Syllabus for Bangladesh Physics Olympiad Category-D

The questions will solely be based on problems. They can involve numerical and/or algebraic operations.

1. Mathematics

a. Algebra: Simplification of formulae by factorisation and expansion. Solving linear systems of equations. Solving equations and systems of equations leading to quadratic and biquadratic equations; selection of physically meaningful solutions. Summation of arithmetic and geometric series.

b. Functions: Basic properties of trigonometric, inverse-trigonometric, exponential and logarithmic functions and polynomials. This includes formulae regarding trigonometric functions of a sum of angles, Solving simple equations involving trigonometric, inverse-trigonometric, logarithmic and exponential functions.

c. Geometry and stereometry: Degrees and radians as alternative measures of angles. Equality of alternate interior and exterior angles, equality of corresponding angles. Recognition of similar triangles. Areas of triangles, trapezoids, circles and ellipses; surface areas of spheres, cylinders and cones; volumes of spheres, cones, cylinders and prisms. Sine and cosine rules, property of inscribed and central angles, Thales' theorem, medians and the centroid of a triangle. Students are expected to be familiar with the properties of conic sections including circles, ellipses, parabolae and hyperbolae.

d. Vectors: Basic properties of vectorial sums, dot and cross products. Double cross product and scalar triple product. Geometrical interpretation of a time derivative of a vector quantity

e. Complex numbers: Summation, multiplication and division of complex numbers; separation of real and imaginary parts. Euler's formula, Conversion between algebraic, trigonometric, and exponential representations of a complex number. Complex roots of quadratic equations and their physical interpretation.

f. Statistics and Data Analysis: Calculation of probabilities as the ratio of the number of objects or event occurrence frequencies. Calculation of mean values, standard deviations. Transformation of a dependence to a linear form by appropriate choice of variables and fitting a straight line to experimental points. Finding the gradient, intercept of a linear graph and their uncertainty estimate (graphically and using the statistical functions of a calculator) Selecting optimal scales for graphs and plotting data points with error bars.

g. Calculus: Finding derivatives of elementary functions, their sums, products, quotients, and nested functions. Integration as the inverse procedure to differentiation. Finding definite and indefinite integrals in simple cases: elementary functions, sums of functions, and using the substitution rule for a linearly dependent argument. Making definite integrals dimensionless by substitution. Geometric interpretation of derivatives and integrals. Finding constants of integration using initial conditions.

h. Approximations and Numerical methods: Using linear and polynomial approximations based on Taylor series. Linearization of equations and expressions. Finding approximate numerical solutions to equations using, e.g., Newton's method or bisection of intervals. Numerical integration using the trapezoidal rule or adding rectangles.

2. Kinematics: Vector representation of displacement, velocity and acceleration; Vector form of the equation of motion under uniform acceleration. Projectile motion,circular motion.Centripetal acceleration.Relation between angular and linear velocity (using vectors); Addition of velocities and angular velocities , Motion of a rigid body as a rotation around an instantaneous centre of rotation ,Angular acceleration.

3. Dynamics: Inertia and forces: Newton's laws of motion; Force Diagrams, Equations of motion, Momentum, Impulse; Conservation of linear momentum (using vectors/ components); Center of mass – uses and calculation via integration. Motion of a system with varying mass (example: Rocket). Conditions for static and dynamic equilibrium; Stable and Unstable equilibrium, Frictional forces,Coefficients of friction. Forces in non-inertial frames : Inertial force, Centrifugal force, Coriolis force (qualitative).

4. Work, Energy and Power: Open and Closed Systems, Calculation of work,

Kinetic Energy and Work-energy theorem; Conservative forces, Potential energy; Conservation of energy, Power.
5. Gravitation: Newton's Law of gravitation, Gravitational field, Gravitational potential Energy; Escape velocity; Kepler's laws. Characteristics of objects in orbit (Energy, momentum, angular momentum etc.)

6. Rotational Mechanics of Rigid Bodies: Angular momentum; Torque; Moment of inertia for simple bodies(spheres, shells, rings, rods, cylinders etc.); Calculating moment of inertia via integration, Parallel axes theorem. Newton's laws for angular motion; Conservation of Angular momentum. Kinetic energy of a rotating body.

