THE REPUBLIC OF UGANDA
Ministry of Education and Sports

ADVANCED SECONDARY CURRICULUM

CHEMISTRY ASSESSMENT GUIDELINES

NCDC
NATIONAL CURRICULUM DEVELOPMENT CENTRE

2026

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NCDC takes responsibility for any shortcomings that might be identified in this publication and welcomes suggestions for effectively addressing the inadequacies. Such comments and suggestions may be communicated to NCDC through P. O Box 7002, Kampala, or Email: admin@ncdc.go.ug or on the Website: www.ncdc.go.ug

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1. Introduction

This assessment guidelines document has been developed as a companion to the Assessment Framework for Advanced Secondary Curriculum and should be read and applied in conjunction with it. The Framework provides the overarching principles, standards, and requirements for assessment across all subjects, while this guideline contextualises those provisions to the specific demands and practices of Chemistry as a subject.

The assessment of Chemistry will be guided by four assessment objectives drawn from the four assessment constructs. The assessment items will be set at the level of the construct allowing learners to integrate knowledge skills and values drawn from the topics within a construct in order to address a societal challenge or problem. The end-of-cycle assessment of Chemistry will be administered by the Uganda National Examinations Board (UNEB). Assessment of Chemistry at the school level will be formative and summative.

1.1 Assessment Objectives

Assessment objective (AO) for Chemistry focus on the learner's ability to:

AO1: Demonstrate understanding of atomic and molecular structures, periodic trends and patterns of chemical reactivity across the Periodic Table.

AO2: Analyse the structure, reactivity, and transformation pathways of organic compounds to predict chemical behaviour, explain natural processes, and propose solutions in real-world and innovative chemical contexts.

AO3: Apply the principles of thermochemistry, electrochemistry, and reaction kinetics to explain, predict, and control chemical processes by relating energy changes, electron transfer, and the rate of reaction in real-life and industrial contexts.

AO4: Apply quantitative chemical principles to analyse, model and predict the amounts of substances, principles of chemical and physical equilibria to interpret, predict and evaluate the behaviour of chemical systems in industrial and real-world contexts.

1.2 Linkage Between Assessment Objectives, Constructs and Syllabus

The table below shows a linkage between the assessment objectives, the constructs and the topics that contribute to the construct.

Table 1:

Table showing relationship between assessment objectives, constructs and the topics in the syllabus

Assessment Objective	Construct	Construct Description	Topics in the Syllabus
AO1	Foundations of atomic structure, bonding and periodicity of elements	Applying knowledge of atomic and molecular structures to interpret periodic trends and chemical reactivity	2. Atomic and electronic structure 3. Bonding and structure 4. Periodicity I 11. Periodicity II
AO2	Structure, reactivity and applications of organic molecules	Explore, predict, and apply the structure, reactivity, and transformation pathways of organic compounds to explain natural processes and support innovation in real-world chemical contexts	6. Organic chemistry 1 9. Organic chemistry II 12.Organic chemistry III

AO3	Thermochemistry, Electrochemistry and Reaction Kinetics	Apply the principles of thermochemistry, electrochemistry, and reaction kinetics to explain, predict, and control chemical processes by relating energy changes, electron transfer, and the rate of reaction in real-life and industrial contexts.	5. Thermochemistry 10. Electrochemistry 13. Reaction Kinetics
AO4	Stoichiometry, Chemical Equilibria Systems	Apply quantitative chemical principles to analyse, model and predict the amounts of substances, principles of chemical and physical equilibria to interpret, predict and evaluate the behaviour of chemical systems in industrial and real-world contexts.	1. Moles and equations 7. Equilibria I 8. Equilibria II

2. Table of Constructs

The table below details the constructs for Chemistry i.e. the competencies/learning outcomes that make up the construct, the expected learner abilities and what assessors should look out for in the learner's work as evidence of achievement of the intended learning outcomes (indicators of mastery).

Construct	Learning Outcomes The learner should be able to:	Abilities The learner is able to:	Indicators of Mastery The learner:	Level of Complexity
FOUNDATIONS OF ATOMIC STRUCTURE, BONDING AND PERIODICITY OF ELEMENTS. Applying knowledge of atomic and molecular structures to interpret periodic trends and chemical reactivity	1) deduce electronic configurations, evaluates their implications for chemical properties and bonding, and synthesises models to predict atomic behaviour in various contexts. 2) analyse the types of chemical bonds and molecular structures, and relates them to the properties and uses of substances in real-life contexts.	a) apply the Aufbau principle, Pauli exclusion principle, and Hund's rule. b) deduce electronic configurations of atoms and ions. c) use electronic configurations to predict reactivity. d) examine the nature and types of radioactive decay.	i) writes electronic configurations for elements across the periodic table. ii) explains how electronic configurations influence chemical properties and types of bonding. iii) recognises types of radioactive decay and their properties.	2-High

	3) analyse the trends and periodic properties of elements, to explain and predict the reactivity and properties of elements in the Periodic Table. 4) analyse the trends in the physical and chemical properties of Group 14 elements, Group 17 elements and d-block elements and relates these trends to their applications in industrial and environmental contexts.	e) apply this knowledge to predict decay rates and half-lives in specific elements. f) evaluate the principles of radioactivity in real-life applications, such as in medicine, industry, and environmental science. g) evaluate the associated health, environmental, and ethical implications of radioactive materials.	iv) explains how factors affecting nuclear stability can be used to predict atomic behaviour. v) explains specific applications of radioactivity in different fields. vi) explains benefits and limitations of radioactivity. vii) assesses the health, environmental and ethical implications of using radioactive materials in real-world contexts assessed. viii) constructs models to represent atomic structure and bonding.	3. High 4-High

		h) justify the formation of ionic and metallic bonds based on electron transfer and electrostatic forces. i) evaluate the properties of ionic and metallic compounds in relation to bond strength and structural composition. j) analyse the formation of covalent bonds including dative covalence.	ix) relates the behaviour of compounds in different chemical contexts. x) differentiates between ionic, covalent, and metallic bonds using examples of substances. xi) models molecular shapes using VSEPR theory and explains how molecular geometry affects physical properties (e.g., polarity, boiling point).	11-High

		k) explain molecular structures by applying VSEPR theory to predict molecular shapes and bond angles. l) analyse the polarity of molecules based on molecular structure and electron distribution. m) analyse periodic trends and electronic structure. n) interpret and analyse periodic data for trends in properties of elements in the periodic table.	xii) explains how bonding types and structures are related to properties such as solubility, conductivity, and hardness in real-world materials (e.g., graphite vs. diamond). xiii) relates use of particular materials is to their bonding and molecular structure. xiv) explains trends in atomic radius, ionization energy, electronegativity, and metallic character across periods and down groups.	

