ZIMBABWE

MINISTRY OF PRIMARY AND SECONDARY EDUCATION

CHEMISTRY SYLLABUS

FORMS 5 - 6

2015 - 2022

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CONTENTS

1.0 PREAMBLE

1.1 Introduction

This two year syllabus is designed to put greater emphasis on the understanding and application of chemistry concepts and principles in an environmental friendly and sustainable manner. It makes learners identify and solve problems practically in a scientific manner. The Form 5 and 6Chemistry syllabus is inclusively made to cater for all categories of learners in an increasingly technological world

1.2 Rationale

Chemistry plays a pivotal role in the technological development of any country since it is embedded in our everyday life.

The study of Chemistry enables learners to be creative and innovative in industry and society by promoting the application of Chemistry in industrial processes for value addition, beneficiation of natural resources and harnessing of available opportunities for entrepreneurship.

The Chemistry syllabus enables learners to develop the following skills:

- Problem solving
- Critical thinking
- Decision making
- Production
- Research
- Conflict resolution
- Leadership
- Self-management
- Communication
- Technological

1.3 Summary of Content

Form 5 and 6 Chemistry syllabus will cover theory and practical activities in the following areas:

- Physical Chemistry
- Inorganic Chemistry
- Organic Chemistry
- Applied Chemistry

1.4 Assumptions

It is assumed that learner:

- have passed ‘O’ level Chemistry
- are familiar with ICT Tools and Braille/Jaws software
- have passed ‘O’ level Mathematics
- are familiar with laboratory apparatus
- are aware of laboratory safety precautions

1.5 Cross - cutting isues

The Chemistry learning area encompasses the cross cutting themes listed below:

- Inclusivity
- Environmental issues
- Indigenous knowledge system
- Enterprise Education
- Life skills
- Team work
- Food security
- Safety and health issues
- Disaster and risk management
- HIV/ AIDS

2.0 PRESENTATION OF SYLLABUS

The Form 5 and 6 Chemistry syllabus is a single document covering Forms 5 and 6.

3.0 AIMS

The aims are to:

- enable learners to develop fundamental principles of Chemistry for application in life and as a basis for further studies in Chemistry and related disciplines.
- inculcate in learners the need for safety and protection of the environment in the study of Chemistry.
- create opportunities for learners to acquire research, experimental, practical, enterprising and technological skills in Chemistry.
- appreciate the usefulness and limitations of the scientific method in the study of Chemistry.
- stimulate in learners the desire to apply Chemistry for the benefit of society as guided by the principles of Unhu/Ubuntu/Vumunhu.

- promote awareness that the applications of Chemistry may be both beneficial and detrimental to the individual and the community.
- develop in learners the appreciation of the use of Chemistry in value creation, addition and beneficiation.

4.0 SYLLABUS OBJECTIVES

Learners should be able to:

- follow instructions in practical work
- make and record observations
- use ICT Tools and Braille/Jaws software to simulate Chemistry phenomena
- apply safety measures in all practical work
- present, analyse and interpret data to establish relationships
- demonstrate knowledge on facts, laws, definitions and concepts of Chemistry
- measure and express quantities to a given level of accuracy and precision
- design a practical solution to a real life problem using knowledge of Chemistry

5.0 METHODOLOGY AND TIME ALLOCATION

5.1 Methodology

Some of the learner centred and multi-sensory methodologies used in the teaching and learning of Chemistry are suggested below. The principles of individualisation, concreteness, totality and wholeness, stimulation and hands-on experience should guide the teachers as they employ the suggested methods:

- Demonstrations
- Experimentation
- Research
- Models
- Site visits
- Simulations
- Seminars
- Discovery
- Exhibitions
- Work related learning

5.1.2 Time Allocation

For adequate coverage of the syllabus, a time allocation of 8 theory 40minutes periods and a block of 4 practical periods per week is recommended. Learners should be engaged in at least one Educational Tour per term, one exhibition per year, and an attachment of one week in any chemical related industry during the course

6.0 TOPICS

6.1 Physical Chemistry:

- Atoms, Molecules and Stoichiometry
- Atomic structure
- Chemical bonding
- States of matter
- Chemical energetics
- Electrochemistry
- Equilibria
- Reaction kinetics

6.2 Inorganic Chemistry:

- Chemical Periodicity of period 3
- Chemistry of Group II elements
- Chemistry of Group IV elements
- Chemistry of Group VII elements

6.3 Organic Chemistry:

- Hydrocarbons
- Halogen derivatives
- Hydroxy compounds
- Carbonyl compounds
- Carboxylic acids and derivatives
- Nitrogen compounds
- Polymerisation

6.4 Applied Chemistry

- Transition Elements
- Phase Equilibria
- Environmental Chemistry
- Nano Chemistry
- Chemistry of Nitrogen and Sulphur

Chemistry Syllabus Forms 5 - 6

7.0 SCOPE AND SEQUENCE CHART

FORM 5 AND FORM 6

TOPIC	FORM 5	FORM 6
7.1 PHYSICAL CHEMISTRY:		
Atoms, Molecules and Stoichiometry	• Relative masses of atoms and molecules • Mass spectra • The mole and Avogadro constant • Empirical and molecular formulae • Stoichiometric calculations	• Stoichiometric reaction ratios • Titration • Percentage yield and percentage purity
Atomic structure	• Sub-atomic particles • Electronic configurations • Ionisation energy	
Chemical bonding	• Ionic bonding • Covalent bonding • Bond reactivity • Dative bonding • Shapes of molecules • Metallic bonding	

States of matter	• Intermolecular forces • Gaseous state • Liquid state • Solid state	
Chemical energetics	• Enthalpy changes • Hess' Law and Born-Haber cycles • Charge density	
Electrochemistry	• Redox processes • Electrode potentials • Electrolysis of acidified water • Electrolytic purification of copper/nickel • Extraction of aluminium • Production of chlorine from brine	• Redox titration • Fuel cells • Quantitative electrolysis
Equilibria	• Chemical Equilibria • Equilibrium constants • Factors affecting equilibrium • Ionic Equilibria • Bronsted-Lowry theory of acids and bases • pH and pOH • Acid and base dissociation constants • Choice of indicators • Titration curves	• Buffer solutions • Solubility products
Reaction kinetics	• Rate equations • Mechanism of reactions • Factors affecting rates of reactions	• Catalysis

7.2 INORGANIC CHEMISTRY		
Chemical Periodicity of period 3	• Variation in Physical properties • Variation in Chemical properties	
Chemistry of Group II elements	• Trends in Physical properties • Trends in Chemical properties • Properties and uses of Group II compounds	
Chemistry of Group IV elements	• Trends in Physical properties • Trends in Chemical properties • Properties and uses of Group IV elements and compounds	
Chemistry of Group VII elements	• Trends in Physical properties • Trends in Chemical properties • Properties and uses of Group VII elements and compounds	
Chemistry of Nitrogen and Sulphur	• Chemical properties of Nitrogen • Chemical properties of Sulphur • Haber Process • Contact Process • Environmental impacts of Nitrogen and Sulphur compounds	

7.3 ORGANIC CHEMISTRY:		
Hydrocarbons		• Nomenclature • Isomerism • Preparation and occurrence • Physical properties • Chemical properties • Reaction mechanisms
Halogen derivatives		• Nomenclature • Isomerism • Preparation • Physical properties • Chemical properties • Reaction mechanisms
Hydroxy compounds		• Nomenclature • Isomerism • Manufacture • Preparation and occurrence • Physical properties • Chemical properties • Reaction mechanisms
Carbonyl compounds		• Nomenclature • Isomerism • Preparation • Physical properties • Chemical properties

Carboxylic acids and derivatives		• Nomenclature • Preparation and occurrence • Physical properties • Chemical properties • Reaction mechanisms
Nitrogen compounds		• Preparation and occurrence • Chemical properties
Polymerisation		• Types of Polymerisation - addition - condensation • Uses of polymers
7.4 APPLIED CHEMISTRY		
Transition Elements		• Characteristic properties • Occurrence and extraction • Chemical properties and uses
Phase Equilibria		• Steam Distillation • Distribution between phases • Chromatography and electrophoresis
Environmental Chemistry		• Pollution • Waste management
Nano Chemistry		• Properties of nanomaterials • Applications of nanomaterials

