Republic of Zambia

Ministry of Education

CHEMISTRY SYLLABUS

SECONDARY EDUCATION ORDINARY LEVEL
FORM 1 - 4

DEVELOPED BY THE CURRICULUM DEVELOPMENT CENTRE
LUSAKA
2024

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VISION

Quality, life- long education for all which is accessible, inclusive and relevant to individual, national and global needs.

PREFACE

The **Chemistry Syllabus** for Forms 1 to 4 is designed to equip learners with a comprehensive understanding of chemistry concepts, fostering a deep appreciation for the role of chemistry in everyday life and its applications in various fields. This syllabus aims to develop students' analytical thinking, problem-solving skills, and practical laboratory techniques through a structured and progressive learning approach.

Chemistry, as a central science, bridges the gap between physical and biological sciences, providing insights into the composition, structure, properties, and changes of matter. This syllabus emphasises the importance of a hands-on, inquiry-based learning experience, encouraging learners to explore, experiment, and engage in scientific reasoning.

This Chemistry Syllabus aims to create a stimulating and supportive learning environment where learners can develop a profound understanding of chemistry. By fostering curiosity, critical thinking, and practical skills, the syllabus prepares learners for further education and careers in science and technology, contributing to their overall intellectual and personal growth.

It is hoped that the Chemistry Syllabus will inspire learners to explore the fascinating world of Chemistry and appreciate its significance in shaping the future.

Joel Kamoko (Mr.)
Permanent Secretary- Educational Services
MINISTRY OF EDUCATION

ACKNOWLEDGMENT

The development of this Ordinary Level Chemistry Syllabus was a collaborative effort, and we would like to extend our sincere gratitude to the individuals, institutions and organisations that provided the technical and financial input to the successful development of this syllabus. These include; the Teachers, Lecturers from colleges and public universities in Zambia, officers from the Directorate of Secondary Education, Directorate of National Science Centre and the Examinations Council of Zambia. Their valuable insights, expertise, and feedback were instrumental in shaping the content, structure, and overall direction of this syllabus. We appreciate their dedication, time, and effort in helping the Ministry of Education to design and develop a comprehensive and relevant Chemistry syllabus.

Last but not the least, the commitment and hard work of all the staff at the Curriculum Development Centre in ensuring that this syllabus comes to reality is recognised.

Charles Ndakala (Dr.)
Director – Curriculum Development
MINISTRY OF EDUCATION

INTRODUCTION

The Ordinary Level (O Level) Chemistry Syllabus is committed to providing an enriching and supportive educational environment where learners can develop a lifelong interest in chemistry. By promoting inquiry, curiosity, and a passion for science, we aim to prepare learners not only for academic success but also for their future roles as informed and responsible citizens in a scientifically advanced society.

We are confident that this chemistry syllabus will inspire and empower learners to achieve their full potential, equipping them with the knowledge and skills necessary to navigate and contribute to the world around them. This syllabus is designed to ensure learners develop a deep understanding of chemical principles while also acquiring practical skills and competencies needed for further education and careers in science.

Problem-solving is a critical skill in Science Technology Engineering and Mathematics (STEM) fields, including chemistry. Here are some strategies and techniques to enhance problem-solving skills:

1. Define the Problem: Clearly articulate the problem and identify the key questions.
2. Gather Information: Collect relevant data and research the topic/subject/task(s).
3. Identify Key Concepts: Determine the fundamental principles and concepts related to the problem.
4. Develop a Hypothesis: Formulate a tentative explanation or solution.
5. Design Experiments: Plan and conduct experiments to test hypotheses.
6. Analyse Data: Interpret and evaluate the results.
7. Share findings: Communicate the findings or results.

The STEM part of chemistry refers to the Scientific, Technological, Engineering, and Mathematical which is composed of:
Science: Understanding the natural world through observation, experimentation, and evidence-based reasoning.

- Introduction to Chemistry
- Matter
- Elements, Compounds and Mixtures
- Atomic Structure
- Bonding
- Chemical Reactions
- Acids, Bases and Salts
- Chemical Kinetics
- Redox
- Stoichiometry and Mole Concept
- Thermochemistry

- Chemical Equilibria
- Electrochemistry
- Periodicity
- Metallurgy
- Non metals
- Organic Chemistry
- Environmental Chemistry

Technology: Apply software and simulations for data analysis and visualisation.

(a) Instrumental analysis
- Digital thermometers,
- Digital balances,
- Centrifuge,
- Electric cells,
- Digital pH meters

(b) Laboratory techniques
- Purification methods,
- Salt preparation,
- Soap preparation,
- Gas preparation.

(c) Chemical processing and manufacturing
- Manufacture of acids and gases, ,
- Mineral processing,
- Chemical waste management,
- Manufacturing of lime, manufacturing of fertiliser

Engineering: Designing laboratory equipment and processes.

(a) Chemical Engineering
- Chemical production,
- Considering factors like efficiency, safety and cost.

(b) Environmental Engineering
- Waste Management,
- Emissions and Pollution Control,
- Climate Change Mitigation

(c) Sustainable Energy
- Renewable energy sources include solar, wind, hydro, geothermal, and biomass, which are becoming increasingly important as the world transitions to a more sustainable energy mix.
- Reduce greenhouse gas emissions

Mathematics: Applying mathematical models to chemical reactions and stoichiometry.

(d) Quantitative Analysis
- Stoichiometry, chemical kinetics, titration,
- Mole concept,
- Calculation of enthalpy change $\triangle H$
- Quantitative electrolysis
- Atomic structure and formation of ions

(e) Statistical Thermodynamics
- Chemical kinetics
- Kinetic theory of matter (States of matter and their changes)

(f) Data Analysis and Visualisation
- Chromatographic data analysis (e.g.High-Performance Liquid Chromatography)
- Data visualisation tools (e.g. graphs, charts)

These STEM aspects of chemistry are crucial for advancing the understanding of chemical principles, developing new technologies, and solving real-world problems.

Structure of the Syllabus

The O'Level Chemistry Syllabus is organised into four levels, corresponding to Forms 1 to 4, with each level building upon the knowledge and skills acquired in the previous year. The content is segmented into topics, subtopics, learning activities, and expected standards each focusing on specific concepts of chemistry.

- **Form 1**: Introduction to Chemistry, Matter, Atomic Structure, Elements, Compounds and Mixtures and Atomic Structures.
- **Form 2**: Bonding, Chemical Reactions, Acids, Bases and Salts, Chemical Kinetics and Redox Reactions.
- **Form 3**: Stoichiometry and Mole Concept, Thermochemistry, Chemical Equilibria, Electrochemistry and Periodicity.
- **Form 4**: Metallurgy, Non-metals, Organic Chemistry and Environmental Chemistry.

Suggested Teaching Methodology

The effective teaching methodologies in STEM Chemistry include:

- **Conducting experiments** : Demonstrate key principles and encourage curiosity among learners.
- **Collaborative learning** : Pair learners to work together, promoting peer-to-peer teaching, discussion, and problem-solving.
- **Conceptual learning** : Connect chemical concepts to everyday life, industry, or current events, making learning relevant and meaningful.
- **Differentiated instructions** : Tailor teaching to meet diverse learning styles, abilities, and interests of different learners.
- **Feedback and reflection** : Encourage learners to reflect on their learning, providing constructive feedback to guide improvement.
- **Inquiry-based learning** : Encourage learners to explore, investigate, and discover chemical concepts through hands-on experiments and activities.
- **Integration of technology** : Use digital tools, simulations, and visualizations to enhance engagement, understanding, and analysis.
- **Problem-based learning** : Present real-world problems or case studies or scenarios, requiring learners to apply chemical knowledge to develop solutions.
- **Project -based learning** : Assign open-ended projects, allowing learners to design, conduct, and present research or applications of chemical concepts.

By implementing these methodologies, a teacher can create an engaging, inclusive, and effective STEM Chemistry learning environment.

Time Allocation

The standard minimum learner-teacher contact time for Chemistry at secondary school level is 4 hours per week, translating to Six (6) periods with at least two double periods per week. The duration for a single period is 40 minutes. The contact time at Secondary school level is planned in such a way as to give ample time for practical activities.

Assessment

This assessment shall include a variety of methods to evaluate the competences of learners in terms of knowledge, skills, and general understanding of scientific concepts. The assessment will involve both formative and summative. Summative assessment will be used to evaluate learners learning at the end of the O level chemistry course to measure learners' achievement against specific competences through final examinations. In order to help teachers and learners identify areas where learners need more support or revision, formative assessment will be used to track learner progress and knowledge throughout the teaching and learning process.

However, assessments shall follow the following pattern:

- School Based Assessment (SBA) shall comprise of assignments, projects, practical work, research and end of term tests during the period of study and as guided by the Examinations Council of Zambia (ECZ). This shall carry **30%** of the total marks.
- Summative assessment shall carry **70%** of the total marks.

The Examinations Council of Zambia shall prepare detailed procedures or guidelines on how SBA will be conducted by the teachers and the management of the assessment results. The standardised national examination shall be administered at the end of Form 4 by the Examinations Council of Zambia.

FORM 1

KEY COMPETENCES

S/N	COMPETENCE	DESCRIPTORS
1	**Analytical Thinking**	• Identify patterns • Compile data, create mental images and address issues • Evaluate solutions
2	**Collaboration**	• Solving puzzle in groups • Play with peers to build relationships • Participate in and express themselves through play activities
3	**Communication**	• Use mathematical/scientific language in different situations • Express oneself using different media and symbols • Ask for feedback
4	**Critical Thinking**	• Ask and answer simple questions • Classify objects according to their attributes • Manipulate different objects • Solve simple problems in life • Match different things according attributes • Arrange objects according to attributes • Compare similarities or differences between objects • Explore the environment • Differentiate good from bad • Recognize and name items in the environment
5	**Environmental Sustainability**	• Dispose trash in the designated place. • Adhere to best practices in environmental management. • Identify a clean environment. • Identify types of waste in local environment
6	**Problem Solving**	• Make connections/link with the inner world or social environment • Use numeracy patterns and relations to solve problems • Manipulate numbers, shapes and symbols to complete a task

