**Topic #1: Measurements and Uncertainties—5 Hours for Both SL and HL**

|  |  |  |
| --- | --- | --- |
| Subtopic | Subtopic Number | IB Points to Understand |
| Measurements in physics | 1.1 | * Fundamental and derived SI units
* Scientific notation and metric multipliers
* Significant figures
* Orders of magnitude
* Estimation
 |
| Uncertainties and errors | 1.2 | * Random and systematic errors
* Absolute, fractional and percentage uncertainties
* Error bars
* Uncertainty of gradient and intercepts
 |
| Vectors and scalars | 1.3 | * Vector and scalar quantities
* Combination and resolution of vectors
 |

**Topic #2: Mechanics—22 Hours for Both SL and HL**

|  |  |  |
| --- | --- | --- |
| Subtopic | Subtopic Number | IB Points to Understand |
| Motion | 2.1 | * Distance and displacement
* Speed and velocity
* [Acceleration](https://blog.prepscholar.com/acceleration-formula-equation)
* Graphs describing motion
* Equations of motion for uniform acceleration
* Projectile motion
* Fluid resistance and terminal speed
 |
| Forces | 2.2 | * Objects as point particles
* Free-body diagrams
* Translational equilibrium
* Newton's laws of motion
* Solid friction
 |
| Work, energy and power | 2.3 | * Kinetic energy
* Gravitational potential energy
* Elastic potential energy
* Work done as energy transfer
* Power as rate of energy transfer
* Principle of conservation of energy
* Efficiency
 |
| Momentum and impulse | 2.4 | * Newton's second law expressed in terms of rate of change of momentum
* Impulse and force–time graphs
* Conservation of linear momentum
* Elastic collisions, inelastic collisions and explosions
 |

**Topic #3: Thermal Physics—11 Hours for Both SL and HL**

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| --- | --- | --- |
| Subtopic | Subtopic Number | IB Points to Understand |
| Thermal concepts | 3.1 | * Molecular theory of solids, liquids and gases
* Temperature and absolute temperature
* Internal energy
* [Specific heat capacity](https://blog.prepscholar.com/specific-heat-capacity-of-water)
* Phase change
* Specific latent heat
 |
| Modelling a gas | 3.2 | * Pressure
* Equation of state for an ideal gas
* Kinetic model of an ideal gas
* Mole, molar mass and the Avogadro constant
* Differences between real and ideal gases
 |

**Topic #4: Waves—15 Hours for Both SL and HL**

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| --- | --- | --- |
| Subtopic | Subtopic Number | IB Points to Understand |
| Oscillations | 4.1 | * Simple harmonic oscillations
* Time period, frequency, amplitude, displacement and phase difference
* Conditions for simple harmonic motion
 |
| Travelling waves | 4.2 | * Travelling waves
* Wavelength, frequency, period and wave speed
* Transverse and longitudinal waves
* The nature of electromagnetic waves
* The nature of sound waves
 |
| Wave characteristics | 4.3 | * Wavefronts and rays
* Amplitude and intensity
* Superposition
* Polarization
 |
| Wave behaviour | 4.4 | * Reflection and refraction
* Snell's law, critical angle and total internal reflection
* Diffraction through a single-slit and around objects
* Interference patterns
* Double-slit interference
* Path difference
 |
| Standing waves | 4.5 | * The nature of standing waves
* Boundary conditions
* Nodes and antinodes
 |

**Topic #5: Electricity and Magnetism—15 Hours for Both SL and HL**

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| --- | --- | --- |
| Subtopic | Subtopic Number | IB Points to Understand |
| Electric fields | 5.1 | * Charge
* Electric field
* Coulomb's law
* Electric current
* Direct current (dc)
* Potential difference
 |
| Heating effect of electric currents | 5.2 | * Circuit diagrams
* Kirchhoff's circuit laws
* Heating effect of current and its consequences
* Resistance expressed as R = V/I
* Ohm's law
* Resistivity
* Power dissipation
 |
| Electric cells | 5.3 | * Cells
* Internal resistance
* Secondary cells
* Terminal potential difference
* Electromotive force (emf)
 |
| Magnetic effects of electric currents | 5.4 | * Magnetic fields
* Magnetic force
 |