		o) evaluate the properties of elements in the periodic table across the period and down the groups. p) apply knowledge of element chemical and physical properties in real-world situations.	xv) interprets data on periodic properties of elements in the periodic table. xvi) compares reactivity of elements based on their position in the Periodic Table, particularly within groups such as alkali metals and halogens. xvii) compares chemical behaviour of elements from different groups and periods using trend data.	

			xviii) applies periodic trends to justify selection of elements for specific functions or reactions (e.g., selecting catalysts or reducing agents). xix) explains the physical and chemical properties (e.g., melting points, reactivity, oxidation states) of elements within Group 14, Group 17, and the d-block. xx) explains the environmental or industrial relevance of these elements	

			(e.g., halogens in water purification, transition metals in catalysts). xxi) recognises progressive changes in properties within each group or block and relating them to their electron configurations. xxii) evaluates advantages and limitations of using specific elements from the groups in industrial applications (e.g., silicon in semiconductors, platinum in catalytic converters).	

STRUCTURE, REACTIVITY AND APPLICATIONS OF ORGANIC MOLECULES Explore, predict, and apply the structure, reactivity, and transformation pathways of organic compounds to explain natural processes and support innovation in real-world chemical contexts	1) analyse the structures, functional groups, and reactivity of organic compounds, and applies knowledge of organic reactions and organic reaction mechanisms to synthesise organic molecules. 2) analyse reaction mechanisms, evaluates reaction pathways and conditions, and designs multi-step syntheses to achieve target compounds (considering alcohols, phenols, carbonyl compounds).	a) analyse structures of organic compounds. b) predict reactivity of organic compounds. c) explain transformation pathways of organic reactions. d) apply the knowledge of structure and reactivity to synthesis. e) carry out projects relating natural processes in real-world chemical contexts to societal problems.	i) recognising functional groups and compound types in organic molecules, including alcohols, phenols, carbonyls, amines, and polymers. ii) predicting products of organic reactions predicted by applying knowledge of reaction types, functional group behaviour, and principles of writing reaction mechanisms. iii) writes reaction mechanisms, using appropriate conventions (e.g., curved arrows) to show electron movement and intermediates.	6-High 9-High 12- High

	3) analyse the chemical properties, industrial applications, and environmental impacts of amines and polymers, evaluates their social and ecological implications, and proposes innovations and sustainable solutions for addressing challenges in their use and disposal.		iv) designs logical multi-step synthetic pathways to produce target organic compounds, justifying reagent selection and reaction conditions. v) explains real-world applications of organic compounds (e.g., pharmaceuticals, plastics, industrial chemicals) and their impacts on health, society, and the environment. vi) proposes sustainable and innovative solutions for reducing environmental harm	

			from the use and disposal of organic compounds, particularly polymers and industrial chemicals.	
MOLECULAR INTERACTIONS AND SYSTEMS DYNAMICS Apply fundamental physical and chemical principles to interpret, model, and predict the behaviour of chemical systems and their transformations under varying conditions	1) analyse stoichiometric relationships, evaluates experimental methods, and synthesises solutions to complex chemical problems. 2) analyse and evaluate thermodynamic principles and processes to predict the spontaneity and feasibility of chemical reactions and processes.	a) perform stoichiometric analysis. b) interpret experimental data. c) solve quantitative chemical problems. d) apply analytical principles to solve real-world problems. e) construct and analyse energy profile diagrams.	i) calculates quantities of reactants and products using mole ratios in different contexts. ii) designs and performs stoichiometric experiments. iii) analyses experimental data to draw valid conclusions.	1-High 5-High

	3) analyse principles of chemical equilibrium and applies them to explain and solve problems related to industrial processes, ionic equilibria, buffer systems, and solubility equilibria in various chemical and real-world contexts.	f) apply Hess's law in multistep chemical reactions. g) use thermochemical equations to solve enthalpy problems. h) predict phase changes using knowledge of physical equilibria.	iv) solves chemical problems involving stoichiometry in real-life situations such as food preservation and water purification. v) constructs and interprets energy profile diagrams for exothermic and endothermic reactions. vi) uses thermochemical principles to analyse and solve enthalpy related problems. vii) carries out projects to solve real-life problems involving energy changes.	7-High

MOLECULAR INTERACTIONS AND SYSTEMS DYNAMICS Apply fundamental physical and chemical principles to interpret, model, and predict the behaviour of chemical systems and their transformations under varying conditions	4) apply principles of physical equilibria and colligative properties to analyse and predict changes in physical systems, including phase transitions and effects of solute concentration on solution behaviour, in scientific and real-world contexts. 5) analyse redox reactions, electrochemical processes and electrochemical cells, applies the principles of electrode potentials to predict reaction spontaneity and electrolysis outcomes.	i) analyse colligative properties based on solute concentration. j) apply Le Chatelier's principle to predict equilibrium shifts. k) solve equilibrium problems involving Kc and Kp. l) solves quantitative problems involving pH and buffer capacity. m) solve problems involving redox equation and EMF of cells.	viii) explains phase transitions using principles of physical equilibria. ix) performs experiments to investigate effects of solute concentrations on colligative properties. x) applies theoretical principles of physical equilibria to predict changes in real world systems. xi) analyses and interprets scientific data on solution behaviour in different physical conditions.	8-Moderate