TOPIC	SUB-TOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
1.1 INTRODUCTION TO CHEMISTRY	**1.1.1 Branches of Chemistry**	1.1.1.1 Demonstrate understanding of chemistry	• Describing chemistry as a science that deals with the study of matter and its properties under different conditions • Investigating the main branches of chemistry such as inorganic chemistry, physical chemistry, organic chemistry, analytical chemistry and biochemistry	• Understanding of chemistry demonstrated accordingly
	1.1.2 Importance of Chemistry	1.1.2.1 Relate the importance of chemistry to everyday life	• Exploring the importance of chemistry • Researching on the role of chemistry in everyday life (*personal care products, food, medicine….)* • Evaluating the impact of chemical processes and products on the environment and human health • Designing solutions to real-world problems using chemistry	• The importance of chemistry to everyday life related correctly
	1.1.3 Safety and Waste Management in the Laboratory	1.1.3.1 Apply laboratory safety	• Applying safety practices in the laboratory such as *precautions, first aid, storage…*	• Laboratory safety applied accordingly
		1.1.3.2 Manage waste in the laboratory	• Classifying laboratory waste (*chemicals, glassware, paper ….)* • Managing laboratory waste (*handling, disposal…*)	• Waste in the laboratory managed accordingly
	1.1.4 Apparatus and Equipment in Chemistry	1.1.4.1 Use apparatus and equipment in chemistry	• Demonstrating the use of various laboratory apparatus and equipment in chemistry related activities	• Apparatus and equipment in chemistry used accordingly
		1.1.4.2 Measure quantities precisely and accurately	• Demonstrating accuracy and precision in measuring quantities such *as time, temperature, mass/weight and volume*	• Quantities in chemistry measured precisely and accurately

TOPIC	SUB-TOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
1.2 MATTER	**1.2.1 States and Basic units of matter**	1.2.1.1 Demonstrate understanding of states and basic units of matter	• Investigating the states of matter such as solids, liquids, gases, plasma. • Exploring the basic units of matter (atoms, molecules, ions)	• Understanding of matter demonstrated correctly
	1.2.2 Kinetic theory of matter	1.2.2.1 Demonstrate understanding of the kinetic theory of matter	• Exploring the principles of the kinetic theory of matter in terms of temperature and kinetic energy, motion and arrangement of particles, collision, diffusion • Demonstrating the evidence of kinetic theory such as diffusion, Brownian motion	• Understanding of the kinetic theory of matter demonstrated correctly
	1.2.3 Heating and Cooling curves of matter	1.2.3.1 Construct the heating and cooling curves of matter	• Constructing the heating and cooling curves • Interpreting heating and cooling curves	• Heating and cooling curves of matter constructed correctly
1.3 ELEMENTS, COMPOUNDS AND MIXTURES	**1.3.1 Elements**	1.3.1.1 Demonstrate understanding of elements in everyday life	• Describing an element (*substance that consists of only one type of atoms*…) • Classifying substances as elements(*metallic and non-metallic elements in everyday life)* • Exploring the diagrammatic representation of elements	• Understanding of elements in everyday life demonstrated accordingly
	1.3.2 Compounds	1.3.2.1 Demonstrate understanding of compounds	• Describing a compound (*substance made up of two or more elements chemically combined*…) • Exploring various compounds in everyday life	• Understanding of compounds demonstrated correctly

TOPIC	SUB-TOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
			• Exploring the diagrammatic representation of elements, compounds and mixtures • Analysing the characteristics of compounds	
	1.3.3 Mixtures	1.3.3.1 Demonstrate understanding of mixtures	• Describing a mixture (*substance made up of two or more substances physically combined…*) • Exploring examples of mixtures in everyday life • Classifying mixtures as homogeneous and heterogeneous • Exploring the diagrammatic representation of mixtures • Comparing and contrasting compounds and mixtures	• Understanding of mixtures demonstrated correctly
	1.3.4 Physical and Chemical changes	1.3.4.1 Differentiate physical and chemical changes	• Exploring, with examples, the physical and chemical changes • Comparing and contrasting physical and chemical changes	• Physical and chemical changes differentiated accordingly
	1.3.5 Criteria of Purity	1.3.5.1 Determine the purity of a substance	• Determining the purity of a substance (*melting point, boiling point, density, refractive index, chromatography and effects of impurities*) • Exploring the importance of pure and impure substances (*in food stuff, medicines, drinks, salt on icy-roads, inhaled oxygen …*)	• The purity of a substance determined correctly
	1.3.6 Purification and Separation Techniques	1.3.6.1 Separate mixtures into their desired components	• Separating mixtures into their components using appropriate techniques (*filtration, evaporation, simple distillation, fractional distillation, crystallization,*	• Mixtures separated into their desired components accordingly

TOPIC	SUB-TOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
			chromatography, separating funnel, centrifugation, sublimation, and decantation) • Investigating the applications and the effects of separating techniques on the environment	
1.4 ATOMIC STRUCTURE	**1.4.1 Structure of an Atom**	1.4.1.1 Demonstrate understanding of an atom and its structure	• Exploring atomic models (*Bohr, Dalton model…*) • Describing an atom (*smallest particle of an element which takes part in a chemical reaction…*) • Describing Bohr Model structure of an atom (*nucleus at the center surrounded by electrons*)	• Understanding of an atom and its structure demonstrated correctly
	1.4.2 Properties of the Sub-atomic particles	1.4.2.1 Explore the properties of the sub-atomic particles	• Identifying subatomic particles (*protons, neutrons and electrons*) • Analysing the relative charges and appropriate relative masses of protons, neutrons and electrons (*charges*: +1, 0, -1 *Masses*: 1, 1, $\frac{1}{1840}$) • Justifying the neutrality of an atom	• Properties of sub-atomic particles explored accordingly
	1.4.3 Atomic number, Z (proton number) and mass number, A (nucleon number)	1.4.3.1 Manipulate the numbers of sub-atomic particles	• Describing atomic and mass number in terms of: (a) atomic number as the number of protons in an atom (b) Mass number as the sum of protons and neutrons in an atom • Formulating expressions relating to numbers of sub atomic particles	• The numbers of sub-atomic particles manipulated correctly

TOPIC	SUB-TOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
			A = Z + N (*changing the subject of formula*)	
	1.5.1 Chemical Symbols and Nuclide Notation	1.5.1.1 Interpret chemical symbols and nuclide notation	• Exploring the chemical symbols of elements (*from the English, Latin, Greek names…..*) • Interpreting and constructing the nuclide notation of atoms, $^{A}_{Z}X$, where X is atomic symbol, A is mass number and Z is atomic number	• Chemical symbols and nuclide notation interpreted correctly
	1.5.2 Electronic Configuration	1.5.2.1 Apply electronic configuration of atoms	• Describing the electronic configuration as the arrangement of electrons in the shells of atoms • Demonstrating the build-up of electrons in shells for the first 20 elements using the formula $2n^2$ taking into consideration the duplet and octet rules by drawing structures of atoms • Relating the electronic configurations of the first 20 elements to their positions on the Periodic Table • Classifying elements as metals or non-metals using their valence electrons and valency • Applying atomic structure concept to position elements on the periodic table	• Electronic configuration of atoms applied correctly
	1.5.3 Isotopic Nature of Elements	1.5.3.1 Determine relative atomic mass of an element from relative isotopic masses.	• Describing isotopes as atoms of the same element having the same number of protons but different mass numbers (nucleon number) • Determining the relative atomic mass of an element given the percentage abundances of isotopes, and from mass spectrum.	• Relative atomic mass of an element from relative isotopic masses determined correctly

TOPIC	SUB-TOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
		1.5.3.2 Manage radioisotopes	• Exploring the uses of radioactive isotopes (*medical treatment of cancer, industrial use as tracers, in archaeology nuclear energy production*) • Exploring the hazardous nature of radioactive isotopes (*health risks, contamination of the environment, nuclear accidents, and mutagens*) • Exploring the safe storage and handling of radioisotopes	• Radioisotopes managed sustainably

FORM 2

TOPIC	SUB-TOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
2.1 BONDING	**2.1.1 Chemical Bonding**	2.1.1.1 Demonstrate understanding of chemical bonding	• Describing chemical bonding (*process by which atoms combine chemically to form molecules or compounds*) • Analysing the types of bonding (*ionic/electrovalent, covalent, metallic…*)	• Understanding of chemical bonding demonstrated correctly
	2.1.2 Ions	2.1.2.1 Demonstrate understanding of ion formation in bonding	• Describing an ion (*atom or chemically bonded group of atoms that have acquired an overall electrical charge*) • Describing the formation of monoatomic ions as cations by electron loss, anions by electron gain • Relating the charges of ions to their valencies • Relating the charges of radicles to their valencies *[(carbonate (CO_3^{2-}), sulphate (SO_4^{2-}), ammonium (NH_4^+), nitrate (NO_3^-), phosphate (PO_4^{3-})]*	• Understanding of Ion formation in bonding demonstrated accordingly
	2.1.3 Chemical Formulae	2.1.3.1 Deduce chemical formulae of compounds	• Assigning valencies to elements and group of atoms (*radicals*) • Formulating chemical formulae of compounds using: (a) valencies (b) charges	• Chemical formulae of compounds deduced accordingly
		2.1.3.2 Demonstrate understanding of chemical compounds	• Naming of chemical compounds; (a) binary and (b) ternary compounds	• Understanding of chemical compounds demonstrated accordingly

TOPIC	SUB-TOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
	2.1.4 Ionic Bonding	2.1.4.1 Demonstrate understanding of ionic bonding	• Describing ionic bond as an electrostatic force of attraction between cations and anions • Describing the formation of ionic (*electrovalent*) compounds • Explaining the properties of ionic compounds (*high melting points/boiling points, high density, conduct electricity in molten state/solution, made of ions, solids at r.t.p* .)	• Understanding of ionic bonding demonstrated correctly
		2.1.4.2 Apply the uses of ionic compounds in our everyday life	• Exploring the uses of ionic compounds	• The uses of ionic compounds in our everyday life applied accordingly
	2.1.5 Covalent Bonding	2.1.5.1 Demonstrate understanding of covalent bonding	• Describing covalent bond as a shared pair of electrons between non-metal atoms	• Understanding of covalent bonding demonstrated correctly
		2.1.5.2 Apply the uses of covalent compounds in everyday life	• Justifying formation of single, double and triple covalent bonds between atoms (*hydrogen(H_2), oxygen(O_2) and nitrogen(N_2) molecules respectively*) • Examining the properties of covalent compounds (*low melting points/boiling points, low density, do not conduct electricity in solid/solution form, made of molecules*) • Describing a molecule as a group of covalently bonded atoms which can exist independently.	• The uses of covalent compounds applied in everyday life accordingly

