



## Syllabus

### PHYSICS

#### **Mechanics:**

##### Translational Motion:

Distance and Displacement, Speed and Velocity, Acceleration, Kinematic Equations, Graphs of Motion, Forces, Newton's Laws of Motion, Newton's Law of Universal Gravitation, Falling Objects, Projectiles, Work, Energy, Power, Center of Mass, Linear Momentum and Impulse, Rotational Motion, Conservation of angular energy and conservation of angular momentum, laws of kinematics and dynamics.

##### Rotational Motion:

Rotational Kinematics, Moment of Inertia, Torque, Angular Momentum, Newton's Second Law for Rotation, Circular Motion, Static Equilibrium, Rotational Work, Rotational Energy, Simple Machines, Fluids mechanics laws such as Pascal's Principle, Archimedes' Principle and Bernoulli's Equation, Properties of fluids at rest (Hydrostatics).

##### Fluid Mechanics:

Density and Pressure, Pascal's Principle, Archimedes' Principle, Hydrodynamics, Fluids Flow, Bernoulli's Equation.

#### **Electromagnetism:**

##### Electricity:

Electric Charge, Electrostatic Force, Electric Field, Electric Flux, Electrostatic Potential, Electrostatic Energy, Capacitors, Capacitance and Dielectrics, Electric Current, Electromotive Force, Resistance, Resistivity, and Ohm's Law, Electric Power and Joule's Heating, Direct Current (DC) and Alternating Current (AC) Electric Circuits.

##### Magnetism:

Magnet and Electromagnet Properties, Magnetic Field, Magnetic Flux, Magnetic Force, Magnetic Torque, Electromagnetic Induction Laws, Inductance, Transformers.



## **Waves and Optics:**

### Waves:

Undamped Simple Harmonic Motion, Damped Oscillations, Driven (Forced) Oscillations and Resonance, Mechanical Waves Characteristics, Mechanical Waves Behavior, Sound in Motion (Doppler Effect).

### Optics:

Electromagnetic Waves, Polarization, Interference, Diffraction, Reflection, Refraction, Mirrors, Thin Lenses.

## **Modern Physics:**

### Theory of relativity:

Einstein's General Theory of Relativity, Equivalence Principle, Frames of Reference. Einstein's Special Theory of Relativity Postulates, Einstein's Special Theory of Relativity Consequences: (Length, Mass, Time, Energy, etc).

### Atomic Physics:

Matter Waves: De Broglie Wavelength, Heisenberg Uncertainty Principle, Blackbody Radiations, Photoelectric Effect, The Compton Effect, Atomic Models and Atomic Spectra, Quantum Physics Application.

### Nuclear Physics:

Nuclear Structure and Properties, Radioactivity, Nuclear Reactions, Elementary Particles, Composite Particles.

## **Thermal Physics**

### Temperature and Heat:

Internal energy, temperature, heat, Temperature Scales, Thermal Equilibrium, Thermal Expansion, Quantity of Heat and Specific Heat Capacity, Calorimetry and Phase Changes, Mechanisms of Heat Transfer.

### Thermodynamics:

Ideal Gas Laws, Kinetic Molecular Theory, Zeroth Law of Thermodynamics (Absolute Zero), First Law of Thermodynamics, Second Law of Thermodynamics.



## CHEMISTRY

### Chemical foundation:

Steps of Scientific Process, Conversion of S.I. Units, Temperature Scales and Conversions, Density Calculations, Scientific Notation, Significant Figures, Accuracy and Precision, Dimensional Analysis.

### Inorganic Chemistry:

Elements, Compounds, and Mixtures; Properties and Interconversions of Solids, Liquids and Gases, Physical and Chemical Changes and Properties of Matter, Laws of Definite Proportion and Conservation of mass, Development of Modern Atomic Theory, Protons, Neutrons, and Electrons, Atomic Number, Mass Number, Isotopes, Properties of Waves, Electromagnetic Radiation, Planck's Quantum Theory, The Photoelectric Effect, Emission Spectra, Distribution of Electrons, The Pauli Exclusion Principle, Hund's Rule, The Aufbau Principle, Periodic Classification of Elements, Periodicity (Atomic and Ionic Radius, Ionization Energy, Electron Affinity, and Electronegativity, Ionic Bond, Formulae of Ionic Compounds, Properties of Ionic Compounds, Covalent Bond, Electronegativity Values and Type of Bond, Lewis Structures for Atoms, Ions and Molecules, Molecular Geometry, Properties of Covalent Compounds, Intermolecular Forces, Properties of intermolecular Forces such as Surface Tension, Viscosity, Vapor Pressure, and Molar Heat of Vaporization, Interpretation of Heating and Cooling Curves, Stoichiometry, Electrolytic Properties of Aqueous Solutions, Factors Affecting Solubility, Molecular, Ionic and Net Ionic Equations, Properties of Acids and Bases, Arrhenius, Bronsted-Lowry, and Lewis, Definitions of Acids and Bases, Acid-Base Equilibria, Acid-Base Titrations, Oxidation and Reduction, Redox Reactions, Corrosion Formation and Protection, Redox Titrations and Calculations, Electrolysis of water, molten and Aqueous Solutions, Gravimetric Analysis.

