

## CHEMISTRY

### 1. INTRODUCTION

This syllabus is drawn purposely for examination, hence the topics are not necessarily arranged in the order in which they should be taught.

The following assumptions were made in drawing of the syllabus:

- (1) That candidates must have covered the Integrated Science/Basic Science or General Science and Mathematics syllabuses at the Junior Secondary School (JSS)/Junior High School (J.H.S) level;
- (2) That candidates would carry out as many of the suggested activities and project work as possible, and consequently develop the intended competencies and skills as spelt out in the relevant Chemistry teaching syllabuses;
- (3) That schools which offer the subject have well-equipped laboratories.

**Note: Candidates are required to have the knowledge of the significant figures, S.I. units and the conventional/IUPAC system of nomenclature.**

### 2. AIMS

The aims and objectives of the syllabus are to assess candidates'

- (1) understanding of basic chemistry concepts;
- (2) level of acquisition of laboratory skills including awareness of hazards and safety measures;
- (3) level of awareness of the inter-relationship between chemistry and other discipline;
- (4) level of awareness of the linkage between chemistry and industry/environment/everyday life in terms of benefits and hazards;
- (5) skills of critical and logical thinking.

### 3. EXAMINATION SCHEME

There shall be three papers - Papers 1, 2 and 3 all of which must be taken. Paper 1 and 2 shall be a composite paper to be taken at one sitting.

**PAPER 1:** Will consist of fifty multiple choice objective questions drawn from Section A of the syllabus (ie the portion of the syllabus which is common to all candidates) . Candidates will be required to answer all the questions within 1 hour for 50 marks.



**PAPER 2:** Will be a 2-hour essay paper covering the entire syllabus and carrying 100 marks. The paper will be in two sections; Sections A and B.

**Section A:** Will consist of ten short structured questions drawn from the common portion of the syllabus. (i.e. Section A of the syllabus). Candidates will be required to answer all the questions for 25 marks.

**Section B:** Will consist of two questions from the common portion of the syllabus (i.e. Section A of the syllabus) and two other questions from the section of the syllabus which is peculiar to the country of the candidate (i.e. either Section B or C of the syllabus). Candidates will be required to answer any three of the questions. Each question shall carry 25 marks.

**PAPER 3:** This shall be a 2-hour practical test for school candidates or 1 hour 30 minutes alternative to practical work test for private candidates. Each version of the paper shall contain three compulsory questions and carry 50 marks.

The questions shall be on the following aspects of the syllabus:

- One question on quantitative analysis;
- One question on qualitative analysis;
- The third question shall test candidates' familiarity with the practical activities suggested in their teaching syllabuses.

**Details of the input into the continuous assessment shall be given by the Council.**

## SECTION A

(For all candidates)

| CONTENT   | NOTES   |
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| <p><b>1.0 INTRODUCTION TO CHEMISTRY</b></p> <p>(a) (i) Measurement of physical quantities.</p> <p>(ii) Scientific measurements and their importance in chemistry.</p> <p>(b) Scientific Methods</p> | <p>(1) Measurement of mass, length, time, temperature and volume.</p> <p>(2) Appropriate SI units and significant figures.</p> <p>(3) Precision and accuracy in measurement.</p> <p>Outline the scientific method to include: Observation, hypothesis, experimentation, formulation of laws and theories.</p>                       |
| <p><b>2.0 STRUCTURE OF THE ATOM</b></p> <p>(a) Gross features of the atom.</p> <p>(b) (i) Atomic number/proton number, number of neutrons, isotopes, atomic mass, mass number.</p>                  | <p>(1) Short account of Dalton's atomic theory and limitations, J.J. Thompson's experiment and Bohr's model of the atom.</p> <p>(2) Outline description of the Rutherford's alpha scattering experiment to establish the structure of the atom.</p> <p>Meaning and representation in symbols of atoms and sub-atomic particles.</p> |

