ADVANCED SYLLABUS CHEMISTRY (A15)

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INTRODUCTION

This syllabus has been designed from the NBTE curriculum for the purpose of evaluation. It prepares candidates for A-level examination and the chemistry syllabus is also designed to lay a solid and broad-based foundation on the advanced principle of the subject matter. The basic and advanced principles of chemistry are best understood by investigating them in the laboratory; therefore the chemistry course should be firmly based on practical work. The theoretical and practical aspects of the subject should form an integrated whole. It is assumed that candidates must have covered and passed at credit level, the chemistry and mathematics syllabus at senior secondary school (S.S.S) level.

Aims

The aim of the syllabus includes.

1. Candidates should be able to demonstrate knowledge with understanding relation to the practice of experimental skills throughout the whole period of the course of study.
2. Candidates should use the chemical knowledge gained in the core syllabus to explore key areas of modern chemical science.
3. The course introduces the candidates to some new chemistry and focuses on the application of chemistry record, industry and everyday life and raises awareness of the associated ethical issues.
4. The course serves as foundation for post-technical education.
5. Inculcating in the candidates the culture of safety precaution.

THE EXAMINATION STRUCTURE

The examination shall consists of two papers

PAPER 1 (THEORY) 150 MARKS

SECTION A shall consist of **ten (10)** short structured questions, each carrying **five (5) marks**. Students are required to attempt all within **1hour**. Total marks are **50.**

SECTION B: (Part A: Physical and Inorganic Chemistry) 100 marks

Part A shall consist of **four (4)** essay questions. Students are required to attempt **three (3)** questions out of the **four (4)** questions, each carrying **20 marks.**

Part B (ORGANIC CHEMISTRY) shall consist of **three (3)** essay questions. Students are required to attempt **two (2)** questions out of the **three (3)** questions, each carrying **20 marks**.

PAPER II (TEST OF PRACTICAL WORK) – 80 MARKS

Students are required to answer all three (3) practical questions within 2hours for 80 marks based on

- Quantitative Analysis
- Qualitative Analysis
- Test of practical work.

ALTERNATE

PAPER 2:- (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.

The paper is a two (2) hour practical paper consisting of three (3) questions and shall carry 80 marks.

S/N	Topics/Objectives	Contents	Activities/Remark
1.	i. Atoms Molecules Elements and Compounds. ii. Relative masses of Atoms and Molecules. iii. Empirical and Molecular masses. iv. Reacting masses and Volumes of (solution and gasses)	Definition of atoms, molecules, element and compounds (Revision only) and interrelation with one another. Definition of relative mass, isotopes, molecular mass and formula mass based on ^{12}C scales. Determination of relative and molecule masses. Definition of empirical and molecular formulae. Construction of balance equations. Preparation of standardize solutions of simple salts acids/bases explanation of solution principle. The law of conservation of matter, law of constant composition, the combining volumes. Atomic mass scale ^{12}C, the standard, determination of the relative atomic and molecular masses by mass spectrometry.	Simple calculation of relative atomic and molecular masses Calculation of empirical and molecular formulae using composition by mass. Calculations including use of the mole concepts involving: i. Reacting masses from formulae and equations. ii. Volumes of gasses.
2.	**Atomic Structure:** i. Features of atom	The concepts of features of atom, the nucleus of the atom i.e. electrical nature of atoms electrons, protons and neutrons from the works of Daltons, Faraday, Thompson, Mosley and Rutherford, Goldstein, Milliken, Becquerel, constant radioactivity. Models of the atom, qualitative description.	Mathematical fractment is NOT required (Qualitative treatment only). Deduce the behaviour of beams of protons, neutrons and electrons in electric.

