Assessment Report

New Zealand Scholarship Chemistry 2022

Standard 93102

Part A: Commentary

Candidates who yielded success in this examination were those that were able to demonstrate a broad understanding of the Chemistry curriculum. Questions broadly covered quantitative analysis, spectroscopic techniques, electrochemical cells, thermochemical principles and calculations, molecular shapes, intermolecular interactions, solubility equilibria, acid-base equilibria, titration calculations and indicators, organic synthesis, and thermodynamics.

Most candidates who were unsuccessful in this examination either left many questions unanswered or were not able to demonstrate sound understanding of the aforementioned core chemistry principles. Candidates should have attempted all questions in the booklet, as blank answers to parts of questions impacted on the potential grades that could be awarded to the remaining work completed. Candidates who were unable to answer entire sections of the examination, for example any of the aqueous equilibria questions, were often not able to reach the threshold for Scholarship with grades achieved from the remaining answered questions.

Candidates who performed well were those who showed good insight and understanding of the chemistry being assessed. They were able to apply their knowledge to unfamiliar contexts, and provide succinct answers that addressed the key components of the questions. Candidates who carried out calculations with clear working and well-rounded answers were recognised for their efforts.

Those candidates who read the question carefully and critically evaluated the information provided correctly, often produced written answers with greater insight and understanding. For example, in Q2(a)(i), candidates were provided one saturated and one unsaturated fatty acid to create three different triglycerides from, and they were told that the fatty acids in each triglyceride had to be identical, with further guidance given in the question to label any stereochemistry. Successful candidates interpreted this information to derive cis and trans isomers of the unsaturated fatty acid and completed the question correctly. Those who constructed triglycerides which did not meet the criteria provided in the question, were not able to answer the question correctly. Similarly, in Q2(a)(ii), candidates were given information on the structure of the surfactant particles, and successful candidates were able to apply their understanding of intermolecular attractions between different particles to provide logical answers to the role that surfactants play in cleaning. Unsuccessful candidates proposed ideas that were not logical, such as that the surfactant acted as a base to hydrolyse the fats into fatty acids to make them soluble in water, or proposed that the fats were able to dissolve into the surfactant as if it was acting as a solvent.

Candidates who showed greater understanding of chemistry principles were often able to write answers that expanded beyond rote-learned responses that may suit some NCEA style questions, but do not make the same amount of sense in unfamiliar contexts. In the final question of the examination, Q4(b), for example, most candidates were able to apply their knowledge and clearly justify the entropy changes occurring that enabled salt to dissolve to form an aqueous solution in water. A significantly smaller range of candidates, however, were able to then go on and explain correctly why salt crystals formed in the solution in a warm room as the volume decreased. Those candidates who recognised that the evaporation of the water must be the major entropy change driving the spontaneous crystallisation process, showed much greater insight than the candidates who tried to use Gibbs free energy to argue that the spontaneous crystallisation of salt must become possible in a warm room, simply because it is at a higher temperature, and this favours the reverse reaction. It can be inferred that candidates who have faced challenging questions in their studies that have required the production of logical, reasoned answers, were better prepared to answer scholarship questions than those candidates who only could only reproduce model answers without insight or clarity of ideas.

Calculations featured in a variety of questions with a variety of contexts and applications of the curriculum. Candidates who could complete calculations related to quantitative analysis, acid-base titrations, solubility, and thermochemistry, yielded significantly better outcomes than those candidates who left those questions blank or incorrectly answered.

A key component to the scholarship examination, which sets it different from the NCEA examinations, is the need for candidates to show application of highly developed knowledge, skills, and understanding to complex situations. Q(1)(b) required students to discuss the kinetic energy of particles and intermolecular attractions in butanoic acid during state change. Successful candidates could relate the flat gradients in parts of the graph to the balance between energy removal from the system and the energy released as intermolecular forces formed. Unsuccessful candidates often incorrectly argued that energy was being used to form intermolecular attractions, potentially due to a weakness in their understanding of thermochemistry. Similarly, candidates who understood that temperature is a measure of average kinetic energy, were better placed to discuss the flat gradients with respect to kinetic energy, than those who incorrectly argued a reduction in the kinetic energy of particles was occurring during the formation of intermolecular forces.

