SYLLABUS FOR LAB ASSISTANT

(SCIENCE)

Unit – 1.0 Atomic Structure and Chemical Bonding

Atoms and its fundamental particles.

Rutherford Model of Atom.

Bohr's Theory, Hydrogen spectrum explanation based on Bohr's Model of Atom.

Wave Mechanical model of atom, de Broglie relationship, Heisenberg Uncertainly Principle

Quantum Numbers, Shapes of Atomic Orbitals.

Pauli's Exclusion Principle, Hund's Rule of Maximum Multiplicity, Aufbau Principle, Electronic Configuration (till atomic number 30).

Concept of Chemical bonding – Cause of chemical bonding, Types of Bonds: Ionic Bond (Nacl, $Cacl_2$, MgO),

Covalent Bond , Polar and Nonpolar Covalent Bonds (H_2,F_2, HF, HCl) & Co-ordinate

Bond (CO, NH_4,O_3,H_2SO_4).

Dipole Moment (NH_3, NF_3), Hydrogen bonding.

Hybridization and molecular geometries.

Unit – 2.0 Solutions

Types of solutions, expression of concentration of solutions.

Colligative properties- relative lowering of vapour pressure, Raoults laws.

Elevation of boiling point , depression of freezing point and osmotic pressure.

Determination of molecular masses using colligative properties.

Abnormal molecular masses and Van't Hoff factor.

Unit- 3.0 Water

Introduction, sources of water. Hardness of Water- Temporary & Permanent hardness.

Degree of Hardness (In terms of $CaCO_3$ equivalent), Unit of Hardness, Quantitative Measurement of

Water Hardness by EDTA method.

Municipal supply of Water, Treatment of water, Water Softening Technique-Soda Lime process, Zeolites method and ion exchange method.

Water quality Index- Biological Oxygen Demand, Chemical Oxygen Demand, Determination of Dissolved Oxygen.

Indian standard specification of drinking water.

Unit – 4.0 Engineering materials

Natural Occurrence of Metals- Minerals, ores.

Metallurgy- General principles of Metallurgy, Gangue, Flux and Slag, Steps involved in metallurgy. Extraction of Aluminium, Iron, & copper from their important ores along with reactions, Properties and uses. Polymers-Homo-polymers and Copolymers, Natural polymers and synthetic polymers, Addition and Condensation polymerization, Thermoplastic and Thermosetting plastic.

Monomers, applications and synthesis of Polythene, PVC, Orlon, Terylene, Nylon 66, Nylon 6, Bakelite.

Natural Rubber and its vulcanization, advantages of vulcanized rubber.

Unit-5.0 Chemistry of Fuel and Lubricants

Fuels, Characteristics of an Ideal Fuel

Classification of Fuel-Solid, Liquid and gas fuel, Calorific Values (HCV and LCV)

Petroleum and its fractional distillation

Cracking, Knocking, Fuel Rating (Octane Number, Cetane number)

Composition, Uses, advantages and disadvantages of LPG, CNG and Biogas

Lubricants - Classification of Lubricants with examples, Functions and Properties of Good Lubricants

Viscosity & Viscosity Index, Flash point, Fire point, Cloud & Pour point

Unit-6.0 Electrochemistry

Introduction, Electrolyte and Nonelectrolyte, Electrolyte and Metallic Conduction, Factors affecting Electrolytic Conductance.

Molar Conductivity and Equivalent Conductivity, Variation of Molar Conductivity, Kohlrausch's law

Faraday's Law of Electrolysis.

Galvanic Cell, Electrode Potential, Measurement of Electrode Potential SHE (Standard Hydrogenelectrode), EMF, Electrochemical Series, Nernst Equation for Electrode Potential

Batteries, Primary Cells-Dry cell, Secondary cell-Lead storage battery, Fuel cells

Unit-7.0 Solid State

General characteristics of solid state, crystalline and amorphous solid.

Classification of crystalline solid- Molecular, ionic, metallic, covalent solids.

Crystal lattice and unit cells- Primitive, BCC, FCC

Imperfections of solid, Magnetic properties- Ferromagnetism, Para Magnetism, diamagnetism, anti-ferromagnetism Melting point determination of crystalline solid by Kjeldahl method.

Unit-8.0 States of Matter

General Introduction- Comparison of the characteristics of solid, liquid and gases.

Gas Laws- Boyle's Law, Charles' Law, Avogadro Law, Ideal Gas Equation, Universal Gas Constant.

Kinetic Theory of Gases, Ideal and Real Gas

Surface tension and viscosity and their determination

Unit-9.0 Chemical Equilibrium

Introduction- Equilibria in chemical processes, reversible reaction, irreversible reaction.

