2022 NCEA Assessment Report

Mana Tohu Mātauranga o Aotearoa
New Zealand Qualifications Authority

Subject: **Chemistry**

Level: **2**

Standards: **91164, 91165, 91166**

Part A: Commentary

Candidates who were able to identify key concept(s) covered in a question provided sufficient evidence towards Achievement level. Candidates that achieved at Merit level or higher were able to plan their answers to ensure they answered all parts of the questions, making references to include comparisons and use correct terminology. These candidates carried out calculations systematically, giving their answer to the correct number of significant figures, and with correct units. Candidates should always link chemistry concepts back to the substances present in the question. If a question asks the candidate to compare and contrast two substances, there needs to be a summary paragraph stating what is similar and what is different. Clear working should be shown for all calculations to allow the marker to award partial grades when a final answer is not fully correct.

Part B: Report on standards

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

Examination

The examination included three questions of which candidates were required to respond to all three. Question 1 required candidates to apply their understanding of Lewis diagrams, molecular shapes, and endothermic reactions. Question 2 required candidates to apply their understanding of bond energy, molecular polarity, enthalpy calculations, and properties of molecular substances. Question 3 required candidates to apply their understanding of substances and their properties, the solubility of ionic compounds, and enthalpy calculations.

Observations

Candidates needed to be accurate with terminology, particularly the difference between electronegativity, electron repulsion, and bond dipoles. Candidates needed to have basic algebraic skills in order to manipulate bond energy equations, and should have prepared for this accordingly. Care needed be taken when discussing endothermic and exothermic reactions to be sure of the direction of heat transfer.

Grade awarding

Candidates who were awarded **Achievement** commonly:

- converted mass to number of moles
- related boiling point to the strength of forces of attraction in a substance

- linked symmetry and shape to molecular polarity
- drew Lewis diagrams correctly and / or named shapes
- calculated the energy of bonds broken in reactants or bonds made in products
- identified the number of bonding / non-bonding regions of electron density around a central atom, and linked this to repulsion theory
- identified that free-moving charged particles are necessary for electrical conduction
- identified that exothermic reactions release energy and have a negative enthalpy
- drew enthalpy diagrams for vaporisation.

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

- confused bonding and particle types in solids
- identified water as a non-polar molecule
- confused electronegativity with electron clouds and bond dipoles
- used mnemonics such as ‘like dissolves like’ without explanation
- confused endothermic and exothermic processes
- used incorrect methods to calculate moles
- stated that ionic substances were polar
- referred to ionic substances as discrete substances.

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

- linked the structure and relative strength of attractive forces between particles to a substance’s boiling point
- carried out a two-step thermodynamic calculation accurately
- linked repulsion of regions of electron density to the shape and observed bond angles of a molecule
- explained how electronegativity, symmetry, and dipole cancellation determines molecular polarity
- described solubility of ionic solids, with reference to the attractive forces formed with water molecules
- correctly drew Lewis diagrams and named shapes
- accurately described the structure of diamond or graphite
- drew labelled enthalpy diagrams for vaporisation.

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

- justified the shapes and bond angles of molecules fully using VSEPR theory
- explained the polarity of molecules comprehensively, by linking electronegativity of atoms to bond polarity, and symmetry to dipole cancellation
- fully described the cooling of surroundings by the absorption of heat energy in order to break bonds in an endothermic process
- compared and contrasted the conductivity of graphite and diamond, with clear links to their structures

- carried out thermodynamic calculations with correct units, sign, and to three significant figures
- drew accurate diagrams depicting how water molecules surrounded ions to facilitate the dissolution of ionic solids.

91165: Demonstrate understanding of the properties of selected organic compounds

Examination

The examination included three questions of which candidates were required to respond to all three. Question 1 required candidates to apply their understanding of structural isomers, the reactivity of saturated vs unsaturated molecules, and elimination reactions of both symmetric and asymmetric alcohols. Question 2 required candidates to apply their understanding of geometric isomers, addition polymerisation, and the interconversion of organic compounds. Question 3 required candidates to apply their understanding of distinguishing tests, reaction schemes, and addition reactions of asymmetric alkenes.

Observations

Core skills, such as naming and drawing organic compounds, are necessary for success at all levels. Candidates should have used the provided bullet points as scaffolding for their answer to ensure all aspects of the question were covered. Identifying and explaining the type of reaction occurring is a recurring skill in this assessment. For Merit and Excellence, students needed to link the concepts covered to the relevant compounds in the question.