		Electronic energy levels (evidence from emission spectra Bohr's atomic theory Arrangement of the electrons in energy levels and diagram Aufbau principle, Pauli's exclusion principle, hund's rules, Heisenberg uncertainty principle and electron configuration.	
	ii. Arrangement of electrons in the energy levels of an atom. iii. Ionization energies, atomic orbital, extra nuclear structure. iv. Distinguish between chemical reactions. v. Nuclear fission and nuclear fusion. vi. Half-Life vii. Effects of radioactive radiation on human beings.	List the main sub-energy levels in an atom. The arrangement of electrons in the energy levels. Explanation of orbital, origin of s,p,d, and f orbitals. Explain the ionization energy and the factors influencing ionization energies of element. Explaination of nuclear chemistry chemical and nuclear reactions. Balancing of simple nuclear reaction. Types and nature of radiations (alpha, beta and Gama rays) Natural and artificial radioactivity. Define Nuclear fission and nuclear fusion. Device used for detecting radio activities. Qualitive treatment of half-life. Application of radioactivity, carbonating and uses in agriculture, medicine and industry.	Describe outline from the experiments of faraday, J.J. Thompson Rutherford and etc. It should be pointed out that contrary to what obtains in a chemical reaction, a new element may be created during a nuclear reaction. Symbols should also be used to identify the type of radiation.
3	**State of Matter:** i. Gaseous State	a. The Basic assumption of the Kinetic theory as applied to idea gas. b. PV=nRT and its uses in determining a value for M. c. Qualitatively in terms of inter molecular forces and molecular size. c(i) the conditions necessary for a gas to approach ideal behaviour. c (ii) the limitations of ideality at very high pressure and very low temperatures.	Simple charts showing graphical representation of gas laws. i.e. Bayle's and Charles' laws.

	Kinetic Molecular theory **(i) The Liquid state.** **(II) The Solid state.**	State all ideal gas laws and calculations State the postulates of Kinetic molecular theory for an ideal gas and the derivation of the expression PV/1/3 mm^2. Differentiate between ideal and real gases. Real gases. Introduction of Vander Waal's force equation (qualitative account) Description using a kinetic molecular model: liquid state, melting, vaporization and vapour pressure. Definition of normal boiling point. Recall that fractional distillation is used for separation of liquid components of crude oil and liquid air. Description in simple terms, the lattice structure of a crystalline solid. Isomephism, unit cell and lattice defects Types of crystal systems and classification of solids e.g. molecular ionic covalent and metallic solids..	Do calculations accompanying them. Sketch and label simple phase diagram e.g. of water and carbon dioxide. Distillation set-up. Models of crystal lattice calculate lattice energy using Born Haber cycle.
4.	**Periodic Table:** 1.1 (a). Variable position of hydrogen in the periodic table. (b). occurrence and preparation from acid and water. (c). Isotopes **1.2. Hydrides** a. reaction of hydrogen with the alkali and alkali metals.	The strength, high melting point and electrical insulating properties of ceramics in terms of their giant molecular structure. i. Differences of hydrogen in terms of its position in the periodic table. ii. Give reasons why it is placed in either group I or VII. iii. Explain how hydrogen occurs as a molecule and also mention at least methods of preparing hydrogen. iv. Mention the three isotope of hydrogen and explain why they are different in their physical properties. Write a good chemical equation for the reaction. Mention source of the hydrides. The reactions of the elements with oxygen and water. The behaviour of oxides and water. Decomposition of the nitrates and	

	b. types of hydrides. **Chemistry of Groups O,I, II, Elements:-** i. Similarities and trends in the properties of the Group II metals magnesium to barium and their compounds. ii. Some uses of Group II compounds. 1.3 i. Periodic Law and Periodic Table. ii. Periodic Properties such as atomic radius, ionization energy, energy electron negativity and electron affinity. iii. Classification into s.p.d. and f block element horizontal vertical and diagonal. iii. Transition element.	carbonates. Interpretations, and predictions from the trends in physical and chemical properties of the elements and their compounds Uses of magnesium oxide as a refractory lining material and calcium carbonate as a building material. The use of lime in agriculture. The trends in the thermal stability of nitrate and carbonate and variation in solubility of sulphates. Explanation of the terms period and group as related to the period table periodic law and table Electronic configurations. The uniqueness of hydrogen atom in the periodic table. Definition of electron affinity, electro-negativity, ionization potentials and etc. Account for variation of properties across a period and down the group of the periodic table and account also for horizontal relationships between elements in the periodic table. Explanation of the meaning of the transition elements and their characteristic properties. Types and uses.	Highlight the uniqueness of hydrogen in relation to the alkali metals and the halogens on the other progression from metallic to Non-metallic.