TOPIC	SUB-TOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
			• Exploring the uses of covalent compounds	
	2.1.6 Metallic Bonding	2.1.6.1 Demonstrate understanding of metallic bonding	• Describing metallic bonding as the electrostatic force of attraction between positively charged ions and the pool of delocalised electrons within a metallic lattice	• Conceptual and understanding of metallic bonding demonstrated correctly
		2.1.6.2 Apply the uses of metallic substances in our everyday life	• Exploring the uses of metallic substances • Justifying the use of specific metallic substances for different applications in everyday life	• The uses of metallic substances in our everyday life applied correctly
	2.1.7 Structure of Compounds	2.1.7.1 Classify compounds into simple and giant structures	• Describing structures of simple and giant compounds • Illustrating structures of simple and giant compounds • Distinguishing different compounds based on the structures (*simple and giant structures - macromolecules and ionic lattices)*	• Compounds classified into simple and giant structures accordingly
2.2 CHEMICAL REACTIONS	**2.2.1 Chemical Reactions**	2.2.1.1 Demonstrate understanding of the principles of chemical reactions	• Describing a chemical reaction (*process in which a substance(s) undergoes a chemical change to produce a new substance(s)*) • Investigating the types of chemical reactions: (a) Direct combination (Synthesis), (b) Decomposition, (c) Single displacement, (d) Double displacement (e) Chain reactions	• Understanding of the principles of chemical reactions demonstrated correctly
	2.2.2 Chemical Equations	2.2.2.1 Construct chemical equations	• Describing a chemical equation • Describing the notation of a chemical equation as reactants forming products (*Reactants → Products*)	• Chemical equations constructed accordingly

TOPIC	SUB-TOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
			• Constructing word equations from descriptive chemical changes • Formulating and balancing chemical equations, with state symbols correctly written in lower case in the same line with the species (not as subscripts) • Constructing net ionic equations from balanced chemical reactions • Investigating chemical reactions as endothermic or exothermic	
2.3 CHEMICAL KINETICS	**2.3.1 Rates of Chemical Reactions**	2.3.1.1 Demonstrate understanding of rates of chemical reactions	• Describing the rate of a chemical reaction • Experimenting on the rates of chemical reactions • Applying rates of chemical reactions in real life situations	• Understanding of rates of chemical reactions demonstrated accordingly
		2.3.1.2 Investigate factors that affect the rates of chemical reactions	• Exploring the factors that affect the rates of a chemical reaction (*temperature, concentration, surface area, pressure, catalyst, light*) • Collecting and interpreting data on the rates of chemical reactions (*graphical representations*) • Exploring methods of controlling the rates of chemical reactions (*manipulating the factors that affect the rates of chemical reactions*)	• Factors affecting the rates of chemical reactions investigated accordingly
2.4 REDOX REACTIONS	**2.4.1 Oxidation and Reduction**	2.4.1.1 Interpret redox reactions	• Analysing oxidation and reduction in terms of: (a) Oxygen//hydrogen exchange (b) Electron transfer (c) Oxidation state changes	• Redox reactions interpreted correctly

TOPIC	SUB-TOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
			• Examining a redox reaction (*reaction involving both oxidation and reduction*) • Identifying the characteristics of oxidising and reducing agents ✓ Oxidising agents (*identified using potassium iodide solution as a reducing agent in the presence of starch or acidified potassium iodide paper*) ✓ Reducing agents (*identified using acidified potassium dichromate or potassium permanganate as oxidizing agents and observe colour changes only)* • Determining oxidation numbers of elements with variable oxidation states • Deducing a redox reaction using oxidation numbers • Describing a non-redox reaction (*reaction in which there is neither oxidation nor reduction involved*)	
2.5 ACIDS, BASES AND SALTS	**2.5.1 Composition of Acids, Bases and Salts**	2.5.1.1 Analyse the composition of acids, bases and salts	• Investigating acids, bases, salts (refer to chemical compositions of acids, bases and salts)	• Composition of acids, bases and salts analysed accordingly
	2.5.2 Acids	2.5.2.1 Demonstrate understanding of acids	• Classifying acids in terms of: (a) Nature (Organic and inorganic) (b) Strength (Strong and weak) • Describing basicity of an acid (*number of ionisable hydrogen(s) present in a molecule of an acid such as monobasic, dibasic and tribasic*)	• Understanding of acids demonstrated correctly

TOPIC	SUB-TOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
		2.5.2.2 Analyse the properties of acids	• Demonstrating the physical and chemical properties of acids :	• Properties of acids analysed accordingly
			(a) Physical properties (*sour taste, pH less than 7, they are electrolytes, corrosive*) (b) Chemical properties (*reactions with metals, bases, carbonates/bicarbonates and effects on indicators. (do not use highly reactive metals such as potassium, sodium, Calcium*) • Exploring uses of acids and their environmental impact	
	2.5.3 Bases	2.5.3.1 Demonstrate understanding of bases	• Classifying bases in terms of solubility and further classifying the soluble ones (alkalis) as strong and weak • Describing acidicity of a base as the number of hydroxides present in a formula such as monoacidic, diacidic and triacidic	• Understanding of bases demonstrated correctly
		2.5.3.2 Analyse the properties of bases	• Demonstrating the physical and chemical properties of bases: (a) Physical properties (*taste, pH greater than 7, texture, electrolytes (alkalis*) (b) Chemical properties (*reactions with acids and ammonium salts, effects on indicators*) • Exploring the uses of bases and their environmental impact	• Properties of bases analysed accordingly
	2.5.4 Oxides	2.5.4.1 Classify oxides	• Describing oxides • Analysing types of oxides (refer to Acidic oxides, Basic oxides, Amphoteric oxides, Neutral oxides) • Exploring the uses of oxides	• Oxides classified correctly

TOPIC	SUB-TOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
	2.5.5 Acid-Base Indicators	2.5.5.1 Apply acid-base indicators to determine the acidity, alkalinity and neutrality of a substance	• Describing acid-base indicators • Investigating types of acid-base indicators • Determining the acidity, alkalinity and neutrality of a substance using pH meter, litmus paper/solution, methyl orange, phenolphthalein, universal indicator paper/solution • Making acid-base indicators from locally available resources	• Acid-base indicators applied to determine acidity, alkalinity and neutrality of a substances accordingly
	2.5.6 Salts	2.5.6.1 Prepare and obtain salts	• Classifying salts *(normal salts, acid salts and basic salts; hydrated and anhydrous salts)* • Preparing soluble salts using appropriate methods with suitable reactants (refer to reaction of acid with alkali (titration); reaction of acid with insoluble base, reaction of acid with metal carbonate, reaction of acid with a reactive metal) • Preparing insoluble salts by precipitation method (*silver chloride, lead (II) sulphate…*) • Obtaining salts from solutions (*by evaporation and crystallization*) • Describing water of crystallization • Discussing the importance of water of crystallization to hydrated salts • Determining the solubility of salts in water (*soluble and insoluble salts*) • Investigating the behaviour of salts with reference to the atmosphere as hygroscopic, efflorescent, deliquescent	• Salts prepared and obtained accordingly

TOPIC	SUB-TOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
		2.5.6.2 Analyse the use of salts in real-world scenarios	• Investigatingon the various uses of salts in different industries, *such as: food preservation, medicine, agriculture …* • Analysing the role of salts in products or processes in industries • Designing a solution using salt to address a real-world problem, *such as preserving food, purifying water…*	• The use of salts in real world scenarios analysed correctly
	2.5.7 Qualitative Analysis	2.5.7.1 Investigate the chemical composition of salts in terms of cations and anions present	• Analysing and identifying cations and anions in their aqueous solutions: (a) Cations being aluminum (Al^{3+}), ammonium ($NH4^{+}$), calcium (Ca^{2+}), copper (II) (Cu^{2+}) iron (II) (Fe^{2+}), iron (III) (Fe^{3+}) and zinc (Zn^{2+}) using aqueous sodium hydroxide and aqueous ammonia (b) Anions being carbonate (CO_3^{-}), chloride (Cl^{-}), iodide (I^{-}), nitrate (NO_3^{-}), sulphate (SO_4^{2-}) • Carrying out chemical test to identify gases such as ammonia (NH_3), carbon dioxide (CO_2), chlorine (Cl_2), hydrogen(H_2), oxygen(O_2), sulphur dioxide (SO_2), water vapour (H_2O)	• Chemical composition of salts in terms cations and anions present investigated accordingly
		2.5.7.2 Apply analysis of salts in creation of economical products	• Exploring the use of analysis of salts in the creation of economical products • Designing a new product that uses salts, (*new type of food preservative, a salt-based fertiliser…*)	• Analysis of salts used in creation of economical products correctly

FORM 3

TOPIC	SUB-TOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
3.1 STOICHIOMETRY AND THE MOLE CONCEPT	**3.1.1 Relative Formula Mass/Relative Molecular Mass** (RFM/RMM)	3.1.1.1 Determine the relative formula mass and relative molecular mass	• Describing the relative atomic mass • Calculating the relative atomic mass of isotopes • Describing the relative molecular mass • Determining the relative formula mass and relative molecular mass	• The relative formula mass and relative molecular mass determined correctly
	3.1.2 Mass Composition/ Percentage Composition	3.1.2.1 Apply the concept of mass composition and percentage composition	• Determining the mass composition and percentage composition of elements in a compound	• The mass composition and percentage composition applied correctly
	3.1.3 The Mole	3.1.3.1 Determine the number of moles of a given substance	• Describing the mole [*amount of substance that contains 6.0 x 10^{23} (Avogadro's constant) particles (atoms, ions, molecules, electrons, protons, neutrons)*] • Determining the number of moles using: (a) Number of particles in relation to Avogadro's constant (b) Physical masses (m) and molar mass (MM) (c) Physical volume (V) and molar volume (V_m) of any gas at r.t.p. /s.t.p (Apply $n = \frac{m}{MM}$ and $n = \frac{V}{Vm}$, where V_m at $r.t.p = 24\,dm^3$ and at $s.t.p = 22.4\,dm^3$	• The number of moles determined correctly

TOPIC	SUB-TOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
	3.1.4 Empirical and Molecular Formula	3.1.4.1 Determine empirical and molecular formula	• Describing empirical and molecular formula • Determining the empirical formula of a compound given: (a) the molecular formula using ratios (b) Percentage composition by mass (c) Masses • Determining the molecular formula from empirical formula using MF = $(EF)_n$	• Empirical and molecular formula determined correctly
	3.1.5 Concentration of Solutions	3.1.5.1 Demonstrate understanding of concentration of solutions	• Describing the concentration of a solution in terms of: (a) mass concentration as the mass of a solute per unit volume of a solution (g/dm^3) (b) mole concentration (molarity, M) as the number of moles per unit volume of solute per unit volume of solution (mol/dm^3) • Applying the dilution law. • Determining concentration given the amount of solute and volume of a solution and vice versa $Molarity = \frac{number\ of\ moles}{volume}$, $M = \frac{n}{v}$ $\text{Mass concentration} = \frac{mass}{volume}$	• Understanding of concentration of solutions demonstrated correctly

