

Assessment Report

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Part A: Commentary

Candidates who achieved Excellence generally used Chemistry vocabulary with confidence and precision and provided concise explanations. Candidates need to be careful that they do not round their answers until the last step of a multi-step calculation. Some candidates need more practice with problem-solving style questions. Candidates should ensure they familiarise themselves with problem-solving style questions from recent examination papers.

Part B: Report on standards

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

Examination



The examination included three questions of which candidates were required to respond to all three. Question One required candidates to apply their understanding of Lewis structures, naming shapes, how entropy changes affect the spontaneity of a reaction, and the enthalpy change involved in dissolving a salt. Question Two assessed the ability of candidates to explain periodic trends in atomic radius and electronegativity and use Hess' law to determine an enthalpy change.

Question Three required candidates to demonstrate their knowledge of the effect of the relative strength of intermolecular forces upon the standard enthalpy of vaporisation for selected molecules, and explain the factors affecting shape and polarity.

The questions covered the requirements of the 2021 assessment specification to demonstrate understanding of thermochemical principles and the properties of particles and substances.

Observations

Candidates should read the questions carefully and only answer what is required. For example, if a question is focused on the trend across a period, then an explanation of the trend down a group is irrelevant.

When discussing intermolecular forces, candidates should state the type of intermolecular force rather than simply referring to bonds/forces, and also clearly indicate that intermolecular forces are attractions between molecules rather than within a molecule. Multi-step calculations should be rounded to the appropriate number of significant figures, generally three, at the end of the calculation rather than after each step to ensure the final answer is accurate.

Grade awarding

Candidates who were awarded **Achievement** commonly:

- completed at least one relevant step of a calculation
- wrote electron configurations using s, p, d notation
- drew Lewis structures
- named molecular shapes
- identified relevant intermolecular forces
- described the factors affecting atomic radii and/or electronegativity

- identified some factors affecting the shape and/or polarity of a molecule.

Candidates whose work was assessed as **Not Achieved** commonly:

- could not identify appropriate attractive forces between particles
- could not calculate enthalpy changes
- could not interpret the information presented in a heating curve
- confused entropy with enthalpy
- could not draw Lewis diagrams or identify molecular shapes
- could not identify the factors affecting molecular shape or polarity.

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

- compared the strength of intermolecular forces between molecules
- distinguished between intramolecular forces and intermolecular forces, and understood which of these is related to changes of state
- explained the entropy changes in the system and/or surroundings for a reaction
- justified the shape of a molecule
- linked the decrease in atomic radius across a period to the increasing number of protons
- completed calculations but often with errors in units and/or significant figures.

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

- explained both the change in entropy of the system and the surroundings, as well as their relative sizes, in determining the spontaneity of a reaction
- completed calculations with appropriate units and significant figures
- explained the decrease in atomic radius across a period in terms of both the number of protons and repulsion from inner energy levels
- justified why fluorine is the most electronegative element
- clearly explained the differing standard enthalpies of vaporisation of selected molecules in terms of the relevant strength of their intermolecular forces

- related the polarity of a molecule to the size and arrangement of the bond dipoles.
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91391: Demonstrate understanding of the properties of organic compounds

Examination

Question One required candidates to draw structural isomers based upon chemical and/or physical properties and explain how different organic products can be obtained using distillation and heating under reflux.

Question Two assessed the ability of candidates to select appropriate reagents to distinguish organic molecules, as well as synthesize a specified organic molecule in several steps from a starting organic molecule.

Question Three required candidates to demonstrate their knowledge of enantiomers, reaction pathways, and the hydrolysis of a polyester.

The questions covered the requirements of the 2021 assessment specification to demonstrate understanding of the properties of organic molecules.

Observations

To be successful in this standard, candidates need to be able to select appropriate reagents and conditions to both change from one functional group to another (often involving several intermediate steps) and identify functional groups. Many candidates struggled to demonstrate their understanding of hydrolysis reactions. Candidates should focus on splitting the functional group with water and adding an -OH and an -H to produce two new functional groups. When drawing structural formulae, candidates should consider carefully which atoms are bonded to each other. For example, the -OH group bonds to a carbon atom through the oxygen atom rather than the hydrogen atom.

Grade awarding

Candidates who were awarded **Achievement** commonly:

- named simple organic molecules
 - drew a straight-chain isomer using multiple pieces of information
 - described the process of distillation
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- understood a primary alcohol can be oxidised to either an aldehyde and/or a carboxylic acid
- selected appropriate reagents for distinguishing organic molecules, including the resulting observations
- completed one or two steps in a chemical synthesis
- drew the tetrahedral arrangement of enantiomers recognised that enantiomers rotate plane polarised light
- identified an ester linkage in a polyester
- defined a hydrolysis reaction and drew a relevant product.