FORM 5 SYLLABUS

8.0 COMPETENCY MATRIX

8.1 PHYSICAL CHEMISTRY

TOPIC	OBJECTIVES Learners should be able to:	CONTENT (ATTITUDES, SKILLS AND KNOWLEDGE)	SUGGESTED LEARNING ACTIVITIES AND NOTES	SUGGESTED RESOURCES
Atoms, Molecules and Stoichiometry	• explain the terms relative atomic, isotopic, molecular and formula masses. • analyse mass spectra in terms of isotopic abundances and molecular fragments. • relate a mole to Avogadro constant. • determine empirical and molecular formulae using combustion data or composition by mass. • construct balanced equations • perform calculations including the use of mole concept involving reacting masses, volumes of gasses,	• Relative masses of atoms and molecules • Mass spectra • The mole and Avogadro constant • Empirical and molecular formulae • Stoichiometric calculations	• Defining the terms relative atomic, isotopic, molecular and formula masses. • Analysing mass spectra • Calculating relative atomic mass from given mass spectra and isotopic abundances. • Calculating number of moles in relation to Avogadro constant. • Analysing combustion and composition data to deduce empirical and molecular formulae. • Conducting practical analysis of stoichiometric relationships involving acid-base titrations and combustion	• A Level Science Kit • Periodic table charts • Mass spectra charts • Dilute hydrochloric acid and sodium hydroxide

TOPIC	OBJECTIVES Learners should be able to:	CONTENT (ATTITUDES, SKILLS AND KNOWLEDGE)	SUGGESTED LEARNING ACTIVITIES AND NOTES	SUGGESTED RESOURCES
	volumes and concentrations of solutions			
Atomic structure	• describe the behaviour of sub-atomic particles in an electric field. • describe electronic configuration of elements in terms of s, p and d orbitals for 1, 2, and 3 quantum numbers. • describe the shapes of s and p orbitals. • explain the term ionisation energy. • deduce the electronic configuration from successive Ionisation energy (IE) data.	• Sub-atomic particles • Electronic configurations • Ionisation energy (IE)	• Explaining the behavior of sub-atomic particles and ions in an electric field. • Deducing electronic configuration of atoms and ions. • Drawing and describing shapes of orbitals. • Analyzing successive ionization energies to deduce configuration.	• A -level science kit • Periodic table • Graph papers • ICT Tools and Braille/Jaws software
Chemical bonding	• Describe ionic bonding as in sodium chloride, magnesium oxide and aluminium oxide. • describe covalent bonding as in hydrogen, oxygen, chlorine, carbon dioxide, hydrogen chloride, ethane, ethene and benzene in terms of orbital overlap. • compare the reactivity of covalent bonds in terms of bond length, bond energy and bond polarity. • describe dative bonding as	• Ionic bonding • Covalent bonding • Bond reactivity	• Discussing ionic bonding • Drawing 'dot and cross' diagrams. • Discussing covalent bonding. • Drawing 'dot and cross' diagrams. • Relating bond reactivity to bond energy, bond length and bond polarity.	• Form 5 and 6 Science Kit • ICT Tools and Braille/Jaws software

TOPIC	OBJECTIVES Learners should be able to:	CONTENT (ATTITUDES, SKILLS AND KNOWLEDGE)	SUGGESTED LEARNING ACTIVITIES AND NOTES	SUGGESTED RESOURCES
	in the formation of ammonium ion and aluminium chloride (Al_2Cl_6) • explain the shapes of and bond angles in molecules using electron pair repulsion; Valency Shell Electron Pair Repulsion) (VSEPR) theory. • describe metallic bonding in terms of a lattice of positive ions that are surrounded by mobile electrons. • describe, interpret or predict the effects of type of bonding on physical properties.	• Dative bonding • Shapes of molecules • Metallic bonding • Intermolecular bonds	• Discussing dative bonding • Drawing 'dot and cross' diagrams • Illustrating bonding and shapes using models.	
States of matter	• describe intermolecular forces based on permanent and induced dipoles. • outline the importance of hydrogen bonding to physical properties of substances. • state the basic assumptions of the kinetic theory as applied to an ideal gas. • explain the validity of the kinetic theory of gases as applied to real gases • use the general	• Intermolecular forces: - Van der Waals - Hydrogen bonding - Permanent dipole – permanent dipole interaction • Gaseous state	• Experimenting to show bond polarity. • Experimenting with ice and water to show Hydrogen-bonding. • Discussing the importance of intermolecular forces to properties of substances. • Discussing the assumptions of the kinetic theory as applied to ideal gases. • Calculating using general gas equation. • Illustrating the behavior of	• Jet of water • Paraffin • Plastic ruler • Polythene rod • Perspex rod • Ice • Copper wire • Tungsten wire

TOPIC	OBJECTIVES Learners should be able to:	CONTENT (ATTITUDES, SKILLS AND KNOWLEDGE)	SUGGESTED LEARNING ACTIVITIES AND NOTES	SUGGESTED RESOURCES
	gas.equation *pV=nRT,* in calculations • describe using a kinetic molecular model, the liquid state, solid state and the interconversion of states. • describe the lattice structure of a crystalline solid which is ionic, simple molecular, giant molecular, hydrogen bonded and metallic.	• Liquid state • Solid state	particles using a molecular model. • Discussing the lattice structures of sodium chloride, iodine, ice, copper, silicon dioxide, diamond and graphite.	• Models
Chemical Energetics	• explain that chemical reactions are accompanied by energy changes mostly in the form of heat energy. • explain the terms • enthalpy changes, • standard enthalpy changes, • bond energy and lattice energy • calculate enthalpy changes using vcΔT • apply Hess Law to construct energy cycles and Born-Haber cycles. • calculate enthalpy changes using energy cycles and Born-Haber cycles. • explain the factors affecting the size of lattice energy.	• Enthalpy changes of: - Reaction - Formation - Combustion - Neutralisation - Hydration - Solution - lattice - electron affinity • Hess Law and Born-Haber cycles • Charge density	• Experimenting to show energy changes (exothermic and endothermic). • Discussing the various enthalpy changes • Experimenting to make fertilizer and calculating heat changes. • Carrying out thermometric titrations. • Plotting graphs of quantity against temperature. • Constructing and analyzing Born-Haber cycles. • Discussing factors affecting lattice energy.	• Form 5 and 6 Science Kit • ICT Tools and Braille/Jaws software
Electrochemistry	• describe redox processes in terms of electron transfer	• Redox processes	• Discussing reduction and oxidation in terms of electron	• Form 5 and 6 Science Kit

TOPIC	OBJECTIVES Learners should be able to:	CONTENT (ATTITUDES, SKILLS AND KNOWLEDGE)	SUGGESTED LEARNING ACTIVITIES AND NOTES	SUGGESTED RESOURCES
	and changes in oxidation state. • describe the terms standard electrode potential and standard cell potential. • describe the measurement of electrode potentials using the standard hydrogen electrode. • predict the feasibility of the reaction from standard cell potential. • describe the production of hydrogen, oxygen, aluminium, copper, nickel and chlorine by electrolysis. • predict the identity of the substance liberated during electrolysis from the state of electrolyte, position in the redox series and concentration.	• Electrode potentials • Electrolysis of acidified water • Electrolytic purification of copper/nickel • Extraction of aluminium • Production of chlorinefrom brine	transfers. • Experimenting on redox reactions. • Drawing the standard hydrogen electrode. • Calculating standard cell potentials. • Experimenting on electrolysis of acidified water and copper sulphate. • Discussing electrolytic production of aluminum and chlorine.	
Equilibria	• explain the terms reversible reaction and dynamic equilibrium. • deduce expressions for equilibrium constants in terms of concentrations (K_c)	• Chemical equilibria • Equilibrium constants	• Discussing reversible reactions and dynamic equilibria. • Deducing equilibrium expressions.	• Form 5 and 6 Science Kit

TOPIC	OBJECTIVES Learners should be able to:	CONTENT (ATTITUDES, SKILLS AND KNOWLEDGE)	SUGGESTED LEARNING ACTIVITIES AND NOTES	SUGGESTED RESOURCES
	and partial pressures (K_p) • calculate the values of K_c, K_p and the quantities present at equilibrium • state Le Chatelier's principle and apply it to deduce effects of changes in temperature, concentration or pressure on a system at equilibrium. • apply the Bronsted-Lowry theory to define acids and bases • Distinguish between strong and weak acids and bases in terms of extent of dissociation • Calculate $[H^+_{(aq)}]$ and pH values for strong and weak acids and bases • Explain the terms pH, K_a, pK_a, pOH, K_b, pK_b, K_w, pK_w and apply them in calculations. • Explain the choice of suitable indicators for acid-base titrations given appropriate data. • Describe graphically the changes in pH during acid-base titrations.	• Le Chatelier's principle and factors affecting equilibrium • Ionic equilibria • Bronsted-Lowry theory of acids and bases • pH and pOH • Acid and base dissociation constants • Choice of indicators • Titration curves	• Calculating the values ofK_c, K_p and quantities present at equilibrium • Deducing direction of shift of equilibrium position using Le Chatelier's principle. • Discussing the Bronsted-Lowry theory, strengths of acids and bases. • Calculating pH, K_a, pK_a, pOH, K_b, pK_b, K_w, pK_wvalues of acids and bases • Discussing the choice of suitable indicators for acid-base titrations. • Drawing titration curves from experimental data.	• Citrus fruits • Vinegar • Flowers • Soft drinks • Ashes • Household detergent

