



Singapore Junior Physics Olympiad

SYLLABUS

(since 2018)



For the Singapore Junior Physics Olympiad (SJPO), no question will require the explicit use of calculus. However, solutions of questions involving calculus are acceptable. This does not mean that questions will not involve calculus concepts, e.g. the physical concept in Newton's second law, graphical representations using concepts of slope and area under the curve all have links to concepts in calculus.

Questions may make use of additional physics not explicitly mentioned in the SJPO syllabus. Additional physics that is not mentioned in the SJPO syllabus but is of a higher-level, i.e. A-Level or university physics, will usually have associated hints in the questions. Questions can require multiple concepts to solve. Multiple concepts can be from different topics.

1. Mechanics of Particles

Kinematics – position, displacement, velocity, acceleration, vectors

Motion of point mass	Vector description of motion of a point mass Relative velocity
Motion in 1d	Motion with constant acceleration (e.g. free fall) or with variable acceleration (e.g. car on straight road)
Motion in 2d	Motion with constant acceleration (e.g. projectile motion) Motion in a circle (involving centripetal acceleration)

Dynamics – inertia, momentum, impulse, forces, energy

Newton's laws of motion	Application of Newton's laws Motion affected by dissipative forces (e.g. friction, fluid resistance)
Forces	Elastic, friction, normal, gravity including Newton's law of gravitation, electric and magnetic
Energy and Power	Conservation of energy, conversion of energy Work done, power Potential energy (PE), kinetic energy (KE)
Impulse and momentum	Conservation of linear momentum Collisions/explosions, coefficient of restitution External and internal forces for a system of particles, centre of mass

2. Mechanics of Rigid Bodies

Statics – equilibrium, stability

Equilibrium of a rigid body	Conditions for static equilibrium, stability
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Kinematics – angular position, angular displacement, angular velocity, angular acceleration, vector products

Rotation	Rotation with constant angular acceleration Relationship between linear and angular quantities
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Dynamics – moment of inertia, torque

Torque	Effect of torque on motion
Angular momentum	Conservation of angular momentum
Rotational KE	Energy of rotational motion



3. Fluid Mechanics

Fluid statics	Density, pressure, buoyancy, surface tension Pascal's law, Archimedes' principle
Fluid dynamics	Continuity equation, mass, momentum, energy Bernoulli's principle

4. Oscillations and Waves

Simple harmonic oscillations:	Solution of the SHM equation
Mechanical, Electrical	Frequency, period, phase difference. Qualitative understanding of damping and resonance.
Waves: Mechanical (Sound, String, Fluid), Electromagnetic	Solutions of the wave equation. Qualitative understanding of attenuation. Propagation of waves, wavelength, wave speed Transverse and longitudinal waves Polarization, Malus' law Principle of superposition Standing waves, interference, diffraction, beats
Geometric optics	Reflection, refraction, dispersion Total internal reflection

5. Electric Charge and Electric Field

Electric charge and electric field	Conservation and quantization of charge Coulomb's law Electric field, Electric flux Motion of charged particles in electric field
Electric potential and capacitance	Electric potential, electric potential energy, electric potential difference Capacitors



6. Current and Magnetic Field

Current, impedance, and potential difference in DC and AC circuits	Ohm's law, resistance, resistivity, (V - I relationship for common passive devices) Impedance in an AC circuit Internal impedance in a source of emf Energy and power in electric circuits Circuits containing non-ohmic devices with known V - I characteristics
Magnetic field and magnetic forces	Motion of charged particles in magnetic field Current in a magnetic field Magnetic field of a current in a long, straight conductor, in a current loop, and in solenoids
Electromagnetic induction and inductance	Magnetic flux Faraday's law, Lenz's law Inductors

7. Thermodynamics

Zeroth law	Thermal equilibrium and absolute temperature
Kinetic theory	Kinetic theory of an ideal gas Equation of state for an ideal gas Avogadro's number
Thermal properties of materials	Thermal conductivity, thermal expansion Heat capacity Latent heat for processes such as boiling and condensation, melting and freezing Thermodynamic processes
First law	Heat, internal energy, and work done by an expanding gas Thermodynamic efficiency