7. Fluids: Concepts of Pressure and Pascal's Equation. Buoyancy and Archimedes' law, Continuity law for fluids and Bernoulli's Equation. Surface Tension, surface energy.

8. Simple Harmonic Motion: Finding equation of motion and its solution, Variation of potential and kinetic energy (graphical); Oscillation of a spring, simple pendulum. Calculation of angular frequency of various oscillatory systems. (Using force approach and Energy approach), Damped Harmonic Oscillators, Different Types of Damping, Forced Oscillation, Resonance (qualitatively).

9. Elasticity: Elasticity and Hooke's law, Stress, strain and Young's Modulus, Potential Energy related to elastic deformations.

10. Heat Transfer and Phase Transitions: Phase transitions (boiling, evaporation, melting, sublimation) and latent heat; saturated vapour pressure, relative humidity; concept of heatconductivity; continuity of heat flux.

11. Kinetic theory of Gases: Ideal Gas, Primary concept of the distribution of velocities of molecules in a gas; Root mean square velocity; Relation of molecular velocity with pressure and temperature; Mean free path. Equipartition theorem (qualitative).

12. Laws of Thermodynamics: Ideal gas law, Thermal equilibrium, Heat and internal energy; Basic thermodynamic processes (isobaric, isochoric, isothermal, adiabatic); First law of thermodynamics. Reversible and irreversible processes, Second law of thermodynamics, Entropy, Efficiency of an engine. Carnot cycle.

13. Statistical Physics: Black body radiation, Planck's Law (qualitative), Wien's Displacement Law, Stefan-Boltzmann law.

14. Waves: General characteristics of waves; Amplitude, wavelength, frequency, phase, intensity; Transverse and longitudinal waves; Superposition and interference; Progressive and standing waves. Doppler's effect. Beats, determination of velocity of sound, Waves in inhomogeneous media: Fermat's Principle, Snell's Law. Energy carried by waves.

15. Electrostatics: Concept of charge, Coulomb's law, Electric fields, potential and equipotential surface. Electric flux, Gauss' Law, Uniqeness theorem, Method of image charges, Capacitors, capacitance, dielectric constant, series and parallel combination of capacitors; energy stored in a capacitor. Energy density of electric fields.

16. Electric current: Current, Voltage, Resistance and Resistivity, Ohm's law; Series and parallel combination of resistances; Kirchhoff's laws,Electromotive force and internal resistance of an electric cell, I-V characteristics of non-Ohmic devices(i.e Diodes). Power dissipated in circuit elements.

17. Magnetism: Magnetic fields, Magnetic flux, Lorentz force on a point charge. Force on a current carrying wire, Gauss' law of magnetism. Magnetic field due to a moving point charge; Biot-Savart's Law, Ampere's Law. Magnetic field due to current in a long straight wire, circular loop. Solenoid. Energy density of magnetic fields.

18. Electromagnetic induction and Alternating Current: Faraday's laws and Lenz's law; Self and Mutual induction. Inductance of various currents configurations (solenoid, toroid etc.) RLC circuits, Root meant square value and peak value of voltage and current. Complex impedances of circuit elements.

19. Electromagnetic Waves: electromagnetic spectrum,Velocity of light (Dependence on medium and wave length): Dispersion of light; Polarisation of light. Geometrical Optics: reflection, refraction, images formed by various mirrors and lens. Wave optics: Wave front, Huygens's principle, Interference. Young's double-slitexperiment, Maxima and minima conditions of an interference pattern, diffraction, diffraction due to a single slit, use of grating; Resolving power of a grating. Polarisation; Linear Polarizers. Electromagnetic waves as transverse waves. Energy transferred by electromagnetic wave: Poynting vector.

20. Quantum Physics: Energy and momentum of photons. Photoelectric effect. De Broglie wavelength. Heisenberg's Uncertainty principle (qualitative). Bohr's model of an
atom. Energy levels of atoms and molecules. Emission and absorption spectrum. Radioactive decay, alpha, beta and gamma decays.Decay law and half-life; nuclear reactions.

21. Theory of relativity: Basic postulates of theory of relativity; Length Contraction and Time dilation, Lorentz transformation, Relativistic momentum and energy, Mass energy equation. Energy momentum four vector. Relativistic collisions.