	6) evaluate factors influencing reaction rates, and apply the principles of reaction, mechanisms and rate laws to predict the speed of chemical reactions under various conditions	n) determine reaction rates and propose mechanisms for reactions.	xii) solves quantitative problems involving equilibrium constant (Kc, Kp) calculations and predicts shifts using Le Chatelier's Principle. xiii) explains how changes in temperature, pressure, and concentration affect equilibrium in industrial processes such as the Haber or Contact process. xiv) calculates pH and predicts buffer capacity, and changes in pH upon the addition of acids or bases to buffer systems.	10-High

			xv) balances complex redox reactions in acidic and basic media using the half-reaction method. xvi) calculates standard cell potentials (E°cell) and predicting spontaneity and direction of redox reactions. xvii) determines the amount of products of electrolysis in various electrolytic cells. xviii) explains the industrial applications of redox reactions in batteries, metal extraction, and corrosion control.	13-High

			xix) determines rate laws from experimental data and calculates orders of reaction and rate constants. xx) carries out experiments to investigate the effect of temperature, catalysts, concentration, and surface area on reaction rate using collision theory and activation energy concepts. xxi) proposes plausible reaction mechanisms consistent with experimental rate laws and recognises the rate-determining step.	

3. Structure of the Assessment Papers

There will be two assessment papers for Chemistry at Advanced Secondary Curriculum (ASC). Paper 1 will be divided into two sections, with each section addressing an assessment objective and Paper 2 will be a practical.

Paper 1 (theory paper) will contain two sections A and B. Section A is compulsory and the Items will come from constructs 3 (Stoichiometry, Thermochemistry and Reaction Kinetics) and 4 (Chemical Equilibria and Electrochemical Systems), respectively, addressing assessment objectives 3 and 4, while Section **B** will have two parts. In Part I two items will come from construct 1 (Foundations of Atomic Structure, Bonding and Periodicity of Elements) where the candidate responds to any **ONE** item addressing assessment objective 1. Items of Part II of Section B will come from Construct 2 (Structure, Reactivity and Applications of Organic Molecules) where the candidate responds to any ONE item addressing assessment objective 2. The items in the paper will be scenario-based and the entire paper will take **2 hours: 45 min.**

Paper 2 (practical paper) will contain two compulsory items picked from any of the four constructs. The paper will test science process skills in the four constructs. The entire paper will take of **3hrs:15min.**

Chemistry

Paper I (Theory)
November 2025
Time: 2 hours 45 minutes

UGANDA ADVANCED CERTIFICATE OF EDUCATION

CHEMISTRY

Time: 2 hours 45 minutes

INSTRUCTIONS TO CANDIDATES:

The paper consists of two sections A and B.

Sections A: consists of TWO **Compulsory** items**.**

Section B: consists of two parts 1 and 2 each having two items. Attempt any **ONE** item from each part of section B.

Section A:

Attempt ALL items in this section

ITEM 1: A renewable energy company is producing bioethanol from sugarcane molasses. The bioethanol is used to power rural micro-grids. The process involves fermenting glucose into ethanol and carbon dioxide using yeast, followed by fractional distillation. The following equilibria and thermochemical data are available:

Substance	Equilibrium concentration (mol/L) at 37 °C
Glucose	0.20
Ethanol	0.30
Carbon dioxide	0.30

To optimise yeast activity, the pH must be kept between 4.5 and 5.5. The team proposes using the acetic acid (CH_3COOH) / sodium acetate (CH_3COONa) buffer system (pKa = 4.74), prepared with 0.1 M acetic acid and 8.4 g sodium acetate in a total volume of 1.0 L.

However, current production suffers from low yield, energy inefficiency, and fluctuating reaction rates due to changing environmental conditions. Using 1.5 g of glucose as your starting feedstock, you are required to analyse the process and recommend improvements.

The table below provides additional kinetic data for glucose fermentation:

[Glucose] (mol/L)	[Yeast] (g/L)	Initial Rate (mol/L·min)
0.10	1	0.003
0.20	1	0.006
0.20	2	0.012
0.20	3	0.018

The management of the company has asked your school science club to carry out a pilot project to improve the yield, efficiency, and consistency of the fermentation process.

Task

As a chemistry student and member of the science club:

a) By applying the equilibrium law, predict how continuous removal of CO_2 would influence the ethanol yield.
b) Determine the suitability of the proposed buffer system to maintain optimal yeast activity during fermentation.
c) From the kinetic data, determine the rate constant for fermentation and suggest scientifically sound methods to increase the rate constant.
d) Suggest ways by which the community members can utilise your findings to manage the fermentation process for their own benefit.

ITEM 2: Chemical industries producing dyes, pharmaceuticals, and other products rely on solvents like naphthalene and precise knowledge of molecular characteristics of additives and impurities. At the same time, the local water supply shows signs of contamination, with an unknown solute T affecting the freezing point of water in storage tanks.

The water treatment facility collected the following data on solute T:

Concentration of T ($g\ dm^{-3}$)	0	30	60	90	120	150
Freezing point (°C)	0	-0.16	-0.32	-0.49	-0.65	-0.81

The Cryoscopic constant for water is 1.86 °C per 1000g per mole

The same company is optimizing an industrial reaction:

$A+2B \rightleftharpoons 2C+D \quad \Delta H^{\theta}=-50\ kJ\ mol^{-1}$

Exp No.	[A] (mol/L)	[B] (mol/L)	Initial rate ($mol\ L^{-1}\ min^{-1}$)
I	4.0×10^{-2}	4.0×10^{-2}	6.40×10^{-3}
II	4.0×10^{-2}	8.0×10^{-2}	1.28×10^{-2}
III	8.0×10^{-2}	4.0×10^{-2}	2.56×10^{-2}
IV	8.0×10^{-2}	8.0×10^{-2}	5.12×10^{-2}

The community depends on safe drinking water and efficient chemical production for economic growth. Your chemistry teacher has requested you to analyse the information to help solve these community problems.

Tasks

a) Construct a rate equation for the industrial reaction.
b) Predict the behaviour of the reaction under different conditions of temperature and pressure.
c) Determine the molecular mass of T so that the chemical company can accurately identify additives, ensure product quality and solve the water quality problem.

