

Chemistry Syllabus for WAEC

INTRODUCTION TO CHEMISTRY

- (a) (i) Measurement of physical quantities.
- (ii) Scientific measurements and their importance in chemistry.
- (b) Scientific Methods

2.0 STRUCTURE OF THE ATOM

- (a) Gross features of the atom.
- (b) (i) Atomic number/proton number, number of neutrons, isotopes, atomic mass, mass number.
- (1) Measurement of mass, length, time, temperature and volume.
- (2) Appropriate SI units and significant figures.
- (3) Precision and accuracy in measurement.

Outline the scientific method to include:

Observation, hypothesis, experimentation, formulation of laws and theories.

- (1) Short account of Dalton's atomic theory and limitations, J.J. Thompson's experiment and Bohr's model of the atom.
- (2) Outline description of Rutherford's alpha scattering experiment to establish the structure of the atom.

Meaning and representation in symbols of atoms and sub-atomic particles.

CONTENT NOTES

- (ii) Relative atomic mass (A_r) and relative molecular mass (M_r) based on the Carbon-12 scale.
- (iii) Characteristics and nature of matter.

(c) Particulate nature of matter: physical and chemical changes.

(d) (i) Electron Configuration

(ii) Orbitals

(iii) Rules and principles

for filling in electrons.

(1) Atomic mass as the weighted average mass of isotopes. Calculation of relative mass of chlorine should be used as an example. (2) Carbon-12 scale as a unit of measurement.

Definition of the atomic mass unit.

Atoms, molecules and ions.

Definition of particles and treatment of particles as building blocks of matter.

Explain physical and chemical changes with examples.

Physical change- melting of solids, the magnetization of iron, dissolution of salt etc.

Chemical change- burning of wood, rusting of iron, decay of leaves etc.

Detailed electron configurations (s,p,d) for atoms of the first thirty elements.

Origin of s,p and d orbitals as sub-energy levels; shapes of s and p orbitals only.

(1) Aufbau Principle, Hund's Rule of Maximum Multiplicity and Pauli Exclusion Principle.

(2) Abbreviated and detailed electron configuration in terms of s, p, and d.

CONTENT NOTES 3.0 STANDARD SEPARATION TECHNIQUES FOR MIXTURES

(a) Classification of mixtures.

(b) Separation techniques

(c) Criteria for purity.

4.0 PERIODIC CHEMISTRY

(a) Periodicity of the elements.

(b) Different categories of elements in the periodic table.

(c) Periodic law:

- (i) Trends on periodic table;
- (ii) Periodic gradation of the elements in the third period (Na – Ar).

Solid-solid, solid-liquid, liquid-liquid, gas-gas with examples.

Crystallization, distillation, precipitation, magnetization, chromatography, sublimation etc.

Boiling point for liquids and melting point for solids.

Electron configurations leading to group and periodic classifications.

Metals, semi-metals, non-metals in the periodic table and halogens. Alkali metals, alkaline earth metals and transition metals as metals.

Explanation of the periodic law.

Periodic properties; atomic size, ionic size, ionization energy, electron affinity and electronegativity.

Simple discrepancies should be accounted for in respect to beryllium, boron, oxygen and nitrogen.

(1) Progression from:

- (i) metallic to non-metallic character of element;
- (ii) ionic to covalent bonding in compounds.

CONTENTS NOTES

(d) Reactions between acids and metals, their oxides and trioxocarbonates (IV).

(e) Periodic gradation of elements in group seven, the halogens: F, Cl, Br and I.

(f) Elements of the first transition series.

$_{21}\text{Sc} - _{30}\text{Zn}$

(2) Differences and similarities in the properties between the second and the third period elements should be stated. (1) Period three metals (Na, Mg, Al).

(2) Period four metals (K, Ca).

(3) Chemical equations.

(4) pH of solutions of the metallic oxides and trioxocarbonates.

Recognition of group variations noting any anomalies.

Treatment should include the following:

- (a) physical states, melting and boiling points;
 - (b) variable oxidation states;
 - (c) redox properties of the elements;
 - (d) displacement reaction of one halogen by another;
 - (e) reaction of the elements with water and alkali (balanced equations required).
- (1) Their electron configurations, physical properties and chemical reactivity of the elements and their compounds.
- (2) Physical properties should include: physical states, metallic properties and magnetic properties.
- (3) Reactivity of the metals with air, water, acids and comparison with s-block elements (Li, Na, Be, Mg).

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CONTENT NOTES5.0 CHEMICAL BONDS

- (a) Interatomic bonding
 - (b) (i) Formation of ionic bonds and compounds.
 - (ii) Properties of ionic compounds.
 - (c) Naming of ionic compounds.
 - (d) Formation of covalent bonds and compounds.
 - (e) (i) Properties of covalent compounds.
 - (ii) Coordinate (dative) covalent bonding.
- (4) Other properties of transition metals should include:
- (a) variable oxidation states;
 - (b) formation of coloured compounds;
 - (c) complex formation;

- (d) catalytic abilities;
- (e) paramagnetism;
- (f) hardness.

Meaning of chemical bonding.

Lewis dot structure for simple ionic and covalent compounds.

Formation of stable compounds from ions. Factors influencing formation: ionization energy; electron affinity and electronegativity difference.

Solubility in polar and non-polar solvents, electrical conductivity, hardness and melting point.

IUPAC system for simple ionic compounds.

Factors influencing covalent bond formation. Electron affinity, ionization energy, atomic size and electronegativity.

Solubility in polar and non-polar solvents, melting point, boiling point and electrical conductivity.

Formation and difference between pure covalent and coordinate (dative) covalent bonds.

CONTENT NOTES

- (f) Shapes of molecular compounds.
- (g) (i) Metallic Bonding
 - (ii) Factors influencing its formation.
 - (iii) Properties of metals.
- (h) (i) Inter molecular bonding
 - (ii) Intermolecular forces in covalent compounds.
 - (iii) Hydrogen bonding
 - (iii) van der Waals forces
 - (iv) Comparison of all bond types.

CONTENT

Linear, planar, tetrahedral and shapes for some compounds e.g. BeCl_2 , BF_3 , CH_4 , NH_3 , CO_2 . Factors should include: atomic radius, ionization energy and number of valence electrons. Types of specific packing not required.

Typical properties including heat and electrical conductivity, malleability, lustre, ductility, sonority and hardness.

Relative physical properties of polar and non-polar compounds.

Description of formation and nature should be treated.

Dipole-dipole, induced dipole-dipole, induced dipole-induced dipole forces should be treated under van der Waal's forces.

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 H_2O , and H_2S explained using Hydrogen bonding.