### Organic Chemistry:

Chemical and Physical Properties of Organic Compounds, Hydrocarbon Types and Nomenclature, Saturated Hydrocarbons: Alkanes and Cycloalkanes, Unsaturated Hydrocarbons: Alkenes and Alkynes, Isomerism, Combustion, Addition, and Substitution Reactions, Aromatic Compounds Nomenclature, Reactions of Aromatic Compounds, Alcohols Nomenclature, Production of Alcohols by Fermentation and in Industry, Reactions of Alcohols, Aldehydes and Ketones Nomenclature and Formation, Carboxylic Acids and Esters, Nomenclature and Formation, Amine Types and Nomenclature, Addition and Condensation of Polymers.



## Physical Chemistry:

Equipment and Units to Measure Gas Quantities, Molar Volume, Kinetic Molecular Theory, Total Pressure and Partial Pressures, The Gas Laws and Problems Involving T, V, P, and n, Pressure of a Gas Collected over Water, Reaction Rate, Factors that affect Reaction Rates, Diffusion Rates of Gases, The Rate Law, Stoichiometry of Gases, Heterogeneous and Homogeneous Catalysis, Collision Theory of Chemical Kinetics, Concept of Equilibrium, Factors that affect Equilibrium, The First Law of Thermodynamics, Enthalpy Changes  $\Delta H$ , Enthalpy of Chemical Reactions, Calorimetry, Thermochemical Equations, Standard Enthalpy of Formation and Reaction, Second and Third Laws of Thermodynamics, Entropy Changes ( $\Delta S$ ), Gibbs Free Energy Changes  $\Delta G$ , Factors Affecting Gibbs Free Energy  $\Delta G$ .

## Analytical Chemistry:

Experimental Measurements, Qualitative Analysis of Inorganic Ions, Chemical Hazards, Safety Principles, Determination of Physical Properties, Criteria of Purity, Instrumental Techniques.

## Nuclear Chemistry:

Radioactive Decay, Nuclear Transformations, Nuclear Fission, Nuclear Fusion, Half-Life, Uses and Risks of Radioactivity.

## MATHEMATICS

### Algebra:

Interpret the structure of expressions, Write expressions in equivalent forms to solve problems, Perform arithmetic operations on polynomials, Understand the relationship between zeros and factors of polynomials, Use polynomial identities to solve problems, Rewrite rational functions, Create equations that describe numbers or relationships, Understand solving equations as a process of reasoning and explain the reasoning, Solve equations and inequalities in one variable, Solve systems of equations, Represent and solve equations and inequalities graphically, Understand the concept of a function and use function notation, Interpret functions that arise in applications in terms of the context, Analyze functions using different representations, Build a function that models a relationship between two quantities, Build new functions from existing functions, Construct and compare linear and exponential models and solve problems, Interpret expressions for functions in terms of the situation they model, Extend the domain of trigonometric functions using the unit circle, Model periodic phenomena with trigonometric functions, Prove and apply trigonometric identities, Extend the properties of



exponents to rational exponents, Use properties of rational and irrational numbers, Reason quantitatively and use units to solve problems, Perform operations with complex numbers, Represent and model with vector quantities, Perform operations on vectors, Perform operations on matrices, and use matrices in applications, Solve problems with limits, Solve basic differentiation problems, Solve basic integration problems.

## **Geometry:**

Transformations for 2D and 3D shapes, Understand congruence in terms of transformation, Prove geometric theorems, Understand similarity in terms of similarity transformations, Prove theorems involving similarity, Define trigonometric ratios and solve problems involving right triangles, Apply trigonometry to general triangles, Understand and apply theorems about circles, Translate between the geometric description and the equation for a conic section, Use coordinates to prove simple geometric theorems algebraically, Explain volume formulas and use them to solve problems, Visualize relationships between 2D and 3D objects.

## **Statistics:**

Summarize, represent, and interpret data on a single variable, Summarize, represent, and interpret data on two categorical and quantitative variables, interpret linear models, Understand and evaluate random processes underlying statistical experiments, Make inferences and justify conclusions from sample surveys, experiments and observational studies, Understand independence and conditional probability and use them to interpret data, Use the rules of probability to compute probabilities of compound events in a uniform probability model, Calculate expected values and use them to solve problems, Use probability to evaluate outcomes of decisions.