005 – CHEMISTRY

INTRODUCTION

This syllabus has been designed from the NBTE Curriculum for the purpose of examination. It is assumed that candidates must have covered the Integrated General Science and Mathematics syllabus at the Junior Secondary School (JSS) Level. The schools presenting candidates for the National Technical Certificate (NTC) must have well equipped laboratories.

AIMS

The aims of the syllabus are to:

a. Provide knowledge in Chemistry which will be appropriate for students who require its application in their various trades/vocational studies and are likely to end their study of Chemistry at the NTC level.

b. Serve as foundation for post-technical education.

c. Provide students with the basic knowledge of the underlying concepts, principles and generalizations of technological processes and products.

e. Enable students carry out practical and project works stated in the teaching syllabus, thus strengthen their ability in the scientific processes of observation, application, problem solving and formulation of mental models.

f. Expose students to the use of S.I. units and the IUPAC system of nomenclature.

g. Create awareness in the students of the inter-relationship between Chemistry and their various trades and its link with their work/job environment.

h. Inculcate in the students the culture of safety precautions.

EXAMINATION SCHEME

The examination shall consist of two papers.

05-1 Paper I (2 ½ hours) 150 marks (Theory)

05-2 Paper 2 (2 hours) 50 marks (Practical)

PAPER I: This is a theory paper. It consist of two Parts – Part A and Part B.

<u>Part A:</u> This shall consist of fifty (50) multiple-choice objective questions, to be answered by candidates in 50 minutes for 50 marks.

Part B: This shall consist of five (5) essay questions from which candidates are expected to attempt FOUR (4) questions only. Each of the essay question carries 25 marks for a total of 100 marks in a duration of hour 1 hour 40 minutes.

PAPER 2 (Practical):

This shall be a 2 hours practical test, either the actual practical or alternative to practical. It shall consist of THREE (3) compulsory questions for a total of 50 marks. The actual practical shall be taken by schools WHILE the alternative to practical shall be taken by private candidates.

ALTERNATIVE TO PRACTICAL

The alternative to practical will test the knowledge of the practical skills and processes that the candidates are expected to have acquired in the practical activities that are prescribed in the syllabus.

S/N	Topic/Objectives	Contents	Activities/Remarks
1.	**Elements Compounds and Mixtures** 1.1 Explain the concepts of elements, compounds and mixtures. 1.2 Identify the properties e.g. melting point, boiling point, solubility etc of common substances in the laboratory. If may be used as basis for choice of separation methods.	1. Concepts of Elements, Compounds and Mixtures. • Physical and Chemical changes • Definition of Elements, Compounds and Mixtures. • Methods of separation of Mixtures.	Use the burning of candle to demonstrate or identify examples of physical and chemical changes in nature. Experimental illustration of the methods of separation of mixtures is required.
2.	**Structure of the Atom** 1.1 Explain the concepts of atoms, molecules and ions (atomic or molecular ions) 1.2 Explain the features of the atom. 1.3 Draw and label the main electronic shells of the atom and explain atomic-number, isotopes, relative atomic mass (Ar), relative molecular mass (Mr) and calculate the relative atomic masses of elements that exhibit isotopy. 1.4 List the main and sub-energy levels in an atom and explain the arrangement of electrons in these energy levels.	1. Concepts of Atoms, Molecules and Ions: Definition and treatment of particles as building block of matter. 2. Gross features of the Atom: • Account of Dalton's Atomic theory. • Outline of the J.J. Thomson's Experiment and Bohr-Rutherford's Alpha Particles Scattering Experiment to establish the structure of the atoms. 3. Electronic Shells. 4. Atomic number, Mass number, Isotopes, Relative atomic number (Ar), Relative molecular mass (Mr). 5. Electronic Energy Levels: • Arrangement of electrons in the main and sub-energy levels. 6. Orbitals. • Origin of s, p, d, and f orbitals as sub-energy levels. • Shapes of s and p –	J.J. Thompson's Experiment should be given. Arrangement of electrons in the main shells (K,L,M) and calculation of relative atomic mass of chlorine as example is required.