TOPIC	OBJECTIVES Learners should be able to:	CONTENT (ATTITUDES, SKILLS AND KNOWLEDGE)	SUGGESTED LEARNING ACTIVITIES AND NOTES	SUGGESTED RESOURCES
Reaction Kinetics	• device suitable experimental techniques for studying the rate ofreaction from given information. • explain the terms: rate of reaction, activation energy, rate equation, order of reaction, rate constant, half-life; rate determining step and catalysis. • explain in terms of collisions the effect of concentration changes and temperature on the rate of a reaction. • explain effect of temperature change in terms of the Boltzmann distribution on the rate of reaction • explain that in the presence of a catalyst a reaction has a different mechanism i.e. one of lower activation energy. • construct rate equations of the form rate =k$[A]^m[B]^n$ for which *m* and *n* are 0, 1 or 2. • calculate initial rate, half-life and rate constant • deduce the order of reaction using initial rate method and concentration time graphs. • show graphicallythat the half	• methods of measuring reaction rates • Rate equations • Factors affecting rates of reactions	• Experimenting on techniques for studying the rate of reaction. • Discussing the terms:rate of reaction, activation energy, rate equation order of reaction; rate constant, half-life rate, determining step and catalysis. • Experimenting on factors affecting rates of reactions. • Drawing Boltzmann distribution curves and reaction profile diagrams. • Constructing rate equations from experimental data • Calculating initial rate, half-life and rate constant.	• Form 5 and 6 Science Kit • ICT Tools and Braille/Jaws software • Graph books

TOPIC	OBJECTIVES Learners should be able to:	CONTENT (ATTITUDES, SKILLS AND KNOWLEDGE)	SUGGESTED LEARNING ACTIVITIES AND NOTES	SUGGESTED RESOURCES
	–life of a first order reaction is constant. • deduce a mechanism from the order of reaction and vice versa.	• Mechanism of reactions	• Deducing the order of reaction using initial rate method and concentration time graphs. • Constructing reaction mechanisms.	

8.2 INORGANIC CHEMISTRY

TOPIC	OBJECTIVES Learners should be able to:	CONTENT (ATTITUDES, SKILLS AND KNOWLEDGE)	SUGGESTED NOTES AND ACTIVITIES	SUGGESTED RESOURCES
Chemical Periodicity of period 3	• describe the variations in atomic radius, ionic radius, ionisation energy, melting point and electrical. conductivity of period 3 elements. • explain the variation in atomic radius, ionic radius and first ionisation energy. • interpret the variation in melting point and electrical conductivity in terms of bonding and structure. • describe the reactions if any, of elements with oxygen, chlorine and water. • explain the variation in oxidation number of oxides and chlorides. • describe the acid base behaviour of oxides • describe the reactions of oxides and chlorides with water. • suggest the type of bonding present in chlorides and oxides from their physical and chemical properties.	• Variation in Physical properties • Variation in Chemical properties	• Discussing trends in physical properties. • Analysing data and sketching graphs on variations in physical properties. • Burning magnesium ribbon. • Reacting sodium and magnesium with cold water • ***NB:** Sodium explodes in	• Graphs • Data booklets • ICT Tools and Braille/Jaws software • Form 5 and 6 Science Kit

TOPIC	OBJECTIVES Learners should be able to:	CONTENT (ATTITUDES, SKILLS AND KNOWLEDGE)	SUGGESTED NOTES AND ACTIVITIES	SUGGESTED RESOURCES
			water • Dissolving oxides and chlorides in water and testing their pH. • Relating physical properties to bonding.	• Sodium chloride • Magnesium chloride • Aluminium oxide • Aluminium chloride
Chemistry of Group II elements	• interpret the trends in physical properties. • describe the reactions of the elements with oxygen and water. • describe the behaviour of oxides with water. • explain the variation in thermal decomposition of the carbonates and nitrates. • explain the variation in solubility of the sulphates.	• Trends in Physical properties • Trends in Chemical properties	• Justifying trends in physical properties using data booklet values. • Experimenting on the reactions of elements with water and oxygen. • Dissolving oxides in water and testing for pH. • Heating carbonates and nitrates;testing products produced. • Dissolving magnesium sulphate, calcium sulphate and barium	• Data booklet • A level Science kit • pH meter

TOPIC	OBJECTIVES Learners should be able to:	CONTENT (ATTITUDES, SKILLS AND KNOWLEDGE)	SUGGESTED NOTES AND ACTIVITIES	SUGGESTED RESOURCES
	• state the properties and uses of group II compounds.	• Properties and uses of Group II compounds	sulphate in water. • Discussing uses of magnesium oxide, calcium oxide, calcium carbonate, magnesium.sulphate, calcium sulphate, barium sulphate, magnesium hydroxide and magnesium trisilicate(MMT)	• magnesium oxide, calcium oxide, calcium carbonate, magnesium sulphate, calcium sulphate, barium sulphate, magnesium hydroxide and magnesium trisilicate (MMT) • Site visits
Chemistry of Group IV elements	• explain the variations in melting and in electrical conductivity of the elements. • explain the variations in bonding, acid-base nature and thermal stability of the oxides of oxidation states II & IV. • describe the bonding, molecular shape and volatility of the tetrachlorides. • explain reactions of the tetrachlorides with water in terms	• Trends in Physical properties • Trends in Chemical properties	• Discussing trends in physical properties. • Experimenting with Lead (IV) oxide, charcoal and coal. • Constructing molecular shapes using models. • Discussing the behaviour	• Form 5 and 6 Science Kit • Lead (IV) oxide • ICT Tools and Braille/Jaws software • Site visits

TOPIC	OBJECTIVES Learners should be able to:	CONTENT (ATTITUDES, SKILLS AND KNOWLEDGE)	SUGGESTED NOTES AND ACTIVITIES	SUGGESTED RESOURCES
	of structure and bonding. • describe the relative stability of higher and lower oxidation states of the elements in their oxides and aqueous solutions. • recognise the properties and uses of the elements and their compounds.	• Properties and uses of Group IV elements and compounds	of tetrachlorides with water and organic solvents. • Experimenting with Lead (IV) oxide. • Discussing properties and uses of elements and compounds such as glass, ceramics, tooth filler, diamond, graphite, carbon-tetrachloride.	
Chemistry of Group VII elements	• describe the trends in volatility and colour of chlorine, bromine and iodine. • interpret the volatility of elements in terms of Van der Waal forces. • explain the relative reactivity of elements as oxidising agents with reference to E^0 values. • explain the reactions of elements	• Trends in Physical properties • Trends in Chemical properties	• Discussing the trends in volatility and colour of chlorine, bromine and iodine. • Calculating E^0 cell values and changes in oxidation	• Form 5 and 6 Science Kit • ICT Tools and Braille/Jaws software • Site visits

TOPIC	OBJECTIVES Learners should be able to:	CONTENT (ATTITUDES, SKILLS AND KNOWLEDGE)	SUGGESTED NOTES AND ACTIVITIES	SUGGESTED RESOURCES
	with hydrogen • explain the relative thermal stabilities of the hydrides in terms of bond energies. • describe the reactions of the halide ions with silver ions followed by aqueous ammonia and with concentrated sulphuric acid • describe the reaction of chlorine with cold and hot aqueous sodium hydroxide. • explain the industrial importance and environmental significance of the halogens and their compounds.	• Properties and uses of Group VII elements and compounds	states for the reactions between halogens and sodium thiosulphate. • Discussing the reactions of elements with hydrogen and relative thermal stabilities of resulting hydrides. • Testing for halide ions • Discussing the industrial importance and environmental significance of halogens and their compounds (e.g. bleaches, PVC, halogenated hydrocarbons as solvents, refrigerants, aerosols and	