NOTES

6.0 STOICHIOMETRY AND CHEMICAL REACTIONS

- (a) (i) Symbols, formulae and equations.
- (ii) chemical symbols
- (iii) Empirical and molecular formulae.
- (iv) Chemical equations and IUPAC names of chemical compounds.
- (v) Laws of chemical combination.
- (b) Amount of substance.

CONTENT

Symbols of the first thirty elements and other common elements that are not among the first thirty elements.

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.

- (1) Combustion reactions (including combustion of simple hydrocarbons)
- (2) Synthesis

- (3) Displacement or replacement
- (4) Decomposition
- (5) Ionic reactions
- (1) Laws of conservation of mass.
- (2) Law of constant composition.
- (3) Law of multiple proportions. Explanation of the laws to balance given equations.
- (4) Experimental illustration of the law of conservation of mass.
- (1) Mass and volume measurements.
- (2) The mole as a unit of measurement; Avogadro's constant, $L = 6.02 \times 10^{23}$ entities mol^{-1} .
- (3) Molar quantities and their uses.
- (4) Moles of electrons, atoms, molecules, formula units etc.

NOTES

- (c) Mole ratios(d) (i) Solutions
- (ii) Concentration terms
- (iii) Standard solutions.
- (e) Preparation of solutions from liquid solutes by the method of dilution.

CONTENT

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.(1) Concept of a solution as made up of solvent and solute.

- (2) Distinguishing between dilute solution and concentrated solution.
- (3) Basic, acidic and neutral solutions.

Mass (g) or moles (mol) per unit volume. Emphasis on current IUPAC chemical terminology, symbols and conventions. Concentration be expressed as mass concentration, g dm^{-3} , molar concentration, mol dm^{-3} .

- (1) Preparation of some primary standards e.g anhydrous Na_2CO_3 , $(\text{COOH})_2$, $2\text{H}_2\text{O}/\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$.

(2) Meaning of the terms primary standard, secondary standard and standard solution.

Dilution factor

NOTES

7.0 STATES OF MATTER

(a) (i) Kinetic theory of matter.

(ii) Changes of state of matter.

(iii) Diffusion

CONTENT

(1) Postulates of the kinetic theory of matter.

(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.

(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.

(2) Illustrations of changes of state using the different forms of water, iodine, sulphur, naphthalene etc.

(3) Brownian motion to be illustrated using any of the following experiments:

(a) pollen grains/powdered sulphur in water (viewed under a microscope);

(b) smoke in a glass container illuminated by a strong light from the side;

(c) a dusty room being swept and viewed from outside under sunlight.

(1) Experimental demonstration of diffusion of two gases.

(2) Relationship between speed at which different gas particles move and the masses of particles.

(3) Experimental demonstration of diffusion of solute particles in liquids.

NOTES

(b) Gases:(i) Characteristics and nature of gases;

(ii) The gas laws;

(iii) Laboratory preparation and properties of some gases.

(c) (i) Liquids

(ii) Vapour and gases.

CONTENT

Arrangement of particles, density, shape and compressibility.

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

$$PV = nRT$$

Ideal and Real gases

Factors responsible for the deviation of real gases from ideal situation.

(1) Preparation of the following gases: H_2 , NH_3 and CO_2 . Principles of purification and collection of gases.

(2) Physical and chemical properties of the gases.

Characteristics and nature of liquids based on the arrangement of particles, shape, volume, compressibility, density and viscosity.

(1) Concept of vapour, vapour pressure, saturated vapour pressure, boiling and evaporation.

(2) Distinction between vapour and gas.

(3) Effect of vapour pressure on boiling points of liquids.

(4) Boiling at reduced pressure.

NOTES

(d) Solids:(i) Characteristics and nature;

(ii) Types and structures;

(iii) Properties of solids.

(e) Structures, properties and uses of diamond and graphite.

(f) Determination of melting points of covalent solids.

8.0 ENERGY AND ENERGY CHANGES

(a) Energy and enthalpy

(b) Description, definition and illustrations of energy changes and their effects.

CONTENT

(1) Ionic, metallic, covalent network and molecular solids. Examples in each case.

(2) Arrangements of particles ions, molecules and atoms in the solid state.

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.

The uses of diamond and graphite related to the structure.

The use of iodine in everyday life.

Melting points as indicator of purity of solids e.g. Phenyl methanedioic acid (benzoic acid), ethanedioic acid (oxalic) and ethanamide.

Explanation of the terms energy and enthalpy. Energy changes associated with chemical processes.

(1) Exothermic and endothermic processes.

(2) Total energy of a system as the sum of various forms of energy e.g. kinetic, potential, electrical, heat, sound etc.

(3) Enthalpy changes involved in the following processes: combustion, dissolution and neutralization.

NOTES

9.0 ACIDS, BASES AND SALTS

(a) Definitions of acids and bases.

(b) Physical and chemical properties of acids and bases.

(c) Acids, bases and salts as electrolytes.

(d) Classification of acids and bases.

(e) Concept of pH

(1) Arrhenius concepts of acids and bases in terms of H_3O^+ and OH^- ions in water.

(2) Effects of acids and bases on indicators, metal Zn, Fe and trioxocarbonate (IV) salts and hydrogentrioxocarbonate (IV) salts.

Characteristic properties of acids and bases in aqueous solution to include:

(a) conductivities, taste, litmus/indicators, feel etc.;

(b) balanced chemical equations of all reactions.

Electrolytes and non-electrolytes; strong and weak electrolytes. Evidence from conductivity and enthalpy of neutralization.

(1) Strength of acids and bases.

(2) Classify acids and bases into strong and weak.

(3) Extent of dissociation reaction with water and conductivity.

(4) Behaviour of weak acids and weak bases in water as example of equilibrium systems.

(1) Definition of pH and knowledge of pH scale.

(2) Measurement of pH of solutions using pH meter, calometric methods or universal indicator.

(3) Significance of pH values in everyday life e.g. acid rain, pH of soil, blood, urine.

CONTENT NOTES (f) Salts: (i) Laboratory and industrial preparation of salts;

(ii) Uses;

(iii) Hydrolysis of salt.

(g) Deliquescent, efflorescent and hygroscopic compound.

(h) Acid-Base indicators

(i) Acid-Base titration

CONTENT

Meaning of salts. Types of salts: normal, acidic, basic, double and complex salts.

- (1) Description of laboratory and industrial production of salts.
- (2) Mining of impure sodium chloride and conversion into granulated salt.
- (3) Preparation of NaOH, Cl₂ and H₂.
- (1) Explanation of how salts forms acidic, alkaline and neutral aqueous solutions.
- (2) Behaviour of some salts (e.g NH₄Cl, AlCl₃, Na₂CO₃, CH₃COONa) in water as examples of equilibrium systems.
- (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.

Use of hygroscopic compounds as drying agent should be emphasized.