SECTION B

Part I: Attempt any one item in this part

ITEM 3: Uganda faces persistent challenges in rural electrification. Many communities rely on unreliable and costly energy sources like diesel generators, kerosene lamps, and car batteries. A Ugandan company is developing solar-powered micro-grids and has invited your chemistry class to help identify suitable materials for solar batteries and wiring. These materials must be affordable, corrosion-resistant, and durable under Uganda's rural conditions.

The company is investigating elements similar to those in Periods 2 and 3 of the Periodic Table. The measured properties of selected elements are shown below:

Element	Atomic Radius (pm)	First Ionisation Energy (kJ/mol)	Electronegativity (Pauling)	Typical Bonding Type
Li	145	520	1.0	Metallic
Mg	130	730	1.5	Metallic

Al	110	1000	2.5	Metallic
Si	95	1250	3.0	Covalent
P	85	1500	3.5	Covalent

Task

As a chemistry learner;

Use your understanding of atomic structure, periodic trends, chemical bonding and the information provided to propose suitable materials for solar batteries and wiring in Uganda's rural micro-grid systems

ITEM 4: Your chemistry class has been invited by a chemical plant management near Lake Victoria to assist in identifying ways of optimising the production of key industrial compounds including sodium oxide, magnesium oxide and silicon dioxide used in glassmaking and ceramics. The plant management has observed inconsistencies in melting points and reactivity, which are affecting product quality and safety. You are tasked with conducting a scientific investigation to analyse periodic trends of the elements, compound properties, and molecular structures to recommend improvements.

Important chemical data of the findings about the elements and their compounds is provided in the table below to assist in the analysis.

Element	Atomic Number	Atomic Radius (pm)	Ionisation Energy (kJ/mol)	Melting Point (°C)	Oxide Melting Point (°C)
Sodium (Na)	11	186	496	98	1275
Magnesium (Mg)	12	160	738	650	2800
Aluminium (Al)	13	143	578	660	2072
Silicon (Si)	14	118	786	1410	1710

Phosphorus (P)	15	110	1012	44	580
Sulphur (S)	16	104	1000	115	Gas/Sublimes
Chlorine (Cl)	17	99	1251	-101	Gas/Gas

Task

As a chemistry learner, write a report about the periodic trends of the elements and their oxides, and recommend improvements to the plant's production processes.

Part II: Attempt any one item in this part

ITEM 5: A certain town in central Uganda faces growing concerns over water pollution from agro-processing industries, especially during the cocoa harvest season. Wastewater from cocoa processing plants often contains organic matter including acids, and amines that can harm aquatic life if released untreated.

A group of entrepreneurs is setting up a small plant to process cocoa husks, a by-product of cocoa bean production, into value-added products. Chemical analysis of the husks shows that they contain ethanol (from natural fermentation), ethanoic acid, small amounts of amines (from protein breakdown), and aromatic aldehydes such as vanillin(4-hydroxy-3-methoxybenzaldehyde).

To address the water pollution challenge and create additional revenue streams, the team plans to:

1) Determine the relationship between the structure of vanillin and ethanoic acid, and their solubility.
2) Convert ethanol into amines for use in water treatment and cosmetics.
3) React ethanoic acid with ethanol to produce an ester for fragrances, and study its reaction mechanism.
4) Evaluate the use of the esters and amines in producing fragrances and cosmetics

You have been tasked by your teacher to design feasible chemical processes, explain the underlying organic chemistry, and propose sustainable solutions to help the plant reduce environmental harm while maintaining profitability.

Task

As a chemistry learner, address the plans for the team and propose suitable solutions.

ITEM 6: In southwestern Uganda, a small cosmetics start-up is producing herbal skin-care creams using locally sourced plant oils, such as shea butter and sunflower oil. The production process generates significant amounts of waste plant oils and fats. These wastes are currently disposed of into nearby drainage systems, causing blockages and foul smells, which has led to complaints from the community and environmental authorities.

The company has approached a team of A-level chemistry students in your school to:

1) Analyse the composition of these waste materials, their functional groups and physical properties,
2) Explore possible chemical processes to convert them into valuable products and their mechanisms,
3) Design a synthetic route to convert compound C into compound D
4) Propose a sustainable chemical process to convert waste A into a useful, marketable product that reduces environmental harm.

Analysis of a sample of the waste oil revealed the presence of a mixture of the following compounds:

Compound	Structure (condensed)
A	$CH_3(CH_2)_{14}COOCH_2CH(OH)CH_2OH$
B	$CH_3(CH_2)_7CH{=}CH(CH_2)_7COOH$
C	$CH_3CH_2CH_2OH$
D	CH_3COCH_3

Task

As a chemistry learner, give written presentation that addresses the company's challenges and outlines scientifically sound, sustainable solutions.

Chemistry

Paper II (Practical)

November 2025

Time: 3 hours 15 minutes

UGANDA ADVANCED CERTIFICATE OF EDUCATION

CHEMISTRY

Time: 3 hours 15 minutes

Instruction to Candidates:

The paper consists of two ITEMS. Attempt both questions.

ITEM 1

In an industrial town, a number of small-scale factories near a river have been reported to discharge wastewater containing various chemicals, including hydrochloric acid, into nearby drainage channels. Recently, environmental supervisory body observed milky cloudiness and poor visibility in parts of the river, believed to exist due to chemical reactions.

The supervisory body suspects that the cloudiness could be a result of a reaction between sodium thiosulphate ($Na_2S_2O_3$), commonly used in some textile industries and hydrochloric acid (HCl). The reaction produces elemental sulphur, which appears as a white precipitate and causes turbidity. To understand how this reaction contributes to pollution, it is important to study how varying concentrations of sodium thiosulphate affect the rate of reaction, and thus, the extent of pollution. You have been contacted to give recommendations based on your investigations.

You are provided with the following reagents:

1) FA1 which is0.1M Sodium thiosulphate solution
2) FA2 which is 2M hydrochloric acid
3) Distilled water
4) A variety of laboratory apparatus and materials

Task

Design an experiment to determine the order of reaction with respect to the concentration of sodium thiosulphate in the reaction and write a report of your findings.