TOPIC	OBJECTIVES Learners should be able to:	CONTENT (ATTITUDES, SKILLS AND KNOWLEDGE)	SUGGESTED NOTES AND ACTIVITIES	SUGGESTED RESOURCES
			chlorine in purification of water).	
Chemistry of Nitrogen and Sulphur	• explain the lack of reactivity of nitrogen. • describe the formation and structure of the ammonium ion and its reaction with alkalis. • explain the manufacture of ammonia by the Haber process in terms of the principles of kinetics and equilibria. • explain the manufacture of sulphuric acid by the Contact process in terms of the principles of kinetics and equilibria. • recognise the industrial importance of sulphuric acid and ammonia. • recognise the environmental consequences of compounds of nitrogen and sulphur	• Chemical properties of Nitrogen • Haber Process • Contact Process • Environmental impacts of Nitrogen and Sulphur compounds	• Discussing the chemical properties of nitrogen. • Discussing the formation and structure of the ammonium ion. • Experimenting on the laboratory preparation of ammonia. • Discussing the Haber process and the Contact process(the kinetics and equilibria). • Preparing ammonium sulphate in the laboratory. • Discussing the environmental consequences of nitrates, nitrogen oxides, sulphur	• Form 5 and 6 Science Kit • ICT Tools and Braille/Jaws software • Site visits • Resource persons

TOPIC	OBJECTIVES Learners should be able to:	CONTENT (ATTITUDES, SKILLS AND KNOWLEDGE)	SUGGESTED NOTES AND ACTIVITIES	SUGGESTED RESOURCES
	• explain the catalytic removal of oxides of nitrogen. • describe the use of sulphur dioxide in food preservation.		oxides. • Discussing the removal of oxides of nitrogen from car exhausts and use of sulphur dioxide.	

FORM 6 SYLLABUS

8.3 PHYSICAL CHEMISTRY

TOPIC	OBJECTIVES Learners should be able to:	CONTENT (ATTITUDES, SKILLS AND KNOWLEDGE)	SUGGESTED LEARNING ACTIVITIES AND NOTES	SUGGESTED RESOURSES
Atoms, Molecules and Stoichiometry	• calculate, using the mole concept the reacting masses, volumes of gases, volumes and concentrations of solution. • determine stoichiometric relationships from calculations. • calculate percentage yield and percentage purity.	• Stoichiometric reaction ratios • Titration • Percentage yield and percentage purity	• Computing reacting masses, volumes of gases, volumes and concentrations of solution from given data • Performing acid-base titrations'. • Deducing stoichiometric relationships from titration results. • Constructing balanced equations.	• Form 5 and 6 Science Kit • ICT Tools and Braille/Jaws software
Electrochemistry	• use redox titration results in quantitative analysis. • describe how the hydrogen oxygen fuel cell operate. • deduce electrode reactions from a given fuel cell. • compare fuel cells with conventional cells. • calculate the quantity of charge, mass and or volume of substance liberated during electrolysis using the relationship, F=Le (Faraday constant, the Avogadro constant and the charge on the electron) • describe how to determine a	• Redox titration • Fuel cells • Quantitative electrolysis	• Performing redox titrations • Discussing the composition and electrode reactions of fuel cells. • Citing advantages and disadvantages of fuel cells over conventional cells. • Determining the quantity of charge, mass and or volume of substance liberated during electrolysis	• Form 5 and 6 Science Kit • ICT Tools and Braille/Jaws software

TOPIC	OBJECTIVES Learners should be able to:	CONTENT (ATTITUDES, SKILLS AND KNOWLEDGE)	SUGGESTED LEARNING ACTIVITIES AND NOTES	SUGGESTED RESOURSES
	value of Avogadro constant by an electrolytic method.		• determining experimentally the value of the Avogadro constant.	
Equilibria	• explain how buffer solutions control pH. • calculate the pH and/or pOH of buffer solutions. • apply the concept of solubility product, K_{sp} • calculate K_{sp} from concentrations and vice versa • explain the common ion effect	• Buffer solutions • Solubility products	• Discussing buffer solutions including their role in controlling blood and soil pH. • Preparing buffer solutions • Determining pH and pOH of buffer solutions • Calculating solubility products from concentrations and vice versa including common ion effect	• Form 5 and 6 Science Kit • ICT Tools and Braille/Jaws software
Reaction kinetics	• Outline the different modes of action of homogeneous and heterogeneous catalysis as exemplified in the Haber process, catalytic removal of oxides of nitrogen in the exhaust gases from car engines, the redox reaction between I^- and $S_2O_8^{2-}$ and catalytic role of NO_x in the oxidation of atmospheric sulphur dioxide.	• Catalysis - Homogeneous - Heterogeneous	• Discussing the different modes of action of homogeneous and heterogeneous catalysis such as Fe in the Haber process and Fe^{2+} in I^- and $S_2O_8^{2-}$ reaction. • Carrying out experiments on decomposition of hydrogen peroxide catalysed by manganese (IV) oxide.	• Form 5 and 6 Science Kit • ICT Tools and Braille/Jaws software

8.4 ORGANIC CHEMISTRY

TOPIC	OBJECTIVES Learners should be able to:	CONTENT (ATTITUDES, SKILLS AND KNOWLEDGE)	SUGGESTED LEARNING ACTIVITIES AND NOTES	SUGGESTED RESOURSES
Hydrocarbons	• use the nomenclature, structural formulae and displayed formulae for hydrocarbons from C_1 to C_{10} • describe the forms of isomerism found in hydrocarbons • explain the use of crude oil and natural gas as sources of hydrocarbons • explain the decrease in volatility with increasing carbon chain • describe the chemical reactions of alkanes, alkenes and arenes • describe the mechanism of free radical substitution, electrophilic addition and electrophilic substitution	• Nomenclature • Isomerism • Preparation and occurrence • Physical properties • Chemical properties • Reaction mechanisms	• Discussing nomenclature, general formula and displayed formulae for hydrocarbons from C_1 to C_{10} • Illustrating forms of isomerism using molecular models • Discussing the process of fractional distillation of crude oil • Discussing the physical properties of hydrocarbons • Experimenting with cooking oil or paraffin to demonstrate cracking • Discussing the chemistry of alkanes as exemplified by the following reactions of ethane: • Combustion • Free radical substitution by chlorine and its mechanism • Discussing the chemistry of alkenes as exemplified by the following reactions of ethene: • Electrophilic addition of steam, hydrogen halides and halogens including mechanism	• Form 5 and 6 Science Kit • ICT Tools and Braille/Jaws software • Molecular models • Cooking oil • Paraffin

TOPIC	OBJECTIVES Learners should be able to:	CONTENT (ATTITUDES, SKILLS AND KNOWLEDGE)	SUGGESTED LEARNING ACTIVITIES AND NOTES	SUGGESTED RESOURSES
			• Catalytic addition of hydrogen • Oxidation by cold dilute manganate (VII) ions to form diol • Oxidation by hot concentrated manganate (VII) ions • Polymerisation • Discussing the chemistry of arenes as examplified by the following reactions of benzene and methyl benzene : • Electrophilic substitution with bromine including mechanism • Nitration including mechanism • Oxidation of the side chain • Predicting whether halogenation will occur on the side chain or on the aromatic nucleus in arene	
Halogen derivatives	• use the nomenclature and displayed formula of halogenoalkanes and halogenoarenes • describe the isomerism associated with halogen derivatives • describe the following nucleophilic substitution reactions of halogenoalkanes as exemplified	• Nomenclature • Isomerism • Chemical properties	• Drawing displayed structures and naming them • Discussing isomerism associated with halogen derivatives • Experimenting with bromoethane, silver nitrate and hot water to show substitution	• Form 5 and 6 Science Kit • ICT Tools and Braille/Jaws software • Journals • Bromoethane • Silver nitrate • Aerosols • Plastics

TOPIC	OBJECTIVES Learners should be able to:	CONTENT (ATTITUDES, SKILLS AND KNOWLEDGE)	SUGGESTED LEARNING ACTIVITIES AND NOTES	SUGGESTED RESOURSES
	by the reactions of bromoethane: hydrolysis, formation of nitriles and formation of primary amines by reaction with ammonia • describe the mechanism of nucleophilic substitution in halogenoalkanes		• Writing equations and formulae of products from nucleophilic substitution • Describing the mechanism of nucleophilic substitution in terms of S_N1 and S_N2	
	• explain the elimination of hydrogen bromide from 2-bromopropane		• Experimenting with ethanolic sodium hydroxide and bromopropane to show elimination	
	• interpret the different reactivities of halogenolkanes and chlorobenzene with particular reference to hydrolysis and to the relative strengths of the C-Hal bonds		• Comparing the strengths of the C-Hal bonds and relating them to reactivity	
	• explain the uses of fluoroalkanes and fluorohalogenoalkanes in terms of their relative chemical inertness • recognise the concern about the effect of chlorofluoroalkanes on the ozone layer	• Uses and environmental impact	• Discussing the uses of fluoroalkanes and fluorohalogenoalkanes and their effects on the environment	