	1.5 Discuss the orbitals of atom and explain the rules for filling electrons in the sub-energy levels. 1.6 Distinguish between chemical reaction and nuclear reaction. 1.7 Explain the nature of the three main types of radiation. 1.8 Define radioactivity. Distinguish between natural and artificial. Explain nuclear fission and nuclear fusion. 1.9 Define 'Half-life' as a measure of the stability of the atomic nucleus. 1.10 Write and balance simple nuclear equation. 1.11 Explain the effects of radioactive radiation on human beings and state the uses of radio isotopes.	orbitals • Aufbau Principle, Hund's rule of Maximum Multiplicity and Pauli's Exclusion Principle. • Abreviated and detailed electronic configuration in terms of s, p and d orbitals from hydrogen to zinc. 7. Nuclear Chemistry: • Chemical reaction and nuclear reaction. • Balancing of simple nuclear equation. • Types and nature of radiations (alpha, Beta and Gamma rays). • Natural and artificial radioactivity • Nuclear fission and nuclear fusion. • Devices used for detecting radioactiveities. • Qualitative treatment of hald life. • Effects and applications of radioactivity, carbon dating, uses in agriculture, medicine and industry.	It is instructive for teachers to point out that contrary to what obtains in chemical reaction, a new element may be created during a nuclear reaction. Symbols too, should be used to identify the type of radiation. Geiger Muller counter of detecting radiation should be described.
3.	**Periodicity of the Element** 1.1 State the periodic law and its application in the formulation of the periodic table. 1.2 Outline the periodic properties and their trends across the period and down a group. 1.3 Outline the periodic graduation of properties	1. Periodic law and table. • Electronic configurations leading to group and periodic classifications. • The uniqueness of hydrogen atom in the periodic table. 2. Periodic properties of the first 30 elements, atomic size, ionization energy,	Highlight the uniqueness of hydrogen in relation to the alkali metals on one hand, and the halogens on the other progression from: i. Metallic to

	of the halogens. 1.4 Explain the meaning of the transition metals and their characteristic properties.	electron affinity and electro negativity. 3. Periodic graduation of the properties of halogens. • Physical states, melting points. • Redox properties, displacement reaction of one halogen by another. 4. Transition metals and their characteristic properties: Electronic configuration, Metallic properties, Chemical reactivities, Magnetic properties, variable oxidation states, formation of complex ions and catalytic properties.	nonmetallic character of elements. ii. Ionic – covalent bonding in compound is required. Properties of chlorine as a typical halogen to include: i. Variable oxidation state. ii. Reaction with H_20 and alkali. should be taught. Note that many typical non-metals e.g. Nitrogen, Sulphur and Chlorine also exhibit variable oxidation states. Note also that zinc has a constant oxidation state of (+2).
4.	**Chemical Bonding** 4.1 Explain chemical bonding and list the types of chemical combinations. 4.2 Illustrate with appropriate examples electrovalent or ionic bonding. List factors that influence the formation of electrovalent compound and outline the properties of an electrovalent or ionic compound. 4.3 Illustrate with appropriate examples, ordinary covalent and	1. Chemical bonding and types of chemical combination. 2. Inter-atomic bonding: a. ionic bonding factors. * ionization energy, electron affinity and electro negativity differences. Properties: Melting points, boiling points and solubility in various solvents. b. Covalent bonding factors: ionization energy, electron affinity and electron negativity differences. Properties such as melting points,	Teachers should present bonding as a process/tendency by which elements attain the structure of the nearest noble gas in the periodic table. Lewis dot structure for ionic and covalent compound should be treated.

	coordinate covalent/dative bonding. List factors which influence the formation of covalent compounds and outline the properties of covalent compounds. 4.4 Draw the shape of simple molecules. 4.5 Explain metallic bonding. List factors that influence the formation of metallic bonds and outline the typical properties of metals.. 4.6 Explain vander Waal's forces. Give examples of the compound in which they exist and explain the variation of melting points and boiling points of noble gases; halogen and alkenes in terms of vander Waal's forces. 4.7 Explain the unusually higher boiling point of HF, H_20 and NH_3 over HCL, H_2S and PH_3 respectively due to hydrogen bonding.	solubility in various solvents. 3. Simple molecules and their shapes i.e. (i) Linear (ii) Non-linear (iii) Tetrachedral.) 4. Metallic bonding: Factors such as atomic radius, ionization potential, and number of valence electrons. Properties to include conductivity, malleability, ductility. 5. Intermolecular bonding. a. vander Waal's forces: relative physical properties of polar and non-polar compounds. b. Hydrogen bonding. * Variation in the boiling points of compounds such as H_20, H_2S	Models should be used where applicable. These should be demonstrated using metals such as Mg, Zn, Sn and Fe. Description of formation and nature should be treated. Dipole-dipole and induced dipolar forces is required.
5.	**Stoichiometry and Chemical Reactions** 5.1 Explain symbols, formulae and equations. List the rules for writing of balanced equations and write balanced chemical equations by applying the rules. 5.2 State and explain the laws of chemical combination. 5.3 Explain the concepts of moles, Avogadro number and constant molar	1. Symbols, formulae and equations. • Chemical symbols. • Empirical and molecular formulae. • Chemical equations. Combining power of elements and oxidation numbers. 2. Laws of chemical combination. • Law of conservation of mass. • Law of constant composition.	Experimental illustration of the laws are required.