ITEM 2

In a certain town, community members have raised concerns about a recent increase in stomach-related illnesses. Investigations by local health authorities linked the issue to the improper handling and storage of water treatment chemicals. A water committee member handed over a solid sample suspected to be part of the treatment residue contaminating drinking water sources.

Your chemistry teacher has brought the sample labelled W from the treatment plant suspected to contain two cations and one anion. You are tasked to systematically investigate and identify the ions present using the reagents provided.

Task:

Design and carry out a systematic investigation to solve the problem and write a report of your findings

3.1 Assessment Rubrics for Sample Items for Chemistry

ITEM 1:

Output	Basis of evaluation	Score 4	Score 3	Score 2	Score 1
A brief pilot-project report proposing and justifying process changes to improve fermentation yield, efficiency, and consistency, supported by measured data and clear recommendations.	a) Determine Kc and explain CO_2 removal effect	i) Correct balanced equation ii) All calculations accurate iii) Correct units iv) Complete explanation of Le' Chatelier's principle and clear prediction of ethanol yield change.	i) Correct balanced equation ii) All calculations correct (minor error in units) iii) Wrong explanation	i) Correct balanced equation ii) Some calculations incorrect with significant arithmetic or conceptual error iii) Incorrect explanation	i) No correct balanced equation ii) Incorrect or no calculation iii) Incorrect or no explanation

	b) Calculate buffer pH and comment on suitability	i) Correct molar mass, ii) Concentration of CH_3COONa, iii) Correct Henderson–Hasselbalch calculation of pH iv) Interpretation of suitability clearly justified.	i) Correct molar mass ii) Correct concentration of CH_3COONa iii) Correct Henderson–Hasselbalch calculation of pH iv) suitability comment not reasonable.	i) Correct molar mass ii) Correct concentration of CH_3COONa iii) Incorrect Henderson–Hasselbalch calculation of pH, iv) suitability comment not reasonable.	i) No or incorrect molar mass ii) Incorrect or no concentration of CH_3COONa iii) Suitability comment missing or irrelevant.
	c) Determine rate constant and suggest improvements	i) Correct rate law application ii) Accurate k calculation with units; iii) At least three scientifically	i) Correct rate law application ii) Accurate k calculation with units iii) At least one scientifically	i) Correct rate law application ii) Accurate k calculation with units iii) No valid method for increasing rate	i) incorrect rate law application ii) Incorrect or no k calculation iii) No valid method to increase rate

		valid, clearly explained methods to increase rate constant.	valid, clearly explained method to increase rate constant.		
	d) Suggest community application of findings	i) At least four realistic, context-specific applications directly linked to findings, ii) Clear benefit to rural bioethanol production.	Three realistic applications, mostly linked to findings.	Two relevant applications but weak connection to findings.	One or no relevant application, poorly connected to findings.

ITEM 2

Output	Basis of evaluation	Score 4	Score 3	Score 2	Score 1
A concise technical report that **(a)** derives the industrial reaction rate equation, **(b)** predicts how rate/equilibrium change with temperature and pressure, and **(c)** calculates the molecular mass of **T** to support additive identification, product quality	a) Rate equation analysis	i) Correctly determines order for both A and B with clear, step-by-step working and correct reasoning ii) Calculates rate constant accurately with correct substitution, units, and shows working iii) writes a fully correct rate equation with correct powers.	i) Correctly determines orders for both A and B but with minimal explanation. ii) Calculates rate constant correctly but omits units or minor working steps iii) Writes correct powers in the rate equation but omits or misstates units.	i) Correctly determines one order but misstates or omits the other. ii) Shows correct method for rate constant but has arithmetic or unit errors iii) Rate equation structure partly correct, but with one wrong power.	i) No attempts or attempts determination but with conceptual or calculation errors for both orders ii) Incorrect or no application of formula for rate equation. iii) Incorrect or no equation form.

control, and safe drinking-water decisions.	b) Effect of conditions	i) Fully explains effect of temperature on rate by linking kinetic energy, collision frequency, and activation energy. ii) Fully explains equilibrium shift direction using ΔH and Le Châtelier's principle iii) Correctly explains no change in equilibrium position with pressure change due to Δn = 0.	i) Correctly states temperature increases rate with brief reasoning ii) Gives correct equilibrium shift with partial explanation iii) States no change in equilibrium with brief explanation.	i) States effects correctly but without scientific reasoning ii) Gives correct equilibrium shift direction without explanation iii) States no change in equilibrium without explanation.	i) Incorrect or incomplete or no statements for temperature or equilibrium effects ii) Incorrect statement about pressure effect.

	c) Molecular mass from freezing point	i) Draws accurate graph with correct title, labelled axes, proper scale, and straight best-fit line ii) Calculates slope accurately using triangle method with correct units iii) Correctly uses slope and K_f to compute MM with correct units.	i) Graph mostly correct but with minor scale or line errors ii) Correct slope with small arithmetic error iii) Correct formula for MM, but minor arithmetic/unit error.	i) Graph drawn but missing one major element (title, labels, or best-fit line) ii) Method for slope correct but value largely inaccurate iii) Method for MM attempted but incorrect substitution.	i) No graph or graph present but incorrectly plotted or with wrong line ii) No or Incorrect slope method iii) Incorrect MM method with value far from expected.