**Topic #6: Circular Motion and Gravitation—5 Hours for Both SL and HL**

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| --- | --- | --- |
| Subtopic | Subtopic Number | IB Points to Understand |
| Circular motion | 6.1 | * Period, frequency, angular displacement and angular velocity
* Centripetal force
* Centripetal acceleration
 |
| Newton's law of gravitation | 6.2 | * Newton's law of gravitation
* Gravitational field strength
 |

**Topic #7: Atomic, Nuclear and Particle Physics—14 Hours for Both SL and HL**

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| --- | --- | --- |
| Subtopic | Subtopic Number | IB Points to Understand |
| Discrete energy and radioactivity | 7.1 | * Discrete energy and discrete energy levels
* Transitions between energy levels
* Radioactive decay
* Fundamental forces and their properties
* Alpha particles, beta particles and gamma rays
* Half-life
* Absorption characteristics of decay particles
* Isotopes
* Background radiation
 |
| Nuclear reactions | 7.2 | * The unified atomic mass unit
* Mass defect and nuclear binding energy
* Nuclear fission and nuclear fusion
 |
| The structure of matter | 7.3 | * Quarks, leptons and their antiparticles
* Hadrons, baryons and mesons
* The conservation laws of charge, baryon number, lepton number and strangeness
* The nature and range of the strong nuclear force, weak nuclear force and electromagnetic force
* Exchange particles
* Feynman diagrams
* Confinement
* The Higgs boson
 |

**Topic #8: Energy Production—8 Hours for Both SL and HL**

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| --- | --- | --- |
| Subtopic | Subtopic Number | IB Points to Understand |
| Energy sources | 8.1 | * Specific energy and energy density of fuel sources
* Sankey diagrams
* Primary energy sources
* Electricity as a secondary and versatile form of energy
* Renewable and non-renewable energy sources
 |
| Thermal energy transfer | 8.2 | * Conduction, convection and thermal radiation
* Black-body radiation
* Albedo and emissivity
* The solar constant
* The greenhouse effect
* Energy balance in the Earth surface–atmosphere system
 |

**Topic #9: Wave Phenomena—17 Hours for HL Only**

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| --- | --- | --- |
| Subtopic | Subtopic Number | IB Points to Understand |
| Simple harmonic motion(HL ONLY) | 9.1 | * The defining equation of SHM
* Energy changes
 |
| Single-slit diffraction(HL ONLY) | 9.2 | * The nature of single-slit diffraction
 |
| Interference(HL ONLY) | 9.3 | * Young's double-slit experiment
* Modulation of two-slit interference pattern by one-slit diffraction effect
* Multiple slit and diffraction grating interference patterns
* Thin film interference
 |
| Resolution(HL ONLY) | 9.4 | * The size of a diffracting aperture
* The resolution of simple monochromatic two-source systems
 |
| Doppler effect(HL ONLY) | 9.5 | * The Doppler effect for sound waves and light waves
 |

**Topic #10: Fields—11 Hours for HL only**

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| --- | --- | --- |
| Subtopic | Subtopic Number | IB Points to Understand |
| Describing fields(HL ONLY) | 10.1 | * Gravitational fields
* Electrostatic fields
* Electric potential and gravitational potential
* Field lines
* Equipotential surfaces
 |
| Fields at work(HL ONLY) | 10.2 | * Potential and potential energy
* Potential gradient
* Potential difference
* Escape speed
* Orbital motion, orbital speed and orbital energy
* Forces and inverse-square law behaviour
 |

**Topic #11: Electromagnetic Induction—16 Hours for HL Only**

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| --- | --- | --- |
| Subtopic | Subtopic Number | IB Points to Understand |
| Electromagnetic induction(HL ONLY) | 11.1 | * Electromotive force (emf)
* Magnetic flux and magnetic flux linkage
* Faraday's law of induction
* Lenz's law
 |
| Power generation and transmission(HL ONLY) | 11.2 | * Alternating current (ac) generators
* Average power and root mean square (rms) values of current and voltage
* Transformers
* Diode bridges
* Half-wave and full-wave rectification
 |
| Capacitance(HL ONLY) | 11.3 | * Capacitance
* Dielectric materials
* Capacitors in series and parallel
* Resistor-capacitor (RC) series circuits
* Time constant
 |