	volume, mole ratio, amount of substance used, mole ratios to determine the stoichiometry of chemical reactions. Mole fraction 5.4 Explain the concept of solution.	• Law of multiple proportion. 3. Amount of substance: • mass and volume measurements. • Avogadro constant. L as the number of carbon atoms in 1 mole (12.00g of ^{12}C). • Molar quantities and their uses. • Mole of electrons, atoms, molecules, formula units. • Mole ratio. • Calculation of **mass** concentration and molar concentration volume and other quantities in chemical reactions. 4. Solutions: • concept of solution as made up of solvent and solute (in a single phase). • Concentration terms. • Standard solutions. Preparation of some primary standard solutions using anhydrous Na_2CO_3, $(COOH)_2 2H_2O$ • dilution factor determination.	
6.	**States of Matter** 1.1 Define And explain the concept if law, theory and hypothesis as usual in science. 1.2 State the postulate of Kinetic theory of matter. Explain the nature of solids, liquids and gasses, change of state of matter	1. Kinetic model of matter. • Postulates of the kinetic theory. • Nature of solids, liquids and gases. • Change of states of matter. • Diffusion, demonstration using	Changes of state of matter should be explained in terms of particle movement, illustration using: candle wax, water, iodine, sulphur, naphthalene etc for the changes of state.

	and diffusion using the kinetic model. 1.3 State and explain the gas laws. Explain each law using the kinetic model. Represent the laws mathematically and graphically (where applicable). Derive the general gas lwaw. 1.4 State the relationship of vapour pressure with the boiling points of liquids. Describe simple methods for the determination of boiling points. 1.5 Classify solids. Compare the properties of the types of solids. Describe the arrangement of ions, molecules and atoms in three dimensions in the solid state. Explain melting points and describe the structure, properties, and uses of diamond and graphite.	diffusion of bromine/iodine/No_2H from a sealed tube into an empty tube and spread of scent of ammonia in a room. 2. Gases: The gas laws. Charles' Boyle's Dalton's, Graham's Avogadro's law and ideal gas equation. Mathematical relation of the gas laws and calculations. Molar volume of a gas at S.T.P. = 22.4dm^3. $\frac{PV}{T} = K$ Derivation of general gas law and calculations. 3. Liquids: • Liquids as an intermediate state between gases and solids in the kinetic molecular sense. • Concept of vapour pressure: simple determination of boiling points. • Standard boiling points. 4. Solids: Types and structure. • Ionic, metallic, covalent and molecular solids • Comparism of the properties of the types of solids. • Regular arrangement of ions, molecules and atoms in three dimensions in the solid state. • Melting points.	Illustration of Brownian motion using: Pollen grain/sulphur in water (viewed under microscope). Smokes in glass container illuminated by a strong light from the side. A dusty room being swept and viewed from outside under sunlight is required. Teachers should endeavour to point out the differences between Dalton's law and dalton's atomic theory.

		• Structures, properties and uses of diamond and graphite.	Experimental illustration of how to determine the boiling points is required. Specific packing arrangement knowledge is NOT required.
7.	**Energy and Energy Changes** 7.1 Define energy. List different forms of energy. State the laws of conservation of energy and explain its units.	1. Energy changes in physical and chemical processes: Enthalpy, energy diagrams, forms of energy, energy content, transfer of energy.	
	7.2 Explain the term exothermic reactions, endothermic reactions, heat of reaction, heat of formation, heat of combustion, heat of neutralization and heat of solution. Measure and calculate heat of neutralization, heat of solution and heat of combustion. 7.3 Concepts of free energy and entropy. Discussion of $\Delta G = \Delta H - T\Delta S$	2. Description, definition and illustrations of energy changes and effects: • Exothermic and endothermic processes. • Total energy of a system as the sum of various forms of energy e.g. kinetic, potential, electrical, heat, sound, etc. • Enthalpy changes of the following: Formation, combustion, solution, neutralization. • Practical knowledge of the measurement of the heats of neutralization, solution and combustion. • Uses of energy changes	Heat of neutralization of HCI and Na$_0$H and heat of solution of sodium trioxothiosulphate pentahydrate in water should be measured and calculated in the laboratory as example. Heat of combustion can also be measured using low-flame spirit/kerosene lamp.