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| <p>(ii) Relative atomic mass (<math>A_r</math>) and relative molecular mass (<math>M_r</math>) based on Carbon-12 scale.</p> <p>(iii) Characteristics and nature of matter.</p> <p>(c) Particulate nature of matter: physical and chemical changes.</p> <p>(d) (i) Electron Configuration</p> <p>(ii) Orbitals</p> <p>(iii) Rules and principles for filling in electrons.</p> | <p>(1) Atomic mass as the weighted average mass of isotopes. Calculation of relative mass of chlorine should be used as an example.</p> <p>(2) Carbon-12 scale as a unit of measurement.<br/>Definition of atomic mass unit.</p> <p>Atoms, molecules and ions.<br/>Definition of particles and treatment of particles as building blocks of matter.</p> <p>Explain physical and chemical changes with examples.<br/>Physical change- melting of solids, magnetization of iron, dissolution of salt etc.<br/>Chemical change- burning of wood, rusting of iron, decay of leaves etc.</p> <p>Detailed electron configurations (s,p,d) for atoms of the first thirty elements.</p> <p>Origin of s,p and d orbitals as sub-energy levels; shapes of s and p orbitals only.</p> <p>(1) Aufbau Principle, Hund's Rule of Maximum Multiplicity and Pauli Exclusion Principle.<br/>(2) Abbreviated and detailed electron configuration in terms of s, p, and d.</p> |

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| <p><b>3.0 STANDARD SEPARATION TECHNIQUES FOR MIXTURES</b></p> <p>(a) Classification of mixtures.</p> <p>(b) Separation techniques</p> <p>(c) Criteria for purity.</p> <p><b>4.0 PERIODIC CHEMISTRY</b></p> <p>(a) Periodicity of the elements.</p> <p>(b) Different categories of elements in the periodic table.</p> <p>(c) Periodic law:</p> <p>(i) Trends on periodic table;</p> <p>(ii) Periodic gradation of the elements in the third period (Na - Ar).</p> | <p>Solid-solid, solid-liquid, liquid-liquid, gas-gas with examples.</p> <p>Crystallization, distillation, precipitation, magnetization, chromatography, sublimation etc.</p> <p>Boiling point for liquids and melting point for solids.</p> <p>Electron configurations leading to group and periodic classifications.</p> <p>Metals, semi-metals, non-metals in the periodic table and halogens. Alkali metals, alkaline earth metals and transition metals as metals.</p> <p>Explanation of the periodic law.</p> <p>Periodic properties; atomic size, ionic size, ionization energy, electron affinity and electronegativity.<br/>Simple discrepancies should be accounted for in respect to beryllium, boron, oxygen and nitrogen.</p> <p>(1) Progression from:<br/>(i) metallic to non-metallic character of element;<br/>(ii) ionic to covalent bonding in compounds.</p> |

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| <p>(d) Reactions between acids and metals, their oxides and trioxocarbonates (IV).</p> <p>(e) Periodic gradation of elements in group seven, the halogens: F, Cl, Br and I.</p> <p>(f) Elements of the first transition series.<br/><math>_{21}\text{Sc} - _{30}\text{Zn}</math></p> | <p>(2) Differences and similarities in the properties between the second and the third period elements should be stated.</p> <p>(1) Period three metals (Na, Mg, Al).<br/>(2) Period four metals (K, Ca).<br/>(3) Chemical equations.<br/>(4) pH of solutions of the metallic oxides and trioxocarbonates.</p> <p>Recognition of group variations noting any anomalies.<br/>Treatment should include the following:<br/>(a) physical states, melting and boiling points;<br/>(b) variable oxidation states;<br/>(c) redox properties of the elements;<br/>(d) displacement reaction of one halogen by another;<br/>(e) reaction of the elements with water and alkali (balanced equations required).</p> <p>(1) Their electron configurations, physical properties and chemical reactivity of the elements and their compounds.<br/>(2) Physical properties should include: physical states, metallic properties and magnetic properties.<br/>(3) Reactivity of the metals with air, water, acids and comparison with s-block elements (Li, Na, Be, Mg).</p> |

