National Certificate of Educational Achievement

2011 Assessment Report

Chemistry Level 3

90696 Describe oxidation-reduction processes

90698 Describe aspects of organic chemistry

90700 Describe properties of aqueous systems

90780 Describe properties of particles and thermochemical principles

COMMENTARY

Candidates were more successful if they produced accurate drawings, showed all working in a logical order with calculations, and wrote legibly.

As stated in previous years, those candidates with minimal practical experience were disadvantaged. Many candidates could identify the chemicals used in various processes but they were unable to demonstrate adequate knowledge about the purpose of the chemicals, or the function of laboratory equipment used in these processes.

STANDARD REPORTS

90696 Describe oxidation-reduction processes

ACHIEVEMENT

Candidates who were awarded Achievement for this standard demonstrated the required skills and knowledge. They typically:

- could label a diagram of an electrochemical cell and use correct conventions to write a correct cell diagram
- recognised that electrons flowed through the external circuit and ions from the salt bridge to the half-cell
- knew the function of the salt bridge
- could calculate a cell potential, with units
- could write half-equations and correctly balance them
- recognised common colours and observations
- recognised that an oxidant was itself reduced and this was reflected in a decrease of oxidation number
- understood that a higher reduction potential meant that it was easier to reduce/better oxidant
- recognised that a redox couple consisted of 2 species, the oxidised and reduced forms.

NOT ACHIEVED

Candidates who were assessed as Not Achieved for this standard lacked some or all of the skills and knowledge required for the award of Achievement. They typically:

- did not read the information in the question – did not put an arrow to show electron flow and did not read that N^{2+} ions were green
- could not assign oxidation numbers correctly
- did not give units for their E^0_{cell} values
- could not write a standard cell diagram
- did not recognise that a salt bridge completes the circuit
- thought that replacing the voltmeter with a wire reversed the cell reactions
- thought that ions flowed through the wire, electrons through the salt bridge, or that ions flowed from one half-cell to another
- used the term “dissolve” incorrectly, by referring to the decrease in mass of an electrode

- used the term “amphiprotic” incorrectly, to refer to a substance that could be oxidised and reduced.

ACHIEVEMENT WITH MERIT

In addition to the skills and knowledge required for the award of Achievement, candidates who were awarded Achievement with Merit typically:

- could relate correct observations to appropriate species
- could relate observations at the anode and the cathode to electron flow or oxidation numbers
- were able to describe the movement of ions from the salt bridge to the correct half-cell and give reasons
- used gain/loss of electrons to explain oxidation/reduction processes
- explained a disproportionation reaction correctly using E^{o}_{cell} values and/or relative reduction potentials
- could place redox couples in order of decreasing reduction potential and justify this by using balanced equations.

ACHIEVEMENT WITH EXCELLENCE

In addition to the skills and knowledge required for the award of Achievement with Merit, candidates who were awarded Achievement with Excellence typically:

- explained a disproportionation reaction correctly using E^{o}_{cell} values and/or relative reduction potentials to justify their answer and related the answer back to the question (i.e. storage of H_2O_2)
- could place redox couples in order of decreasing reduction potential and justified their answers using balanced equations and oxidation numbers
- could relate correct species to appropriate observations clearly and consistently
- could link the observations of a redox reaction to the process using either oxidation numbers or electron transfer.

90698 Describe aspects of organic chemistry

ACHIEVEMENT

Candidates who were awarded Achievement for this standard demonstrated the required skills and knowledge. They typically:

- named and drew organic structures correctly
- identified functional groups correctly based on experimental evidence
- identified enantiomers and defined them as a molecule with a chiral carbon or as a carbon connected to four different groups of atoms
- identified an amide link and drew one monomer correctly
- recognised that the strength of a nylon rope would decrease if it came into contact with acid
- described a test to distinguish between an amine and an amide
- wrote equations for the formation of amides and amines, including the organic products and reagents.

NOT ACHIEVED

Candidates who were assessed as Not Achieved for this standard lacked some or all of the skills and knowledge required for the award of Achievement. They typically:

- drew structures with 5 bonds on a carbon atom
- drew structures with missing hydrogen atoms
- confused potassium permanganate with potassium dichromate
- omitted or incorrectly used the IUPAC numbering system
- omitted the word damp from a description of the test for amines.