		including energy contents of foods and fuels. • Conditions for spontaneous changes as consequences of balance between tendency towards lower enthalpy and tendency toward higher entropy.	
8.	**Acids, Bases and Salts.** 1.1 Define acid, base and salt. Explain Arrhenius theory of acids and basicity of an acid. 1.2 Outline the various physical and chemical properties and chemical properties of acids, bases and salts. Balance chemical equations of ionic reactions. 1.3 Explain the preparation of acids and salts by various methods. 1.4 Define electrolyte and non-electrolyte. Distinguish between strong and weak electrolytes. Determine the conductances and enthalpy of neuralization of acids, bases and salts. 1.5 Explain the pH scale. Use it to determine the acidity and alkalinity of aqueous solutions. 1.6 Explain the behaviour of weak acids and bases in water. Compare the conductances of molar solutions of strong and weak acids and bases. 1.7 Explain hydrolysis and	1. Acids, bases and salts: • Definition. • Arrhenius concept of acids and bases. • Basicity of and acid 2. Physical and chemical properties of acids and bases: • Conductivities, taste etc. • Concept of amphoterism • Balanced chemical equations of all reactions. 3. Preparation of acids and salts: • Deliquescent efflorescent and hygroscopic substances. 4. Acids, bases and salts as electrolytes. • Electrolytes and non-electrolytes, strong and weak electrolytes. • Evidence from conductivity and enthalpy of neutralization. 5. The pH • knowledge of the pH scale. • as a measure of acidity and alkalinity	The use of deliquescent and hygroscopic substances as drying agents should be emphasized.

	the behaviour of some salts. 1.8 Explain the elementary theory of indicators: State the working oH ranges of methyl orange and phenolphthalein. 1.9 Identify correctly the relevant apparatus for acid-base titrations. Carry out titrations using acids, bases and appropriate indicators.	of aqueous solutions • Simple calculations of pH and poH from given data 6. Weak acids and weak bases: • Behaviour of acids and bases in water as an example of equilibrium system. • Comparison of the conductances of molar solutions of strong and weak acids and bases. 7. Hydrolysis: Qualitaive • Explanation of the hydrolysis • Behaviour of NH_4CI $AICI_3$, $CuSO_4$, Na_2CO_3H, Na_2S, $CuNO_3$ CH_3COONa in water. Compare with NaCI, $CaCI_2$, $Ba(NO_3)_2$, K_2SO_4. 8. Acid-base indicators: • Indicators as weak organic acids and bases. • Colour of indicator at any pH dependent on relative amounts of acid and base forms. • Working ranges of methyl orange and phenolphthalein 9. Acid-base titrations: • Relevant apparatus for acid-base titrations. • Workings of indicators in acid-base titrations. • Determine concentrations, % purity, water of crystallization from the experimental result.	Teachers should discuss the domestic and industrial applications of pH measurement sketching and interpretation of pH curves. Teacher is advised to approach this practically, testing the various solutions with litmust paper or litmus solution.

			Titration involving weak acids versus strong bases, strong acids versus strong bases, using the appropriate indicators and their application in quantitative determination should be treated.
9.	**Solubility** 9.1 Explain the general principles of solubility.	1. Define solution, saturated solution, super saturated solution and solubility. 2. Factors affecting solubility 3. Determination of solubilities of substance. 4. Solubility curves and their applications.	Solubility should be expressed in $Moldm^{-3}$ of solution.
10.	**Rates of Reaction and Equilibrium Systems** 1.1 Define rate of reaction. Explain factors affecting rates of reactions. Discuss the theory of reaction rates. 1.2 Explain the general principles of equilibrium, Le Chatelier's principle and factors affecting positions\ of equilibrium in chemical reactions.	1. Rates of reaction: • definition of the rates of reaction for gaseous systems: Pressure may be used as concentration terms. • Collision theory and activation energy theory. • Factors influencing collision such as temperature and concentration, surface area/nature of reactions. • Concentration time graph • Effective collision. • Activation energy • Energy profile diagrams showing activation energy and enthalpy change. 2. Equilibrium systems: • Reversible and irreversible reactions.	