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| <p><b>5.0 CHEMICAL BONDS</b></p> <p>(a) Interatomic bonding</p> <p>(b)(i) Formation of ionic bonds and compounds.</p> <p>(ii) Properties of ionic compounds.</p> <p>(c) Naming of ionic compounds.</p> <p>(d) Formation of covalent bonds and compounds.</p> <p>(e)(i) Properties of covalent compounds.</p> <p>(ii) Coordinate (dative) covalent bonding.</p> | <p>(4) Other properties of transition metals should include:</p> <ul style="list-style-type: none"><li>(a) variable oxidation states;</li><li>(b) formation of coloured compounds;</li><li>(c) complex formation;</li><li>(d) catalytic abilities;</li><li>(e) paramagnetism;</li><li>(f) hardness.</li></ul> <p>Meaning of chemical bonding.<br/>Lewis dot structure for simple ionic and covalent compounds.</p> <p>Formation of stable compounds from ions. Factors influencing formation: ionization energy; electron affinity and electronegativity difference.</p> <p>Solubility in polar and non-polar solvents, electrical conductivity, hardness and melting point.</p> <p>IUPAC system for simple ionic compounds.</p> <p>Factors influencing covalent bond formation. Electron affinity, ionization energy, atomic size and electronegativity.</p> <p>Solubility in polar and non-polar solvents, melting point, boiling point and electrical conductivity.</p> <p>Formation and difference between pure covalent and coordinate (dative) covalent bonds.</p> |

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| <p>(f) Shapes of molecular compounds.</p> <p>(g)(i) Metallic Bonding</p> <p>(ii) Factors influencing its formation.</p> <p>(iii) Properties of metals.</p> <p>(h)(i) Inter molecular bonding</p> <p>(ii) Intermolecular forces in covalent compounds.</p> <p>(iii) Hydrogen bonding</p> <p>(iii) van der Waals forces</p> <p>(iv) Comparison of all bond types.</p> | <p>Linear, planar, tetrahedral and shapes for some compounds e.g. <math>\text{BeCl}_2</math>, <math>\text{BF}_3</math>, <math>\text{CH}_4</math>, <math>\text{NH}_3</math>, <math>\text{CO}_2</math>.</p> <p>Factors should include: atomic radius, ionization energy and number of valence electrons. Types of specific packing not required.</p> <p>Typical properties including heat and electrical conductivity, malleability, lustre, ductility, sonority and hardness.</p> <p>Relative physical properties of polar and non-polar compounds.<br/>Description of formation and nature should be treated.<br/>Dipole-dipole, induced dipole-dipole, induced dipole-induced dipole forces should be treated under van der Waal's forces.</p> <p>Variation of the melting points and boiling points of noble gases, halogens and alkanes in the homologous series explained in terms of van der Waal's forces; and variation in the boiling points of <math>\text{H}_2\text{O}</math>, and <math>\text{H}_2\text{S}</math> explained using Hydrogen bonding.</p> |



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| <p><b>6.0 STOICHIOMETRY AND CHEMICAL REACTIONS</b></p> <p>(a) (i) Symbols, formulae and equations.</p> <p>(ii) chemical symbols</p> <p>(iii) Empirical and molecular formulae.</p> <p>(iv) Chemical equations and IUPAC names of chemical compounds.</p> <p>(v) Laws of chemical combination.</p> <p>(b) Amount of substance.</p> | <p>Symbols of the first thirty elements and other common elements that are not among the first thirty elements.</p> <p>Calculations involving formulae and equations will be required. Mass and volume relationships in chemical reactions and the stoichiometry of such reactions such as: calculation of percentage composition of element.</p> <p>(1) Combustion reactions (including combustion of simple hydrocarbons)</p> <p>(2) Synthesis</p> <p>(3) Displacement or replacement</p> <p>(4) Decomposition</p> <p>(5) Ionic reactions</p> <p>(1) Laws of conservation of mass.</p> <p>(2) Law of constant composition.</p> <p>(3) Law of multiple proportions.<br/>Explanation of the laws to balance given equations.</p> <p>(4) Experimental illustration of the law of conservation of mass.</p> <p>(1) Mass and volume measurements.</p> <p>(2) The mole as a unit of measurement; Avogadro's constant, <math>L = 6.02 \times 10^{23}</math> entities <math>\text{mol}^{-1}</math>.</p> <p>(3) Molar quantities and their uses.</p> <p>(4) Moles of electrons, atoms, molecules, formula units etc.</p> |

