2024 NCEA Assessment Report

Subject: Chemistry

Level: 2

Achievement standard(s): 91164, 91165, 91166

General commentary

Candidates who achieved well provided relevant definitions, effective explanations, and correct evidence, and consistently recognised the concept in question. Candidates who achieved at Merit or higher applied correct terminology throughout each part of an answer, consistently used chemical conventions, and ensured attention to detail regarding units and significant figures in calculated answers. Linking of evidence with concepts and relating back to examples in the question, comparing as required, was an essential Excellence skill.

Report on individual achievement standard(s)

Achievement standard 91164: Demonstrate understanding of bonding, structure, properties and energy changes

Assessment

The assessment had three questions, and candidates were expected to answer all parts of all three questions. The assessment gave ample opportunities for candidates to demonstrate their understanding by applying and explaining the chemical concepts linking bonding, structure, and properties of chemical compounds, and the energy involved in physical and chemical changes.

Commentary

Successful candidates were able to identify key concepts in questions, demonstrate clear understanding in recognition and representation of exothermic and endothermic reactions, apply correct terminology to explanations, particularly around molecular polarity and solubility with regard to electronegativity and bond dipoles, and drew accurate chemical structures. At Merit level or higher, candidates were able to relate chemical concepts to the examples given in the question and to compare and contrast, stating what was similar and what was different using consistent chemical conventions throughout.

Grade awarding

Candidates who were awarded **Achievement** commonly:

- identified a difference in electronegativity between atoms in bonds
- drew Lewis diagrams and/or named shapes
- converted mass into the number of moles
- calculated bonds, broken or formed

- labelled enthalpy change or reactants and products on an energy diagram
- identified a number of bonding and non-bonding regions in a molecule
- identified the types of solid particles and attractive forces between them
- identified that melting point is related to strength of attractive forces
- identified that attractions or similar polarities are needed for a substance to be soluble in water
- identified that non-directional bonds are needed for malleability
- recognised that conductivity requires mobile charged particles.

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

- linked the number of bonding regions to parent geometry and bond angle using repulsion theory
- linked symmetry / asymmetry and strength of polar bonds within molecules to dipole cancellation / reinforcement
- used the correct process for two consecutive steps of a thermodynamic calculation
- linked relative strength of forces with the amount of energy needed for melting a solid substance
- linked polarity and the strength of attractive forces between the solute and solvent to the solubility of a substance
- correctly calculated bond enthalpy, allowing for minor error
- linked structure and bonding of a metallic substance to conductivity and malleability
- correctly labelled an enthalpy diagram from a given equation with formulae and units
- converted kg to g in calculation.

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

- rounded correct thermodynamic calculations to three significant figures with correct units
- drew clear annotated diagrams for the dissolving of an ionic substance in water, with dipoles on water and charges on dissolved ions
- justified the solubility of an ionic and a non-polar solute, with reference to polarity and the strength of attractive forces that need to be overcome
- compared and contrasted molecular shapes linking areas of electron density, repulsion theory, the number of bonded and unbonded areas, and bond angles
- justified the conductivity and malleability of a metal, and linked this to its uses
- justified the polarity of molecules with reference to electronegativity, bond polarity, and symmetry of dipole arrangements.

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

- used incorrect formulae for thermodynamic calculations
- could not describe the polarity of a water molecule
- assigned incorrect bond angles to shapes of molecules
- used incorrect terminology for ions, molecules, electronegativity, dipoles, polar, and non-polar
- used the wrong particle type and attractive forces for types of solid
- attributed conductivity solely to mobile electrons
- did not recognise that attractions were needed for substances to dissolve.

Achievement standard 91165: Demonstrate understanding of the properties of selected organic compounds

Assessment

The assessment had three questions, and candidates were expected to answer all parts of all three questions. The assessment gave ample opportunities for candidates to demonstrate their understanding of the properties of organic compounds linking to structure and functional groups.

Commentary

Successful candidates were able to demonstrate the core skills of naming and drawing chemical structures with consistent attention to detail, including positioning of functional groups regarding classification and isomers. At Merit or higher, candidates who used the bullet points to assist with answering all parts of the question linked the identified reaction type to the chemical concepts throughout their explanation of reactions, including relating to the relevant compound in the question.

Grade awarding

Candidates who were awarded **Achievement** commonly:

- correctly named and drew some organic compounds
- identified the functional groups in a compound
- used chemical properties to distinguish between functional groups
- identified a reagent, observation, or product
- identified observations based on solubility
- explained one aspect of addition polymerisation
- identified saturated or unsaturated in the monomer or polymer
- predicted some reagents, products, and reaction types in a reaction scheme
- drew a tertiary haloalkane or explained what tertiary means
- identified the correct reaction type and provided a basic explanation
- drew the major and minor products formed, but were unable to link their answer to Markovnikov's rule
- identified symmetry / asymmetry as a factor that influenced the number of products made in an addition reaction
- were able to draw structural isomers, but commonly included secondary alcohols
- recognised that a carbon to carbon double bond could be formed in either direction in the elimination reaction.

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

- correctly named and drew all organic compounds
- linked a reagent to a reaction type, product and structure, or observation
- identified observations based on solubility, and linked this to the functional group
- distinguished between chemicals based on their MP / BP
- drew a polymer given the monomer, and explained all aspects of the term addition polymerisation
- explained the reactivity of the monomer and polymer in terms of C=C / alkenes / unsaturated and C–C / alkanes / saturated
- predicted most reagents, products, and reaction types in a reaction scheme
- drew a tertiary haloalkane, and explained why it was tertiary
- used Markovnikov's rule to explain why a major and minor product were formed

- explained why a symmetrical reagent produced only one product, while an asymmetrical reagent produced two different products
- drew multiple structural isomers that were primary alcohols
- used Zaitsev's rule to explain why two products are formed.