Being able to answer questions related to any area of the Chemistry curriculum is essential to achieving in this scholarship examination. Regardless of which internal and external standards that candidates have been supported through in their schooling, additional preparation should be carried out for all other areas of the curriculum, to ensure a thorough base of knowledge going into the examination. Due to the differences in layout, scaffolding, and style of questions between NCEA level 3, and scholarship, candidates who have experience with working through past scholarship examination questions ahead of the examination will be best prepared for the unfamiliar contexts and problem-solving required to answer the questions.

Overall, those candidates who were awarded scholarship and outstanding scholarship had prepared well for the examination, produced a greater quantity of correct answers, and demonstrated a broad and deep understanding of chemistry at this level.

Part B: Report on Performance

Candidates who were awarded Scholarship with **Outstanding Performance** commonly:

- comprehensively justified the electrochemical process using a cell potential calculation, balanced full equation, description of observations, and description of direction of electron flow
- identified using reduction potentials that HCl would not be an appropriate acid to use, and justified using a cell potential calculation
- justified the gradient of the line within sections B-C and D-E with consideration of the exothermic formation of intermolecular forces balancing out with the energy being removed from the sample, and there being no changes to the kinetic energy of particles during this time
- identified that section C-D had the data needed to determine the specific heat capacity of the liquid, and the additional data required were the energy being removed, and the mass / moles of the butanoic acid in the sample
- reasoned that condensation required the formation of more forces than solidification
- carried out correct calculations to determine the percentage of silver and copper in the alloy and stated the alloy did not meet the standard
- drew correct structures for the three triglycerides using the instructions provided in the question
- were able to relate the stereochemistry of the cis / trans alkene functional groups to the shapes of the triglyceride molecules, the impact this had on their packing, and the strength of intermolecular attractions
- accounted for the hydrogen bonding present in water, non-polar interactions in triglycerides, and the interactions between these species with the surfactant particles, with emphasis on the charged ionic head interacting with water, and the non-polar tail interacting with triglyceride molecules
- accounted for the formation of the precipitate and complex ion, and impacts of hydrochloric acid, using balanced equilibrium equations and equilibrium principles
- calculated the correct volume required for equivalence, and the three pH values identified in the titration, with a clear account of the assumptions made.

- Understood that indicators were acid-base conjugate pairs, and relate this to protonation / deprotonation and the colours observed during a titration
- could account for the pH range of the indicator being + / –1 of the pK_a of the indicator, and relate this to the equivalence point of the titration curve to justify the indicator being inappropriate
- calculated the amount of energy released in the thermochemical reaction
- provided logical reasons for the differences in formation energy of an ionic solid and a molecular gas by comparing the attractions formed or broken in the process
- justified propanone, with reference to multiple aspects of spectroscopic data, and elimination of propanal based on symmetry and carbon bonding environments
- were able to solve the identity of the organic compounds in the scheme using the information provided
- drew clear and precise structures for the organic molecules in the scheme, using expanded, or condensed, structural formulae, and identified the two reagents required
- explained the changes occurring to the system and surroundings entropy, and total entropy, in both the dissolving and precipitation processes, with clear links to the evaporation of water being the key factor in the spontaneity of the precipitation process.

Candidates who were awarded **Scholarship** commonly:

- accounted for the spontaneity of an electrochemical process with support of most of: balanced equations, observations, cell potential calculations, and direction of electron flow
- accounted for the gradient of the line within section B-C or D-E with consideration of the exothermic bond formation balancing out with the energy being removed from the sample, or the lack of changes to the kinetic energy of particles during this time
- related the formation of new intermolecular attractions, or increasing network of attractions, to the different lengths of sections B-C and D-E
- identified that section C-D had the data needed to determine the specific heat capacity of the liquid