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| (c) Mole ratios   | Use of mole ratios in determining stoichiometry of chemical reactions. Simple calculations to determine the number of entities, amount of substance, mass, concentration, volume and percentage yield of product.  |
| (d) (i) Solutions   | <ol style="list-style-type: none"><li>(1) Concept of a solution as made up of solvent and solute.</li><li>(2) Distinguishing between dilute solution and concentrated solution.</li><li>(3) Basic, acidic and neutral solutions.</li></ol>   |
| (ii) Concentration terms  | Mass (g) or moles (mol) per unit volume. Emphasis on current IUPAC chemical terminology, symbols and conventions. Concentration be expressed as mass concentration, $\text{g dm}^{-3}$ , molar concentration, $\text{mol dm}^{-3}$ .   |
| (iii) Standard solutions.   | <ol style="list-style-type: none"><li>(1) Preparation of some primary standards e.g anhydrous <math>\text{Na}_2\text{CO}_3</math>, <math>(\text{COOH})_2 \cdot 2\text{H}_2\text{O}/\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}</math>.</li><li>(2) Meaning of the terms primary standard, secondary standard and standard solution.</li></ol> |
| (e) Preparation of solutions from liquid solutes by the method of dilution. | Dilution factor  |

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| <p><b>7.0 STATES OF MATTER</b></p> <p>(a) (i) Kinetic theory of matter.</p> <p>(ii) Changes of state of matter.</p> <p>(iii) Diffusion</p> | <p>(1) Postulates of the kinetic theory of matter.</p> <p>(2) Use of the kinetic theory to explain the following processes: melting of solids, boiling of liquids, evaporation of liquids, dissolution of solutes, Brownian motion and diffusion.</p> <p>(1) Changes of state of matter should be explained in terms of movement of particles. It should be emphasized that randomness decreases (and orderliness increases) from gaseous state to liquid state and to solid state and vice versa.</p> <p>(2) Illustrations of changes of state using the different forms of water, iodine, sulphur, naphthalene etc.</p> <p>(3) Brownian motion to be illustrated using any of the following experiments:</p> <ul style="list-style-type: none"><li>(a) pollen grains/powdered sulphur in water (viewed under a microscope);</li><li>(b) smoke in a glass container illuminated by a strong light from the side;</li><li>(c) a dusty room being swept and viewed from outside under sunlight.</li></ul> <p>(1) Experimental demonstration of diffusion of two gases.</p> <p>(2) Relationship between speed at which different gas particles move and the masses of particles.</p> <p>(3) Experimental demonstration of diffusion of solute particles in liquids.</p> |

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| <p>(b) Gases:</p> <p>(i) Characteristics and nature of gases;</p> <p>(ii) The gas laws;</p> <p>(iii) Laboratory preparation and properties of some gases.</p> | <p>Arrangement of particles, density, shape and compressibility.</p> <p>The Gas laws: Charles'; Boyle's; Dalton's law of partial pressure; Graham's law of diffusion, Avogadro's law. The ideal gas equation of state. Qualitative explanation of each of the gas laws using the kinetic model. The use of Kinetic molecular theory to explain changes in gas volumes, pressure, temperature. Mathematical relations of the gas law <math>PV = nRT</math></p> <p>Ideal and Real gases<br/>Factors responsible for the deviation of real gases from ideal situation.</p> <p>(1) Preparation of the following gases: <math>H_2</math>, <math>NH_3</math> and <math>CO_2</math>. Principles of purification and collection of gases.<br/>(2) Physical and chemical properties of the gases.</p> |
| <p>(c) (i) Liquids</p> <p>(ii) Vapour and gases.</p>  | <p>Characteristics and nature of liquids based on the arrangement of particles, shape, volume, compressibility, density and viscosity.</p> <p>(1) Concept of vapour, vapour pressure, saturated vapour pressure, boiling and evaporation.<br/>(2) Distinction between vapour and gas.<br/>(3) Effect of vapour pressure on boiling points of liquids.<br/>(4) Boiling at reduced pressure.</p>   |