TOPIC	OBJECTIVES Learners should be able to:	CONTENT (ATTITUDES, SKILLS AND KNOWLEDGE)	SUGGESTED LEARNING ACTIVITIES AND NOTES	SUGGESTED RESOURSES
Hydroxy compounds	• use the nomenclature and displayed formulae to describe the structure of primary, secondary and tertiary alcohols • describe the isomerism associated with alcohols • describe the manufacture of ethanol using fermentation process • explain the physical properties of hydroxy compounds in terms of bonding • describe the reactions of alcohols as exemplified by ethanol during combustion, substitution to give halogenoalkanes, reaction with sodium, oxidation to carbonyl compounds and carboxylic acids, dehydration and ester formation • describe the reaction of the methyl secondary alcohol with alkaline iodine • describe the reactions of phenol with bases, sodium and during nitration and bromination of the	• Nomenclature • Isomerism • Manufacture of ethanol • Physical properties • Chemical properties of alcohols	• Discussing the structure, nomenclature and classification of alcohols • Drawing structures of optical and structural isomers • Preparing of ethanol by fermentation using locally available resources • Discussing the solubility and volatility of alcohols • Discussing reactions of alcohols • Distinguishing between primary, secondary and tertiary alcohols by oxidation reactions • Deducing the presence of CH_3 CH (OH) – group in an alcohol using alkaline aqueous iodine • Discussing the reactions of phenol	• Form 5 and 6 Science Kit • ICT Tools and Braille/Jaws software • Marula • Baobab Fruits • Grapes • Ethanol • Acidified potassium dichromate • Propan – 2-ol • 2methylpropan – 2-ol

TOPIC	OBJECTIVES Learners should be able to:	CONTENT (ATTITUDES, SKILLS AND KNOWLEDGE)	SUGGESTED LEARNING ACTIVITIES AND NOTES	SUGGESTED RESOURSES
	aromatic ring • explain the relative acidities of water, phenol and ethanol	• Chemical properties of phenols	• Comparing the acidity of water, phenol and ethanol	
Carbonyl compounds	• use the nomenclature and displayed formulae to describe the structure of aldehydes and ketones • explain the isomerism associated with aldehydes and ketones • describe the formation aldehydes and ketones from primary and secondary alcohols respectively • outline the mechanism of nucleophilic addition reaction of hydrogen cyanide with aldehydes and ketones • describe the reduction of aldehydes and ketones using $NaBH_4$ • suggest a suitable test for a given carbonyl compound	• Nomenclature • Isomerism • Preparation • Chemical properties	• Discussing the nomenclature and displayed formulae of aldehydes and ketones • Drawing structures to illustrate the isomerism in carbonyl compounds • Preparing aldehydes and ketones from respective alcohols • Analysing the mechanism of nucleophilic addition reaction of hydrogen cyanide with aldehydes and ketones • Discussing the reactions of carbonyl compounds, with $NaBH_4$, 2.4-DNPH, Fehling's solution, alkaline iodine and Tollens reagent	• Form 5 and 6 Science Kit • ICT Tools and Braille/Jaws software • Ethanol • Acidified potassium dichromate • Propan – 2-ol

TOPIC	OBJECTIVES Learners should be able to:	CONTENT (ATTITUDES, SKILLS AND KNOWLEDGE)	SUGGESTED LEARNING ACTIVITIES AND NOTES	SUGGESTED RESOURSES
Carboxylic acids and derivatives	• interpret the nomenclature and formulae of carboxylic acids and their derivatives • describe the formation of carboxylic acids from alcohols, aldehydes and nitriles • recall the reactions of carboxylic acids in the formation of salts, esters and acyl chlorides • explain the acidity of carboxylic acids and of chlorine substituted ethanoic acids in terms of their structures • describe the reactions of acyl chlorides with water, alcohols, phenols and primary amines • explain the relative ease of hydrolysis of acyl chlorides, alkyl chlorides and aryl chlorides • illustrate the formation of esters from carboxylic acids or acyl chlorides using ethyl ethanoate and phenyl benzoate as examples	• Nomenclature • Preparation and occurrence • Chemical properties	• Drawing displayed formulae for carboxylic acids and their derivatives • Preparing carboxylic acids and esters • Constructing equations for the reactions of carboxylic acids • Comparing the acidity of carboxylic acids and substituted carboxylic acids • Discussing the reactions of acyl chlorides with water, alcohols, phenols and primary amines • Discussing the relative ease of hydrolysis of acyl chlorides, alkyl chlorides and aryl chlorides • Preparing esters from carboxylic acids or acyl chlorides	• Form 5 and 6 Science Kit • ICT Tools and Braille/Jaws software • Vinegar

TOPIC	OBJECTIVES Learners should be able to:	CONTENT (ATTITUDES, SKILLS AND KNOWLEDGE)	SUGGESTED LEARNING ACTIVITIES AND NOTES	SUGGESTED RESOURSES
	• describe the acid and base hydrolysis of esters • state the uses of carboxylic acids and esters	 • Uses of carboxylic acids and esters	• Manufacturing soap from fats and oils • Investigating uses of carboxylic acids and esters	• Fats • Oils • Ash
Nitrogen compounds	• describe the formation of ethylamine by reduction of nitrile and of phenylamine by reduction of nitrobenzene • explain the relative basicity of ammonia, alkylamines and phenylamines in terms of their structures • describe the reaction of phenylamine with: - aqueous bromine - nitrous acid • describe the coupling of benzenediazonium chloride and phenol and the use of similar reactions in the formation of dyestuff	• Preparation and occurrence • Chemical properties	• Discussing the formation of ethylamine by reduction of nitrile and of phenylamine by reduction of nitrobenzene • Comparing the relative basicity of ammonia, alkylamines and phenylamines in terms of their structures • Discussing the reactions of phenylamine with aqueous bromine and with nitrous acid • Discussing the hydrolysis of diazonium salt to give phenol • Synthesizing dyestuff	• Form 5 and 6 Science Kit • ICT Tools and Braille/Jaws software • Dyestuff • Nitrous Acid

TOPIC	OBJECTIVES Learners should be able to:	CONTENT (ATTITUDES, SKILLS AND KNOWLEDGE)	SUGGESTED LEARNING ACTIVITIES AND NOTES	SUGGESTED RESOURSES
	• describe the formation of amides from the reaction between RNH_2 and R'COCl • describe acid-base hydrolysis of amides • investigate the acid/base properties of amino acids and the formation of zwitterions • illustrate the formation of peptide bonds in protein and polypeptide formation • describe the hydrolysis of proteins	• amides	• Discussing the formation and hydrolysis of amides • Deducing the product of hydrolysis of amides • Analysing the acid/base properties of amino acids i.e. from titration curves • Constructing equations to show formation of peptide bonds • Drawing structures of the products of hydrolysis	
Polymerisation	• Describe the characteristics of addition polymers as examplified by polythene and PVC • explain condensation polymerisation as in polyesters and polyamides • predict the type of polymerisation reaction for a given monomer or pair of monomers • deduce the repeat unit of a polymer obtained from a given monomer or pair of monomers • identify the monomer(s) present in a given section of a polymer molecule	• Types of Polymerisation - addition - condensation	• Classifying polymers • Drawing repeat units from given monomers or sections of polymers and vice versa • Building models of polymers	• Samples of polymers • ICT Tools and Braille/Jaws software • Molecular models
	• recognise the uses of polymers	• Uses of polymers	• Discussing uses of polymers • Visiting sites	