5.	**Chemical Bonding** i. Electrovalent or ionic bond	Chemical bonding and the various types. Using Lewis structure (Electron Dot/cross formula to illustrate with appropriate examples of the electrovalent or ionic bond Physical and chemical properties of ionic bond solids in relation to the bond type. Important of octet rule to explain valencies. Important of ionization potential electron affinity and electro negativity.	Using sodium chloride and magnesium oxide including the use of "dot/cross" diagrams.
	ii. Covalent bond	The octet of electrons confers stability Lewis structure for covalent compounds. Explanation of unequal sharing of electron pair by bonded atom. Covalent bonding in terms of orbital overlap giving ∂ and π bonds. Explain sp, sp^2 and sp^3 hybridization in carbons. Describe hydrogen bonding. Common compounds with multiple bonds.	Charts/model showing the nature of bonding in molecule.
	iii. Co-ordinate or dative bond	Explanation of bond energy and bond length co-ordinate (dative bond) bonding as in the formation of the ammonium ion and in the $AlCl_3$ molecule. Explanation of the formation of co-ordinate bonding in transition metal complexes and hydrated ion. Explain the shapes of bond angles in molecule by using the repulsion (including lone pairs).	Showing the shape of, and bond angles in the ethane, ethane and benzene molecule in terms of Q and π bonds.
	Iv. Metallic bonding Vander Waals forces, and intermolecular bonding.	Explanation of metallic bonding, water molecule bonding and Vander Waals forces with appropriate examples. General properties of metals. Difference between metallic and electrolytic conduction. The existence in non-polar molecule e.g. helium etc. Relationship between the strength of vander waals forces and phase change temperature e.g. bpt of inert gases and hydrogen halides, iodine(s) andchlorine(g)	Using simple examples Bf_3 (trigonal) Co_2 (leness) CH_3 (tetrahedral) NH_3 (pyramidal) H_2O (non-linear). Showing understanding of chemical reactions in terms of energy transfer associated with breaking and making chemical bonds

PRACTICAL CHEMISTRY
PRACTICAL CHEMISTRY TO RUN CONCURRENTLY WITH THEORY

S/N	Topics/Objectives	Contents	Activities/Remark
6.	i. Energy Effects	Determination of enthalpy of reaction e.g. neutralization Explanation of the precautions necessary in the experiment. Differences between specific heat, molar heat capacity for a given chemical substance	Using a simple well insulated calorimeter calculation of heat of reaction. Distillation kit.
	ii. Equilibrium	The principles of liquid- liquid extraction: extraction as method of extraction. Factors that will affect the partition of coefficient. Equilibrium laws and equilibrium constant. Dynamics nature of equilibrium. Factors that affect equilibrium values and position.	
	iii. Distillation (simple and steam)	Dissolution of a sparingly solution salt in an equilibrium process. Definition of solubility and solubility product solubility product expressions for bi-cad termolecular electrolytes monitoring the rates of simple reactions.	Use simple distillation acid method of purification e.g. mulding water. Stop clock, calorimeter graph papers/board.
	iv. Chemical Kinetics	Application of simple distillation in purification. Techniques of steam distillation.	
	v. Determination of activation energy	Definition of reaction and rate law. Acid hydrolysis of an ester as a first order reaction. .	

S/N	Topics/Objectives	Contents	Activities/Remark
7.	**Qualitative** (i) Inorganic Analysis	Analysis of onions Co^{2-}_3, HCO_3, S^{2-}, NO^-_2, CL^-, Br^-, I^-, NO^-_3, SO^{2-}_3, SO^2_3, Analysis of cations Na^+, Ca^{2+}, K^+, pb^{2+}, Cu^{2+}, NH_4^+, Zn^{2+}, fe^{2+}, fe^{3+}, Ba^{2+}, Sn^{2+}, Sn^{4+}, Al^{3+}.	Beach reagents e.g. aqueous ammonia aq sodium hydroxide i.e. common reagent and apparatus for inorganic analysis.
	(II) Organic Analysis	Experiment in basic techniques in organic chemistry. Determination of melting point and boiling points, filtration, distillation, fractional distillation, recrystallisation. Test for functional groups analysis-unstauration, alkcanols, alkcanals, alkcanones, alkcanoic acid amines and phenols. Solubility and litmus Test. Tests for starch, proteins, fats and oils. Characteristic action of dilute Hcl on solid sample or aqueous solutions and concentrated H_2SO_4 on solid samples. Comparative study of the halogens, displacement reactions. Characteristics tests of the gases Theory of volumetric analysis. Operations and methods Acid/base titration. Preparation of dil Hcl on solid samples or aqueous solution and concentrated H_2SO^4 on solid samples Calculation, mole, morality.	Reagents and apparatus for qualitative organic analysis. Solid samples of CL^-, SO^{2-}_3, Co^2_3, NO_3^{2-}, SO^2_4 e.g. O^2, NH_3, Co^2, Hcl, SO^2, s. Use of litmus will NOT be accepted as confirmatory chemical test EXCEPT for the identification of ammonia gas. Regional acid appropriative for qualitative analysis. Calculations based on mole, morality concentration and etc