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| <p>(d) Solids:</p> <p>(i) Characteristics and nature;</p> <p>(ii) Types and structures;</p> <p>(iii) Properties of solids.</p> <p>(e) Structures, properties and uses of diamond and graphite.</p> <p>(f) Determination of melting points of covalent solids.</p> | <p>(1) Ionic, metallic, covalent network and molecular solids. Examples in each case.</p> <p>(2) Arrangements of particles ions, molecules and atoms in the solid state.</p> <p>Relate the properties of solids to the type of interatomic and intermolecular bonding in the solids. Identification of the types of chemical bonds in graphite and differences in the physical properties.</p> <p>The uses of diamond and graphite related to the structure.</p> <p>The use of iodine in everyday life.</p> <p>Melting points as indicator of purity of solids e.g. Phenyl methanedioic acid (benzoic acid), ethanedioic acid (oxalic) and ethanamide.</p> |
| <p><b>8.0 ENERGY AND ENERGY CHANGES</b></p> <p>(a) Energy and enthalpy</p> <p>(b) Description, definition and illustrations of energy changes and their effects.</p>  | <p>Explanation of the terms energy and enthalpy. Energy changes associated with chemical processes.</p> <p>(1) Exothermic and endothermic processes.</p> <p>(2) Total energy of a system as the sum of various forms of energy e.g. kinetic, potential, electrical, heat, sound etc.</p> <p>(3) Enthalpy changes involved in the following processes: combustion, dissolution and neutralization.</p>  |

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| <p><b>9.0 ACIDS, BASES AND SALTS</b></p> <p>(a) Definitions of acids and bases.</p> <p>(b) Physical and chemical properties of acids and bases.</p> <p>(c) Acids, bases and salts as electrolytes.</p> <p>(d) Classification of acids and bases.</p> <p>(e) Concept of pH</p> | <p>(1) Arrhenius concepts of acids and bases in terms of <math>\text{H}_3\text{O}^+</math> and <math>\text{OH}^-</math> ions in water.</p> <p>(2) Effects of acids and bases on indicators, metal Zn, Fe and trioxocarbonate (IV) salts and hydrogentrioxocarbonate (IV) salts.</p> <p>Characteristic properties of acids and bases in aqueous solution to include:</p> <p>(a) conductivities, taste, litmus/indicators, feel etc.;</p> <p>(b) balanced chemical equations of all reactions.</p> <p>Electrolytes and non-electrolytes; strong and weak electrolytes. Evidence from conductivity and enthalpy of neutralization.</p> <p>(1) Strength of acids and bases.</p> <p>(2) Classify acids and bases into strong and weak.</p> <p>(3) Extent of dissociation reaction with water and conductivity.</p> <p>(4) Behaviour of weak acids and weak bases in water as example of equilibrium systems.</p> <p>(1) Definition of pH and knowledge of pH scale.</p> <p>(2) Measurement of pH of solutions using pH meter, calometric methods or universal indicator.</p> <p>(3) Significance of pH values in everyday life e.g. acid rain, pH of soil, blood, urine.</p> |