TOPIC	SUB-TOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
	3.1.6 Standard Solutions	3.1.6.1 Prepare standard solutions	• Describing a standard solution • Preparing standards solutions starting with: soluble solids Concentrated solutions $M_1V_1 = M_2V_2$, • Calculating specific gravity (density) and % purity.	• Standard solutions prepared suitably and correctly
	3.1.7 Reacting Quantities	3.1.7.1 Carry out calculations involving stoichiometric reacting quantities	• Describing reacting quantities • Carrying out calculations involving stoichiometric reacting quantities (*moles, masses, volumes of gases and volumetric analysis (titration)*	• Calculations involving stoichiometric reating quantities carried out correctly
		3.1.7.2 Determine the number of moles in hydrates	• Determining the number of moles (n) in hydrates ($X.nH_2O$) by:- (a) Gravimetric analysis (solids) (b) Volumetric analysis (liquids)	• Number of moles in hydrates determined correctly
		3.1.7.3 Determine percentage yield	• Determining percentage yield: $\%\ \text{yield} = \frac{\text{Actual yield}}{\text{Theoretical yield}} X\ 100$	• Percentage yield determined correctly
		3.1.7.4 Determine percentage purity	• Determining percentage yield and purity: $\%\ \text{Purity} = \frac{\text{Amount of component}}{\text{Amount of mixture}} X\ 100$	• Percentage purity determined correctly
	3.1.8 Environmental Stoichiometry	3.1.8.1 Solve environmental problems using stoichiometric principles	• Exploring the environmental stoichiometry (*study of the balance of chemical elements and compounds in the environment in relation to the composition of clean air*	• Stoichiometric principles used to solve environmental problems

TOPIC	SUB-TOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
			• *(Nitrogen 78%, oxygen 20%, carbon dioxide 0.03%, rare gases 1%, and water with a variable percentage)* • Exploring the environmental impact of chemical reactions • Solving environmental problems using stoichiometric principles	
		3.1.8.2 Explore the benefits of atom economy	• Describing atom economy (*the measure of efficiency of chemical reactions or processes*), $\text{Atom economy} = \frac{\text{Molecular mass of desired products}}{\text{Sum of molecular mass of all reactants}} X\ 100$ • Exploring the benefits of atom economy as: (a) Reduced waste and bi-product (b) Minimised environmental impact (c) Lower resource consumption	• The benefits of atom economy explored accordingly
3.2 THERMO CHEMISTRY	**3.2.1 Thermochemical Reactions**	3.2.1.1 Demonstrate understanding of thermal reactions	• Describing thermochemistry (*study of heat energy changes associated with chemical reactions and physical changes)* • Investigating characteristics of endothermic and exothermic reactions (*enthalpy changes, energy profile diagrams (catalysed and uncatalyzed), determine enthalpy*	• Understanding of thermal reactions demonstrated correctly

TOPIC	SUB-TOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
			changes using bond energies and temperature changes ($H = mc\Delta T$) and natural processes such as respiration and photosynthesis)	
		3.2.1.2 Determine the enthalpy change of endothermic and exothermic reactions	• Determining enthalpy change (*refer to endothermic and exothermic reactions in relation to bond breaking and bond formation or using bond energies and temperature changes*)	• The enthalpy change of endothermic and exothermic reactions determined correctly
	3.2.2 Sources of Energy	3.2.2.1 Justify the need to harness alternative sources of energy	• Exploring the advantages and disadvantages of sources energy in terms of safety, cost, renewable and non-renewable, clean and unclean • Exploring the effects of using energy on the environment such as pollution, greenhouse effects (global warming)	• The need to harness alternative sources of energy justified accordingly
	3.2.3 Nuclear Energy	3.2.3.1 Demonstrate understanding of nuclear energy	• Discussing nuclear energy as the energy released from the nucleus of a radioactive atom through fission and fusion • Analysing case studies of nuclear power plants, including their design, operation, and safety features • Evaluating the advantages and disadvantages of nuclear energy • Designing solutions to challenges related to nuclear energy, such as safety concerns or waste disposal	• Understanding of nuclear energy demonstrated accordingly

TOPIC	SUB-TOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
		3.2.3.2 Analyse the uses of nuclear energy in our daily life	• Analyzing the uses of nuclear energy (*medical industry, electricity generation...)*	• The use of nuclear energy in our daily life analysed accordingly
3.3 EQUILIBRIUM	**3.3.1 Chemical Equilibrium**	3.3.1.1 Demonstrate understanding of chemical equilibrium.	• Describing chemical equilibrium (*state in a reversible chemical reaction where the rate of the forward reaction is equal to the rate of backward reaction resulting in constant concentrations of the products and reactants over time*)	• Understanding off chemical equilibrium demonstrated correctly.
	3.3.2 Reversible Reactions	3.3.2.1 Demonstrate reversibility of chemical reactions	• Demonstrating the reversibility nature of chemical reactions that proceed in both forward and backwards directions • Exploring reversibility of chemical reactions • Demonstrating thermal dissociation of ammonium salts	• Reversibility of chemical reactions demonstrated correctly
	3.3.3 Dynamic Equilibrium	3.3.3.1 Analyse the characteristics of a chemical reaction in a dynamic equilibrium	• Describing a dynamic equilibrium • Exploring the characteristics of a chemical reaction in dynamic equilibrium in terms of: *(a) rates of forward and backward reactions are equal* (b) *The amounts of reactants and products are constant*	• The characteristics of a chemical reaction in a dynamic equilibrium analysed correctly
		3.3.3.2 Evaluate the factors that affect position of dynamic equilibrium	• Investigating the factors that affect the position of equilibrium (*temperature, concentration, pressure) applying Le Chartelier's principle. (Refer to Haber process)*	• The factors that affect position of dynamic equilibrium evaluated correctly

TOPIC	SUB-TOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
3.4 ELECTRICITY AND CHEMISTRY	**3.4.1 Electrochemistry**	3.4.1.1 Demonstrate understanding of electrochemistry.	• Describing electrochemistry (*study of the relationship between electricity and chemical reactions*)	• Understanding of electrochemistry demonstrated correctly
	3.4.2 Conductors and Non - Conductors	3.4.2.1 Evaluate the properties and applications of conductors and non-conductors	• Investigating electrical conductivity of various materials (*metals and non-metals*) • Evaluating the properties and applications of conductors and non-conductors • Classifying electrical conductivity of various materials (*metals and non-metals*) • Researching on real-world applications of conductors and non-conductors (*electronics, transportation, medicine…)*	• Properties and applications of conductors and non-conductors evaluated correctly
	3.4.3 Electrolysis	3.4.3.1 Demonstrate understanding of electrolytic processes	• Describing electrolysis (*chemical process that uses electric current to drive a chemical reaction at the electrodes*) • Analysing solutions of compounds as electrolytes and non-electrolytes *[(solutions of strong acids, alkalis and salts) and weak electrolytes* • *(solutions of weak acids and alkalis) such as ionic compounds in solution/molten and covalent compounds*]	• Understanding of electrolytic processes demonstrated correctly

TOPIC	SUB-TOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
			• Investigating the electrolytic decomposition of molten binary ionic compounds (*lead (II) bromide, aluminium oxide,* referring to the half electrode reactions. *Metals to be produced at the cathode by reduction and non-metals to be produced at the anode by oxidation* • Deducing the electrode products given a suitable electrolyte and electrodes • Discussing the electrochemical series as the arrangement of ions in order of their electrode potentials • Applying the electrochemical series in the preferential discharge of ions in the electrolysis of the following: (a) Dilute sulphuric acid (H_2SO_4) (b) Concentrated hydrochloric acid (HCl) (c) Copper (II) sulphate ($CuSO_4$) (d) Concentrated sodium chloride/ brine (NaCl)	
	3.4.4 Quantitative Electrolysis (Faraday's Laws)	3.4.4.1 Determine quantities of electrolytic products	• Applying Faraday's Laws to determine the quantities of electrolytic products at the electrodes and the ionic charges	• Quantities of electrolytic products determined correctly

TOPIC	SUB-TOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
	3.4.5 Industrial Application of Electrolysis	3.4.5.1 Analyse the uses of electrolytic processes in industries	• Exploring the application of electrolysis such as extraction of metals (aluminium), electroplating, purification of metals (copper), anodizing, chemical manufacturing (H_2SO_4, NaOH, Cl_2, H_2)	• Uses of electrolytic processes in industries analysed accordingly
	3.4.6 Chemical Cell	3.4.6.1 Construct electrolytic cells	• Constructing an electric cell by connecting two different electrodes dipped in suitable electrolyte to produce electricity • Relating reactivity series of metals to the amount of electricity produced by a simple cell • Comparing and contrasting simple cells and electrolytic cells in terms of similarities such as oxidation at the anode and reduction at the cathode, and differences such as polarities (charges) and nature of electrodes	• Electrolytic cells constructed correctly
3.5 PERIODICITY	**3.5.1 Periodic Table**	3.5.1.1 Demonstrate understanding of Groups and Periods of the Periodic table	• Analysing trends in Periods (period 3) and various Groups (I, II and VII) in terms of physical and chemical properties: *(a) Physical properties: solubility, melting and boiling points, density, colour, state of matter, atomic size,*	• Understanding of Groups and Periods of the Periodic table demonstrated correctly

TOPIC	SUB-TOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
			(b) *Chemical properties: reactivity, electropositivity, electronegativity*	
		3.5.1.2 Apply periodic trends to determine metallic and non-metallic nature of elements	• Determining metallic and non-metallic nature using periodic trends	• The Periodic trends to determine metallic and non-metallic nature of elements applied correctly
		3.5.1.3 Apply periodic trends to predict the properties of newly discovered elements	• Researching on the trends of elements in the same group and period as the new element • Predicting the properties of a new element with a specific atomic number using the periodic trends • Conducting a collaborative research project to investigate the discovery of new elements and the role of Periodic trends in predicting their properties	• The Periodic trends applied to predict the properties of newly discovered elements correctly
		3.5.1.4 Analyse the uses of elements in particular groups	• Exploring the importance of halogens (*fluorine in tooth paste, chlorine in water treatment, antiseptics*) • Exploring the uses of the noble gases in providing an inert atmosphere such as: *(i) lighting (argon, neon, krypton)* *(ii) insulation (argon and krypton)* *(iii) medical application in anaesthesia (xenon)* (iv) *welding (argon and helium)*	• The uses of elements in particular Groups analysed accordingly

