

Physics Syllabus

1. Scalars and Vectors

Distinction between scalar and vector quantities
Addition and subtractions of vectors
Multiplication and division of vectors by scalars
Decomposition of vectors into parallel and perpendicular components along chosen axes

2. Motion

Kinematic concepts (displacement, distance, trajectory, velocity, speed, acceleration)
Frames of reference
Instantaneous and average values of speed, velocity and acceleration
Relative motion (relative velocity, relative acceleration)
Uniform motion in a straight line
Uniformly accelerated motion in a straight line
Uniform circular motion (centripetal acceleration)
Harmonic motion (simple harmonic oscillator)
Models: mass on a spring, simple pendulum
Period and frequency of harmonic oscillations
Graphical representation of motion
Elements of relativistic mechanics (speed of light, time dilation, length contraction, relativistic mass, momentum and energy)

3. Forces and dynamics

Newton's laws of motion
Newton's first law
translational equilibrium
inertial reference frames
Newton's second law (momentum and impulse)
Newton's third law
Law of conservation of linear momentum (isolated system, inertial frame)
Inelastic collisions
Rockets (reaction engine)
Fictitious forces, analysis of motion in noninertial reference frames
Dry friction
Static friction
Kinetic friction
Force due to air resistance (terminal velocity)

4. Fundamental interactions (gravitation, electromagnetic, strong interaction,

week interaction)

Elementary particles (bosons, fermions: leptons, quarks (hadrons))

Gravitational field

Newton's law of universal gravitation

Visualization of gravitational field - gravitational field lines

First and second cosmic velocities

Weightlessness and overload

Vertical free fall, vertical throw and horizontal throw near the Earth's surface

Electric field

Electric charge and Coulomb's law

Visualization of static electric field - electrostatic field lines

Motion of charged particles in static electric field

Magnetic field

Visualization of magnetic field - magnetic field lines

Magnetic field around a cylindrical current-carrying conductor

Magnetic field in a solenoid

Motion of charged particles in static magnetic field (Lorentz force)

Electromagnetic waves (properties, spectrum)

Strong interaction, week interaction

5. Matter properties

Atomic structure and physical properties of matter

Solid phase

Amorphous body

Crystal body

Thermal expansion of a solid body

Liquid phase

Internal structure of liquids

Models of water structure

Surface tension, meniscus

Gaseous phase

Electric properties of matter

Electric conductors (metals)

Electrical conductivity of metals as a function of temperature

Insulators

Semiconductors

Magnetic properties of matter

Diamagnetic materials

Paramagnetic materials

Ferromagnetic materials

6. Order and chaos in nature

Kinetic model of an ideal gas

The ideal gas equation

Boyle's law ($T = \text{const}$ isothermal process)

Charles's law ($p = \text{const}$; changes of thermal energy and work done by a gas in isobaric process)

Gay-Lussac's law ($V = \text{const}$; changes of thermal energy in isochoric process)
First law of thermodynamics (practical calculations/usage/application)
Entropy and Second Law of Thermodynamics (formulate the law and resulting conclusions only)
Heat engines
 The Carnot engine
 Efficiency of thermodynamic engines
 Reversible/irreversible process (examples)

7. Optics

The nature of light
 Speed of light
 Relation of speed, frequency and wavelength
 Visible light spectrum
Reflection of light
 Reflection in a plane and in a curved mirror (mirror equation)
 Constructing images formed by mirrors (type of image, magnification)
Refraction of light
 Refractive index
 Snell's law
 Dispersion due to a prism
 Critical angle and total internal reflection
Lenses
 Types of lenses
 Focus, focal length, optical power, magnification
 Image formation
 Thin lens equation
 Optical power of a thin lens (lens maker's formula)
Optical instruments
 Microscope
 Telescope
 Aberrations
Diffraction
 Diffraction grating
Interference
 Interference from two point source
 Young's double slit experiment
Polarization and polarizer
 Absorptive polarizer
 Beam-splitting polarizer
 Polarization by reflection (Brewster angle)
 Birefringent polarizer
External photoelectric effect (photoelectric cell)
Bohr's model of the hydrogen atom
 Atomic energy states
 Emission spectrum (frequencies, wavelengths)
Absorption and emission spectra . application of spectrum analysis
Laser . design and practical application
The eye and sight

Myopia (nearsightedness) and hyperopia (farsightedness)
Correction of vision defects

8. Energy transport and transformation

Work, energy and power

Kinetic energy

Potential energy

Gravitational potential energy

Elastic potential energy

Transformation of energy in harmonic motion

Mechanical resonance

The Principle of Energy Conservation

The Equivalence of Mass and Energy ($E=mc^2$)

Nuclear fission

Nuclear structure

Mass number, atomic number

Nuclear energy levels

Isotope, nucleon

Uranium-235 chain reaction

Nuclear mass defect, nuclear binding energy

Radioactive decay law

Half-life of nuclear decay

Nuclear radiation (α particles, β particles, radiation) applications

Description of energy transport in wave movement

Description of thermal energy transfer

convection

conduction

radiation

9. Structure and evolution of Universe

Analysis of thermonuclear fusion in stars

Solar System . sizes and distances between astronomic objects

Planet movement . Kepler's laws

Star evolution, H-R diagram

The Big-Bang Model

10. Unity of micro-world and macro-world

De Broglie's hypothesis . a matter wave

Experimental confirmation of de Broglie hypothesis

Wave. particle duality

Heisenberg uncertainty principle