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

- consistently drew structures and named them with correct terminology
- linked multiple reagents to the observation, reaction type, product, and conditions
- identified observations based on solubility, and linked this to the functional group, as well as distinguishing chemicals based on their MP / BP, linked to the increased carbon chain length
- discussed all aspects of additional polymerisation and the reactivity of the monomers and polymers with reference to C=C / alkenes / unsaturated and C–C / alkanes / saturated
- predicted all reagents, products, and reaction types in a reaction scheme
- justified the choice of major / minor products with specific reference to the structure of the reactant
- drew all of the structural isomers that were primary alcohols
- justified the absence of major / minor products with reference to Zaitsev's rule and the structure of the reactant.

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

- incorrectly used terms such as ions or molecules to describe bonding atoms
- gave Fl as the symbol for fluorine
- referred to an alcohol group as OH^-, hydroxide, or OH atom
- drew bonds to the wrong atom, e.g., C–HO instead of C–OH
- were unable to identify the functional groups in a compound
- used incorrect or unnecessary conditions with a reagent
- did not give the correct reaction type, observation, or product for a reagent
- did not use physical or chemical properties to distinguish between organic compounds, or confused chemical properties with physical properties
- did not determine whether a functional group was soluble in water
- did not identify whether MP / BP increased or decreased with size, or considered it as based solely on the number of bonds rather than strength of bonds
- confused the melting point and boiling point
- made comparisons to the time to boil instead of the difference in temperature
- did not convert a monomer into a polymer
- did not explain any aspects of addition polymerisation
- did not discuss the reactivity of monomers and polymers
- did not predict any reagents, products, or reaction types in a reaction scheme
- did not draw a tertiary haloalkane or explain what tertiary means
- did not draw geometric or structural isomers
- did not identify or draw addition / elimination reactions or products
- drew structural isomers that were the same but drawn differently.

Achievement standard 91166: Demonstrate understanding of chemical reactivity

Assessment

The assessment had three questions and candidates were expected to answer all parts of all three questions. The assessment gave multiple opportunities for candidates to demonstrate their understanding of chemical reactivity applying chemical vocabulary, symbols, and conventions.

Commentary

Successful candidates were able to apply the required vocabulary in their answers to each specific question linking to the chemical concepts of rates of reaction and equilibrium principles. A fundamental knowledge of expected acid and base formulas and their pH was required. At Merit or higher, candidates demonstrated a clear ability to understand and write chemical equations and a good mathematical competency, including evidence of working for calculated answers.

Grade awarding

Candidates who were awarded **Achievement** commonly:

- recognised the relationship between concentration and amount of particles and rate of reaction
- recognised and defined a catalyst
- calculated [H_3O^+] from a given pH
- wrote an equation from a given K_c expression
- substituted correctly into an equation for calculating Q based on given concentration data
- identified the direction of equilibrium favoured when a change occurs to the system or comparison between Q and K_c
- recognised conjugate acid-base pairs
- identified the role of mobile charged particles for electrical conductivity
- identified correct pH for a variety of solutions
- wrote a dissociation equation (including correct arrows) for a variety of solutions in water.

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

- linked an increase in concentration to the amount of particles and the resultant increase in collisions per unit time
- compared the gradient / amount of reactant particles in different sections on a rate of reaction graph
- linked catalyst definition with resultant increase in rate of reaction
- calculated a Q value for a reaction and linked its magnitude to the reaction when comparing K_c
- described the direction of equilibrium favoured when a change occurs to the system and subsequent outcome on the concentration of reactant and product yield
- linked an increase in K_c to an increase in products in an equilibrium mixture
- linked an increase in temperature to favouring the endothermic reaction in an equilibrium mixture
- related the conductivity of an acid or base to the amount / number of ions present through the degree of dissociation and ionisation
- calculated pH from interpreting strong base concetration providing [OH^-].

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

- provided a detailed response to the effect of concentration, changed over the course of a reaction at sections A and B
- were systematic in their responses and had a clear approach to writing answers
- elaborated on the effect of concentration or, a catalyst on the rate of reaction, by including reference to the graph showing mass change over a period of time and activation energy
- completed calculations with correct units and used appropriate significant figures
- used equilibrium principles to explain the effect of changes in concentration and pressure on the position of an equilibrium
- linked change of temperature with K_c change to justify forward / reverse reaction as exothermic / endothermic reactions
- distinguished between strong / weak acids and bases and salt in terms of pH and ions
- analysed the strength of the above chemical substances in terms of their ions and related this to conductivity.

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

- demonstrated little understanding of subject specific knowledge of the standard
- made obvious errors (e.g., in Question Three (b)(i) and (ii), not identifying ammonia and HNO_3 as a weak base and a strong acid)
- did not calculate [H_3O^+] from a given solution concentration
- struggled to identify the role of a catalyst
- did not recognise that concentration links closely with rate of reaction
- did not write an equilibrium reaction equation based on given expression
- did not identify the changes to the direction of an equilibrium under stress
- confused electrons with ions when describing electrical conductivity
- did not identify conjugate acid-base pairs or write K_c expression of the given equation.