TOPIC	SUB-TOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
		3.5.1.5 Design sustainable solutions to reduce the environmental impact of halogen compounds	• Examining harmful effects of halogens and their compounds on the environment such as chlorofluorocarbons (CFCs) in ozone layer depletion • Designing sustainable solutions to reduce the environmental impact of halogen compounds	• Sustainable solutions to reduce the environmental impact of halogen compounds designed correctly
	3.5.2 Transition Metals	3.5.2.1 Investigate properties and uses of transition elements	• Exploring the typical properties of transition metals (*density, high melting and boiling points, coloured compounds (iron (II) green, iron (III) brown, copper(II) blue), variable valencies and form complex ions*) • Conducting experiments to investigate the properties of transition elements (*reactivity or catalytic activity*) • Exploring the uses of transition metals (*catalysts, alloys, construction…*)	• Properties and uses of transition elements investigated sustainably
	3.5.3 Properties of Metals	3.5.3.1 Investigate physical and chemical properties of metals	• Describing a metal (*a pure substance that ionises by losing electrons*) • Investigating physical properties of metals (*thermal and electrical conductivity, sonorosity, malleability, ductility, lustre, density, melting and boiling points, tensile strength*)	• Physical and chemical properties of metals investigated correctly

TOPIC	SUB-TOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
			• Investigating chemical properties of metals (*reactivity with dilute acids, water/steam, oxygen, displacement reactions with other metals*)	
	3.5.4 Reactivity Series	3.5.4.1 Determine the reactivity series of metals	• Determining the reactivity series of metals using dilute acids, water/steam, oxygen/air, displacement reactions and simple cells • Analysing data from experiments involving the reactivity series of metals, including identifying patterns and trends	• The reactivity series of metals determined correctly

FORM 4

TOPIC	SUB-TOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
4.1 METALLURGY	**4.1.1 Mineral Ores**	4.1.1.1 Demonstrat understanding of metallurgy	• Discussing metallurgy (*a science and technology of metals, focusing on their occurrence, properties, extraction, processing and theirs uses*)	• Understanding of metallurgy correctly demonstrated
		4.1.1.2 Identify different mineral ores in the local environment	• Exploring occurrence mineral ores in the local environment • Identifying different mineral ores using their physical and chemical properties • Classifying different mineral ores using their physical and chemical properties • Researching on the sources of metals (*copper, gold, emeralds, nickel, lithium, cobalt, iron, aluminium, zinc, manganese…*)	• Different mineral ores identified in the local environment accordingly
	4.1.2 Extraction of Metals	4.1.2.1 Demonstrate understanding of metal extraction	• Discussing the sustainable ways of extracting metals: copper, iron, zinc (*by chemical reduction*) and aluminium (*electrolytic reduction)* • Illustrating metal extraction process for a specific ore, including the steps involved and the equipment needed	• Understanding of metal extraction demonstrated correctly

TOPIC	SUB-TOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
	4.1.3 Uses of Metals	4.1.3.1 Analyse the uses of metals in everyday life	• Analysing the various uses of metals in everyday life *(construction and building materials: steel, aluminum, copper, transportation; cars, airplanes, bicycles, electronics and technology; copper wiring, aluminum casings, packaging and consumer goods; aluminum cans, steel containers…)* • Developing sustainable metal use practices in a specific context, including strategies for reducing waste and promoting recovering, reusing, recycling…	• Uses of metals in everyday life analysed correctly
		4.1.3.2 Analyse the impact of toxic metals on ecosystems and human health	• Investigating the harmful effects of metals (*lead poisoning- brain damage, infertility…; sodium ions- raising high blood pressure, alzehermia… mercury- lung, brain, kidney damage…*)	• The impact of toxic metals on ecosystems and human health analysed correctly
	4.1.4 Alloys	4.1.4.1 Design an alloy for a specific application	• Describing alloys (*mixtures of two or more metals and / or non-metals such as brass, bronze, steel)* • Drawing the structural representation of alloys	• An alloy designed for a specific application accordingly

TOPIC	SUB-TOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
			• (*different nuclei positive ions in a sea of delocalised electrons*) • Explaining the advantages of using alloys over pure metals (*conductivity, strength, weight, hardness, resistance to corrosion…*) • Relating the uses of alloys to their properties (*cutlery, food packaging, aircraft parts…)* • Designing an alloy for a specific application (*refer to composition, processing, properties*…)	
	4.1.5 Corrosion and its Prevention	4.1.5.1 Prevent corrosion of metals	• Describing corrosion (*refer to chemical wearing of metals by oxidation using atmospheric oxygen in presence of moisture*) • Demonstrating corrosion (rusting) of iron • Relating corrosion to the reactivity of metals • Applying different methods of preventing corrosion (*sacrificial protection, painting, greasing/oiling, alloying and galvanizing*…)	• Corrosion of metals prevented accordingly

TOPIC	SUB-TOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
4.2 NON-METALS	**4.2.1 General Properties of Non-Metals**	4.2.1.1 Investigate the physical and chemical properties of non-metals	• Describing non-metals (*pure substances that ionise by gaining electrons. exception of hydrogen…*) • Investigating the physical properties of non-metals (*density, melting and boiling points, thermal and electrical conductivity, physical states at r.t.p …*) • Investigating the chemical properties of non-metals • Demonstrating use of the physical and chemical properties of non-metals to solve problems (*identifying unknown substances or predicting chemical reactions…*)	• Physical and chemical properties of non-metals investigated accordingly
	4.2.2 Hydrogen	4.2.2.1 Prepare hydrogen gas	• Preparing, collecting, and testing hydrogen gas in the laboratory (*by action of moderately reactive metals with water/steam and dilute acids and collect by upward delivery method, puts out a lighted splint with a 'pop; sound)*	• Hydrogen gas prepared correctly
		4.2.2.2 Investigate the industrial manufacture of hydrogen	• Demonstrating the physical and chemical properties of hydrogen gas (*COWSLIPS*)	• Industrial manufacture of hydrogen investigated correctly

TOPIC	SUB-TOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
			• Exploring the industrial manufacture of hydrogen (*by cracking, electrolysis of water/brine and from natural gas)*	
		4.2.2.3 Analyse the uses of hydrogen gas	• Exploring the uses of hydrogen (*reducing agent, fuel for rockets, manufacture of ammonia and margarine, welding…)*	• The uses of hydrogen gas analysed correctly
	4.2.3 Oxygen	4.2.3.1 Prepare oxygen gas	• Preparing, collecting, and testing oxygen gas in the laboratory *(catalytic decomposition of hydrogen peroxide and thermal catalytic decomposition of potassium chlorate, collected above water and re-lights the glowing splint…*)	• Oxygen gas prepared correctly
		4.2.3.2 Investigate the industrial manufacture of oxygen	• Exploring the industrial manufacture of oxygen by fractional distillation of liquid air	• Industrial manufacture of oxygen investigated correctly
		4.2.3.3 Investigate the properties and uses of oxygen gas.	• Analysing the physical and chemical properties of oxygen gas (*colour, odour, solubility, combustion...)* • Exploring the uses of oxygen in industrial and natural processes (*combustion,*	• Properties and uses of oxygen gas investigated correctly

TOPIC	SUB-TOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
			welding, in blast furnace, respiration…)	
		4.2.3.4 Practise sustainable ways of protecting the ozone layer	• Demonstrating environmental awareness and concern for the impact of human activities on the ozone layer • Recognising the importance of ozone layer (*trapping ultraviolet radiation and dangers of its depletion causing skin cancer and respiratory diseases…)* • Designing solutions to protect the ozone layer	• Sustainable ways of protecting the ozone layer practised accordingly
	4.2.4 Nitrogen	4.2.4.1 Prepare ammonia gas in the laboratory	• Preparing, collecting and testing ammonia gas in the laboratory (*by action of a base on an ammonium salt and collected by upward delivery method, turn red litmus paper blue)* • Investigating the physical and chemical properties of ammonia in terms of (*colour, odour, density/weight, solubility and as reducing agent, a base/alkali, a complexing reagent)*	• Ammonia gas prepared in the laboratory correctly

TOPIC	SUB-TOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
		4.2.4.2 Investigate the industrial manufacture of nitrogen and its related products	• Exploring the industrial manufacture of nitrogen (*by fractional distillation of liquid air)* • Exploring the industrial manufacture of ammonia (*by Haber process)*	• The industrial manufacture of nitrogen and its related products investigated correctly
		4.2.4.3 Analyse the uses of nitrogen	• Exploring the characteristics of nitrogen (*non-reactive, insoluble gas…)* • Analysing the uses of nitrogen (*used as refrigerant, in food packaging, used in the manufacture of ammonia gas…*)	• The uses of nitrogen analysed correctly.
	4.2.5 Chlorine	4.2.5.1 Prepare chlorine gas and its associated products	• Preparing, collecting and testing chlorine gas *(by action of hot concentrated hydrochloric acid on manganese (IV) oxide, collected by downward delivery method, turn dump blue litmus paper red and then bleaches it respectively)* • Investigating the physical and chemical properties of chlorine *(colour, odour, density, solubility, poisonous, reactions with iron, non-metals (H_2, S, O_2, P) sulphur dioxide, iron (II) salts and halides)*	• Chlorine gas and its associated products prepared correctly

TOPIC	SUB-TOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
			• Exploring the uses of chlorine (*sterilising water, manufacture of polyvinylchloride (PVC), Hydrochloride (HCl), in bleaching agents…)* • Exploring the industrial manufacture of chlorine by electrolysis of brine (NaCl) • Preparing, collecting and testing hydrogen chloride gas (*by action of concentrated sulphuric acid on solid metallic halides, collected by downward delivery method, react with ammonia to form a white smoke respectively)* • Investigating the physical and chemical properties of hydrogen chloride gas (*in terms of colour, odour, density, solubility and poisonous, reaction with ammonia and water*) • Preparing hydrochloric acid (*by dissolving hydrogen chloride gas in water)* • Exploring the uses of hydrochloric acid	

TOPIC	SUB-TOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
			(*manufacture of fertilisers, metal pickling, water treatment, as a typical acid, house hold cleaning agent…)*	
	4.2.6 Sulphur	4.2.6.1 Prepare sulphur dioxide	• Investigating the formation of sulphur dioxide (*combustion of sulphur, fossil fuels ...)* • Preparing, collecting and testing sulphur dioxide in the laboratory (*by action of warm dilute acids on sulphites, collected by downward delivery, turn acidified potassium dichromate (VI) green/decolourises purple potassium manganate (VII))* • Investigating the physical and chemical properties of sulphur dioxide (*in terms of colour, odour, density, solubility, poisonous, reaction with water, action on indicators and as a reducing agent)* • Exploring the uses of sulphur dioxide (*food preservatives, bleaching wood pulp for making paper, manufacture of sulphuric acid*)	• Sulphur dioxide prepared correctly

TOPIC	SUB-TOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
			• Investigating the impact of sulphur dioxide on the environment *(air pollution, acid rain, damage to infrastructure, climate change, respiratory effects on humans)* • Exploring sustainable ways of reducing emissions of sulphur diode (*transition to cleaner energy sources, implementation of pollution control technologies, energy efficiency improvement, use of low sulphur fuels, sustainable agriculture practices, public awareness and education*) • Exploring the industrial manufacture of sulphuric acid (*contact process*) • Exploring environmental impact of Contact process (*air pollution, resource depletion, water pollution, greenhouse gas emissions*) • Investigating sustainable ways of mitigating the environmental impact of contact process (*resource efficiency, energy efficiency,*	