		• Meaning of equilibrium constant and its mathematical expression. • Statement of Le Chatelier's principles. • Factors affecting the position of equilibrium of chemical reactions.	Experimental demonstration of the effect of the factors on equilibrium position of chemical reactions is required.
11.	**Redox Reactions** 1.1 Explain the concepts of oxidation and reduction, reducing and oxidizing agents, redox reactions. Outline the rules for the determination of oxidation numbers of elements in substances. 1.2 Describe electrochemical cells and outline their applications.	1. Definitions of oxidation and reduction, reducing and oxidizing agents in terms of: • Addition and removal of oxygen and hydrogen. • Loss and gain of electrons. • Change in oxidation number. 2. Oxidation numbers/states 3. Tests for oxidants and reductants. 4. Balancing of redox equations by: • ion, electron, or change in oxidation number/state. • Half reactions and overall reactions. • Categorising of processes at the electrodes. 1. Standard electrode potentials of electrochemical cells. 2. Drawing and writing of the cell diagrams. 3. Electromotive force of cells. 4. Distinction between primary and secondary	Teachers sould emphasise the fact that oxidation and reduction are simultaneous and complementary processes illustration of substances that act as oxidizing and reducing agent in (a) different reaction (b) the same reaction e.g. disproportion IUPAC system of nomenclature is required.

	1.3 Explain the principles/mechanisms of electrolysis. Discuss the factors that determine the preferential discharge of ions at the electrode and their practical applications. 1.4 Explain the concept of corrosion on metals.	cells. 5. Daniell cell, Lead acid accumulator, dry cell and their use as generators of electrical energy from chemical energy. 1. Principles of electrolysis 2. Comparison of the mechanism of electrolysis with electrochemical cells 3. Faraday's Law 4. Practical applications 1. Corrosion treated as redox process. 2. Rusting of iron and its economic implication. 3. Prevention based on relative magnitude of electrode potentials, preventive methods like galvanizing, sacrificial cathodic protection, and non-redox methods.	Simple calculations based on the relation F = Le = 96,500C and mole ratios to determine mass, volume of gases, number of entities, etc.
12.	**Basic Chemistry of Non-Metals** 12.1 Describe and explain the preparation, properties, and qualitative tests of some selected elements.	1. Oxygen: Laboratory and industrial preparation, properties, uses and tests, binary compounds of oxygen: acidic oxides, basic oxides, amphoteric oxides, neutral oxides and higher oxides.. 2. Hydrogen: Laboratory and industrial preparation, properties, uses and tests, isotopes of hydrogen. 3. Water and solution: Composition of H_2O_2 hardness of water, properties and test.	The teacher could mention the other allotropic modification of oxygen i.e. ozone (O3). The contributions of 2H the isotopes and to the making of 3H **heavy water** and hydrogen bomb respectively. Reference should be made to acidulated water.
		4. Halogens: Chlorine: Laboratory preparation, properties and	Qualitative tests for the chloride ions should be

		reactions. Uses of chlorine and halogen compounds Laboratory preparation of HCL gas is required 5. Nitrogen: Laboratory and industrial preparation, properties and uses, compounds of nitrogen: • NH_3 laboratories/ industrial preparation and uses. • HNO_3: Laboratory preparation, reactions and uses. • NO_2: Laboratory/ industrial preparation, properties and uses. 6. Carbon: Allotropes, general properties, CO & CO_2 reparation, properties and uses. 7. Sulphur: Allotropes and uses. Compound of sulphur; sulphides, trioxosulphate (IV) acid and salt, tetraoxosulphate (VI) acid – industrial preparation, reactions and uses. 8. Noble gases: Properties and uses.	mentioned Fountain experiment to illustrate solubility of HCL and NH_3 Demonstration of the oxidation of Halides to other halogen by chlorine. Coal – different types and destructive distillation is required. Candidates are expected to appreciate the fact that some noble gases do form compound when specially treated with fluorine.