ITEM3

Output	Basis of evaluation	Score 4	Score 3	Score 2	Score 1
A brief technical justification recommending suitable **solar battery materials** and **micro-grid wiring conductors/insulators** for rural Uganda, based on **atomic structure, periodic trends, and bonding**, using the	a) Relate trends in ionization energy and atomic radius to periodic table positions	i) Correctly states both trends ii) Accurately explains both trends with clear reasoning linked to nuclear charge and shielding iii) Correctly identifies all periodic positions.	i) Correctly states both trends ii) Partially explains both trends with correct reasoning iii) Correct periodic positions.	i) Correctly states both trends ii) Incorrect reasoning incomplete or partially correct iii) Correctly identifies at least half of positions.	i) No correct trends or correctly states both trends or correctly identifies at least half of positions. ii) Incorrect reasoning incomplete or partially correct or no reasoning.

provided information.	b) Using equations, discuss reactions with air, water, and acids and influence on use	i) Writes correct equations for all relevant reactions ii) Accurately describes reactivity differences iii) Clearly links to uses to all elements	i) Writes correct equations for all relevant reactions ii) Accurately describes reactivity differences iii) Links reactivity to uses for most elements with reasonable justification	i) Writes correct equations for at least half the reactions ii) Partial reactivity explanation iii) No clear linkage of reactivity to uses	i) Few or no correct equations; ii) Minimal or no meaningful explanation iii) Weak or no link to uses.
	c) Explain how bonding and structure determine real-life applications	i) Correctly explains bonding type and structure for each element	i) Correctly explains bonding and structure for most elements	i) Correctly explains bonding and structure for some elements	i) No or minimal bonding/structure explanation

		ii) Accurately links structure and bonding to specific real-life applications.	ii) Accurately links structure and bonding to specific real-life applications for most elements	ii) Linkage of structure and bonding to application inaccurate, vague or partially relevant.	ii) Little or no application connection.

ITEM 4

Output	Basis of evaluation	Score 4	Score 3	Score 2	Score 1
Structured technical report explaining periodic trends and oxide properties, applying them to the plant's process context, and presenting 3–5 scientifically justified recommendations to improve production efficiency, quality, and safety.	Understanding of Periodic Trends	Accurately explains the trend in atomic radius and ionisation energy and connects it to reactivity.	Accurately explains both trends clearly with relevant connections to reactivity for one of the properties.	Explains both trends, but does not clearly link them to reactivity.	States the trends with vague or inadequate explanations
	Analysis of Compound Properties	Thorough comparison of melting points and bonding types with accurate chemical reasoning.	Good comparison with mostly accurate explanations of bonding and melting points.	Basic comparison; some inaccuracies in bonding or melting point analysis.	Inaccurate or limited comparison; explanations are vague or partially incorrect.

	Explanation of Molecular Structure	Detailed and accurate description of silicon dioxide's structure, bonding, and industrial relevance.	Clear explanation of structure and bonding with relevant industrial links.	Basic description; some relevant points about structure and use.	Limited understanding of molecular structure and industrial relevance.
	Recommendations for Optimisation	Innovative, feasible, and well-justified recommendations based on chemical evidence.	Practical and justified recommendations with some chemical reasoning.	Basic recommendations justification is present, but limited.	No clear or few recommendations; weak or unclear justification.
	Scientific Communication	Report is exceptionally well-organised, uses precise terminology, and includes diagrams or data effectively.	Report is well-structured, uses appropriate terminology, and includes some visuals.	Report is organised; terminology is mostly correct; visuals may be limited.	Report is disorganised or lacks clear structure; terminology is inconsistent; visuals are minimal.

ITEM 5

Output	Basis of evaluation	Score 5	Score 4	Score 3	Score 2
A concise technical proposal that outlines feasible chemical process options, explains the key organic chemistry involved, and recommends sustainable, cost-effective actions to reduce the plant's environmental	a) Solubility and Acidity Prediction	i) Correctly explains Moderate solubility (H-bonding in phenol and amines vs hydrophobic aromatic ring) ii) Correctly explains weak acidity of phenol and amine basicity.	i) Correctly explains Moderate solubility (H-bonding vs hydrophobic aromatic ring) OR ii) Correctly explains weak acidity of phenol and amine basicity.	i) Partially explains Moderate solubility (H-bonding vs hydrophobic aromatic ring) ii) Partially explains weak acidity of phenol and amine basicity.	i) no response or Incorrect or Partially explains Moderate solubility (H-bonding vs hydrophobic aromatic ring) OR ii) Partially explains weak acidity of phenol and amine basicity

impact while maintaining profitability.	b) Synthetic Route	Correct route from benzene to compound with correct reagents and conditions	Correct route from benzene to compound without correct reagents and conditions	Two relevant steps from benzene to compound	One relevant or incorrect steps from benzene to compound
	Mechanism	Correct mechanism with all steps (generation of nitronium ion, electrophilic attack and re-organisation)	Mechanism with correct first step and electrophilic attack.	Mechanism with only formation of the nitronium ion	Mechanism only starting at the electrophilic attack or no relevant route or mechanism.
	c) Environmental Risk Mitigation	Two risks and their mitigations clearly explained	One risk identified and clearly explained	Risks and mitigations identified with no clear explanation	None or irrelevant or only one risk or mitigation identified

ITEM 6

Output	Basis of evaluation	Score 4	Score 3	Score 2	Score 1
A written presentation that summarises the company's key chemistry-related challenges, explains the relevant scientific principles, and proposes 3–5 feasible, sustainable solutions with clear justification and expected benefits for each.	Understanding of composition and properties (A–D)	i) Correctly identifies all functional groups; ii) Clearly explains physical properties with correct chemical reasoning; iii) Notes likely triglycerides in waste.	i) Correctly identifies main functional groups; ii) Gives plausible explanations of properties and environmental impact.	i) Identifies most functional groups; ii) Explanations are partial or imprecise.	i) Fails to identify or identifies only one or two functional groups correctly; ii) No meaningful or limited or inaccurate property discussion.
	Chemical knowledge and mechanisms (waste conversion routes)	i) Provides clear step-by-step mechanisms for conversions	i) Describes reactions qualitatively with conditions	i) Gives basic descriptions of reactions	i) Incomplete reaction ii) No correct mechanism or meaningful

		ii) Correct catalysts and conditions; discusses pros/cons and green options.	ii) Mentions environmental/waste aspects.	ii) Mechanisms incomplete or missing key details.	chemical detail.
	Synthetic route: C → D	i) Proposes efficient stepwise route (1-propanol → propene → 2-propanol → acetone); ii) Gives reagents, conditions, mechanisms; iii) Explains sustainability and alternatives.	i) Correct overall route and reagents with some mechanistic justification. ii) Misses some conditions iii) No sustainability alternatives	i) Proposes a route but with missing steps ii) Some reagents incorrect iii) No conditions	i) Incomplete route incomplete or chemically implausible ii) Major errors in reagents/ conditions.