TOPIC	SUB-TOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
			emission and pollution control, life cycle assessment, green chemistry) • Exploring the uses of sulphuric acid (*explosives, drying agent, making soap, fertilisers…)*	
	4.2.7 Carbon	4.2.7.1 Explore the nature and uses of carbon and its products	• Discussing allotropes of carbon (*crystalline -graphite, diamond, non-crystalline - coke, coal, soot, charcoal)* • Exploring the physical properties of allotropes of carbon and their uses • Investigating the formation and properties of carbon monoxide (*by incomplete combustion of carbon and carbon compounds, reduction of carbon dioxide by carbon)*	• The nature and uses of carbon and its products explored correctly
		4.2.7.2 Prepare carbon dioxide	• Preparing, collecting and testing carbon dioxide (*by reacting dilute acids with carbonates or bicarbonate, collected by downward delivery method/above water form white precipitate with lime water)*	• Carbon dioxide prepared correctly

TOPIC	SUB-TOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
			• Exploring the physical and chemical properties of carbon dioxide (*in terms of color, odour, density, solubility, reaction with lime water/alkalis, water and carbon)* • Exploring the uses of carbon dioxide (*fire extinguishers, carbonated drinks, dry ice, baking, photosynthesis)*	
		4.2.7.3 Explore the manufacturing of limestone	• Analysing uses of limestone /calcium carbonate (*manufacture of lime, cement, glass, iron, tiles…)* • Exploring the manufacture of lime from limestone (*by thermal dissociation of limestone*) • Exploring the uses of lime and slaked lime (*neutralizing acidic soil, lime as a drying agent for ammonia…)*	• Manufacturing of limestone explored correctly
	4.2.8 Silicon	4.2.8.1 Investigate the nature and uses of silicon and its products	• Describing silicon as a metalloid • Exploring the uses of silicon (*in semi-conductors, transistors, diodes and capacitors*)	• The nature and uses of silicon and its products investigated accordingly

TOPIC	SUB-TOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
			• Investigating silicones as macromolecules that exist as oils, waxes or plastics and their structures represented as:  • Comparing and contrasting the fire resistance of silicone plastics to carbon-based macromolecules, the nature of silicones with reference to nature of combustion products, silicones produced silicon dioxide/sand (SiO_2) while organic based macromolecules produce carbon dioxide (CO_2). • Exploring the uses of silicones (*silicon chips, artificial hips, breasts, oils, waxes, plastics...)* • Exploring the forms of silicon dioxide (*sand, silica, quartz)* and their uses (*making glass, as fire extinguisher, iron extraction, construction)*	

TOPIC	SUB-TOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
4.3 ORGANIC CHEMISTRY	**4.3.1 Introduction to Organic Chemistry**	4.3.1.1 Demonstrate the understanding of organic chemistry.	• Describing organic chemistry • Describing organic compounds • Exploring the characteristics of homologous series (*general molecular formula, functional group, physical and chemical properties, nomenclature)*	• Understanding of organic chemistry demonstrated correctly
	4.3.2 Saturated and Unsaturated Hydrocarbons (Non-Cyclic)	4.3.2.1 Evaluate the nature and uses of saturated and unsaturated hydrocarbons	• Illustrating the structures of aliphatic alkanes up to ten (10) carbon atoms • Naming the structures of aliphatic alkanes up to ten (10) carbon atoms. (*Involve concepts of tetravalency and catenation of carbon, use of general formula* C_nH_{2n+2}*, name by IUPAC system)* • Demonstrating the structures of alkane isomers and their names using models (*use ideas of branched and unbranched butane and pentane and nomenclature according to IUPAC system)* • Illustrating and naming the structures of aliphatic alkenes and alkynes up to ten carbon atoms (*Involve concept of*	• The nature and uses of saturated and unsaturated hydrocarbons explored correctly

TOPIC	SUB-TOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
			catenation (chain), use general formula C_nH_{2n} and C_nH_{2n-2}, named by IUPAC system, name ending '-ene' and '-yne') • Demonstrating the structures of alkene and alkyne positional isomers and their names *(use ideas of branched and unbranched butene/butyne and pentene/pentyne and nomenclature follows IUPAC system)* • Exploring the preparation of alkanes, alkenes and alkynes (*refer to methane, ethane and ethyne*) • Exploring the non-apparent reactivity of alkanes as compared to other organic compounds • Investigating physical and chemical properties of alkanes, alkenes • Testing for unsaturation (*decolourises bromine water rapidly*) ***(Note:** Preparation, uses, and properties of alkynes not required.)* • Exploring fractional distillation of petroleum (*crude oil*)	

TOPIC	SUB-TOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
			• Investigating fractions of crude oil and their uses • Evaluating the environmental impact of fractional distillation of crude oil (*refer to air pollution, water pollution, waste management, resource depletion, land use and habitat disruption, climate change…*) • Exploring ways of sustainable production of crude oil (*refer to energy efficient distillation process, carbon capture and storage, use of renewable feed stock, recycling and waste management, life cycle assessment)* • Investigating the environmental impact of the combustion of hydrocarbons (*air and water pollution, greenhouse gas emissions, climate change, acid rain health impact…)* • Exploring sustainable ways of addressing combustion of hydrocarbons (*carbon capture,*	

TOPIC	SUB-TOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
			• *utilisation and storage, green chemistry, circular economy: recover, reuse, reduce, recycle*) • Exploring sustainable combustion practices	
	4.3.3 Carboxylic Acids and Alcohols	4.3.3.1 Demonstrate understanding of carboxylic acids	• Illustrating and naming structures of carboxylic acids up to five (5) carbon atoms (*involve concept of catenation (chain); use general formula* $C_nH_{2n+1}COOH$*)* • Exploring the preparation of carboxylic acids (*refer to ethanoic acid by oxidation of ethanol, hydrolysis of esters*) • Investigating physical and chemical properties of carboxylic acids (a. *physical properties: density, solubility, state of matter, boiling and melting points, b. chemical properties: reaction with bases, carbonates, metals and alcohols)* • Exploring the uses of carboxylic acids (*food flavouring, esterification, soap manufacturing, in drinks…)*	• Understanding of carboxylic acids demonstrated correctly

TOPIC	SUB-TOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
		4.3.3.2 Explore the preparation of alcohols	• Describing alcohols • Exploring different types of alcohols • Illustrating the structure of alcohols up to 5 carbon atoms • Preparing alcohols (*refer to ethanol by hydration of ethene, fermentation of sugar and hydrolysis of esters)* • Investigating physical and chemical properties of alcohols (*physical properties: density, solubility, state of matter, boiling and melting points; chemical properties: combustion, esterification, dehydration and oxidation)* • Exploring the uses of Alcohols (as *a fuel, as solvents, disinfectants, beer and wine, drug manufacturing…)*	• Preparation of alcohol explored correctly
	4.3.3 Alkyl Alkanoates (Esters)	4.3.3.1 Demonstrate understanding of Esters	• Describing esters • Illustrating structures of esters up to five (5) carbon atoms (*involve concept of catenation (chain), organic compound with*	• Understanding of esters demonstrated correctly

TOPIC	SUB-TOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
			ester link and end with '-oate', general formula; $C_mH_{2m+1}C(=O)-O-C_nH_{2n+1}$ *Where m = 0, 1, 2, 3…. and n = 1, 2, 3…)* • Naming structures of esters up to five (5) carbon atoms (*involve concept of catenation (chain), organic compound with ester link and end with '-oate', general formula;* $C_mH_{2m+1}C(=O)-O-C_nH_{2n+1}$ *Where m = 0, 1, 2, 3…. and n* = 1, 2, 3…*)*	
		4.3.3.2 Prepare Esters (Alkyl Alkanoates) for different uses	• Exploring the preparation of esters by esterification • Investigating physical and chemical properties of esters (*Physical properties: density, solubility, state of matter, boiling and melting points; chemical properties: combustion and hydrolysis)* • Exploring the uses of esters: as in *(perfumes, flavouring and preservation)*	• Esters for different uses prepared accordingly

TOPIC	SUB-TOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
	4.3.4 **Macromolecules** (Polymers)	4.3.4.1 Demonstrate understanding of macromolecules	• Describing macromolecules (*giant molecules formed by combination of many small molecules-monomers)* • Exploring macromolecules and their formation (*synthetic macromolecules: polyethene, polyvinyl chloride, polypropene, polystyrene, polytetrafluoroethene (PTFE)/Teflon, nylon, terylene; natural macromolecules: fats, starch and proteins*) • Analysing the formation of macromolecules (*as addition polymers and condensation polymers*) • Investigating the nature of plastics (*as thermal plastics and thermosets)* • Comparing/contrasting the structures of macromolecules (*nylon, proteins, terylene, fats)* • Exploring the typical uses of plastics and synthetic fibres (*in carrier bags, buckets, pipes, clothing, tents, strings, ropes…)* • Investigating the biodegradability of polymers and their effects on the environment. • Investigating the hydrolysis of fats, proteins and starch	• Understanding of macromolecules demonstrated correctly

TOPIC	SUB-TOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
		4.3.4.2 Make plastics, soaps and glycerine	• Demonstrating the formation of soaps (*saponification*) and glycerine (*by alkali and acid hydrolysis respectively*)	• Plastics, soaps and glycerine made correctly
4.4 ENVIRONMENTAL CHEMISTRY	4.4.1 **Chemistry and the Environment**	4.4.1.1 Analyse the role of chemistry in sustaining the environment.	• Discussing environmental chemistry *(the study of chemical processes in the environment and how humans and biological activities affect them (anthropological activities)* • Researching on the impact of human activities on the environment and the role of chemistry in addressing these issues. • Analysing the role of chemistry in environmental sustainability	• The role of chemistry in sustaining the environmental related correctly
	4.4.2 Pollution and Remediation	4.4.2.1 Investigate pollution control and mitigation.	• Investigating types of pollution (*air, water, land …*) • Exploring pollution control and mitigation measures (*solid management, water and waste treatment, recover, reuse, recycle, reduce …*)	• Pollution control and mitigation investigated accordingly
	4.4.3 Role of Chemistry in Sustainable Agriculture	4.4.3.1 Investigate the role of chemistry in sustainable agriculture	• Investigating the use of sustainable agricultural practices (*green pesticides, integrating bio waste management, crop rotation and inter-cropping techniques, enhancing agroforestry, liming the soil…)*	• The role of chemistry in sustainable agriculture investigated correctly