8.5 APPLIED CHEMISTRY

TOPIC	OBJECTIVES Learners should be able to:	CONTENT (ATTITUDES, SKIILS AND KNOWLEDGE)	SUGGESTED LEARNING ACTIVITIES AND NOTES	SUGGESTED RESOURSES
Transition Elements	• explain what is meant by transition, in terms of d-block element forming one or more stable ions with incomplete d-orbitals • analyse the electronic configuration of the first row transition elements and their ions • recognise that the atomic radii, ionic radii and first ionisation energies of the transition metals are relatively invariant • contrast qualitatively the melting point, density, atomic radius, first ionisation energy and conductivity of the transition elements with those of calcium as a typical s-block element • describe the tendency of transition elements to have variable oxidation states • explain the formation of complexes in terms of co-ordinate bonds and the splitting of d orbitals • describe the shape of four-fold and six fold complexes	• Characteristic properties • Variable oxidation state	• Discussing characteristic properties of transition elements • Working out the electronic configuration of the first row transition elements and their ions • Analyzing atomic radii, ionic radii and first ionisation energies data of the transition metals • Comparing the melting points, densities, atomic radii, first ionisation energies and conductivities of the transition elements with those of calcium as a typical s-block element • Experimenting to show variable oxidation states • Discussing formation of complexes	• Form 5 and 6 Science Kit • ICT Tools and Braille/Jaws software

	• explain the types of isomerism that complexes may exhibit • explain ligand exchanges in terms of competing equilibria and stability constants • explain redox reactions of complexes in terms of E^0 values • interpret the effect of ligand exchange on E^0 values • explain, in terms of d orbital splitting, why transition element complexes are usually coloured • explain changes in colour of complexes as a result of ligand exchange • explain the magnetic properties of transition metals and their complexes in terms of paired and unpaired d electrons. • describe the occurrence, relative stability and colour of vanadium ions and its compounds • describe the uses of vanadium and its compounds	• Complex formation • Colour concept • Catalysis • Magnetism	• Drawing shapes of complexes and showing isomerism • Experimenting on ligand exchange • Calculating E^0 cells to predict feasibility of reactions • Discussing the splitting of d-orbitals in colour formation of complexes • Experimenting on magnetic properties of transition metals and their complexes • Deducing magnetic properties from electronic configurations • investigating the occurrence relative stability and colour of vanadium ions and compounds • discussing the uses of vanadium and compounds	

	• describe the occurrence, relative stability and colour of chromium aqueous ions and compounds containing the metal in the +3 and +6 oxidation states. • explain uses of chromium and its compounds • describe the use of dichromate (VI) as an oxidising agent • describe the chromate (VI) to dichromate (VI) interconversion • describe the occurrence and relative stability and colour of manganese ions and compounds containing the metal in the +2, +4, +6 and +7 oxidation states • demonstrate redox reactions involving MnO_2, MnO_4^{2-} and MnO^-_4 • describe the occurrence, relative stability and colour of iron compounds, • describe the effect of pH and	• Chromium • occurence • chemical properties and its uses • manganese • occurrence • chemical properties and uses • iron • occurrence and extraction	• investigating the occurrence relative stability and colour of chromium ions and its compounds • discussing the uses of chromium and its compounds • testing for alcohol and for sulphur dioxide using dichromate (VI) • demonstrating the interconversion of chromate (VI) to dichromate (VI) using dilute acids and alkalis • Investigating the occurrence relative stability and colour of manganese compounds • Experimenting on the disproportionation of MnO_4^{2-} • Investigating the occurrence relative stability and colour of iron compounds • Experimenting on the effect of pH on stability of iron and its ions	• Ammonium vanadate (V), • Manganese dioxide • Hydrogen peroxide • Sodium hydroxide

	the cyanide ligand on stability of iron and its ions • explain the biochemical importance of iron in haemoglobin and in cytochrome • analyse the rusting of iron and its prevention • distinguish between Fe^{2+} (aq) and Fe^{3+} (aq) using $Fe(CN)_6^{3-}$ (aq) and SCN^-(aq), respectively • describe the use of iron and its compounds	• chemical properties and uses	• Discussing the biochemical importance of iron in haemoglobin and in cytochrome • Investigating conditions for iron to rust and its prevention • Testing for Fe^{2+} (aq) and Fe^{3+} (aq) using $Fe(CN)_6^{3-}$ (aq) and SCN^-(aq), respectively • Discussing the use of iron and its compounds	• Iron nails • Magnesium ribbon • Potassium hexacyanoferrate (III) • Potassium Thiocyanate
	• Describe the occurrence, relative stability and colour of cobalt ions and compounds containing the metal in its +2 and +3 oxidation states, • explain the effect of ligands and/or temperature on the stability and geometry of cobalt complexes, using as examples • $[Co(H_2O)_6]^{2+}$ $[CoCl_4]^{2-}$, and $[Co(NH_3)_6]^{2+}$ $[Co(NH_3)_6]^{3+}$ • explain the uses of cobalt as in alloys, anhydrous cobalt (II) ions as a test for water and its biochemical importance	• cobalt • Occurrence • Chemical properties and uses	• Investigating the occurrence relative stability and colour of cobalt compounds • Experimenting on the effects of temperature on stability of cobalt complexes • Discussing the uses of cobalt and its compounds	

	• describe the occurrence, production and purification of nickel from its sulphide ore • explain the use of nickel in alloys(e.g. alnico)and as a hydrogenation catalyst • describe the occurrence, production and purification of copper, • describe the occurrence and relative stability of ions and compounds containing the metal in the +1 and +2 oxidation states, including the disproportionation and stabilisation of Cu^{+} (aq) • describe the reaction of Cu^{2+}(aq) with I^{-}(aq) • explain uses of copper and its compounds as in brass, bronze, other alloys, and in the test for aldehydes • describe the occurrence and extraction of platinum • identify elements which occur together with platinum • suggest the uses of platinum group metals	• Nickel • Occurrence and extraction • Chemical properties and uses • copper • Occurrence and extraction • Chemical properties and uses • Platinum group metals (PGM) - occurrence - extraction - uses	• Discussing the occurrence, production and purification of nickel from its sulphide ore • Discussing the use of nickel in alloys • Discussing the occurrence, production and purification of copper, • Investigating the occurrence, relative stability and colour of copper compounds • Experimenting on the reaction of Cu^{2+}(aq) with I^{-}(aq) • Discussing the uses of copper and its compounds • Investigating the occurrence and extraction of platinum • Visiting sites	

Phase Equilibria	• explain steam distillation of two immiscible liquids • demonstrate an awareness of the applications of steam distillation • explain the term partition coefficient • calculate partition coefficient for a system in which the solute is in the same molecular state in the two solutions • explain solvent extraction • explain: paper, high performance liquid, ion exchange, thin layer, column and gas/liquid chromatography in terms of absorption and/or partition, based on appropriate practical experience • demonstrate an awareness of the applications of these methods of chromatography in industry and medicine • describe the process of electrophoresis, and the effect of pH • describe the hydrolysis of proteins, separation and detection of the products by electrophoresis • outline the process of analysis of genes and genetic fingerprinting	• Steam Distillation • Distribution between phases • Chromatography • electrophoresis • genetic fingerprinting	• experimenting on steam distillation • discussing methods of distillation • working out partition coefficient for a system • carrying out solvent extraction • Performing thin layer, column and paper chromatography • Discussing industrial and medical applications of chromatography • Discussing electrophoresis and genetic fingerprinting	• Form 5 and 6 Science Kit • ICT Tools and Braille/Jaws software • Chromatography kit and chromatograms • Resource persons

Environmental Chemistry	• outline the main industrial methods of controlling sulphur dioxide emission (flue gas desulphurisation, alkaline scrubbing, use of limestone-based fluidised beds) • recognise the use of lean-burn engines and catalytic converters in reducing pollutant emissions from petrol-driven cars • deduce environmental considerations related to the usage and generation of power (with particular reference to fossil fuels and nuclear energy) • identify other potential power sources • recognise the hazards associated with random emission from uranium-bearing rocks and with nuclear accidents • recognise the potential application and risks of nanomaterials	• Air Pollution and Control • applications of nanomaterials - medicine - water purification - environmental pollution control and remediation	• Discussing the main causes of air pollution • Discussing the methods of controlling pollution • Discussing environmental impact of power generation • Visiting sites • Case studying • Discussing the concepts of nanoscience and nanotechnology • Predicting the potential applications and risks of nanomaterial	• ICT Tools and Braille/Jaws software • Resource persons

	• outline the use of ion exchange in the treatment of industrial waste • recognise the potential consequence of the use of land-filling and incineration (including the importance of temperature control and the possible release of dioxins) for the disposal of solid waste • outline the advantages and disadvantages of dumping waste at sea and in rivers (including sewage and the problems associated with oil spillages) • recognise the problems associated with heavy metals in the environment, e.g. lead, mercury and chromium • recognise the problems associated with the disposal of radioactive waste and mine waste	• Waste management • Ion exchange • Incineration • Land filling • Recycling	• Discussing the various methods of waste management • Discussing advantages and disadvantages of different methods of waste management • Case studying • Visiting sites	• Resource persons

9.0 ASSESSMENT

(a) ASSESSMENT OBJECTIVES

The scheme of assessment is grounded in the principle of inclusivity and equalisation of opportunities hence does not condone direct or indirect discrimination of learners.