Grade awarding

Candidates who were awarded **Achievement** commonly:

- classified alcohols as primary, secondary or tertiary
- defined structural isomerism
- identified correct reaction types occurring in organic reactions
- described observations in distinguishing tests
- drew and named simple organic compounds
- partially identified reagents used and products formed in an organic reaction scheme
- stated why two products formed in addition / elimination reactions of asymmetric compounds
- drew geometric isomers, and identified one feature common to compounds able to form such isomers
- drew the structure of an addition polymer
- identified one compound using a chemical or physical property.

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

- were unable able to predict any reagents or products in a reaction scheme
- did not classify alcohols as primary, secondary, or tertiary
- did not correctly identify reaction types in organic conversions

- did not name or draw organic compounds
- confused structural isomerism with geometric isomerism
- did not identify correct observations of distinguishing tests.

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

- classified alcohols as primary, secondary, or tertiary, with reference to their physical structures
- linked structural isomerism to the molecular formula and physical structures of the molecules in question
- explained a particular reaction type with reference to structural changes occurring to a molecule, during an organic reaction
- predicted most reagents and products in a reaction scheme,
- used Markovikov / Zaitsev's rule to determine major and minor products, with explanation
- linked symmetry / asymmetry of molecules to the number of products formed in an organic reaction
- linked the rigidity of the double bond to the spatial arrangement of atoms / groups of atoms
- used the chemical and physical properties of compounds to distinguish between two or three compounds of different homologous series.

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

- predicted all reagents and products in a reaction scheme
- justified the type of reaction occurring with reference to products, observations, and conditions
- justified the different requirements for geometric isomers, and related these back to the context in the question
- drew and justified the various products formed when alkenes are reacted with an asymmetric reagent
- consistently used chemistry vocabulary, symbols, and conventions.

91166: Demonstrate understanding of chemical reactivity

Examination

The examination included three questions, and candidates were required to respond to all three. Question 1 required candidates to apply their understanding of K_c expressions with associated calculations, pH, and electrical conductivity of strong and weak acids, as well as factors that affected systems at equilibrium. Question 2 required students to further demonstrate their understanding of factors that affected systems at equilibrium, as well as how catalysts affected chemical rates of reaction. Question 3 required students to apply their understanding of strong and weak acids and bases, including pH calculations, and how temperature affected chemical rates of reaction.

Observations

Candidates needed to familiarise themselves with the reactions of common acids and bases with water, as well as how to write equations for the dissolution of ionic salts. A firm understanding of how hydronium ion concentration and pH are related was beneficial in this standard. Clear working was required for the awarding of partial grades in calculation questions when an error has been made. Candidates needed to be aware of the increased level of understanding required for Level 2 compared with Level 1, with respect to acid and bases, as well as reaction rates.

Grade awarding

Candidates who were awarded **Achievement** commonly:

- identified products of acid-base reactions, with minor errors
- recognised that conductivity of an aqueous solution requires mobile charged particles
- wrote a correct K_c expression
- predicted the favoured direction when changes are made to equilibrium systems
- recognised that a temperature increase leads to an increase in the kinetic energy of particles
- identified that a catalyst provides an alternative pathway for a reaction to occur
- calculated the hydronium ion concentration of solution, given its pH value.

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

- incorrectly identified the favoured direction when a change was made to a system at equilibrium
- believed delocalised electrons were responsible for the conductivity of aqueous solutions
- confused reaction rates with equilibrium principles
- stated that chemical equilibrium occurs when the concentration of all species is equal
- did not correctly link acid / base strength to degree of dissociation or ion concentration
- did not write equations for the reactions of weak acids / bases with water, nor for the dissolution of an ionic solids
- wrote incorrect K_c expressions when given an equation for a system at equilibrium.

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

- explained the favoured direction when a change is made to a system at equilibrium
- linked increasing temperature / addition of a catalyst to the reaction rate using collision theory
- explained the conductivity of a solution by linking the degree of dissociation to ion concentration
- correctly identified the relationship between pH and hydronium ion concentration
- wrote correct equations for the reaction of common acids / bases with water and linked this to pH / conductivity
- wrote a correct K_c expression and calculated its value

- explained that chemical equilibrium is obtained when the rates of both the forward and reverse reactions are equal.

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

- recognised that the equilibrium constant describes a ratio of product to reactant concentration, and could apply the implications of this relationship to the equilibrium shift observed when a system at equilibrium is heated
- accurately described the pH of a weakly basic salt, with reference to the initial dissolution of the salt, the subsequent reaction of the basic ion with water, and the resultant hydroxide / hydronium ion concentration
- elaborated on the effects that changing temperature and the addition of a catalyst had on the frequency of successful collisions, and the effect this had on reaction rate
- fully explained how acid / base strength affects the degree of dissociation, hydronium ion concentration, pH and conductivity
- elaborated upon the effect of making changes to systems at equilibrium.