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| <p>(f) Salts:</p> <p>(i) Laboratory and industrial preparation of salts;</p> <p>(ii) Uses;</p> <p>(iii) Hydrolysis of salt.</p> <p>(g) Deliquescent, efflorescent and hygroscopic compound.</p> <p>(h) Acid-Base indicators</p> <p>(i) Acid-Base titration</p> | <p>Meaning of salts.</p> <p>Types of salts: normal, acidic, basic, double and complex salts.</p> <p>(1) Description of laboratory and industrial production of salts.</p> <p>(2) Mining of impure sodium chloride and conversion into granulated salt.</p> <p>(3) Preparation of NaOH, Cl<sub>2</sub> and H<sub>2</sub>.</p> <p>(1) Explanation of how salts forms acidic, alkaline and neutral aqueous solutions.</p> <p>(2) Behaviour of some salts (e.g NH<sub>4</sub>Cl, AlCl<sub>3</sub>, Na<sub>2</sub>CO<sub>3</sub>, CH<sub>3</sub>COONa) in water as examples of equilibrium systems.</p> <p>(3) Effects of charge density of some cations and anions on the hydrolysis of their aqueous solution. Examples to be taken from group 1, group 2, group 3 and the d-block element.</p> <p>Use of hygroscopic compounds as drying agent should be emphasized.</p> <p>(1) Qualitative description of how acid-base indicator works.</p> <p>(2) Indicators as weak organic acids or bases (organic dyes).</p> <p>(3) Colour of indicator at any pH dependent on relative amounts of acid and forms.</p> <p>(4) Working pH ranges of methyl orange and phenolphthalein.</p> <p>(1) Knowledge and correct use of relevant apparatus.</p> <p>(2) Knowledge of how acid-bases indicators work in titrations.</p> |





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| <p><b>11.0 CHEMICAL KINETICS AND EQUILIBRIUM SYSTEM</b></p> <p>(a) Rate of reactions:</p> <p>(i) Factors affecting rates;</p> <p>(ii) Theories of reaction rates;</p> <p>(iii) Analysis and interpretation of graphs.</p> <p>(b) Equilibrium:</p> <p>(i) General Principle;</p> | <p>(1) Definition of reaction rate.</p> <p>(2) Observable physical and changes: colour, mass, temperature, pH, formation of precipitate etc.</p> <p>(1) Physical states, concentration/ pressure of reactants, temperature, catalysts, light, particle size and nature of reactants.</p> <p>(2) Appropriate experimental demonstration for each factor is required.</p> <p>(1) Collision and transition state theories to be treated qualitatively only.</p> <p>(2) Factors influencing collisions: temperature and concentration.</p> <p>(3) Effective collision.</p> <p>(4) Activation energy.</p> <p>(5) Energy profile showing activation energy and enthalpy change.</p> <p>Drawing of graphs and charts.</p> <p>Explanation of reversible and irreversible reactions. Reversible reaction i.e. dynamic equilibrium. Equilibrium constant K must be treated qualitatively. It must be stressed that K for a system is constant at constant temperature.</p> <p>Simple experiment to demonstrate reversible reactions.</p> |

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| <p>(ii) Le Chatelier's principle.</p> <p><b>12.0 REDOX REACTIONS</b></p> <p>(a) Oxidation and reduction process.</p> <p>(b) Oxidizing and reducing agents.</p> <p>(c) Redox equations</p> <p>(d) Electrochemical cells:</p> <p>(i) Standard electrode potential;</p> <p>(ii) Drawing of cell diagram and writing cell notation.</p> | <p>Prediction of the effects of external influence of concentration, temperature pressure and volume changes on equilibrium systems.</p> <p>(1) Oxidation and reduction in terms of:</p> <ul style="list-style-type: none"><li>(a) addition and removal of oxygen and hydrogen;</li><li>(b) loss and gain of electrons;</li><li>(c) change in oxidation numbers/states.</li></ul> <p>(2) Determination of oxidation numbers/states.</p> <p>(1) Description of oxidizing and reducing agents in terms of:</p> <ul style="list-style-type: none"><li>(a) addition and removal of oxygen and hydrogen;</li><li>(b) loss and gain of electrons;</li><li>(c) change in oxidation numbers/state.</li></ul> <p>Balancing redox equations by:</p> <ul style="list-style-type: none"><li>(a) ion, electron or change in oxidation number/states;</li><li>(b) half reactions and overall reaction.</li></ul> <p>Definition/Explanation</p> <p>(1) Standard hydrogen electrode: meaning of standard electrode potential (<math>E^\ominus</math>) and its measurement.</p> <p>(2) Only metal/metal ion systems should be used.</p> |