- (1) Qualitative description of how acid-base indicator works.
- (2) Indicators as weak organic acids or bases (organic dyes).
- (3) Colour of indicator at any pH dependent on relative amounts of acid and forms.
- (4) Working pH ranges of methyl orange and phenolphthalein.
- (1) Knowledge and correct use of relevant apparatus.
- (2) Knowledge of how acid-bases indicators work in titrations.

NOTES

10.0 SOLUBILITY OF SUBSTANCES

- (a) General principles
- (b) Practical application of solubility.
- (3) Acid-base titration experiments involving HCl, HNO₃, H₂SO₄ and NaOH, KOH, Ca(OH)₂, CO₃²⁻, HCO₃⁻. (4) Titration involving weak acids versus strong bases, strong acids versus weak bases and strong acids versus strong bases using the appropriate indicators and their applications in quantitative determination; e.g. concentrations, mole ratio, purity, water of crystallization and composition.
- (1) Meaning of Solubility.
- (2) Saturated and unsaturated solutions.
- (3) Saturated solution as an equilibrium system.

- (4) Solubility expressed in terms of: mol dm^{-3} and g dm^{-3} of solution/solvent.
- (5) Solubility curves and their uses.
- (6) Effect of temperature on solubility of a substance.
- (7) Relationship between solubility and crystallization.
- (8) Crystallization/recrystallization as a method of purification.
- (9) Knowledge of soluble and insoluble salts of stated cations and anions.
- (10) Calculations on solubility.

Generalization about solubility of salts and their applications to qualitative analysis. e.g. Pb^{2+} , Ca^{2+} , Al^{3+} , Cu^{2+} , Fe^{2+} , Fe^{3+} , Cl^- , Br^- , I^- , SO_4^{2-} , S^{2-} , and CO_3^{2-} , Zn^{2+} , NH_4^+ , SO_3^{2-}

Explanation of solubility rules.

CONTENT NOTES 11.0 CHEMICAL KINETICS AND EQUILIBRIUM SYSTEM

- (a) Rate of reactions:
 - (i) Factors affecting rates;
 - (ii) Theories of reaction rates;
 - (iii) Analysis and interpretation of graphs.
- (b) Equilibrium:
 - (i) General Principle;

CONTENT

- (1) Definition of reaction rate.
- (2) Observable physical and changes: colour, mass, temperature, pH, formation of precipitate etc.
- (1) Physical states, concentration/ pressure of reactants, temperature, catalysts, light, particle size and nature of reactants.
- (2) Appropriate experimental demonstration for each factor is required.
- (1) Collision and transition state theories to be treated qualitatively only.
- (2) Factors influencing collisions: temperature and concentration.

- (3) Effective collision.
- (4) Activation energy.
- (5) Energy profile showing activation energy and enthalpy change.

Drawing of graphs and charts.

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.

Simple experiment to demonstrate reversible reactions.

NOTES

- (ii) Le Chatelier's principle.

12.0 REDOX REACTIONS

- (a) Oxidation and reduction process.
- (b) Oxidizing and reducing agents.
- (c) Redox equations
- (d) Electrochemical cells:
 - (i) Standard electrode potential;
 - (ii) Drawing of cell diagram and writing cell notation.

CONTENT

Prediction of the effects of external influence of concentration, temperature pressure and volume changes on equilibrium systems.

- (1) Oxidation and reduction in terms of:
 - (a) addition and removal of oxygen and hydrogen;
 - (b) loss and gain of electrons;
 - (c) change in oxidation numbers/states.
- (2) Determination of oxidation numbers/states.
- (1) Description of oxidizing and reducing agents in terms of:

- (a) addition and removal of oxygen and hydrogen;
- (b) loss and gain of electrons;
- (c) change in oxidation numbers/state.

Balancing redox equations by:

- (a) ion, electron or change in oxidation number/states;
- (b) half reactions and overall reaction.

Definition/Explanation

- (1) Standard hydrogen electrode: meaning of standard electrode potential (E°) and its measurement.
- (2) Only metal/metal ion systems should be used.

NOTES

(iii) e.m.f of cells;(iv) Application of Electrochemical cells.

(e) Electrolysis:

- (i) Electrolytic cells;
- (ii) Principles of electrolysis;
- (iii) Factors influencing discharge of species;
- (iv) Faraday's laws;
- (v) Practical application;

CONTENT

(1) Electrochemical cells as a combination of two half-cells.(2) The meaning of magnitude and sign of the e.m.f.

(1) Distinction between primary and secondary cells

(2) Daniell cell, lead acid battery cell, dry cells, fuel cells and their use as generators of electrical energy from chemical reactions.

Definition.

Comparison of electrolytic and electrochemical cells; weak and strong electrolyte.

Mechanism of electrolysis.

Limit electrolytes to molten PbBr_2

and NaCl , dilute NaCl solution, concentrated NaCl solution, $\text{CuSO}_4(\text{aq})$, dilute H_2SO_4 , $\text{NaOH}(\text{aq})$ and $\text{CaCl}_2(\text{aq})$ (using platinum or graphite and copper electrodes).

Simple calculations based on the relation $1\text{F} = 96,500\text{ C}$ and mole ratios to determine mass, volume of gases, number of entities, charges etc. using half and overall reactions.

Electroplating, extraction and purification of metals.

(vi) Corrosion of metals

WAEC Area of Concentration for Chemistry and Other Important Topics

NOTES

13.0 CHEMISTRY OF CARBON COMPOUNDS

(a) Classification

(b) Functional group

(b) Separation and purification of organic compounds.

(c) Petroleum/crude oil

CONTENT

(1) Corrosion treated as a redox process.

(2) Rusting of iron and its economic costs.

(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.).

Broad classification into straight chain, branched chain, aromatic and alicyclic compounds.

Systematic nomenclature of compounds with the following functional groups: alkanes, alkenes, alkynes, hydroxyl compounds (aliphatic and aromatic), alkanolic acids, alkyl alkanoates (esters and salts) and amines.

Methods to be discussed should include: distillation; crystallization; drying and chromatography.

- (1) Composition and classification.
- (2) Fractional distillation and major products.
- (3) Cracking and reforming.
- (4) Petro-chemicals: sources; uses e.g. as starting materials of organic synthesis.
- (5) Quality of petrol, meaning of octane number and its importance to the petroleum industry.

NOTES

(d) Determination of empirical and molecular formulae and molecular structures of organic compounds. (e) General properties of organic compounds:

(i) Homologous series;

(ii) Isomerism.

(f) Alkanes:

(i) Sources, properties;

(ii) Uses.