8.	**Organic Chemistry**	General Principles of organic chemistry. i. Brief review of the development of organic chemistry. ii. Classification of organic compound as aliphatic, aromatic and cyclic. iii. Describe members of (ii) above of both saturated and unsaturated. iv. Methods used to purity organic compounds. v. homologous series, functional groups. vi. The concepts of melting and boiling points to purity organic compounds.	Melting and boiling point apparatus.
	(i). Determination of organic compound	Elemental analysis, percentage composition empirical and molecular formula, structural formula.	
	(ii) Electronic theory in organic chemistry.	Definition Hybridization leading to formation of carbon, carbon single, double and triple bonds (sp, sp^2, sp^3). Characterization of bond types. Bond energy inductive and resonance effects.	Sketch the shape of sp, sp^2, sp^3 hybridization.
		b. Non-polar functional group chemistry. i. Alkanes-Structure and physical properties substitution reactions including mechanism. ii. Alkenes: Structure and physical properties. Reactions: addition, Oxidation, polymerization stereoisomerism-definition, geometrical and optical isomers and condition for optical isomerism.	Structural isomerism in alkanes with up to five carbon atoms. Models showing shapes and stereo chemistry of organic molecule.
	(iii) Benzene	Structure and aromaticity of Benzene: introduction to electrophilic substitution reactions.	
	(iv) Nomenclature	: Common (trivia) names, IUPAC names of classes of compounds.	
	(v) Petro chemistry	Introduction to petro chemistry. Organ of petroleum, importance fractional distillation of crude oil, component, properties and uses. Octane member and cracking	
	(vi) Coal tar Chemistry	origin, production, important components and uses.	

S/N	Topics/Objectives	Contents	Activities/Remark
9.	**Concepts of Acids and Bases.** A. Acids and Bases in reaction to theories of i. Arrhenius, Bronsted, lowry and lewis. ii. Behaviour of Electrolytes iii. Water as a solvent. iv. Classification of Electrolytes B. i. Acids and Bases reaction. ii. Strength of acids and bases. C. Concepts of hydration, hydrolysis. D. Salts i. Types ii. Formation	Define acids bases in terms of Arrhenius, Bronsted-Lowry and Lewis concepts Define electrolytes Explain the behaviors of electrolytes, and gibe some examples of them. Differentiate between weak and strong electrolytes Explain why water is regarded as a solvent. Mention types of water. Classify the electrolytes into weak and strong electrolytes. Identify acids/bases in a chemical reaction, giving the basis for the classification: - weak/strong acids/ bases. Recall reactions of water as acid and bases. Explain why water cannot act as Lewis acid. Recall Ka/kb as a measure of acid/ base strength. Explain the term conjugate pair. Recall that all non-octet molecules are potential Lewis acid e.g. BF_3. Distinguish between hydration and hydrolysis. Test aqueous solution of NH_4Cl and Na_2Co_3 with litmus paper or suitable acid bases indicator to confirm hydrolysis of these salts in water. Define salt. Mention different types of salts. Describe formation of salts from acid base reaction etc.	

S/N	Topics/Objectives	Contents	Activities/Remark
	E. Buffers, i. Buffer solution ii. Types iii. Importance of Buffers. F. Equilibria and Equilibrium contents i. Properties of a system in equilibrium ii. The general equilibrium expression as an experimental result. iii. Dynamic nature of equilibrium. $\Delta G=0$, this should be expressed both in terms pressure Kp and concentration kc. iv. equilibrium constant v. solubility products vi. Soluble salts. vii. Common ion effect.	Explain the concept of buffers. Define buffers solution Mention its types Enumerate the importance of buffers e.g. in biochemistry and medicine. Recall various equilibrium expression in various terms up to $Kp=Kc\ (RT)\ \Delta n$ Recall that at equilibrium $\Delta G=O$. Write expression for some equilibrium reactions of dissociation of H_2O_2, content process etc. Recall that equilibrium are dynamic and that the principle of equilibrium depends on the equilibrium amount of reactions and products, which is dependent on temperature. State the law of equilibrium constant. Write the expression of the equilibrium constant. Distinguish solubility product expression from general equilibrium expression e.g. $AB_3 \rightarrow A^+ + B^-$ $ksp = \{A^+\}\{B^-\}$ Explain the meaning of solubility products in terms of products of concentration of ions in solution. Determine the solubility of sparingly soluble salt in water when the solubility product constant is given and vice-versa. Explain the meaning of common ion effect State the effects of common ion on solubility compound such as $BaSo_4$, e.g. solubility of $BaSo_4$ in $100dm^3$ of 0.100 mole dm^{-3} Na_2So_4 solution $ksp=1.5x10^{-9}$.	