ACHIEVEMENT WITH MERIT

In addition to the skills and knowledge required for the award of Achievement, candidates who were awarded Achievement with Merit typically:

- justified the identification of particular functional groups in substances, given observations from various reactions
- identified an enantiomer and justified their choice
- drew both monomers correctly given a segment of the polymer
- explained the effect of acid hydrolysis on the strength of nylon rope and gave the organic product
- gave one reason for the use of refluxing.

ACHIEVEMENT WITH EXCELLENCE

In addition to the skills and knowledge required for the award of Achievement with Merit, candidates who were awarded Achievement with Excellence typically:

- discussed acid hydrolysis of nylon rope and described changes to the properties of the rope, included a drawing of the salt produced
- wrote fully balanced equations for the formation of both an amide and an amine
- understood the importance of water in using litmus as a test to distinguish between an amine and an amide
- demonstrated an understanding of the importance of using reflux to increase the rate of a reaction, and to prevent loss of volatile reactants/products
- completed a reaction scheme linking organic compounds with appropriate reagents and conditions
- understood when a reagent required aqueous or alcoholic conditions.

OTHER COMMENTS

Candidates were more successful if they took care when drawing organic structures. Care was demonstrated when candidates showed the connectivity of atoms by bonds correctly, e.g. showing the O of an OH group connected to a C atom, rather than the H atom being connected.

Some candidates drew structures without H atoms.

As mentioned in previous years successful candidates realised that organic liquids are not aqueous until water is added, or that water is required for the litmus test, hence the requirement of damp litmus.

Successful candidates understood the concept that not all organic reactions go through to completion.

Some candidates had memorised a detailed reaction scheme of all the reactions covered in Level 3 Chemistry course, yet to be successful needed to apply the information to the question being asked.

90700 Describe properties of aqueous systems

ACHIEVEMENT

Candidates who were awarded Achievement for this standard demonstrated the required skills and knowledge. They typically:

- identified weak acids and bases
- converted pK_a values to K_a and pH values to $[H_3O^+]$
- linked rising pH to increasing $[OH^-]$
- identified the characteristics and function of a buffer system
- wrote equations for acids and bases reacting with water
- performed single step calculations correctly
- identified the species present when a salt dissolves
- wrote an equation correctly for the equilibrium present in a saturated solution and from this, generated a K_s expression
- identified the effect a common ion would have on the solubility of a salt.

NOT ACHIEVED

Candidates who were assessed as Not Achieved for this standard lacked some or all of the skills and knowledge required for the award of Achievement. They typically:

- lacked the ability to write chemical equations/formulae for a given situation
- described features of acid-base titrations incorrectly
- incorrectly used one way arrows in an equilibrium equation
- confused weak acids and bases and were unable to distinguish between them
- did not recognise pH changes in terms of changing $[OH^-]$
- were unable to write a K_a expression in the correct form e.g. included solids and/or water
- failed to acknowledge that a neutralisation reaction had produced new species, and suggested that the original acid and base were present in equal concentrations at equivalence point
- lacked knowledge of the ions present when a salt dissolves.

ACHIEVEMENT WITH MERIT

In addition to the skills and knowledge required for the award of Achievement, candidates who were awarded Achievement with Merit typically:

- wrote equations competently for the aqueous equilibria that are established between weak acids/bases and water
- explained the different concentrations of all species present in weak acid/base equilibria
- recognised factors that affect the equilibrium in solutions of marginally soluble ionic solids and explained the effects in terms of common ions or ionic product

- recognised the significance of the midpoint of an acid-base titration together with the endpoint, and explained the presence and concentration of most species present at each point
- showed correctly how weak/strong acid/bases react with water and then linked this to the species present in solution, but lacked a complete explanation for the relative concentrations of all of the ions
- performed multiple step calculations and linked obtained answers to the chemistry they described
- were able to calculate the solubility of a sparingly soluble ionic compound given a K_s value.