(g) Alkenes:

(i) Sources and properties;

CONTENT

- (1) Gradation in physical properties.
- (2) Effects on the physical properties by introduction of active groups into the inert alkane.
- (1) Examples should be limited to compounds having maximum of five carbon atoms.
- (2) Differences between structural and geometric/stereo isomerism.
- (1) Laboratory and industrial preparations and other sources.
- (2) Nomenclature and structure.
- (3) Reactivity:
 - (a) combustion;
 - (b) substitution reactions;

(c) cracking of large alkane molecules.

As fuels, as starting materials for synthesis. Uses of haloalkanes and pollution effects.

(1) Laboratory preparation.

(2) Nomenclature and structure.

NOTES

(ii) Uses;

(iii) Laboratory detection.

(h) Alkynes:

(i) Sources, characteristic properties and uses;

(ii) Chemical reactions.

(i) Benzene:

(i) Structure and physical properties;

(ii) Chemical properties.

CONTENT

(3) Addition reactions with halogens hydrogen, bromine water, hydrogen halides and acidified water. (4) Oxidation: hydroxylation with aqueous KMnO_4 .

(5) Polymerization.

Use of reaction with Br_2/water , Br_2/CCl_4 and $\text{KMnO}_{4(\text{aq})}$ as means of characterizing alkenes.

(1) Nomenclature and structure.

(2) Industrial production of ethyne.

(3) Uses of ethyne.

(4) Distinguishing test between terminal and non-terminal alkynes.

(5) Test to distinguish between alkane, alkene and alkyne.

Chemical reactions: halogenation, combustion, hydration and hydrogenation.

Resonance in benzene. Stability leading to substitution reactions.

- (1) Addition reactions: hydrogenation and halogenation (mechanism not required).
- (2) Compare reactions with those of alkenes.

NOTES

- (J) Alkanols: (i) Sources, nomenclature and structure;
- (ii) Classification;
- (iii) Physical properties;
- (iv) Chemical properties;
- (v) Laboratory test;
- (vi) Uses.
- (k) Alkanoic acids:
- (i) Sources, nomenclature and structure;
- (ii) Physical properties;

CONTENT

- (1) Laboratory preparation including hydration of alkenes.
- (2) Industrial and local production of ethanol including alcoholic beverages,
- (3) Harmful impurities and methods of purification should be mentioned.
- (4) Recognition of the structure of mono-, di- and triols.

Primary, secondary and tertiary alkanols.

Boiling point, solubility in water. Including hydrogen bonding effect.

- (1) Reaction with:
 - (a) Na;
 - (b) alkanoic acids (esterification);
 - (c) conc. H_2SO_4 .
- (2) Oxidation by:

(a) $\text{KMnO}_{4(aq)}$;

(b) $\text{K}_2\text{Cr}_2\text{O}_{7(aq)}$;

(c) I_2 in $\text{NaOH}_{(aq)}$.

Laboratory test for ethanol.

Methanoic acid –insect bite.

Ethanoic acid – vinegar.

Recognition of mono and dioic acid.

Boiling point, solubility in water.

Including hydrogen bonding effect.

NOTES

(iii) Chemical properties;(iv) Laboratory test;

(iv) Uses.

(I) Alkanoates as drivatives of alkanoic acids:

(i) Sources, nomenclature, preparation and structure;

(ii) Physical properties;

(iii) Chemical properties;

(iv) Uses.

14.0 CHEMISTRY, INDUSTRY AND THE ENVIRONMENT

(a) Chemical industry

CONTENT

Acid properties only i.e. reactions with H_2O , NaOH , NH_3 , NaHCO_3 , Zn and Mg .

Reaction with NaHCO_3 , Na_2CO_3 .

Uses of ethanoic and phenyl methanoic (benzoic) acids as examples of aliphatic and aromatic acids respectively.

Preparation of alkyl alkanoates (esters) from alkanoic acids.

Solubility, boiling and melting point.

Hydrolysis of alkyl alkanoates (mechanism not required).

Uses of alkanoates to include production of soap, flavouring agent, plasticizers, as solvents and in perfumes.

- (1) Natural resources in candidate's won country.
- (2) Chemical industries in candidates own country and their corresponding raw materials.
- (3) Distinction between fine and heavy chemicals.

NOTES

(b) Pollution: air, water and soil pollution;

(c) Biotechnology.

15.0 BASIC BIOCHEMISTRY AND SYNTHETIC POLYMERS

(a) Proteins:

(i) Sources and properties;

(ii) Uses of protein.

(b) Amino acids

CONTENT

(4) Factors that determine location of chemical industries.(5) Effect of industries on the community.

- (1) Sources, effects and control.
- (2) Greenhouse effect and depletion of the ozone layer.
- (3) Biodegradable and non-biodegradable pollutants.

Food processing, fermentation including production of gari, bread and alcoholic beverages e.g. Local gin.

Proteins as polymers of amino acids molecules linked by peptide or amide linkage.

Physical properties e.g. solubility

Chemical properties to include:

- (a) hydrolysis of proteins;
- (b) laboratory test using Ninhydrin/Biuret reagent/Millons reagent.
- (1) Nomenclature and general structure of amino acids.
- (2) Difunctional nature of amino acids.

NOTES

- (c) Fats/oils: (i) Sources and properties;
- (ii) General structure of fats/oils;
- (iii) Preparation of soap;
- (iv) Uses of fats/oils.
- (d) Carbohydrates:
 - (i) Sources and nomenclature;
 - (ii) Properties;

CONTENT

As alkyl alkanoates (esters).

From animals and plants.

Physical properties such as solubility.

Chemical properties:

- (a) acidic and alkaline hydrolysis;
- (b) hydrogenation;
- (c) test for fats and oil.

As mono-, di-, and tri- esters of propane-1,2,3-triol (glycerol).

- (1) Preparation of soap (saponification) from fats and oils.
- (2) Comparison of soap less detergents and their action on soft and hard water.
- (1) Classes of carbohydrates as:

- (a) monosaccharides;
 - (b) disaccharides;
 - (c) polysaccharides.
- (2) Name and components of various classes of carbohydrates.
- (1) Physical properties such as solubility of sugars.
 - (2) Chemical properties- Hydrolysis of disaccharides into monosaccharides.
- (3) Test for reducing sugars using sugar strips, Fehling's or Benedicts solution or Tollen's reagent.

NOTES

(iii) Carbohydrate as examples of polymer;(iv) Uses.

(e) Synthetic polymers:

(i) Properties;

(ii) Uses of polymers.

- (1) Starch as a polymer made up of glucose units.
 - (2) Condensation of monosaccharides to form disaccharides and polysaccharides.
- (1) Definition of terms: monomers, polymers and polymerization.
 - (2) Addition and condensation polymerization.
 - (3) Classification and preparation based on the monomers and comonomers.
- (1) Thermoplastics and thermosets.
 - (2) Modification of properties of polymers.
 - (3) Plastics and resins.
 - (4) Chemical test on plastics using:
 - (a) heat;
 - (b) acids;
 - (c) alkalis.