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| <p>(iii) e.m.f of cells;</p> <p>(iv) Application of Electrochemical cells.</p> <p>(e) Electrolysis:</p> <p>(i) Electrolytic cells;</p> <p>(ii) Principles of electrolysis;</p> <p>(iii) Factors influencing discharge of species;</p> <p>(iv) Faraday's laws;</p> <p>(v) Practical application;</p> | <p>(1) Electrochemical cells as a combination of two half-cells.</p> <p>(2) The meaning of magnitude and sign of the e.m.f.</p> <p>(1) Distinction between primary and secondary cells</p> <p>(2) Daniell cell, lead acid battery cell, dry cells, fuel cells and their use as generators of electrical energy from chemical reactions.</p> <p>Definition.</p> <p>Comparison of electrolytic and electrochemical cells; weak and strong electrolyte.</p> <p>Mechanism of electrolysis.</p> <p>Limit electrolytes to molten <math>\text{PbBr}_2</math> and <math>\text{NaCl}</math>, dilute <math>\text{NaCl}</math> solution, concentrated <math>\text{NaCl}</math> solution, <math>\text{CuSO}_{4(\text{aq})}</math>, dilute <math>\text{H}_2\text{SO}_4</math>, <math>\text{NaOH}_{(\text{aq})}</math> and <math>\text{CaCl}_{2(\text{aq})}</math> (using platinum or graphite and copper electrodes).</p> <p>Simple calculations based on the relation <math>1\text{F} = 96,500 \text{ C}</math> and mole ratios to determine mass, volume of gases, number of entities, charges etc. using half and overall reactions.</p> <p>Electroplating, extraction and purification of metals.</p> |

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| <p>(vi) Corrosion of metals.</p> <p><b>13.0 CHEMISTRY OF CARBON COMPOUNDS</b></p> <p>(a) Classification</p> <p>(b) Functional group</p> <p>(b) Separation and purification of organic compounds.</p> <p>(c) Petroleum/crude oil</p> | <p>(1) Corrosion treated as a redox process.</p> <p>(2) Rusting of iron and its economic costs.</p> <p>(3) Prevention based on relative magnitude of electrode potentials and preventive methods like galvanizing, sacrificial/cathodic protection and non-redox methods (painting, greasing/oiling etc.).</p> <p>Broad classification into straight chain, branched chain, aromatic and alicyclic compounds.</p> <p>Systematic nomenclature of compounds with the following functional groups: alkanes, alkenes, alkynes, hydroxyl compounds (aliphatic and aromatic), alkanolic acids, alkyl alkanolates (esters and salts) and amines.</p> <p>Methods to be discussed should include: distillation; crystallization; drying and chromatography.</p> <p>(1) Composition and classification.</p> <p>(2) Fractional distillation and major products.</p> <p>(3) Cracking and reforming.</p> <p>(4) Petro-chemicals: sources; uses e.g. as starting materials of organic synthesis.</p> <p>(5) Quality of petrol, meaning of octane number and its importance to the petroleum industry.</p> |