ACHIEVEMENT WITH EXCELLENCE

In addition to the skills and knowledge required for the award of Achievement with Merit, candidates who were awarded Achievement with Excellence typically:

- discussed the relative concentrations of all species present when a weak acid and a weak base formed an aqueous equilibrium
- wrote and re-arranged expressions for K_s and K_a, and accurately calculated unknowns from these. Calculations were accurate to 3 significant figures
- discussed how the formation of a complex ion must be considered in a situation with a high pH on selected metal hydroxides as opposed to restricting the discussion to one of common ion effect
- used equations in explanation of key features on a titration curve for the titration of a weak acid/strong base, including the concentrations of species present both at the mid-point of the titration and the end point
- linked the K_a expression to the pK_a of the acid and hence to the pH at the midpoint of the buffer zone
- answered in coherent sentences and used equations correctly to illustrate understanding
- calculated the number of moles of a salt required to be added to a particular volume of an acid to give a buffer of a particular pH
- showed a thorough understanding of buffer action including equations showing buffer action.

OTHER COMMENTS

Successful candidates set out their calculations tidily and were less likely to become confused, and therefore less likely to create errors in their working.

Some candidates were unable to recognise the acid-base nature of substances, especially HF. Explanation of species present in solution often did not match the description of NH_3 or HF that a candidate had previously given. Many candidates changed answers to HF from strong acid to weak acid, possibly after reading its pK_a value.

Only a few candidates recognised the possibility of complex ion formation in Question 2(c).

Some candidates did not recognise the dissociation of water and/or refer to K_w and its significance in Question 1.

90780 Describe properties of particles and thermochemical principles

ACHIEVEMENT

Candidates who were awarded Achievement for this standard demonstrated the required skills and knowledge. They typically:

- wrote electron configuration in *s, p, d, f* format for atoms
- could explain the size difference between atoms and ions
- could interpret information from a graph
- drew Lewis diagrams of molecules with more than 4 pairs of electrons around the central atom
- gave limited responses of the polarity of molecules
- could recall equations for use in thermochemical calculations
- knew what different ΔH expressions were
- could recall some information about intermolecular bonding and its effect on boiling point.

NOT ACHIEVED

Candidates who were assessed as Not Achieved for this standard lacked some or all of the skills and knowledge required for the award of Achievement. They typically:

- used energy Level number format for electron configuration or used incorrect conventions for electron configurations
- could not explain periodic concept
- did not count valence electron correctly for Lewis diagrams or recall molecule shapes
- were confused as to the meaning of different ΔH expressions
- confused intermolecular bonding (particularly hydrogen bonding) with intramolecular bonding
- did not show working in calculations.

ACHIEVEMENT WITH MERIT

In addition to the skills and knowledge required for the award of Achievement, candidates who were awarded Achievement with Merit typically:

- wrote electron configurations for atoms and ions using the correct conventions
- could use electron configurations to explain periodic properties
- could draw correct Lewis diagrams and use these to predict shape and polarity of molecules with 5 and 6 pairs of electrons around the central atom
- manipulated equations correctly to calculate $\Delta_r H$
- understood the difference between the various ΔH expressions
- discussed the relationship between intermolecular bonding and boiling point of the hydrides of Group 16
- showed correct working in calculations.

ACHIEVEMENT WITH EXCELLENCE

In addition to the skills and knowledge required for the award of Achievement with Merit, candidates who were awarded Achievement with Excellence typically:

- justified the differences in the size of both atoms and ions, and the trends in ionisation energy using the correct vocabulary and illustrating their answers using electron arrangement
- could explain the anomalies in the trends of ionisation energy by comparing electron configurations
- could give a complete, coherent and accurate explanation for the differences in boiling point of the group 16 hydrides, and relate this to the energy needed to separate the molecules
- could use bond energy data to correctly calculate the heat of combustion of methanol and give the correct units
- could use Hess's Law to prove the value of the heat of combustion of propene by giving correct equations and clearly showing how these equations were manipulated.

OTHER COMMENTS

Successful candidates were able to write electron configurations correctly, using lower case letters, showing energy level numbers with all orbitals present, and showing electron numbers as superscripts.

Candidates who were careful when drawing Lewis diagrams, showing each electron dot in distinct pairs, and used either a line or dots, but not together, for each bonding pair, were more successful.

There was sometimes confusion as to what a hydrogen bond was. Some referred to it as the bond between the O and H in a molecule.

Successful candidates who set out their calculations tidily were less likely to become confused and therefore less likely to create errors in their working.