Chemistry Syllabus for WAEC 2024-2025

INTRODUCTION TO CHEMISTRY

- (a) (i) Measurement of physical quantities.
- (ii) Scientific measurements and their importance in chemistry.
- (b) Scientific Methods

2.0 STRUCTURE OF THE ATOM

- (a) Gross features of the atom.
- (b) (i) Atomic number/proton number, number of neutrons, isotopes, atomic mass, mass number.
- (1) Measurement of mass, length, time, temperature and volume.
- (2) Appropriate SI units and significant figures.
- (3) Precision and accuracy in measurement.

Outline the scientific method to include:

Observation, hypothesis, experimentation, formulation of laws and theories.

- (1) Short account of Dalton's atomic theory and limitations, J.J. Thompson's experiment and Bohr's model of the atom.
- (2) Outline description of Rutherford's alpha scattering experiment to establish the structure of the atom.

Meaning and representation in symbols of atoms and sub-atomic particles.

CONTENT NOTES

- (ii) Relative atomic mass (A_r) and relative molecular mass (M_r) based on the Carbon-12 scale.
- (iii) Characteristics and

nature of matter.

- (c) Particulate nature of matter: physical and chemical changes.
- (d) (i) Electron Configuration
- (ii) Orbitals

(iii) Rules and principles

for filling in electrons.

(1) Atomic mass as the weighted average mass of isotopes. Calculation of relative mass of chlorine should be used as an example. (2) Carbon-12 scale as a unit of measurement.

Definition of the atomic mass unit.

Atoms, molecules and ions.

Definition of particles and treatment of particles as building blocks of matter.

Explain physical and chemical changes with examples.

Physical change- melting of solids, the magnetization of iron, dissolution of salt etc.

Chemical change- burning of wood, rusting of iron, decay of leaves etc.

Detailed electron configurations (s,p,d) for atoms of the first thirty elements.

Origin of s,p and d orbitals as sub-energy levels; shapes of s and p orbitals only.

(1) Aufbau Principle, Hund's Rule of Maximum Multiplicity and Pauli Exclusion Principle.

(2) Abbreviated and detailed electron configuration in terms of s, p, and d.

CONTENT NOTES 3.0 STANDARD SEPARATION TECHNIQUES FOR MIXTURES

(a) Classification of mixtures.

(b) Separation techniques

(c) Criteria for purity.

4.0 PERIODIC CHEMISTRY

(a) Periodicity of the elements.

(b) Different categories of elements in the periodic table.

(c) Periodic law:

(i) Trends on periodic table;

(ii) Periodic gradation of the elements in the third period (Na – Ar).

Solid-solid, solid-liquid, liquid-liquid, gas-gas with examples.

Crystallization, distillation, precipitation, magnetization, chromatography, sublimation etc.

Boiling point for liquids and melting point for solids.

Electron configurations leading to group and periodic classifications.

Metals, semi-metals, non-metals in the periodic table and halogens. Alkali metals, alkaline earth metals and transition metals as metals.

Explanation of the periodic law.

Periodic properties; atomic size, ionic size, ionization energy, electron affinity and electronegativity.

Simple discrepancies should be accounted for in respect to beryllium, boron, oxygen and nitrogen.

(1) Progression from:

- (i) metallic to non-metallic character of element;
- (ii) ionic to covalent bonding in compounds.

CONTENTS NOTES

(d) Reactions between acids and metals, their oxides and trioxocarbonates (IV).

(e) Periodic gradation of elements in group seven, the halogens: F, Cl, Br and I.

(f) Elements of the first transition series.

$_{21}\text{Sc} - _{30}\text{Zn}$

(2) Differences and similarities in the properties between the second and the third period elements should be stated. (1) Period three metals (Na, Mg, Al).

(2) Period four metals (K, Ca).

(3) Chemical equations.

(4) pH of solutions of the metallic oxides and trioxocarbonates.

Recognition of group variations noting any anomalies.

Treatment should include the following:

- (a) physical states, melting and boiling points;

- (b) variable oxidation states;
 - (c) redox properties of the elements;
 - (d) displacement reaction of one halogen by another;
 - (e) reaction of the elements with water and alkali (balanced equations required).
- (1) Their electron configurations, physical properties and chemical reactivity of the elements and their compounds.
- (2) Physical properties should include: physical states, metallic properties and magnetic properties.
- (3) Reactivity of the metals with air, water, acids and comparison with s-block elements (Li, Na, Be, Mg).

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CONTENT NOTES5.0 CHEMICAL BONDS

- (a) Interatomic bonding
 - (b) (i) Formation of ionic bonds and compounds.
 - (ii) Properties of ionic compounds.
 - (c) Naming of ionic compounds.
 - (d) Formation of covalent bonds and compounds.
 - (e) (i) Properties of covalent compounds.
 - (ii) Coordinate (dative) covalent bonding.
- (4) Other properties of transition metals should include:
- (a) variable oxidation states;
 - (b) formation of coloured compounds;
 - (c) complex formation;
 - (d) catalytic abilities;
 - (e) paramagnetism;
 - (f) hardness.

Meaning of chemical bonding.

Lewis dot structure for simple ionic and covalent compounds.

Formation of stable compounds from ions. Factors influencing formation: ionization energy; electron affinity and electronegativity difference.

Solubility in polar and non-polar solvents, electrical conductivity, hardness and melting point.

IUPAC system for simple ionic compounds.

Factors influencing covalent bond formation. Electron affinity, ionization energy, atomic size and electronegativity.

Solubility in polar and non-polar solvents, melting point, boiling point and electrical conductivity.

Formation and difference between pure covalent and coordinate (dative) covalent bonds.

CONTENT NOTES

(f) Shapes of molecular compounds.

(g) (i) Metallic Bonding

(ii) Factors influencing its formation.

(iii) Properties of metals.

(h) (i) Inter molecular bonding

(ii) Intermolecular forces in covalent compounds.

(iii) Hydrogen bonding

(iii) van der Waals forces

(iv) Comparison of all bond types.

CONTENT

Linear, planar, tetrahedral and shapes for some compounds e.g. BeCl_2 , BF_3 , CH_4 , NH_3 , CO_2 . Factors should include: atomic radius, ionization energy and number of valence electrons. Types of specific packing not required.

Typical properties including heat and electrical conductivity, malleability, lustre, ductility, sonority and hardness.

Relative physical properties of polar and non-polar compounds.

Description of formation and nature should be treated.

Dipole-dipole, induced dipole-dipole, induced dipole-induced dipole forces should be treated under van der Waal's forces.

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 H_2O , and H_2S explained using Hydrogen bonding.