TOPIC	SUB-TOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
	4.4.4 Climate Change	4.4.4.1 Demonstrate understanding of climate change	• Describing climate change (*long-term changes in temperatures and weather patterns; (**Note**: climate change effects are regional specific around the world*)	• Understanding of climate change demonstrated correctly
		4.4.4.2 Investigate causes and effects of climate change	• Exploring the causes of climate change (*deforestation, industrial processes, burning fossil fuels…*) • Analysing the effects of climate change *(depletion of ozone layer, global warming, floods, drought …*) • Designing mitigation measures of climate change (*transition to renewable energy sources, enhancing agroforestry …*)	• Causes and effects of climate change investigated correctly
	4.4.5 Water Management	4.4.5.1 Demonstrate understanding of water management	• Describing water management (*the management of water resources under set standard policies and regulations*) • Analysing the methods of water management (*water purification, water harvesting and artificial rain, repurposing water…*)	• Understanding of water management demonstrated correctly

APPENDIX: DETAILED SPECIFICATIONS -APPARATUS AND CHEMICALS

ITEM	DESCRIPTION	DETAILED SPECIFICATIOS
1	RUBBER GLOVES (PAIRS)	(i) GLOVES RUBBER FLOC LINED Nominal (ii) Lengths 300mm ORANGE/YELLOW, GLOVES RUBBER FLOC LINED Nominal Lengths 300mm BLACK
2	THERMOMETERS	(i) Mercury White back, glass with bulb, Partial immersion, Range:-10º C to 110º Cat 1 º C (ii) Mercury White back, glass with bulb, Partial immersion, Range:-5 º C to 50 º C at 0.2 º C
(a) 3	THE FUME BOARD	Fume Cupboard for monitoring gases during preparations of dangerous gases fitted at the back of each chemistry lab
(b) 4	DENSITY BOTTLES 50MLS	Borosilicate glass with capillary stopper
(c) 5	DENSITY BOTTLES 25MLS	Density bottle, borosilicate glass with capillary stopper, unadjusted 25mls
(d) 6	GLASS JARS	Cylindrical glass jar,100mm high, without lid
(e) 7	MORTARS AND PESTLES	Mortars and pestles all porcelain, grinding surfaces unglazed, mortar: 110mm outside diameter, glazed
(f) 8	BOILING TUBE	Test tube (Pyrex) borosilicate glass, heavy glass wall, 25mm diameter to fit bung, rimmed 15x25mm usually pack of 12
(g) 9	TRIPOD STAND AND GAUZES	Tripod stand: cast iron triangular top, 200x125mm: Gauze: wire mesh, square, 125x25mm with asbestos centre
(h) 10	TEST TUBE RACKS	Nylon coated wire rack to hold 12 test tube of 16mm
(i) 11	WATER BATH WITH ACCESSORIES	Water Bath, Analogue, 24L- Corrosion resistance tank, Easy to use analogue controls, electronically controlled ensuring good temperature stability. The accessory cover should be gable shaped and designed so that any condensation runs to the interior walls of the bath.
(j) 12	REFRIGERATION	(i) Laboratory Refrigeration with separation freezing compartment with 150 L lower compartment, 40 L upper freezer compartment. Overall dimension (WXLXH) (ii) Medicine refrigerator. Overall dimensions (W x D x H) 379x 500x 702 mm, 28 Litres capacity, automatic defrosting, CFC free. Storage bin, Adjustable mesh shelves, Lockable door. (iii) Spark free laboratory refrigerator, internally free from sources of heat, arc or spark, adjustable thermostat with range 0 ºC to +8 ºC, CFC free, size (W x Lx H) 502 x 508 x 629mm. Separate upper freezer compartment with controlled defrost refrigerator section. Lockable doors
(k) 13	BEAKERS (600ML): GLASS PYREX	Ref 100/18 manufactured from Pyrex) borosilicate glass, Complies with ISO 3819, Low form, 600ml graduated to 500ml
(l) 14	BEAKERS (250MLS): GLASS PYREX	Ref 1000/10 manufactured from (Pyrex) borosilicate glass, Complies with ISO 3819, Low form 250mls and graduated to 25mls.

CHEMISTRY LABORATORY

ITEM	DESCRIPTION	DETAILED SPECIFICATIOS
(m) 15	BEE HIVE SHELVES	Earthenware/ porcelain, cylindrical with nominal diameter of 75mm, holes and spare for fitting tube

ITEM	DESCRIPTION	DETAILED SPECIFICATIOS
(n) 16	BEAKERS (100MLS): GLASS PYREX	Ref 1000/04 manufacture from Pyrex borosilicate glass, Complies with ISO 3819, Low from, graduated to 100ml.
(o) 17	BURETTES	Burette, moramber soda- lime glass, 50mls graduated in 0.1mls divisions, with single bore stopcock
(p) 18	BUCHNER FUNNELS	(i) Buchner Type- Polypropylene Two piece construction, autoclavable. Capacity of 40mls, filter paper size 42.5 mm, filter diameter 55mm. (ii) Buchner Type- olyproperlene two piece construction, autoclavable, filter diameter 70 mm (iii) Buchner Type- Porcelain, filter diameter 55mm Dimensions are nominal
(q) 19	BUNSEN BURNERS	Die- cast base with integral inlet tube 8mm bore flexible gas tubing. Base finish in chemically resistant blue acrylic paint. Overall height approx. 124mm. Bunsen burner fitted with control stopcock and pilot flam. For use with LPG gas.
(r) 20	LIEBIG CONDENSER	Liebig condenser 14/23 socket and 260mm overall length
(s) 21	CRUCIBLES	Porcelain crucible low from with lid. Capacity: 25mls, diameter 46mm, height 27mm
(t) 22	CORKS AND RUBBER BUNGS	(i) Cork stoppers, no holes, size ranging from 6 x 9 16 mm to 47 x 50 x 32 mm assorted pack (ii) Bungs, one – hole stoppers, made of natural rubber, red size diameters (BS 2775) (iii) Bungs, one – hole stoppers, made of natural rubber, red mixed pack size ranging from 5x 7 x 16mm to 37 x 42 x 38mm(BS 2775) Bungs, two holes stopper rubber, red with 5mm diameter hole size ranging from 15x 18 x 24mm to 57 x 49 mm pack (BS2775)
(u) 23	CHROMATOGRAPHY PAPER (4CM)	Preferred “Whatman brand”4cm
(v) 24	EVAPORATING DISHES	Porcelain, type Round Bottom shallow form with spout, Capacity of 50ml- 70mm diameter x 28mm height.
(w) 25	INDICATOR BOTTLES	Clear glass with plastic stopper, vinyl teat and graduated pipette. 100ml capacity with 1x 0.5ml
(x) 26	MEASURING CYLINDER	CYLINDER PP CLASS B WITH MOULDED GRADUATIONS AND SPOUT 100ML
(y) 27	MEASURING CYLINDER	CYLINDER PP CLASS B WITH MOULDED GRADUATIONS AND SPOUT 500ML
		(i) Polypropylene, bulb class B, graduated in 0.2mls divisions
		(ii) Borosilicate (Pyrex) graduated in 0.2ml divisions
(z) 28	PROTECTIVE GOGGLES	Single lens- clear polycarbonate lens to BS E166 1B, soft PVC Frame with adjustable elastic headband and clear wide angles lens.

ITEM	DESCRIPTION	DETAILED SPECIFICATIOS
(aa) 29	REAGENT BOTTLES 250ML GLASS	Borosilicate (Pyrex 1516 series or equivalent),250ml, graduated 1ml divisions, wide mouth, can be used up to 140 c,
		(i) With Polyprolene screw cap and clear pouring ring.
		(ii) With pipette stoppers
		(iii) With Screw top soda glass stopper
(bb) 30	ELECTRONIC BALANCE (ANALYTICAL BALANCE)	Portable electronic balance 2000g x 1 g with 146x 133mm pan, mains adaptor, container of 100ml and 3 Alkaline size AA
(cc) 31	TEST TUBES 25MMX 150MM	(i) Borosilicate (Pyrex), medium wall, rimmed size 150mm tall, 25mm diameter (i) Borosilicate (Pyrex) Glass, light wall rimmed 125mm tall, 16mm diameter
(dd) 32	THISTLE FUNNELS	Glass with plain stem, Stem length of 25omm diameter of 6mm
(ee) 33	TEST TUBES 16MM X 125MM	(ii) Borosilicate (Pyrex) Glass, medium wall rimmed 125mm tall, 16mm diameter (iii) Soda lime glass, light wall rimmed 125mm tall, 16mm diameter
(ff) 34	TUBING RED RUBBER	Tubing natural red rubber 6.5mm bore x 1.5mm wall coil of 10 metres.
(gg) 35	TROUGH	Staining trough black polyacetal with push fit lid 100x 85 x 55 mm
(hh) 36	HOFFMANN VOLTAMMETER	Hoffman voltammeter for determination of chemical composition by electrolysis Glass unit two connecting limbs, each of capacity 50mls, graduated limbs to 50 x 0.2mls, reservoir tube and funned shaped bulb with a stop cock at the top of each limb, overall length of approximately 650mm, carbon (110mm) and platinum (13x10mm) electrodes mounted in rubber stoppers for insertion into open ends of voltammeter limbs. For use on 12 Volts d.c supply. Accessories to include a set of mounts to support limbs, a stand, base and rod of minimum length 600mm, crocodile clips to accept 4mm plugs.
(ii) 37	VOLUMETRIC FLASK 2000ML	Made of borosilicate glass with polyethylene stopper and enamel graduations and inscriptions. 2000ml with stopper 14/23
(jj) 38	VOLUMETRIC FLASK 1000ML	Made of borosilicate glass with polyethylene stopper and blue enamel graduations and inscriptions. 1000ml stopper 24/29. Pyrex
(kk) 39	VOLUMETRIC FLASK 500ML	Made of borosilicate glass with polyethylene stopper and blue enamel graduations and inscriptions. 500ml stopper 19/26
(ll) 40	MEASURING CYLINDER	Cylinder pp class b with moulded graduations and spout 50ml
(mm) 41	MEASURING CYLINDER	Cylinder pp class b with moulded graduations and spout 25ml
(nn) 42	MEASURING CYLINDER	Cylinder pp class b with moulded graduations and spout 10ml
(oo) 43	FLASK	Erlenmeyer flask borosilicate (Pyrex) glass, conical, graduated 25ml wide neck, to fit bung 27
(pp) 44	ANTI ACID COATS	(i) Lab coats type white unisex press- stud front with pockets small. Medium and large. (ii) Lab coats white cotton drill unisex press-stud front with pockets small, medium and large.
(qq) 45	ANT ACID AOPRONS	Rubber, rib Fronted size 1000mm in length
(rr) 46	CHEMICAL BEAM BALANCE	Sliding weight, bench mounting with flat steel platform approximately 430 x 380mm, Heavy - duty model. 25kg x 5g
(ss) 47	TRIPLE BEAM BALANCE	Triple beam balance capacity 2610g readability 0.1g with three beams, graduated 0 o 500g x 100g, 0 to 100 g x 10g, 0 to 10g x 0.1g with a flat stainless steel pan. 150mm diameter. Magnetically damped beam movement.