S/N	Topics/Objectives	- Contents	Activities/Remark
	G. Precipitation reactions.	- State various applications of solubility products as - i.Determination of insoluble salts. - Ii.Precipitation - Precipitation of insoluble salts - Inorganic analysis-ppt of sulphide.	Carry out the experiment on solubility.
10.	**Polar functional Group Chemistry.** **Hydroxyl group** i. Alcohols ii. Important methods of preparation of alcohols. Laboratory and commercial methods of preparing ethanol and others. iii. Reactions with metals, bases, alkyhalides,. iv. Oxidation, dehydration v. Test for alcohols and uses.	- Display formula of the following classes of alcohols: primary, secondary and tertiary and classify their hydroxyl compound as well. Interpret, and use the terminology associated with functional group, free radical and initiation (OH, RCH_2). - Classification and comparison of Acidity. - Outline the procedure for the preparation of alcohols; ethanol.	
	vi. Phenols Its acidity; reaction with metals (Na), Bases and and alkyhalides.	Deduce the presence of a $CH_3CH(OH)$-group in an alcohol from its reaction with alkaline aqueous iodine to form tri-iodo methane. Identify a reaction of alcohol with metals, bases and alkyhlides. Write a balanced equation for the oxidation reaction of alcohol to ethanol. Carbonyl compounds and carboxylic acids dehydration to alkenes. Explain what happens when alcohol burns in air. Enumerate the industrial and commercial uses. Recall the chemistry of phenol as examplified by the following reactions. i. Sodium ii. Bases	Carry out the experiment to demonstrate the chemical properties of alcohols.

11.	**Carbonyl Group.** i. Aldehydes (examplified by ethanol). ii. Structure iii. Physical properties iv. Methods of preparation	iii. Nitration of and bromination of the aromatic ring. Explain the acidity of water, phenol and ethanol. Give the structural formula of Aldehydes; RCHO Distinguish polar and non-polar groups. Compare the boiling points and the melting points Outline the important methods of preparation, oxidation of primary akanals.	
12	i.Reaction of Aldehydes Nucleophylic addition to the carbonyl Group. ii.Test for Aldehydes	Give the structural formula of Aldehydes Compare the difference in the boiling and melting points. Distinguish between polar and non-polar groups. Identify the formation of aldlydes from primary alcohols using $Cr_2O_7^{2-}$ (H^+. Explain the following reactions:- Tollens reagent, Fehlings with ainmonia, hydrazine and their derivatives including mechanism; aldo condensation. Describe the reduction of aldhydes; e.g. using NABH4 Describe the use of 2, 4 – dinitrophenyl hydrazine (2,4-DNPH) reagent to detect the presence of carbonyl compounds.	

13.	Kentones (exemplified by Propanone) i. Reaction of Ketone ii. Halogenations of Ketones iii. Cannizaro reaction iii. Test for Ketones	Deduce the nature (Ketone) of an unknown carbonyl compound from the results of simple test (i.e. fehlings and Tollen's reagent). Describe the reaction of CH_3CO-compound with alkaline aqueous iodine to give tri-iodomethane.	Carry out the experiment on Tollens ie reagents and fehling's solution test.
14.	**Carboxylic acids-COOH and derivatives.** iv. Carboxylic acid (examplified by ethanoic acid and benzoic acid). i. Formation from primary alcohols and nitriles ii. Salt, ester and acyl chloride ormation iii. Polarity iv. Hydrogen boiling in carboxylic acids and its medication by inductive effects and mesomeric effects. v. Acyl chlorides (ethanoyl chloride) i. Ease of hydrolysis compared with alkyl and aryl chlorides ii. Reaction with alcohols, phenols and primary anines iii. Synthesis reactions of aromatic sulphonic acids.	Write the structural formula of monocarboxylic acid and give its IUPAC nomenclature. Describe the formation of carboxylic acids from alcohols, aldyhdes and nitriles. Describe the reaction of carboxylic acids in the formation of salts, esters and acyl chlorides. Explain the acidity of carboxylic acids and of chloride of carboxylic acid and chlorine substituted ethanoic acids in terms of their structures. Describe resonance structure of carboxylic group. Explain the effect of resonance stability of carbonyl group on acidity. Explain the relative ease of hydrolysis of acyl chlorides, alky chlorides and aryl chlorides. Describe the reactions of acyl chlorides with alcohols, phenols and primary amines.	
15.	**Esters (ethyl ethanoate and phenyl benzoate).** i. Formation from carboxylic acid and acyl chlorides.	Describe the formation of Esters from carboxylic acid or acyl chlorides e.g. ethyl ethanoate and phenyl benzoate. Describe the acid and base	Carry out the experiment.