NOTES

6.0 STOICHIOMETRY AND CHEMICAL REACTIONS

- (a) (i) Symbols, formulae and equations.
- (ii) chemical symbols
- (iii) Empirical and molecular formulae.
- (iv) Chemical equations and IUPAC names of chemical compounds.
- (v) Laws of chemical combination.
- (b) Amount of substance.

CONTENT

Symbols of the first thirty elements and other common elements that are not among the first thirty elements.

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.

- (1) Combustion reactions (including combustion of simple hydrocarbons)
- (2) Synthesis
- (3) Displacement or replacement
- (4) Decomposition
- (5) Ionic reactions
- (1) Laws of conservation of mass.

- (2) Law of constant composition.
- (3) Law of multiple proportions. Explanation of the laws to balance given equations.
- (4) Experimental illustration of the law of conservation of mass.
- (1) Mass and volume measurements.
- (2) The mole as a unit of measurement; Avogadro's constant, $L = 6.02 \times 10^{23}$ entities mol^{-1} .
- (3) Molar quantities and their uses.
- (4) Moles of electrons, atoms, molecules, formula units etc.

NOTES

- (c) Mole ratios
- (d) (i) Solutions
- (ii) Concentration terms
- (iii) Standard solutions.
- (e) Preparation of solutions from liquid solutes by the method of dilution.

CONTENT

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.

(1) Concept of a solution as made up of solvent and solute.

(2) Distinguishing between dilute solution and concentrated solution.

(3) Basic, acidic and neutral solutions.

Mass (g) or moles (mol) per unit volume. Emphasis on current IUPAC chemical terminology, symbols and conventions. Concentration be expressed as mass concentration, g dm^{-3} , molar concentration, mol dm^{-3} .

(1) Preparation of some primary standards e.g anhydrous Na_2CO_3 , $(\text{COOH})_2$, $2\text{H}_2\text{O}/\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$.

(2) Meaning of the terms primary standard, secondary standard and standard solution.

Dilution factor

NOTES

7.0 STATES OF MATTER

(a) (i) Kinetic theory of matter.

(ii) Changes of state of matter.

(iii) Diffusion

CONTENT

(1) Postulates of the kinetic theory of matter.

(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.

(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.

(2) Illustrations of changes of state using the different forms of water, iodine, sulphur, naphthalene etc.

(3) Brownian motion to be illustrated using any of the following experiments:

(a) pollen grains/powdered sulphur in water (viewed under a microscope);

(b) smoke in a glass container illuminated by a strong light from the side;

(c) a dusty room being swept and viewed from outside under sunlight.

(1) Experimental demonstration of diffusion of two gases.

(2) Relationship between speed at which different gas particles move and the masses of particles.

(3) Experimental demonstration of diffusion of solute particles in liquids.

NOTES

(b) Gases:(i) Characteristics and nature of gases;

(ii) The gas laws;

(iii) Laboratory preparation and properties of some gases.

(c) (i) Liquids

(ii) Vapour and gases.

CONTENT

Arrangement of particles, density, shape and compressibility.

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

$$PV = nRT$$

Ideal and Real gases

Factors responsible for the deviation of real gases from ideal situation.

(1) Preparation of the following gases: H_2 , NH_3 and CO_2 . Principles of purification and collection of gases.

(2) Physical and chemical properties of the gases.

Characteristics and nature of liquids based on the arrangement of particles, shape, volume, compressibility, density and viscosity.

(1) Concept of vapour, vapour pressure, saturated vapour pressure, boiling and evaporation.

(2) Distinction between vapour and gas.

(3) Effect of vapour pressure on boiling points of liquids.

(4) Boiling at reduced pressure.

NOTES

(d) Solids:(i) Characteristics and nature;

(ii) Types and structures;

(iii) Properties of solids.

(e) Structures, properties and uses of diamond and graphite.

(f) Determination of melting points of covalent solids.

8.0 ENERGY AND ENERGY CHANGES

(a) Energy and enthalpy

(b) Description, definition and illustrations of energy changes and their effects.

CONTENT

(1) Ionic, metallic, covalent network and molecular solids. Examples in each case.

(2) Arrangements of particles ions, molecules and atoms in the solid state.

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.

The uses of diamond and graphite related to the structure.

The use of iodine in everyday life.

Melting points as indicator of purity of solids e.g. Phenyl methanedioic acid (benzoic acid), ethanedioic acid (oxalic) and ethanamide.

Explanation of the terms energy and enthalpy. Energy changes associated with chemical processes.

(1) Exothermic and endothermic processes.

(2) Total energy of a system as the sum of various forms of energy e.g. kinetic, potential, electrical, heat, sound etc.

(3) Enthalpy changes involved in the following processes: combustion, dissolution and neutralization.

NOTES

9.0 ACIDS, BASES AND SALTS

(a) Definitions of acids and bases.

(b) Physical and chemical properties of acids and bases.

(c) Acids, bases and salts as electrolytes.

(d) Classification of acids and bases.

(e) Concept of pH

(1) Arrhenius concepts of acids and bases in terms of H_3O^+ and OH^- ions in water.

(2) Effects of acids and bases on indicators, metal Zn, Fe and trioxocarbonate (IV) salts and hydrogentrioxocarbonate (IV) salts.

Characteristic properties of acids and bases in aqueous solution to include:

- (a) conductivities, taste, litmus/indicators, feel etc.;
- (b) balanced chemical equations of all reactions.

Electrolytes and non-electrolytes; strong and weak electrolytes. Evidence from conductivity and enthalpy of neutralization.

- (1) Strength of acids and bases.
- (2) Classify acids and bases into strong and weak.
- (3) Extent of dissociation reaction with water and conductivity.
- (4) Behaviour of weak acids and weak bases in water as example of equilibrium systems.
- (1) Definition of pH and knowledge of pH scale.
- (2) Measurement of pH of solutions using pH meter, calometric methods or universal indicator.
- (3) Significance of pH values in everyday life e.g. acid rain, pH of soil, blood, urine.

CONTENT NOTES (f) Salts: (i) Laboratory and industrial preparation of salts;

(ii) Uses;

(iii) Hydrolysis of salt.

(g) Deliquescent, efflorescent and hygroscopic compound.

(h) Acid-Base indicators

(i) Acid-Base titration

CONTENT

Meaning of salts. Types of salts: normal, acidic, basic, double and complex salts.

- (1) Description of laboratory and industrial production of salts.
- (2) Mining of impure sodium chloride and conversion into granulated salt.
- (3) Preparation of NaOH, Cl_2 and H_2 .
- (1) Explanation of how salts forms acidic, alkaline and neutral aqueous solutions.

(2) Behaviour of some salts (e.g. NH_4Cl , AlCl_3 , Na_2CO_3 , CH_3COONa) in water as examples of equilibrium systems.