	Sustainable process design (waste A → useful product)	Presents detailed, realistic process: pre-treatment, catalyst choice, reaction conditions, separation, coproduct valorisation, recycling, effluent treatment; shows environmental/regulatory awareness.	Proposes biodiesel/soap process with catalysts, separations, and sustainability considerations.	Mentions biodiesel/soap, but lacks process detail or sustainability justification.	Suggests single simple option without detail or sustainability.
	Presentation, safety and feasibility	i) Well-structured report; ii) Equations balanced;	i) Well-structured presentation ii) Balanced Equations	i) Adequate structure, but lacks clarity in parts	i) Poorly organised report ii) Safety/feasibility missing;

		iii) Safety hazards identified with mitigation; iv) Realistic next steps	iii) Safety hazards noted iv) Most steps not feasible.	ii) Most Equations not balanced iii) Safety not addressed iv) No feasible steps.	iii) Unrealistic suggestions.

3.2 Sample Assessment Paper

Chemistry Paper 2 (Practical Paper)

Duration: 3 hours:15 min.

Instruction to Candidates:

The paper consists of two ITEMS. Attempt both questions.

ITEM 1

In an industrial town, a number of small-scale factories near a river have been reported to discharge wastewater containing various chemicals, including hydrochloric acid, into nearby drainage channels. Recently, the environmental supervisory body observed milky cloudiness and poor visibility in parts of the river, believed to exist due to chemical reactions.

The supervisory body suspects that the cloudiness could be a result of a reaction between sodium thiosulphate ($Na_2S_2O_3$), commonly used in some textile industries and hydrochloric acid (HCl). The reaction produces elemental sulphur, which appears as a white precipitate and causes turbidity. To understand how this reaction contributes to pollution, it is important to study how varying concentrations of sodium thiosulphate affect the rate of reaction, and thus, the extent of pollution. You have been contacted to give recommendations based on your investigations.

You are provided with the following reagents:

1) FA1 which is0.1M Sodium thiosulphate solution
2) FA2 which is 2M hydrochloric acid
3) Distilled water
4) A variety of laboratory apparatus and materials

Task

Design an experiment to determine the order of reaction with respect to the concentration of sodium thiosulphate in the reaction and write a report of your findings.

ITEM 2

In a certain town, community members have raised concerns about a recent increase in stomach-related illnesses. Investigations by local health authorities linked the issue to the improper handling and storage of water treatment chemicals. A water committee member handed over a solid sample suspected to be part of the treatment residue contaminating drinking water sources.

Your chemistry teacher has brought the sample labelled W from the treatment plant suspected to contain two cations and one anion. You are tasked to systematically investigate and identify the ions present using the reagents provided.

Task:

Design and carry out a systematic investigation to solve the problem and write a report of your findings

3.3 Chemistry Practical Assessment Rubric

Item 1: Assessment Rubric

Output	Basis of evaluation	Score 4	Score 3	Score 2	Score 1
A designed experiment that determines the reaction order with respect to the concentration of sodium thiosulphate, together with a written report presenting the method, results, analysis, and conclusions from the investigation.	**Interpretation of task**: Aim, Variables and Hypothesis	i) Aim is precise, linked to theory; ii) Correctly Variables iii) Hypothesis is testable	i) Aim is precise, linked to theory; ii) Identifies all variables with minor gaps. iii) Hypothesis is testable with sound rationale and qualitative prediction.	i) General aim understandable but broad; ii) Incomplete identification of variables iii) Hypothesis is plausible but generic with limited rationale.	i) Vague/ambiguous/incorrect/ missing aim with important elements missing; ii) Partial or misclassified or not identified variables with controls largely unspecified; iii) Hypothesis vague/missing.

	Analysing the situation: Materials and Reagents	Complete, accurate list with correct spelling and relevance to all planned tests; no unnecessary items.	Mostly complete list; minor omissions or small inaccuracies.	List contains most essential items, but with notable omissions.	List incomplete or inaccurate or irrelevant (important reagents missing).
	Logical flow of ideas: Methodology	i) Detailed, logical sequence of tests; ii) Steps clear, replicable, and systematic; iii) Safety/accuracy .	i) Detailed, logical sequence of tests; ii) Steps clear, replicable, and systematic iii) Safety/ accuracy not catered for.	i) Detailed, logical sequence of tests; ii) Steps provided but some incomplete, disorganized, or lacking clarity. iii) Safety/accuracy not catered for.	i) No logical sequence of tests; ii) Steps provided but some incomplete, disorganized, or lacking clarity. iii) No safety/accuracy catered for.
	Risks and Mitigations	Identifies chemical/physical /biological hazards; cites GHS	Major hazards and PPE listed; reasonable	Basic hazards acknowledged; generic PPE;	Few hazards noted or hazards not addressed; mitigations

		where relevant; specifies PPE, controls, spill/first aid and disposal steps compliant with policy.	mitigations; minor gaps.	limited mitigation detail.	insufficient or inappropriate.
	Presentation of Data	Tables/graphs are well formatted with titles, labels, units, correct significant figures; appropriate graph type; error bars/uncertainty shown where relevant.	Mostly correct formatting; minor unit/sig fig issues; graph type appropriate.	Basic table/graph with titles/units; no error representation; formatting inconsistent.	Disorganised layout; missing labels/units; inappropriate or confusing display.
	Data Analysis and Interpretation	Correct calculations; shows working; includes uncertainty/percent yield/error; accounts for	Calculations correct; basic error/percentages; sound interpretation; minor slips.	Essential calculations done; limited error treatment; interpretation reasonable but superficial.	Calculation errors and/or misinterpretation/ or no analysis; ignores anomalies; weak linkage to theory.

		anomalies with theoretical reasoning; interprets against hypothesis.			
	Conclusion and Recommendation	Conclusion directly supported by data; addresses hypothesis; acknowledges limitations; gives feasible improvements and real-world applications/implications.	Supported conclusion; notes some limitations; offers sensible improvements.	States conclusion; loosely tied to data; generic improvement notes.	Conclusion weak or contradicted by data or missing or incorrect; no limitations or next steps.