Characteristics of chemical equilibrium, Law of mass action, Relation between Kp and Ks

Factors affecting equilibrium, Le-Chatelier's Principle, Effect of change in concentration, pressure, and temperature on equilibrium

Concepts of acids and bases (Bronsted-Lowry and Lewis Concept), Ionic product of water

Hydrogen ion concentration, pH scale, Simple numerical problems on pH and pOH

Unit 10.0 Chemical Kinetics

General introduction, Classification of reaction on the basis of Rate.
Rate of reaction, Order of reaction, Molecularity of a reaction: Zero order, First order, Secondorder reactions.
Derivation of rate constant for zero, first, and second order reactions.
Half-life period of a reaction, Units of Rate constant. Effect of Temperature on Rate constant (Arrhenius equation)

Unit-11. Aliphatic Hydrocarbons

Nomenclature of organic compound.
Types of structural Isomerism– chain, position, functional and metamerism.
Synthesis of Alkane from unsaturated hydrocarbon and alkyl halides, synthesis of alkene fromalkyl halide and Alcohol, synthesis of alkynes from calcium carbide and vicinal di halides.
Chemical properties- halogenation of alkanes, alkenes and alkynes, hydro halogenation of alkenesand alkynes.
Synthesis of Aldehydes and Ketones from oxidation of alcohols and dehydrogenation of alcohols.
Nueleophilic addition reaction of aldehyde and ketone with hydroxyl ion and 2,4- Dinitrophenylhydrazine.
Oxidation of aldehyde and ketones using Tollens' and Fehling's reagentand halo form reaction.

Unit-12. Aromatic Compounds

Nomenclature of substituted benzene.
Concept of Aromaticity.
Synthesis of benzene from decarboxylation of aromatic acids, reduction of phenol.
Chemical properties of benzene- Electrophilic substitution reaction – nitration, halogenation. Friedel – Crafts, alkylation.
Synthesis of aromatic amines from nitro benzene and amide (Hoffmann bromide degradation reaction).
Reaction of amines with Benzene sulphonyl chloride and Carbylamines reaction.

PHYSICS

1. Measurement in engineering and science unit of Physical quantity, SI Units, Accuracy and Precision of instrument, Error in measurement. Absolute error, relative error and percentage error, Basic measuring instrument vernier calipers micrometer screw gauge, Spherometer, ammeter, voltmeter, Wheatstone bridge & Potentiometer with their least count, range, accuracy.

2. Newton's law of motion, Linear momentum & impulse, conservation of linear momentum, Force, Friction, Weight, Tension, Spring force, Normal reaction, Up thrust, Work, Energy & Power, Kinetic energy & Potential energy, Conservation of energy.

- Simple concept of circular & rotational motion, centripetal force and centrifugal force, moment of inertia, Torque, angular momentum and its conservation.

3. Elastic and Plastic body, stress and Strain with their types, Hooks Law, young modulus bulk modulus and modulus of rigidity. Simple pendulum and bar-pendulum. Simple harmonic motion, Damped, Forced and resonant vibrations.

- Cohesive and adhesive forces. Angle of contact, Shape of Liquid surface in Capillary tube, Capillary rise and radius of capillarity.
- Newton's law of viscosity, coefficient of viscosity, Stream line and turbulent flow, Reynolds number, Stocks law and terminal velocity.

4. Concept of heat and temperature, mode of heat transfer, scales of temperature and their relationship expansion of solids and liquids, coefficient of linear, surface and cubical expansion and relation among them, Specific heat, Cp and Cv.

5. Law of reflection of light & refraction of light, Snell's law, Prism, Mirror formula and Lens formula.

6. Parallel and series combination of capacitor, parallel Plate Capacitor, Ohms law, series and parallel combination of resistance, Kirchhoff's law, Heating effect of current, electromagnetic induction, Faraday's law of electromagnetic induction, Lenz's Law.

7. Properties of photon, photoelectric effect, law and characteristics of photoelectric effect, Einstein's photoelectric equation, construction, working and application of photoelectric cell.

- Semiconductor, P-type & N-type semiconductor, P-N Junction diode, Transistor, PNP and NPN transistor.
- LASER, Properties of Laser, Spontaneous and stimulated emission, Application of Laser in industry and Medical.
- Optical Fiber, Construction and working principle, Critical angle, total internal reflection, acceptance angle and numerical aperture, Application of optical fiber in industry, Communication, Sensor and medical

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MATHEMATICS

Algebra

- Basic operations and properties of numbers
- Solving linear equations and inequalities
- Functions and graphs
- Polynomial and rational functions
- Exponential and logarithmic functions
- Systems of equations

Trigonometry

- Trigonometric ratios and functions
- Unit circle and circular functions
- Graphs of trigonometric functions
- Identities and equations
- Applications in physics (e.g., wave motion, oscillations)

Calculus

- Limits and continuity
- Derivatives: rules, applications, and interpretation
- Integrals: definite and indefinite integrals, applications to area and volume
- Fundamental Theorem of Calculus
- Multivariable calculus basics (partial derivatives, multiple integrals)

Linear Algebra

- Vectors and matrices
- Matrix operations and determinants
- Systems of linear equations (Gauss elimination)
- Eigenvalues and eigenvectors
- Applications in quantum mechanics and systems of equations

Differential Equations

- First-order differential equations
- Applications to physics (e.g., motion, decay)
- Second-order differential equations
- Solutions of differential equations

Statistics and Probability

- Descriptive statistics: mean, median, mode, standard deviation
- Probability theory: basic concepts, random variables, distributions

- Applications in experimental data analysis
- Introduction to regression and correlation

Complex Numbers

- Basics of complex numbers
- Polar form and De Moivre's Theorem

Coordinate Geometry

- Cartesian coordinate system basics
- Distance and Midpoint Formulas
    - Calculating distance and finding midpoints
- Slope and Equations of Lines
    - Slope-intercept, point-slope forms
- Polar Coordinates
    - Converting between polar and Cartesian coordinates