(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.

Use of hygroscopic compounds as drying agent should be emphasized.

(1) Qualitative description of how acid-base indicator works.

(2) Indicators as weak organic acids or bases (organic dyes).

(3) Colour of indicator at any pH dependent on relative amounts of acid and forms.

(4) Working pH ranges of methyl orange and phenolphthalein.

(1) Knowledge and correct use of relevant apparatus.

(2) Knowledge of how acid-bases indicators work in titrations.

NOTES

10.0 SOLUBILITY OF SUBSTANCES

(a) General principles

(b) Practical application of solubility.

(3) Acid-base titration experiments involving HCl , HNO_3 , H_2SO_4 and NaOH , KOH , $\text{Ca}(\text{OH})_2$, CO_3^{2-} , HCO_3^- . (4) Titration involving weak acids versus strong bases, strong acids versus weak bases and strong acids versus strong bases using the appropriate indicators and their applications in quantitative determination; e.g. concentrations, mole ratio, purity, water of crystallization and composition.

(1) Meaning of Solubility.

(2) Saturated and unsaturated solutions.

(3) Saturated solution as an equilibrium system.

(4) Solubility expressed in terms of: mol dm^{-3} and g dm^{-3} of solution/solvent.

(5) Solubility curves and their uses.

(6) Effect of temperature on solubility of a substance.

(7) Relationship between solubility and crystallization.

(8) Crystallization/recrystallization as a method of purification.

(9) Knowledge of soluble and insoluble salts of stated cations and anions.

(10) Calculations on solubility.

Generalization about solubility of salts and their applications to qualitative analysis. e.g. Pb^{2+} , Ca^{2+} , Al^{3+} , Cu^{2+} , Fe^{2+} , Fe^{3+} , Cl^- , Br^- , I^- , SO_4^{2-} , S^{2-} , and CO_3^{2-} , Zn^{2+} , NH_4^+ , SO_3^{2-}

Explanation of solubility rules.

CONTENT NOTES 11.0 CHEMICAL KINETICS AND EQUILIBRIUM SYSTEM

(a) Rate of reactions:

(i) Factors affecting rates;

(ii) Theories of reaction rates;

(iii) Analysis and interpretation of graphs.

(b) Equilibrium:

(i) General Principle;

CONTENT

(1) Definition of reaction rate.

(2) Observable physical and changes: colour, mass, temperature, pH, formation of precipitate etc.

(1) Physical states, concentration/ pressure of reactants, temperature, catalysts, light, particle size and nature of reactants.

(2) Appropriate experimental demonstration for each factor is required.

(1) Collision and transition state theories to be treated qualitatively only.

(2) Factors influencing collisions: temperature and concentration.

(3) Effective collision.

(4) Activation energy.

(5) Energy profile showing activation energy and enthalpy change.

Drawing of graphs and charts.

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.

Simple experiment to demonstrate reversible reactions.

NOTES

(ii) Le Chatelier's principle.

12.0 REDOX REACTIONS

(a) Oxidation and reduction process.

(b) Oxidizing and reducing agents.

(c) Redox equations

(d) Electrochemical cells:

(i) Standard electrode potential;

(ii) Drawing of cell diagram and writing cell notation.

CONTENT

Prediction of the effects of external influence of concentration, temperature pressure and volume changes on equilibrium systems.

(1) Oxidation and reduction in terms of:

(a) addition and removal of oxygen and hydrogen;

(b) loss and gain of electrons;

(c) change in oxidation numbers/states.

(2) Determination of oxidation numbers/states.

(1) Description of oxidizing and reducing agents in terms of:

(a) addition and removal of oxygen and hydrogen;

(b) loss and gain of electrons;

(c) change in oxidation numbers/state.

Balancing redox equations by:

(a) ion, electron or change in oxidation number/states;

(b) half reactions and overall reaction.

Definition/Explanation

(1) Standard hydrogen electrode: meaning of standard electrode potential (E°) and its measurement.

(2) Only metal/metal ion systems should be used.

NOTES

(iii) e.m.f of cells;(iv) Application of Electrochemical cells.

(e) Electrolysis:

(i) Electrolytic cells;

(ii) Principles of electrolysis;

(iii) Factors influencing discharge of species;

(iv) Faraday's laws;

(v) Practical application;

CONTENT

(1) Electrochemical cells as a combination of two half-cells.(2) The meaning of magnitude and sign of the e.m.f.

(1) Distinction between primary and secondary cells

(2) Daniell cell, lead acid battery cell, dry cells, fuel cells and their use as generators of electrical energy from chemical reactions.

Definition.

Comparison of electrolytic and electrochemical cells; weak and strong electrolyte.

Mechanism of electrolysis.

Limit electrolytes to molten PbBr_2

and NaCl , dilute NaCl solution, concentrated NaCl solution, $\text{CuSO}_{4(\text{aq})}$, dilute H_2SO_4 , $\text{NaOH}_{(\text{aq})}$ and $\text{CaCl}_{2(\text{aq})}$ (using platinum or graphite and copper electrodes).

Simple calculations based on the relation $1F = 96,500\text{ C}$ and mole ratios to determine mass, volume of gases, number of entities, charges etc. using half and overall reactions.

Electroplating, extraction and purification of metals.

(vi) Corrosion of metals

WAEC Area of Concentration for Chemistry and Other Important Topics

NOTES

13.0 CHEMISTRY OF CARBON COMPOUNDS

(a) Classification

(b) Functional group

(b) Separation and purification of organic compounds.

(c) Petroleum/crude oil

CONTENT

(1) Corrosion treated as a redox process.

(2) Rusting of iron and its economic costs.

(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.).

Broad classification into straight chain, branched chain, aromatic and alicyclic compounds.

Systematic nomenclature of compounds with the following functional groups: alkanes, alkenes, alkynes, hydroxyl compounds (aliphatic and aromatic), alkanoic acids, alkyl alkanoates (esters and salts) and amines.

Methods to be discussed should include: distillation; crystallization; drying and chromatography.

(1) Composition and classification.

(2) Fractional distillation and major products.

(3) Cracking and reforming.

- (4) Petro-chemicals: sources; uses e.g. as starting materials of organic synthesis.
- (5) Quality of petrol, meaning of octane number and its importance to the petroleum industry.

NOTES

(d) Determination of empirical and molecular formulae and molecular structures of organic compounds. (e) General properties of organic compounds:

(i) Homologous series;

(ii) Isomerism.

(f) Alkanes:

(i) Sources, properties;

(ii) Uses.

(g) Alkenes:

(i) Sources and properties;

CONTENT

(1) Gradation in physical properties.

(2) Effects on the physical properties by introduction of active groups into the inert alkane.