Modifications of arrangements to accommodate candidates with special needs must be put in place in both continuous and summative assessments. These modifications must neither give these candidates an undue advantage over others nor compromise the standards being assessed.

NB: For further details on arrangements, accommodations and modifications refer to the assessment procedure booklet.

The three assessment objectives in A - Level Chemistry are:
1: Knowledge with understanding
2: Handling information and problem solving
3: Experimental skills, investigations and applications

1: Knowledge with understanding
Candidates should be able to demonstrate knowledge and understanding of:

- scientific phenomena, facts, laws, definitions, concepts, theories
- scientific vocabulary, terminology, conventions (including symbols, quantities and units)
- scientific instruments and apparatus, including techniques of operation and aspects of safety
- scientific quantities and their determination
- scientific and technological applications with their social, economic and environmental implications.

2: Handling information, problem solving, synthesis, analysis and evaluation
In words or using other written forms of presentation (e.g. symbolic, graphical and numerical), candidates should be able to:

- locate, select, organise and present information from a variety of sources
- translate information from one form to another
- manipulate numerical and other data
- use information to identify patterns, report trends and draw inferences
- present reasoned explanations of phenomena, patterns and relationships
- make predictions and hypotheses
- solve problems, including some of a quantitative nature.

3: Experimental skills, investigations and applications
Candidates should be able to:

- know how to use techniques, apparatus, and materials (including following a sequence of instructions, where appropriate)
- make and record observations and measurements
- interpret and evaluate experimental observations and data
- plan investigations, evaluate methods and suggest possible improvements (including the selection of techniques, apparatus and materials).
- solve everyday life challenges, acquire and enhance enterprising skills using the knowledge of chemistry

(b) SCHEME OF ASSESSMENT

The scheme of assessment for Form 5 and 6Chemistry comprises
i) Continuous assessment, and
ii) Summative assessment.
The final grade in Form 5 and 6Chemistry is 30% continuous assessment and 70% summative assessment.

The assessment shall be administered as follows:
Continuous Assessment/Profile
This component will consist of standardised tests in Practical, Theory and Projects administered during the first 5 terms.

Level	Assessment tasks	Frequency	Weighting
Form 5	• Practical test • Theory test • Project	• 2 per term • 3 per term • 1 per year	10%
Form 6	• Practical test • Theory test • Project	• 3 per term • 3 per term • 1 per year	20%

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Summative assessment

- Paper 1: Multiple choice questions
- Paper 2: Structured theory questions
- Paper 3: Free response, short essay type questions
- Paper 4: Practical examination

Learners are required to enter for all the 4 papers

Paper	Type of paper	Duration	Marks	Paper Weighting %
1	Multiple choice	1hr	40	11
2	Structured Theory questions	1hr 30mins	60	17
3	Free Response short essay type questions	2hrs 30mins	90	28
4	Practical examination	2hrs 30mins	50	14

Paper 1: Theory: the paper consists of 40 compulsory multiple choice items. 30 items will be of the direct choice type and 10 of the multiple completion type. Each question shall have 4 response items.

Paper 2: Theory. The paper consist of 6 compulsory structured questions, 10 marks each. Learners answer all the questions on the Question Paper

Paper 3: Theory

This paper will consist of 4 sections, Section A, B, C and D
Section A, based mainly on the Physical Chemistry Section
Section B, based mainly on Inorganic Chemistry
Section C, based mainly on Organic Chemistry
Section D, based mainly on the Applications of Chemistry
Leaners will be required to answer a total of 6 questions, 2 questions from Section A, 1 question from Section B, 2 questions from Section C and 1 question from Section D.The paper will be marked out of 90 and scaled down to a mark of 50.

Paper 4: Practical Examination
The paper consist of 3 compulsory structured questions based on qualitative analysis, quantitative analysis and planning/design. The paper will be marked out of 50 marks.

SKILL	Paper 1	Paper 2	Paper 3	Paper 4
Knowledge, Understanding and Handling of information	45% (18marks)	42% (25marks)	40% (40marks)	
Problem solving Analysis, Synthesis and Evaluation	55% (22marks)	58% (35 marks)	60%(60marks	
Practical skills				100%(50marks)

10.0 GLOSSARY/APPENDICES

10.1 GLOSSARY OF TERMS USED IN SYLLABUS/SCIENCE PAPERS

It is hoped that the glossary (which is relevant only to science subjects) will prove helpful to candidates as a guide, i.e. it is neither exhaustive nor definitive. The glossary has been deliberately kept brief not only with respect to the number of terms included but also to the descriptions of their meanings. Candidates should appreciate that the meaning of a term must depend in part on its context.

1 Define (the term(s)…) is intended literally. Only a formal statement or equivalent paraphrase being required.

2 What do you understand by/What is meant by (the term(s)…) normally implies that a definition should be given, together with some relevant comment on the significance or context of the term(s) concerned, especially where two or more terms are included in the question. The amount of supplementary comment intended should be interpreted in the light of the indicated mark value.

3 State implies a concise answer, with little or no supporting argument, e.g. a numerical answer that can be obtained ‘by inspection’.

4 List requires a number of points, generally each of one word, with no elaboration. Where a given number of points is specified, this should not be exceeded.

5 Explain may imply reasoning or some reference to theory, depending on the context.

6 Describe requires candidates to state in words (using diagrams where appropriate) the main points of the topics. It is often used with reference either to particular phenomena or to a particular experiment. In the former instance the term usually implies that the answer should include reference to (visual) observations associated with the phenomena.

In other contexts, describe and give an account of should be interpreted more generally, i.e. the candidate has greater discretion about the nature and the organisation of the material to be included in the answer. Describe and explain may be coupled in a similar way to state and explain.

7 Discuss requires candidates to give a critical account of the points involved in the topic.

8 Outline implies brevity, i.e. restricting the answer to giving essentials.

9 Predict or deduce implies that the candidate is not expected to produce the required answer by recall but by making a logical connection between other pieces of information. Such information may be wholly given in the question or may depend on answers extracted in an earlier part of the question.

10 Comment is intended as an open-ended instruction, inviting candidates to recall or infer points of interest relevant to the context of the question, taking account of the number of marks available.

11 Suggest is used in two main contexts, i.e. either to imply that there is no unique answer (e.g. in chemistry, two or more substances may satisfy the given conditions describing an 'unknown'), or to imply that candidates are expected to apply their general knowledge to a 'novel' situation, one that may be formally 'not in the syllabus'.

12 Find is a general term that may variously be interpreted as calculate, measure, determine etc.

13 Calculate is used when a numerical answer is required. In general, working should be shown, especially where two or more steps are involved.

14 Measure implies that the quantity concerned can be directly obtained from a suitable measuring instrument, e.g. length, using a rule, or angle using a protractor.

15 Determine often implies that the quantity concerned cannot be measured directly but is obtained by calculation, substituting measured or known values of other quantities into a formula, e.g. relative molecular mass.

16 Estimate implies a reasoned order of magnitude statement or calculation of the quantity concerned, making such simplifying assumptions as may be necessary about points of principle and about the values of quantities not otherwise included in the question.

17 Sketch, when applied to graph work, implies that the shape and/or position of the curve need only be qualitatively correct, but candidates should be aware that, depending on the context, some quantitative aspects may be looked for, e.g. passing through the origin, having an intercept, asymptote or discontinuity at a particular value.

In diagrams, sketch implies that a simple, freehand drawing is acceptable: nevertheless, care should be taken over proportions and the clear exposition of important details.

18 Construct is often used in relation to chemical equations where a candidate is expected to write a balanced equation, not factual recall but by analogy or by using information in the question.

19 Compare requires candidates to provide both the similarities and differences between things or concepts.

20 Classify requires candidates to group things based on common characteristics.

PRACTICAL GUIDELINES (PAPER 4)

The practical paper may include the following:

(i) A volumetric analysis problem, based on one set of titrations;

A knowledge of the following volumetric determination will be assumed: acids and alkalis using suitable indicators; iron (II), ethanedioic acid (and its salts), by potassium manganate (VII); iodine and sodium thiosulphate. Simple titrations involving other reagents may also be set but, where appropriate, sufficient working details will be given.