3.4 Item 2 Assessment Rubric

Output	Basis of evaluation	Score 4	Score 3	Score 2	Score 1
A structured qualitative analysis report that identifies the two cations and one anion in sample W, presenting the step-by-step tests performed with the given reagents, the observations, the confirmatory	Research focus (Aim, Hypothesis and Variables)	Aim is precise, hypothesis is clearly linked and justified, and variables (independent, dependent, controlled) are clearly identified and relevant.	Aim and hypothesis clearly stated; variables mostly identified and relevant.	Aim and hypothesis present but somewhat vague; variables incomplete or partly relevant.	Aim or hypothesis weakly stated or absent; variables mostly missing or unclear.
	Materials and Reagents	Complete, accurate list with correct spellings and relevance to all planned tests; no unnecessary items.	Mostly complete list; minor omissions or small inaccuracies.	List contains most essential items, but with notable omissions.	List incomplete or inaccurate (important reagents missing).

evidence, and the final justified conclusion of the ions present.	Methodology	i) Detailed, logical sequence of tests; ii) Steps clear, replicable, and systematic; iii) Safety/ accuracy.	i) Detailed, logical sequence of tests; ii) Steps clear, replicable, and systematic iii) Safety/accuracy not catered for.	i) Detailed, logical sequence of tests; ii) Steps provided, but some incomplete, disorganised, or lacking clarity. iii) Safety/accuracy not catered for.	i) No logical sequence of tests; ii) Steps provided, but some incomplete, disorganised, or lacking clarity. iii) No safety/accuracy catered for.
	Observations	All observations recorded accurately with correct detail (colour, precipitate, odour, changes); systematic and well-presented.	Most observations correct; a few details missing, but overall accurate.	Observations recorded, but some inaccuracies or incomplete details.	Observations vague or missing, partially incorrect, or not systematic.

	Deductions	Logical deductions for each test, clearly linked to observations and consistent with science process skills.	Most deductions correct and linked to observations; only minor errors.	Some correct deductions, but with noticeable errors or gaps.	Deductions mostly inaccurate or missing or poorly linked to observations.
	Conclusion/ Comment	Conclusion integrates all evidence, and reflects on hypothesis validity.	Conclusion correct and consistent with most evidence; minor omissions.	Conclusion partially correct	Conclusion vague or missing or inconsistent with evidence.

4. Performance Level Descriptors

Construct	Performance level	Descriptor
To Apply knowledge of atomic and molecular structures to interpret periodic trends and chemical reactivity (AO1: Atomic Structure, Bonding, Periodicity)	Exceptional	Clearly explains atomic structure, bonding, and periodic trends, accurately predicts reactivity using strong reasoning, and confidently applies this knowledge to new and unfamiliar problems.
	Outstanding	Gives clear explanations of bonding and periodic trends, predicts reactivity accurately in most cases, and applies knowledge effectively in familiar situations.
	Satisfactory	Shows a good basic understanding of atomic structure and periodicity, correctly predicts simple trends, but needs support with unusual or complex patterns.
	Basic	Shows limited understanding of bonding and periodic trends, can recall facts, but struggles to apply them, and often gives incomplete or incorrect predictions.
	Elementary	Shows very little understanding of atomic structure or periodicity, frequently misinterprets trends and reactivity, and requires significant teacher support.
To explore, predict, and apply the structure, reactivity, and	Exceptional	Accurately interprets organic structures, correctly predicts reactions and mechanisms, and independently applies organic chemistry to real-life situations.

Construct	Performance level	Descriptor
transformation pathways of organic compounds to explain natural processes and support innovation in real-world chemical contexts (AO2: Organic Chemistry)	Outstanding	Understands most reactions and mechanisms, predicts outcomes with few errors, and applies these ideas to familiar real-world situations.
	Satisfactory	Understands basic organic structures and reactions, predicts simple outcomes fairly well, and can apply ideas to straightforward examples with guidance.
	Basic	Recognises basic organic reactions, but struggle to explain them, often make unclear or incorrect predictions, and require support to apply their knowledge.
	Elementary	Struggles to understand organic structures and reactions, is unable to reliably predict outcomes, and requires step-by-step guidance.
Apply quantitative chemical principles to analyse, model and predict the amounts of substances, energy changes and reaction rates in chemical systems under varying conditions.	Exceptional	Accurately applies stoichiometry, thermochemistry, and kinetics to **analyse, model, and predict** amounts, energy changes, and rates across varied conditions; justifies assumptions and checks reasonableness.
	Outstanding	Correctly applies principles to **solve multi-step** problems and predict outcomes under changing conditions; minor slips do not affect conclusions.
	Satisfactory	Applies core principles to **routine** problems (moles, ΔH, rate calculations) with generally correct methods; limited modelling of changing conditions.

Construct	Performance level	Descriptor
(AO3: Stoichiometry, Thermochemistry and Reaction Kinetics)	Basic	Uses **partly correct** methods for simple calculations; struggles to link conditions to amounts/energy/rates; frequent errors or incomplete reasoning.
	Elementary	Shows **minimal** understanding; calculations are mostly incorrect or missing; cannot reliably interpret or predict amounts, energy changes, or rates.
Apply principles of chemical and physical equilibria and electrochemistry to interpret, predict and evaluate the behaviour of chemical systems in industrial and real-world contexts. (AO4: Chemical Equilibria and Electrochemical Systems)	Exceptional	Integrates equilibria + electrochemistry to **predict, justify, and evaluate** complex industrial systems; uses correct models/calculations and optimises decisions with clear trade-offs.
	Outstanding	Accurately **interprets and predicts** system behaviour in real contexts; applies correct principles and calculations with minor omissions; gives sound evaluations.
	Satisfactory	Applies key principles to **interpret** familiar systems and make reasonable predictions; limited evaluation; occasional errors but conclusions mostly valid.
	Basic	Shows partial understanding; **describes** trends more than explains; predictions are inconsistent; minimal evaluation and frequent conceptual/calculation errors.
	Elementary	Identifies a few terms or facts; cannot reliably apply principles; predictions/evaluations are largely incorrect or absent.

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