(1) Examples should be limited to compounds having maximum of five carbon atoms.

(2) Differences between structural and geometric/stereo isomerism.

(1) Laboratory and industrial preparations and other sources.

(2) Nomenclature and structure.

(3) Reactivity:

(a) combustion;

(b) substitution reactions;

(c) cracking of large alkane molecules.

As fuels, as starting materials for synthesis. Uses of haloalkanes and pollution effects.

(1) Laboratory preparation.

(2) Nomenclature and structure.

NOTES

(ii) Uses;

(iii) Laboratory detection.

(h) Alkynes:

(i) Sources, characteristic properties and uses;

(ii) Chemical reactions.

(i) Benzene:

(i) Structure and physical properties;

(ii) Chemical properties.

CONTENT

(3) Addition reactions with halogens hydrogen, bromine water, hydrogen halides and acidified water. (4) Oxidation: hydroxylation with aqueous KMnO_4 .

(5) Polymerization.

Use of reaction with Br_2/water , Br_2/CCl_4 and $\text{KMnO}_{4(\text{aq})}$ as means of characterizing alkenes.

(1) Nomenclature and structure.

(2) Industrial production of ethyne.

(3) Uses of ethyne.

(4) Distinguishing test between terminal and non-terminal alkynes.

(5) Test to distinguish between alkane, alkene and alkyne.

Chemical reactions: halogenation, combustion, hydration and hydrogenation.

Resonance in benzene. Stability leading to substitution reactions.

(1) Addition reactions: hydrogenation and halogenation (mechanism not required).

(2) Compare reactions with those of alkenes.

NOTES

(J) Alkanols: (i) Sources, nomenclature and structure;

(ii) Classification;

(iii) Physical properties;

(iv) Chemical properties;

(v) Laboratory test;

(vi) Uses.

(k) Alkanoic acids:

(i) Sources, nomenclature and structure;

(ii) Physical properties;

CONTENT

(1) Laboratory preparation including hydration of alkenes.

(2) Industrial and local production of ethanol including alcoholic beverages,

(3) Harmful impurities and methods of purification should be mentioned.

(4) Recognition of the structure of mono-, di- and triols.

Primary, secondary and tertiary alkanols.

Boiling point, solubility in water. Including hydrogen bonding effect.

(1) Reaction with:

(a) Na;

(b) alkanoic acids (esterification);

(c) conc. H_2SO_4 .

(2) Oxidation by:

(a) $\text{KMnO}_{4(\text{aq})}$;

(b) $\text{K}_2\text{Cr}_2\text{O}_{7(\text{aq})}$;

(c) I_2 in $\text{NaOH}_{(\text{aq})}$.

Laboratory test for ethanol.

Methanoic acid –insect bite.

Ethanoic acid – vinegar.

Recognition of mono and dioic acid.

Boiling point, solubility in water.

Including hydrogen bonding effect.

NOTES

(iii) Chemical properties;(iv) Laboratory test;

(iv) Uses.

(I) Alkanoates as drivatives of alkanoic acids:

(i) Sources, nomenclature, preparation and structure;

(ii) Physical properties;

(iii) Chemical properties;

(iv) Uses.

14.0 CHEMISTRY, INDUSTRY AND THE ENVIRONMENT

(a) Chemical industry

CONTENT

Acid properties only i.e. reactions with H_2O , NaOH , NH_3 , NaHCO_3 , Zn and Mg .

Reaction with NaHCO_3 , Na_2CO_3 .

Uses of ethanoic and phenyl methanoic (benzoic) acids as examples of aliphatic and aromatic acids respectively.

Preparation of alkyl alkanoates (esters) from alkanoic acids.

Solubility, boiling and melting point.

Hydrolysis of alkyl alkanoates (mechanism not required).

Uses of alkanoates to include production of soap, flavouring agent, plasticizers, as solvents and in perfumes.

- (1) Natural resources in candidate's won country.
- (2) Chemical industries in candidates own country and their corresponding raw materials.
- (3) Distinction between fine and heavy chemicals.

NOTES

- (b) Pollution: air, water and soil pollution;
- (c) Biotechnology.

15.0 BASIC BIOCHEMISTRY AND SYNTHETIC POLYMERS

- (a) Proteins:
 - (i) Sources and properties;
 - (ii) Uses of protein.
- (b) Amino acids

CONTENT

- (4) Factors that determine location of chemical industries.(5) Effect of industries on the community.
- (1) Sources, effects and control.
- (2) Greenhouse effect and depletion of the ozone layer.
- (3) Biodegradable and non-biodegradable pollutants.

Food processing, fermentation including production of gari, bread and alcoholic beverages e.g. Local gin.

Proteins as polymers of amino acids molecules linked by peptide or amide linkage.

Physical properties e.g. solubility

Chemical properties to include:

- (a) hydrolysis of proteins;
- (b) laboratory test using Ninhydrin/Biuret reagent/Millons reagent.

(1) Nomenclature and general structure of amino acids.

(2) Difunctional nature of amino acids.

NOTES

(c) Fats/oils: (i) Sources and properties;

(ii) General structure of fats/oils;

(iii) Preparation of soap;

(iv) Uses of fats/oils.

(d) Carbohydrates:

(i) Sources and nomenclature;

(ii) Properties;

CONTENT

As alkyl alkanoates (esters).

From animals and plants.

Physical properties such as solubility.

Chemical properties:

(a) acidic and alkaline hydrolysis;

(b) hydrogenation;

(c) test for fats and oil.

As mono-, di-, and tri- esters of propane-1,2,3-triol (glycerol).

(1) Preparation of soap (saponification) from fats and oils.

(2) Comparison of soap less detergents and their action on soft and hard water.

(1) Classes of carbohydrates as:

(a) monosaccharides;

(b) disaccharides;

- (c) polysaccharides.
- (2) Name and components of various classes of carbohydrates.
- (1) Physical properties such as solubility of sugars.
- (2) Chemical properties- Hydrolysis of disaccharides into monosaccharides.
- (3) Test for reducing sugars using sugar strips, Fehling's or Benedicts solution or Tollen's reagent.

NOTES

(iii) Carbohydrate as examples of polymer;(iv) Uses.

(e) Synthetic polymers:

(i) Properties;

(ii) Uses of polymers.

- (1) Starch as a polymer made up of glucose units.
- (2) Condensation of monosaccharides to form disaccharides and polysaccharides.
- (1) Definition of terms: monomers, polymers and polymerization.
- (2) Addition and condensation polymerization.
- (3) Classification and preparation based on the monomers and comonomers.
- (1) Thermoplastics and thermosets.
- (2) Modification of properties of polymers.
- (3) Plastics and resins.
- (4) Chemical test on plastics using:
 - (a) heat;
 - (b) acids;
 - (c) alkalis.