	ii. Hydrolysis (under acidic and basic conditions) iii. Uses of esters.	hydrolysis of esters. Describe the formation of polyesters. State the major commercial uses of esters e.g. flavourings, perfumes, solvents etc.	
16.	**Amino Group; NH_2** - Amines structure - The functional group. i. Primary amines (ethylamine and phenyl amine i. Formation ii. Salt formation iii. Other reactions of phenylamine with acids and basicity. **iv. Physical properties of amine.** Separation by Hinsberg method important usage. **Test for amines.**	Draw the structure of some amines and their nomelature using the IUPAC system. Identify the functional group. Describe the formation of ethylamine (by) nitrile reduction and of phenylamine (by reduction of nitrobenzene). Explain the relatives basicities of ammonia, ethylamine and phenylamine in terms of their structures. State some physical properties of amine; in relation to gases, liguids, polarity, smell and hydrogen bonding. Describe the Hinsberg method of separation. Mention the importance and uses of Amines in polyamides and nylon. Describe how amines can be tested in the laboratory.	
17.	**Fats and Oils** i. Definition and importance of fats and oils. ii. Process of soap making. Reaction with Hard water, mineral acids, - Formation of scum - Formation of Ionized fatty acids. **Mode of cleaning action.** - Hydrophobic and hydrophilic.	Define fats and oils State the importance of fats and oils. Outline the processes involve in soap and detergent. Distinguish between soap and detergent making.	
18	**Drying Oils** i. Mode of action ii. Use in points and vanishes	Describe the mode of action of drying oils and also Explain the use in points and vanishes Define saponification Explain the action of soap in	Carry out the experiment.

		hard water, acidic water. State how scum and unionized fatty acids are formed. Distinguish between the hydrophobic (tail) and hydrophilic actions. Describe the cleaning action of soap.	
19.	**Amino Acids** - Structure - Properties of amino acids - Acid and base - Zwitterions formation **Classification** i. Natural occurance ii. Essential amino acids.	Draw the Structural formula of the amino acids. Identify the functional groups. NH2 and- COOH. Describe the acid/base properties of amino acids. Describe the formation of Zwitterions. Distinguish between naturally occurring amino acids and essential amino-acids.	
20.	**Proteins** i. Structure, based on the peptide linkage. **ii.** Hydrolysis of protein	Classify the amino acid, Glycine, alanine, cystein and phenylalanine. Describe the formation of pepetide bonds between amino acids and hence Explain protein formation Describe the hydrolysis of proteins. Describe the formation of polygamides.	
21.	**Quantitative and Qualitative analysis:** Theory of volumetric analysis. i. Operation and methods calculations i. Mole ii. Molarity	- Explain the meaning of quantitative and qualitative analysis. - Define volumetric analysis. - Explain its mole of operations and how it can be achieves. - State the reagents that can be used. - Define mole and ratio as used in volumetric analysis. - State how mole ratio can be achieved.	Carry out the experiment on Acid/Base titration using a suitable indicator.

		- Define morality - Explain how morality can be calculated from a reaction of an acid and base.	
22	**Chemical energetic**	-Enthalpy changes ΔH of formation, combustion, hydration, solution, neutralization and atomization; bond energy; lattice energy; electron affinity. - Hess' law, including born-harber cycles	
23	**Electrochemistry** **a. Redox processes** **b. Electrode potentials** **c. Electrolysis**	-Electron transfer and changes in oxidation (oxidation state) -Standard electrode (redox) potential, the redox series -Standard cell potential and their uses. -Batteries and fuel cells. -Factors affecting the amount of substance liberated during electrolysis. -The faraday constant; Avogadro constant; their relationship. -Industrial uses of electrolysis.	