13.	**Metals and Their Compounds** 13.1 Differentiate between metals and non-metals. Discuss the general principles of extraction of metals. Describe the extraction of selected metals. 13.2 Apply the activity series.	1. Distinction between metals and non-metals. Relative abundance of metals/metallic ors in nature. 2. Principle of extraction of metals. Preliminary preparations. • Electrolysis • Reduction of chlorides. • Reduction of oxides/sulphides. • Thermal and chemical reduction 3. Extraction and uses of: a. Alkali metals – lithium, sodium and potassium. Alkaline earthmetals. b. Ca, Mg, and AL c. transition of metals – Fe, Cu, Ag and Au d. Important compounds of Na, K, Mg, Ca, A1, Ba, Cu, Ag, Zn, Hg, Fe and their uses. 4. Alloys of Fe, Cu, AL Pb and Zn 5. Activity series	Experimental determination is required. The uses of alkali metals as precipitating agents in cation analysis should be stressed.
14.	**Basic Principles of Organic Chemistry** 14.1 Describe and explain the major classification and nomenclature, separation and purification methods and general properties of organic compounds.	1. Classification and nomenclature. Root names. Functional groups 2. Separation and purification methods – distillation, crystallization, drying, chromatography. 3. Determination of the empirical and molecular formulae and the molecular structure. 4. Homologous series. 5. Isomerism: 6. Differences between structural geometric/ stereoisomerism.	Teachers should use models to illustrate the shapes of molecules of hydrocarbon and isomerism. Example should be limited to compounds having maximum if five carbon atoms.

15.	**Chemistry of Hydrocarbons** 1.1 Explain the major classification of hydrocarbons. Write the general and structural formulae and identify their functional groups. 1.2 Explain the sources, properties and uses of the alkanes. 1.3 Describe and explain the process of refining petroleum.	1. Hgydrocarbons: a. Definition of hydrocarbons. b. Sources of hydrocarbons • coal. • Natural gas and petroleum. c. Classifications of hydrocarbons. • Aliphatic. • Cyclic–aliphatic and aromatic. d. Classifications of aliphatic hydrocarbons. e. Distinction between saturated and unsaturated hydrocarbons. f. General and structural formulae of alkanes, alkenes and Alkynes. g. Identification of the functional groups. 2. Alkanes: • Laboratory and industrial preparation. • Nomenclature and structure. • Reactivity: Combustion, substitution reactions, cracking of large alkane molecules. • Uses of alkanes: As fuels, starting materials for synthesis. • Isomerism in alkanes. 3. Petroleum: • Composition. • Fractional distillation and major products. • Cracking process and reforming. • Petrochemicals. • Octane numbr and	Test for unsaturation is required. The uses of haloalkanes and pollution effects should be treted.

	1.4 Explain the sources, properties and uses of alkenes. 1.5 Explain the sources, properties and uses of alkynes. 1.6 Describe the structure and properties of the benzene (both physical and chemical).	antiknock • Uses. 4. Alkenes: • Laboratory preparation. • Nomenclature and structure. • Main reactions such as addition reactions with halogens, bromine water, hydrogen halides: Oxidation: Hydroxylation with aqeous $KMnO_4$ • Laboratory detection: Use of reaction with $Br_2.CCI_4$ as a means of characterizing alkenes. 5. Alkynes: • Laboratory preparation or production. • Nomenclature and structure. • Industrial uses of ethyne e.g. oxyacetylene (oxyethyne) in lamps. 6. Benzene: • Resonance in benzene. • Halogenations. • Addition reactions. • Comparison of its reaction with those of Alkenes.	Mechanisms not required.

16.	**Chemistry of the Alkanos** 16.1 Explain the sources, nomenclature, structure, classification, properties and laboratory test of alkanas.	1. General formula of alkanols as CnH_2+_1OH. 2. Functional group of alkanols as OH. 3. Molecular and structural formula and the IUPAC names of the first vew, 4. General methods of preparation. 5. Fermentation process as a method of preparation and from ethene a, a by product of the cracking process. 6. Classification of alkanols. • Primary • Secondary • Tertiary 7. Physical and chemical properties. 8. Uses of ethanol 9. Test	Prepare ethanol by fermentation of starch. Mention should be made of the oxidation of primary and secondary alkanols to alkanals and alkanones respectively.
17.	**Basic Chemistry of Alkanoic Acids and Alkanoates** 17.1 Explain the sources, nomenclature, structure, properties, uses and test of alkanoic acids and alkanoates	1. Alkanoic acids: General formula of the alkanoic acids as $C_nH_{2n+1}COOH$ • Functional groups as COOH. • Molecular and structural formula and IUPAC names of the first few members. • Physical and chemical properties. • Uses and properties of ethanoic and phenyl methanoic (benzoic) acids as examples of aliphatic and aromaic acids respectively. • Laboratory est. • Reaction with $NaHCO_3$ 2. Alkanoates: • Preparation of alkyl alkanoates (esters) from alkanoic acids. • Physical and chemical	Teachers should point out the existence of diaalkanoic acid e.g. ethane –1-2 dioic acid and aromatic acid e.g. phenyl methanoic acid (benzoic acid). Acidic properties should be emphasized.