Candidates whose work was assessed as **Not Achieved** commonly:

- did not differentiate distillation and heating under reflux
- used incorrect reagents to distinguish organic molecules
- stated that enantiomers rotate in the plane polarised light
- stated that water was eliminated rather than required in a hydrolysis reaction
- did not draw an amide/peptide linkage
- did not attempt most questions.

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

- drew structural formulae of isomers based upon a molecular formula and chemical and/or physical properties
- explained how distillation and heating under reflux could be used to obtain the different products of primary alcohol oxidation
- linked reagents and observations to reaction type and organic product when distinguishing organic functional groups
- drew both dipeptides formed between two amino acids
- completed a full synthetic pathway with minor errors/omissions
- drew enantiomers and explained how to distinguish them
- linked the hydrolysis of a polyester to the required reagents and products.

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

- drew structural formulae of multiple isomers given a molecular formula and chemical/physical properties
 - fully linked the process of distillation and heating under reflux to their use in synthesising aldehydes and carboxylic acids
 - accurately distinguished organic compounds with correct reagents, observations, reaction types, and organic products
 - completed synthetic pathways with reagents and conditions
 - fully explained the hydrolysis of a polyester with reference to required reagents, conditions, and structural formulae of products.
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91392: Demonstrate understanding of equilibrium principles in aqueous systems

Examination

The examination included three questions of which candidates were required to respond to all three. Question One required candidates to calculate the solubility of a sparingly soluble solid, explain the effect of a common ion on solubility, and predict whether a precipitate will form when two solutions are mixed. Question Two assessed the ability of candidates to explain how buffers function, and to compare the pH and electrical conductivity of two weakly acidic solutions. Question Three provided candidates with a selection of both calculation and explanation-style questions in the context of a titration curve.

The questions covered the requirements of the 2021 assessment specification to demonstrate understanding of equilibrium principles in aqueous systems.

Observations

Many candidates did not make the link between the calculated solubility of $\text{Mg}(\text{OH})_2$ and the concentrations of Mg^{2+} ions and OH^- ions. Candidates should refer to the solubility and the mole ratios in the equilibrium equation to determine these concentrations. Candidates should clearly indicate the relevant species to which each step of a calculation pertains to ensure recognition can be given for correct steps in a multi-step calculation. When explaining the function and properties of a buffer solution, candidates should refer to the relative

concentrations of weak acid and conjugate base rather than the concentrations of hydronium and hydroxide ions. It is the ratio of weak acid to conjugate base that determines the pH and effectiveness of a buffer solution. Many candidates assumed that the weak acid with the lowest pH would be a better electrical conductor. However, candidates need to recognise that although acidic salts are weak, they completely dissociate to produce a high concentration of ions.

Grade awarding

Candidates who were awarded **Achievement** commonly:

- wrote both the equation and the K_s expression for the equilibrium occurring in a saturated solution
- calculated the solubility of magnesium hydroxide
- identified the presence of a common ion
- predicted precipitation by comparing Q_s with K_s
- recognised a buffer solution resists a change in pH
- stated that the presence of ions in a solution enables it to conduct electricity
- labelled the equivalence point on the titration curve
- identified an appropriate indicator for an acid-base titration.

Candidates whose work was assessed as **Not Achieved** commonly:

- included solid $Mg(OH)_2$ in the K_s expression
- did not calculate solubility for an AB_2 type solid
- explained incorrectly that dilution does not affect the pH of a buffer since water is neutral
- referred to charged particles rather than ions as the requirement for a solution to conduct electricity
- confused pK_a with pH
- included Na^+ ions as a species present in propanoic acid
- left most questions unattempted.

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

- used equilibrium principles to explain how a system at equilibrium would respond on addition of a common ion
- used the correct process to calculate whether a precipitate will form after two solutions are mixed
- explained how a buffer resists a change in pH on addition of a strong base
- explained the difference in electrical conductivity of solutions of a weak acid and an acidic salt
- understood that the pKa of an indicator gives the range over which it changes colour and the need for the equivalence point to fall within this range
- calculated the pH of a basic solution at the equivalence point.

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

- showed clearly the steps of a calculation, with correct units and number of significant figures
- determined, by calculation, whether a precipitate would form after two solutions are mixed
- explained that the relative concentrations of buffer components are responsible for the pH of the buffer solution
- compared the pH of solutions of a weak acid and an acidic salt based on pKa values, with support from relevant equations
- calculated the pH after NaOH solution has been added past the equivalence point of a titration
- explained that dilution of NaOH solution affects its pH.

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[2018 \(PDF, 127KB\)](#)

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