to prepare a buffer solution at a specified pH, outlining how a solution could be modified in the laboratory to function as a buffer, and justifying the pH of three different solutions. Question Three was set in the context of a titration curve, and included explaining the suitability of indicators to identify the equivalence point, calculating the pH at the equivalence point, comparing the electrical conductivity of the solution in the flask at different points of the titration, calculating the pH of the solution in the flask after the equivalence point, and explaining the difference in pH between the solution in the burette and the solution in the flask after the equivalence point.

All three questions required both explanations and calculations to gain Excellence. The questions covered the requirements of the 2025 assessment specifications to demonstrate understanding of equilibrium principles in aqueous systems.

Commentary

Candidates scored highly on the solubility equilibrium questions. There was also a noticeable improvement in candidate understanding of how buffers are prepared and how they function.

Candidates generally struggled with questions relating to the titration curve. Candidates often correctly estimated the pH at the equivalence point from the curve when explaining their choice of indicator, but then incorrectly calculated the pH to be basic. It seemed that candidates had rote-learned how to calculate the pH at the equivalence point and the pH after the equivalence point for a weak acid versus strong base titration curve, and did not recognise that the titration curve in the assessment was actually for a weak base versus strong acid titration.

Grade awarding

Candidates who were awarded **Achievement** commonly:

- wrote the equilibrium equation and K_s expression for a saturated solution
- calculated the solubility product of iron(II) hydroxide
- recognised the addition of a strong acid to a saturated solution of iron(II) hydroxide will decrease the concentration of hydroxide ions present
- recognised nickel ions form a complex ion with cyanide ions
- compared the ionic product with the solubility product to predict precipitation
- described the function of a buffer solution
- used the correct process to calculate the mass of an acidic salt required to prepare a buffer solution
- identified the pH range over which a solution will function as a buffer
- recognised that the pH decreases as the hydronium ion concentration increases
- described why methyl red was a suitable indicator for the acid-base titration.

Candidates who were awarded **Achievement with Merit** commonly:

- used equilibrium principles to explain the effect of adding a strong acid on the solubility of a sparingly soluble solid
- used equilibrium principles to explain the effect of complex ion formation on the presence of a precipitate
- determined, by calculation, that a precipitate would form when two solutions were added together
- explained how a buffer solution functions when strong base is added
- outlined how a solution could be modified to function as a buffer
- justified the pH of two different solutions in terms of the degree of dissociation and the concentration of hydronium ions
- explained the electrical conductivity of a weakly basic solution
- calculated the pH of the solution in the flask after the equivalence point.

Candidates who were awarded **Achievement with Excellence** commonly:

- explained how a solution could be modified in the laboratory to function as a buffer
- explained, with reference to the titration curve and the pK_a values of the indicators, why methyl red would be a better indicator to detect the equivalence point than thymol blue
- calculated the pH of the solution at the equivalence point
- explained why the pH of the solution in the flask differs from that in the burette after strong acid is added past the equivalence point.

Candidates who were awarded **Not Achieved** commonly:

- gave the incorrect charges on ions
- could not dilute the concentration of ions when two solutions were mixed
- could not distinguish solutions based upon their degree of dissociation
- referred to charged particles, rather than ions, when describing the electrical conductivity of a solution
- substituted incorrectly into expressions for calculations.