ITEM	DESCRIPTION	DETAILED SPECIFICATIOS
(tt) 48	SIMPLE BUT CHART BALANCE	Weighing scale, mechanical with large easy to read dial. 10Kg x 50g readability. Robust all- steel construction with a dish like pan size of approximately 400 x 280mm in stainless steel.
(uu) 49	DISPEMSING MONARCH TYPE BALNCE	Compact pharmaceutical dispensing balance non crown stamped or ce verified 500mg - 100g
(vv) 50	CLAMP RETORT	Clamp natural finish cork/rubber lined interlocking jaws and 8mmdiameter rod for articles up to 80 mm
(ww) 51	CLAMP BOSS	Boss head alloy with blue plastic headed nickel plated screws, straight to fit 127 mm retort stand rod and to hold flat objects
(xx) 52	CLAMP STAND	Stands for retort and bosses with bases
(yy) 53	ACETIC ACID	17.4m Concentration in 2.5l soda lime glass bottles 6.4M Concentration in 2.5L soda glass bottles
(zz) 54	ALUMINIUM CARBONATE (BASIC)	Packed in Small Size Containers of 500g

ITEM		DESCRIPTION	DETAILED SPECIFICATIOS
(aaa)	55	ALUMIMIUM FOIL	Rolls of foil of 90m long and 500mm wide, regular
(bbb)	56	ALUMINIUM AMMONIUM SULPHATE	Packed in small Size Containers of 500g
(ccc)	57	ALLUMINIUM CHLORIDE (ANHYDROUS)	Packed in Smaller Size Containers of 500g for school use
(ddd)	58	ALLUMINIUM POTASIUM SULPHATE	Granular, Packed in smaller Size Containers of 500g for school use.
(eee)	59	ALLUMINIUM SULPHATE	Crystal, Packed in smaller Size Containers of 500g
(fff)	60	AMMONIA (LIQUID) S.G.0.19 ANALAR	(i) Ammonia Liquid in 2.5l soda lime glass bottles (ii) 15M Concentration Ammonia (Ammonium Hydroxide) in 2.5L soda lime bottles
(ggg)	61	AMMONIUM (CHLORIDE)	Granular, Packed in Smaller Size Containers of 500g for School Use
(hhh)	62	AMMONIA FERROUS SULPHATE (AMMONIUM SULPHATE/IRON II AMMONIUM SULPHATE)	Crystals, Packed in Smaller Containers of 500g for School Use
(iii)	63	AMMONIA FERRIC SULPHATE (AMMONIUM SULPHATE/ IRON III AMMONIUM SULPHATE)	Crystals, Packed in Smaller Size Containers of500g for School Use
(jjj)	64	AMMONIUM SULPHATE	Granular, Packed in Smaller Size Containers of 500g for School Use
(kkk)	65	AMONIUM NITRATE	Crystals, Packed in Bottles of 500g for School Use
(lll)	66	BARRIUM CHLORIDE	Crystals, Packed in Smaller Size containers of 500g for School Use
(mmm)	67	CALCIUM METAL	Turnings (98.8% pure) Packed in 100g bottles
(nnn)	68	CALCIUM HYDROXIDE	Powder, Packed in Smaller Size bottles of 500g for school use
(ooo)	69	CALCIUM NITRATE	Crystals, Packed in Smaller Size Containers of 500g for school use
(ppp)	70	CALCIUM OXIDE	(i) Lumps, Packed in Smaller Size Containers of 500g for school use (ii) Powder, packed in bottles of 500g
(qqq)	71	CARBON TETRACHHLORIDE	Packed in 2.5l
(rrr)	72	CHLOROFORM	Packed in 500ml in soda lime glass bottles.
(sss)	73	COBALT NITRATE	Crystals Packed in small size containers of 500g
(ttt)	74	COPPER METAL	(i) Foil 0.05mm thick, packed in 100g containers (ii) Metal packed in Containers of 500g
(uuu)	75	COPPER CHLORIDE (CUPRIC)	(i) Crystals packed in Containers of 500g
(vvv)	76	COPPER NITRATE (CUPRIC) CRYSTALS	Crystals packed in containers of 500g for school use
(www)	77	COPPER (CUPRIC) CRYSTALS	Crystals packed in Smaller Size Containers of 500g
(xxx)	78	ETHYL ALCOHOL (INDUSTRIAL)	(i) Packed in 2.5L in soda lime glass bottles
(yyy)	79	FORMIC ACID	Packed in 500mls in soda lime glass bottles
(zzz)	80	HYDROCHLORIC ACID	(i) 12M concentration packed in 2.5l in soda lime glass bottles (ii) 6M concentration packed in 2.5L soda lime glass bottles

ITEM	DESCRIPTION	DETAILED SPECIFICATIOS
(aaaa) 81	IRON METAL	(i) Filings (Fine Form) Packed in 500g bottles (ii) Powder packed in 500g bottles (iii) Mesh packed in 500g bottles
(bbbb)	FERROUS SULPHATE	Crystals packed in 500g containers
(cccc)	FERROUS SULPHATE	Shots (small Balls) packed in 500g in bottles
(dddd)	LEAD ACETATE	Flakes, Packed in 500g in bottles
(eeee)	LEAD CARBONATE (BASIC)	Powder, packed in 500g in bottles
(ffff)	LEAD NITRATE	Crystals, Packed in 500g in smaller containers for school use
(gggg)	LITMUS PAPER	(i) Litmus blue, Test paper, Whatman, book of 20 leaves (ii) Litmus re, Test paper, Whatman, book of 20 leaves (iii) Litmus neutral, strips, 100 strips in a container
(hhhh)	LITMUS POWDER	Indicating powder, packed in 25g in bottles
(iiii)	MAGNESIUM RIBBON	Roll of Ribbon of 0.15mm x 3.2 mm x 36.6m about 25g each
(jjjj)	METHANOL	Liquid, packed in iL in soda lime glass bottles
(kkkk)	METHYLATED SPIRIT(COLOURED)	Liquid, packed in 2.5l in soda glass bottles
(llll)	METHYL INDICATORS (SOLID)	(i) Methyl orange packed in 100g container (ii) Methyl red packed in 100g containers (iii) Methyl violet packed in 100g containers (iv) Methyl blue packed in 100g containers
(mmmm)	NITRIC ACID	(i) 16M concentration (27%) in 2.5 in soda lime glass bottles (ii) 6M concentration (32%) in 2.5l in soda lime glass bottles
(nnnn)	POTASSIUM CARBONATE	Anhydrous, packed in 500g in small containers
(oooo)	POTASSIUM DICHROMATE	Crystals, packed in 500g in bottles
(pppp)	POTASSIUM CHROMATE	Crystals, packed in 500g in bottles
(qqqq)	POTASSIUM NITRATE	Crystals, packed in 500g in bottles
(rrrr)	POTASSIUM PERMANGATE	Crystals, packed in 500g in bottles
(ssss)	SILVER NITRATE	(i) Crystals, packed in 100g in bottles
(tttt)	SODIUM CARBONATE (ANHYDROUS)	Granular, packed in 500g in bottles
(uuuu)	SODIUM HYDROGEN CARBONATE	Crystals, packed in 500g in bottles
(vvvv)	SODIUM HYDROXIDE PELLETS	(i) Pellets, packed in 500g in bottles (ii) Pellets, Packed in 2.5kg in bottles
(wwww)	POTASSIUM IODINE	(i) Solution, 0.1M concentration packed in 2.5L in bottles (ii) Test Paper (100 papers)

ITEM	DESCRIPTION	DETAILED SPECIFICATIOS
(xxxx)	ALUMINIUM NITRATE	Crystals, packed in 500g in bottles
(yyyy)	SULPHURIC ACID	(i) 18M concentration packed in 2.5L in soda lime glass bottles (ii) 0.5M concentration packed in 2.5L in soda lime bottles (iii) 1M concentration packed in 2.5L in soda lime glass bottles (iv) 3M concentration, packed in 2.5L
(zzzz)	HYDROGEN PEROXIDE	30 volume concentration on 500 ml in soda lime bottles
(aaaaa)	MANGANESE DIOXIDE	Powder in 500g in bottles
(bbbbb)	POTASSIUM BROMIDE	Crystals, packed in 500g in bottles
(ccccc)	POTASSIUM CHLORATE	Granular, packed in 500g in bottles
(ddddd)	POTASSIUM HYDROXIDE	Pellets, packed in 500g in bottles
(eeeee)	CALCIUM CHLORIDE	Flakes, packed in 500g in bottles
(fffff)	CALCIUM CARBONATE	Marble chips in 500g bottles
(ggggg)	ZINC (METAL)	Shots (Small balls) packed in 500g in bottles
(hhhhh)	ZINC SULPHATE	Crystals in 500g in bottles
(iiiii)	SODIUM SULPHATE	Crystals, packed in 500g in bottles
(jjjjj)	FERRIC CHLORIDE	Lumps, in 500g in bottles
(kkkkk)	BARIUM HYDROXIDE	Crystals, packed in 500g in bottles
(llllll)	BROMINE	Liquid packed in 100ml in brown bottles
(mmmmm)	AMMONIUM HYDROXIDE	15M Concentration Ammonium Hydroxide packed in 2.5 Soda lime
(nnnnn)	AMMONIUM MOLYBDATE	Crystals packed in 100g in bottles
(ooooo)	AMMONIUM PHOSPHATE (DIBASIC)	Crystals packed in 500g in bottles
(ppppp)	POTTASIUM NITRATE	Crystal packed in 500g in bottles
(qqqqq)	POTASSIUM SULPHATE	Crystals packed in 500g in bottles
(rrrrr)	BENEDICTS'S QUANTITATIVE SOLUTION	Liquid packed in 2.5Litre in soda lime bottles
(sssss)	BROMOTHYMOL BLUE INDICATOR	Powder in 5g in bottles

REFERENCES

Ministry of Education, Curriculum Development Centre, Chemistry Syllabus (2013), Lusaka, Zambia.

Ministry of Education, Curriculum Development Centre, Environmental Health and Pollution Management Education Framework (2023)., Lusaka: Zambia

Ministry of Finance and National Development, (2022). Eighth National Development Plan, Republic of Zambia

Ministry of Education, Zambia Education Curriculum Framework (2023), Lusaka, Zambia.