		properties . Fats and oils as a product of esterification. • Saponification, hardening of oils. • Detergents. • Comparison of soapy and soapless detergents with respect to their action with soft and hard water. respectively. Laboratory preparation of soapy detergents and soapless detergents.	
18.	**Chemistry of Some Macro Molecules (Polymers)** 1.1 Explain the source, properties and important uses of some macro-molecules.	1. Amino acids: * Difunctional nature of amino acids. 2. Natural and synthetic polymers: • Definition • Types of polymers. Natural polymers: a. Carbohydrates: formulae, properties, classification and uses. b. Proteins: Polymers of amino molecules linked by peptides or amide linkage. c. Hydrolysis uses in living system. Synthetic polymers: Classification and monomers and co-polymers.	Simple examples of amino-acids should be given. Experimental differentiation of reducing and non reducing of sugars should be carried out.
19.	**Application of Chemistry in Industries and Environment** 19.1 Differentiate between types of chemical industries, their raw materials and explain alloy, their composition	1. Chemistry in nature. • History of the development of the chemical industry. • Important chemical industries in Nigeria, and their corresponding raw materials.	

	and uses.	• Distinction between fine and heavy chemicals. • Factors influencing the siting of chemical industries. • Effects of industries on the community. 2. Extraction of metals: • Raw materials, processing, main products, by-products, recycling of AL, and Fe, Au or Sn. • Uses of metals. • Define and list the common alloys: Cu, AL, Pb, and Fe and their uses.	
		3. Pollution: • Sources, effects and control. • Green house effect and depletion of the ozone layer. • Biodegradable pollutants. 4. Biotechnology: Food processing, fermentation including production of kenkey/gari, bread and alcoholic beverages e.g. local gin.	

20.0 PRACTICALS

20.1 <u>General skills and Principles</u>

Candidates are expected to be familiar with the following skills and principles

Measurement of length, mass and volume.

Preparation and dilution of standard solutions.

Filtration, recrystallization and melting point determination.

Measurements of heats of neutralization and solution.

Determination of pH values of various solutions by colorimetry.

Determination of rates of reaction from concentration versus time curve.

20.2 <u>Quantitative Analysis</u>

Acid-base titrations: Preparation of standard solutions. Primary and secondary standard.

The use of standard solutions of acid and alkalis and the indicators, methylorange and phenolphthalein to determine

(i) The concentrations of acids and alkaline solutions.

(ii) The molar masses of acids and bases and water of crystallizations.

(iii) The solubility of acids, bases and salts.

(iv) The percentage purity of acids and bases.

Candidates are expected to be conversant with calculations on both direct and back titrations. Calculation should be to 3 significant figures.

20.3 <u>Qualitative Analysis:</u>

No formal scheme of analysis is required.

(a) i. Characteristics tests for the following cations with dil. NaOH and NH_3(aq).

(1) NH_4+; Ca^2+ Pb^{2+}; Cu^{2+}; Fe^{2+}; Fe^{3r}; $A1^{3+}$; and Zn^{2+}

(2) Confirmatory tests for the above cations.

(b) i. Characteristic action of dil. HCI on solid samples or aqueous solutions and concentrated H_2SO_4 on solid samples of the following:

CI^-, SO_3^{2-}, CO_3^{2-}, NO_3^{2-} , SO_4^{2-}

ii. Confirmatory tests for the above anions.

(c) comparative study of the halogens, displacement reactions.

(d) Characteristic tests of the following gasses: O_2; H_2; NH_3; CO_2; HCI; and SO_2, H_2S.

Note: that the use of litmus paper will not be accepted as a confirmatory chemical test except for the identification of ammonia gas.

(e) Characteristic test tube reactions of the functional groups in the following simple organic compounds. Alkenes, Alkanols, Alkanoic acids, sugars (using Fehling's and Benedict's solutions only), starch (iodine test only) and protein (using the Ninhydrin test, xanthoproteic test, Biuret test and Millon's test only).