- calculated the percentage of silver in the alloy, and stated that the alloy does not meet the sterling silver standard.
- drew structures for two different triglycerides, which met the criteria outlined in the question
- compared the shapes of the triglyceride chains, with reference to the impact of a double bond versus the more linear saturated chains, in relation to molecular packing and intermolecular attractions
- identified that polar water will not dissolve the non-polar oil / fat molecules, due to the inability to form strong attractions between the particles
- described interactions between water and triglyceride molecules with the surfactant particles, and how this facilitated mixing and the cleaning process
- accounted for the formation of the precipitate, complex ion, or impact of HCl, using equilibrium equations and logical chemical species
- calculated the correct volume required for equivalence, and most of the pH values in the titration curve correctly, but may have not accounted for the assumptions
- described the pH range of the indicator being + / –1 of the pK_a of the indicator, and related this to the equivalence point of the titration curve to state the indicator was not appropriate
- calculated the enthalpy change for the reaction using a Hess's law approach
- gave a logical reason for the variation in the enthalpy of formation values provided
- identified propanone with reasons linked to spectroscopic data
- accounted for the majority of organic molecules in the scheme provided, but were unable to complete all structures correctly
- accounted for the changes to the entropy of the system and surroundings, and total entropy change, during the dissolving of NaCl in water.

Other candidates

Candidates who were **no**t awarded Scholarship commonly:

- did not answer many parts of the questions

- did not read the questions carefully, missing key aspects, resulting in answers which made little sense
- did not complete the examination, leaving large parts blank and not attempted
- were unable to apply their chemistry knowledge to unfamiliar contexts
- did not identify the correct cell process
- could not describe the observations for common oxidation-reduction species
- could not balance oxidation-reduction half equations
- did not use the electrochemical data provided to identify HCl as the inappropriate acid for the reaction
- did not recognise that the formation of intermolecular forces was exothermic, and stated that energy was being used to form bonds
- described decreases in kinetic energy during the flat parts of the curve
- could not account for the gradient of the cooling curve in different sections
- could not carry out quantitative calculations using provided data
- were unable to draw triglycerides that met the criteria outlined in the question
- were unable to identify valid reasons for variation in the melting points of the different triglycerides
- incorrectly attempted to explain that surfactants were basic, and thus yielded basic hydrolysis of the triglycerides
- could not identify the formation of the copper hydroxide precipitate, ammonia complex ion, or impacts of HCl on the equilibrium reactions
- could not complete a solubility calculation
- were unable to determine the pH values in a titration using the data provided
- could not account for the common assumptions made in pH calculations
- incorrectly described the useful range of the indicator was within + / –1 of the pH of the equivalence point
- were unable to account for the conjugate acid-base nature of the indicator species

- incorrectly stated the indicator would change colour to green at a pH of 7, when hydronium and hydroxide were in equal concentration
- stated the indicator was appropriate for the titration with incorrect reasoning
- were unable to carry out calculations using Hess's law
- tried to carry out calculations using all enthalpy values provided, or treated all enthalpy value as formation enthalpy values and carried out an incorrect calculation
- incorrectly described the bonding in CaO as covalent / intermolecular when accounting for the variation in enthalpy of formation values provided
- were unable to interpret spectroscopic data to correctly identify the identity of the unknown compound
- were unable to draw the structures of organic molecules which met the criteria provided in the question
- used skeletal structures instead of expanded or condensed structural formulae when accounting for the organic molecules
- could not identify correct system or surroundings entropy changes during the processes outlined in the question
- attempted to justify the precipitation of salt on the basis of the room being warmer, and this somehow reversing the prior spontaneous process, with no consideration given to the evaporation of the water / reduction in volume of the solution
- incorrectly tried to use Gibbs free energy to justify that the warming of the room simply altered the direction of the salt dissolution / precipitation equilibrium
- did not recognise that the volume of solution decreasing was related to the evaporation of the water, a positive change in the system entropy in the solution, enabling the precipitation process to be spontaneous
- made errors in the drawing of organic compounds, e.g. 5 bonds around C
- left whole questions blank
- were unable to approach a question with multiple stages or parts
- could not apply Level 3 chemistry understanding to unfamiliar contexts
- could not communicate chemistry knowledge

- did not manage time effectively
- do not appear to have practised past scholarship exam questions
- applied a rote-learned method to a question which required a different approach.

Subject page

Previous years' reports

2021

2020

2019

2018

2017

2016