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| <p>(d) Determination of empirical and molecular formulae and molecular structures of organic compounds.</p> <p>(e) General properties of organic compounds:</p> <p>(i) Homologous series;</p> <p>(ii) Isomerism.</p> <p>(f) Alkanes:</p> <p>(i) Sources, properties;</p> <p>(ii) Uses.</p> <p>(g) Alkenes:</p> <p>(i) Sources and properties;</p> | <p>(1) Gradation in physical properties.</p> <p>(2) Effects on the physical properties by introduction of active groups into the inert alkane.</p> <p>(1) Examples should be limited to compounds having maximum of five carbon atoms.</p> <p>(2) Differences between structural and geometric/stereo isomerism.</p> <p>(1) Laboratory and industrial preparations and other sources.</p> <p>(2) Nomenclature and structure.</p> <p>(3) Reactivity:</p> <p>(a) combustion;</p> <p>(b) substitution reactions;</p> <p>(c) cracking of large alkane molecules.</p> <p>As fuels, as starting materials for synthesis. Uses of haloalkanes and pollution effects.</p> <p>(1) Laboratory preparation.</p> <p>(2) Nomenclature and structure.</p> |

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**SECTION B**

*(For candidates in Ghana only)*

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## 16.0 PRACTICALS

### (a) GENERAL SKILLS AND PRINCIPLES

Candidates will be expected to be familiar with the following skills and principles:

- (i) Measurement of mass and volume;
- (ii) Preparation and dilution of standard solutions;
- (iii) Filtration, recrystallisation and melting point determination;
- (iv) Measurement of heats of neutralization and solutions;
- (v) Determination of pH value of various solutions by colorimetry;
- (vi) Determination of rates of reaction from concentration versus time curves;
- (vii) Determination of equilibrium constants for simple system.

### (b) QUANTITATIVE ANALYSIS

#### Acid-base titrations

The use of standard solutions of acids and alkalis and the indicators; methyl orange, methyl red and phenolphthalein to determine the following:

- (i) The concentrations of acid and alkaline solutions;
- (ii) The molar masses of acids and bases and water of crystallization.
- (iii) The solubility of acids and bases;
- (iv) The percentage purity of acids and bases;
- (v) Analysis of  $\text{Na}_2\text{CO}_3/\text{NaHCO}_3$  mixture by double indicator methods (Ghanaians only).
- (vi) Stoichiometry of reactions.

#### Redox titrations

Titration of the following systems to solve analytical problems:

- (i) Acidic  $\text{MnO}_4^-$  with  $\text{Fe}^{2+}$ ;
- (ii) Acidic  $\text{MnO}_4^-$  with  $\text{C}_2\text{O}_4^{2-}$ ;
- (iii)  $\text{I}_2$  in KI versus  $\text{S}_2\text{O}_3^{2-}$ .

### (d) QUALITATIVE ANALYSIS

No formal scheme of analysis is required.

- (i) Characteristic tests of the following cations with dilute  $\text{NaOH}_{(\text{aq})}$  and  $\text{NH}_3_{(\text{aq})}$ ;

$\text{NH}_4^+$ ;  $\text{Ca}^{2+}$ ;  $\text{Pb}^{2+}$ ;  $\text{Cu}^{2+}$ ;  $\text{Fe}^{2+}$ ;  $\text{Fe}^{3+}$ ;  $\text{Al}^{3+}$ ; and  $\text{Zn}^{2+}$ .

- (ii) Confirmatory tests for the above cations.

- (iii) Characteristic reaction of dilute HCl on solids or aqueous solutions and conc.  $\text{H}_2\text{SO}_4$  on solid samples of the following:  
 $\text{Cl}^-$  ;  $\text{SO}_3^{2-}$  ;  $\text{CO}_3^{2-}$  ;  $\text{NO}_3^-$  and  $\text{SO}_4^{2-}$ .
- (iv) Confirmatory tests for the above anions
- (v) Comparative study of the halogens; displacement reactions.
- (vi) Characteristic tests for the following gases:  $\text{H}_2$ ;  $\text{NH}_3$ ;  $\text{CO}_2$ ; HCl and  $\text{SO}_2$ .
- (vii) Characteristic test tube reactions of the functional groups in the following simple organic compounds: Alkenes; alkanols; alkanolic acids, sugars (using Fehling's and Benedict's solutions only); starch (iodine test only) and proteins (using the Ninhydrin test, Xanthoproteic test, Biuret test and Millon's test only).