(ii) Candidates may be required to carry out an experiment that involves the determination of some quantity, e.g. the enthalpy change of a reaction or, the rate of a reaction. Such experiments will depend on the simple manipulation of usual laboratory apparatus.

(iii) An observational problem in which the candidate will be asked to investigate, by specified experiments, an unknown substance. The substance may be an element, a compound or a mixture.

It will be assumed that candidates will be familiar with
(i) the reactions of the following cations: NH_4^+; Mg^{2+}; Al^{3+}; Ca^{2+}; Cr^{3+}; Mn^{2+}; Fe^{2+}; Fe^{3+}; Cu^{2+}; Zn^{2+}; Ba^{2+}; Pb^{2+};
(ii) the reactions of the following anions: CO_3^{2-}; NO_3^-; NO_2^-; SO_4^{2-}; SO_3^{2-}; Cl^-; Br^-; I^-; CrO_4^{2-};
(iii) tests for the following gases: NH_3; CO_2; Cl_2; H_2; O_2; SO_2, as detailed in the qualitative analysis notes which will be included in the question paper.

The substances to be investigated may contain ions not included in the above list: in such cases, candidates will not be expected to identify the ions but only to draw conclusions of a general nature.

Candidates should not attempt tests, other than those specified, on substances, except when it is appropriate to test for a gas.
Exercises requiring a knowledge of simple organic reactions, e.g. test-tube reactions indicating the presence of unsaturated hydrocarbons, alcoholic, phenolic and carboxylic groups, may also be set, but this would be for the testing of observation skills and drawing general conclusions only.

Candidates are NOT allowed to refer to note books, text books or any other information in the Practical examination.

Practical Techniques

The following notes are intended to give schools and candidates an indication of the accuracy that is expected in quantitative exercises and general instructions for qualitative exercises.

(a) Candidates should normally record burette readings to the nearest 0.05cm3 and they should ensure that they have carried out a sufficient number of titrations, e.g. in an experiment with a good end-point, at least two titres within 0.10cm3.

(b) Candidates should normally record: weighings to the nearest 0.01g,
temperature readings to the nearest 0.1oC when using a thermometer with a precision of 0.2oC.

(c) In qualitative analysis exercises, candidates should use approximately 1cm depth of a solution (1-2 cm3) for each test and add reagents gradually, ensuring good mixing, until no further change is seen. Candidates should indicate at what stage a change occurs, writing any deductions alongside the observation on which they are based. Answers should include details of colour changes, precipitates formed, the names and chemical tests for any gases evolved (equations are not required).

Marks for deductions or conclusions can only be gained if the appropriate observations are recorded.

10.2 APPARATUS FOR FORM 5 - 6 SCIENCE KIT

This list given below has been drawn up in order to give guidance to schools concerning the apparatus that are expected to be generally available for examination purposes. The list is not intended to be exhaustive: in particular, items (such as Bunsen burners, tripods and glass-tubing) that are commonly regarded as standard equipment in a chemical laboratory are not included. Unless otherwise, the allocation is “per candidate”.

Two 50cm3burettes,
Two 25 cm3pipettes,
One 10 cm3pipette,
Teat pipette
One pipette filler
Three 250 cm3Conical flasks
Volumetric flasks, 100cm3 and 150 cm3
Measuring cylinders,10cm3 25 cm3, 50 cm3 and100cm3
500cm3Wash bottle
Two medium size filter funnels
Porcelain crucible, approximately 15 cm3, with a lid
Evaporating basin, at least 30 cm3
Beakers, squat form lip: 100 cm3, 250 cm3
Thermometers: -10oC to +110oC at 1oC; at 0.2oC precision
-5oC to +50oC at 0.2oC
Plastic beaker, e.g. polystyrene, of approximate capacity 150 cm3
Test-tubes (some of which should be Pyrex or hard glass) approximately 125 mm x 16 mm Boiling tubes, approximately 150 mm x 25 mm
Clocks (or wall-clock) to measure to an accuracy of about 1s. (Where clocks are specified, candidates may use their own wrist watches if they prefer).
Balance, single-pan, direct reading, 0.01g or better (1 per 8-12 candidates).

Details of the requirements for a particular examination are given in the Instructions for Supervisors which are sent to Centres several weeks prior to the examination. These Instructions also contain advice about colour-blind candidates.

Supervisors are reminded of their responsibilities for supplying the Examiners with the information specified in the Instructions. Failure to supply such information may cause candidates to be unavoidably penalised.

The attention of Centres is drawn to the Handbook for Centres which contain a section on Science Syllabi which includes information about arrangements for practical examinations.

QUALITATIVE ANALYSIS NOTES

[Key: ppt = precipitate; sol. = soluble; insol = insoluble; xs = excess.]

1 Reactions of aqueous cations

[Key: ppt = precipitate; sol. = soluble; insol = insoluble; xs = excess.]

1 Reactions of aqueous cations

cation	reaction with	
	NaOH(aq)	NH_3(aq)
aluminium, Al^{3+}(aq)	white ppt. sol. in xs	white ppt. insol. in xs
ammonium, NH_4^+(aq)	ammonia produced on heating	
barium Ba^{2+}(aq)	no ppt. (if reagents are pure)	no ppt.
calcium, Ca^{2+}(aq)	white. Ppt. with high [Ca^{2+}(aq)]	no ppt.
chromium (III), Cr^{3+}(aq)	grey-green ppt. sol. in xs giving dark green solution	grey-green ppt. insol. in xs
copper(II), Cu^{2+}(aq),	blue ppt. insol. in xs	pale blue ppt. sol. in xs giving dark blue solution
iron (II), Fe^{2+}(aq)	green ppt. insol. in xs	green ppt. insol. in xs
iron (III), Fe^{3+}(aq)	red-brown ppt. insol. in xs	red-brown ppt. insol. in xs
lead (II), Pb^{2+}(aq)	white ppt. sol. in xs	white ppt. insol. in xs
magnesium, Mg^{2+}(aq)	White ppt. insol. in xs	white ppt. insol. in xs
manganese (II), Mn^{2+}(aq)	off-white ppt. insol. in xs	off-white ppt. insol. in xs
zinc, Zn^{2+}(aq)	White ppt. sol. in xs	white ppt. sol. in xs

[Lead (II) ions can be distinguished from aluminium ions by the insolubility of lead (II) chloride].

Reactions of anions

Ion	Reaction
carbonate, CO_3^{2-}	CO_2 liberated by dilute acids
chromate (VI) $CrO_4^{2-}(aq)$	yellow soln turns orange with $H^+(aq)$; gives yellow ppt. with $Ba^{2+}(aq)$; gives bright yellow ppt. with $Pb^{2+}(aq)$
chloride, C*l*$^-$(aq)	gives white ppt. with $Ag^+(aq)$ (sol. in $NH_3(aq)$) gives white ppt. with $Pb^{2+}(aq)$
bromide, $Br^-(aq)$	gives pale cream ppt. with $Ag^+(aq)$ (partially sol. in $NH_3(aq)$); gives yellow ppt. with $Pb^{2+}(aq)$
iodide, $I^-(aq)$	gives yellow ppt. with $Ag^+(aq)$ (insol. in $NH_3(aq)$); gives yellow ppt. with $Pb^{2+}(aq)$
nitrate, $NO_3^-(aq)$	NH_3 liberated on heating with $OH^-(aq)$ and Al foil
nitrite, $NO_2^-(aq)$	NH_3 liberated on heating with $OH^-(aq)$ and Al foil; NO liberated by dilute acids (colourless NO – (pale) brown NO_2 in air)
sulphate, $SO_4^{2-}(aq)$	gives white ppt. with $Ba^{2+}(aq)$ or with $Pb^{2+}(aq)$ (insol. in xs dilute strong acids)
sulphite, $SO_3^{2-}(aq)$	SO_2 liberated with dilute acids; gives white ppt. with $Ba^{2+}(aq)$ (sol. in dilute strong acids)

3 Test for gases

Gas	Test and test result
ammonia, NH_3	turns damp red litmus paper blue;
carbon dioxide, CO_2	gives a white ppt. with limewater (ppt. dissolves with xs CO_2)
chlorine, Cl_2	bleaches damp litmus paper
hydrogen, H_2	“pops” with a lighted splint
oxygen, O_2	relights a glowing splint
sulphur dioxide, SO_2	turns aqueous potassium dichromate (VI) from orange to green