**Topic #12: Quantum and Nuclear Physics—16 Hours for HL Only**

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| --- | --- | --- |
| Subtopic | Subtopic Number | IB Points to Understand |
| The interaction of matter with radiation(HL ONLY) | 12.1 | * Photons
* The photoelectric effect
* Matter waves
* Pair production and pair annihilation
* Quantization of angular momentum in the Bohr model for hydrogen
* The wave function
* The uncertainty principle for energy and time and position and momentum
* Tunnelling, potential barrier and factors affecting tunnelling probability
 |
| Nuclear physics(HL ONLY) | 12.2 | * Rutherford scattering and nuclear radius
* Nuclear energy levels
* The neutrino
* The law of radioactive decay and the decay constant
 |

**Option A: Relativity—15 Hours for SL and HL**

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| --- | --- | --- |
| Subtopic | Subtopic Number | IB Points to Understand |
| The beginnings of relativity | A.1 | * Reference frames
* Galilean relativity and Newton's postulates concerning time and space
* Maxwell and the constancy of the speed of light
* Forces on a charge or current
 |
| Lorentz transformations | A.2 | * The two postulates of special relativity
* Clock synchronization
* The Lorentz transformations
* Velocity addition
* Invariant quantities (spacetime interval, proper time, proper length and rest mass)
* Time dilation
* Length contraction
* The muon decay experiment
 |
| Spacetime diagrams | A.3 | * Spacetime diagrams
* Worldlines
* The twin paradox
 |

**Additional HL Relativity Topics—10 More Hours for HL**

|  |  |  |
| --- | --- | --- |
| Subtopic | Subtopic Number | IB Points to Understand |
| Relativistic mechanics(HL ONLY) | A.4 | * Total energy and rest energy
* Relativistic momentum
* Particle acceleration
* Electric charge as an invariant quantity
* Photons
* MeV c^–2 as the unit of mass and MeV c^–1 as the unit of momentum
 |
| General Relativity(HL ONLY) | A.5 | * The equivalence principle
* The bending of light
* Gravitational redshift and the Pound–Rebka–Snider experiment
* Schwarzschild black holes
* Event horizons
* Time dilation near a black hole
* Applications of general relativity to the universe as a whole
 |

**Option B: Engineering Physics—15 Hours for SL and HL**

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| --- | --- | --- |
| Subtopic | Subtopic Number | IB Points to Understand |
| Rigid bodies and rotational dynamics | B.1 | * Torque
* Moment of inertia
* Rotational and translational equilibrium
* Angular acceleration
* Equations of rotational motion for uniform angular acceleration
* Newton's second law applied to angular motion
* Conservation of angular momentum
 |
| Thermodynamics | B.2 | * The first law of thermodynamics
* The second law of thermodynamics
* Entropy
* Cyclic processes and pV diagrams
* Isovolumetric, isobaric, isothermal and adiabatic processes
* Carnot cycle
* Thermal efficiency
 |

**Additional HL Engineering Physics Topics—10 More Hours for HL**

|  |  |  |
| --- | --- | --- |
| Subtopic | Subtopic Number | IB Points to Understand |
| Fluids and fluid dynamics(HL ONLY) | B.3 | * Density and pressure
* Buoyancy and Archimedes' principle
* Pascal's principle
* Hydrostatic equilibrium
* The ideal fluid
* Streamlines
* The continuity equation
* The Bernoulli equation and the Bernoulli effect
* Stokes' law and viscosity
* Laminar and turbulent flow and the Reynolds number
 |
| Forced vibrations and resonance(HL ONLY) | B.4 | * Natural frequency of vibration
* Q factor and damping
* Periodic stimulus and the driving frequency
* Resonance
 |

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| --- | --- | --- |
| Subtopic | Subtopic Number | IB Points to Understand |
| Introduction to imaging | C.1 | * Thin lenses
* Converging and diverging lenses
* Converging and diverging mirrors
* Ray diagrams
* Real and virtual images
* Linear and angular magnification
* Spherical and chromatic aberrations
 |
| Imaging instrumentation | C.2 | * Optical compound microscopes
* Simple optical astronomical refracting telescopes
* Simple optical astronomical reflecting telescopes
* Single-dish radio telescopes
* Radio interferometry telescopes
* Satellite-borne telescopes
 |
| Fibre optics | C.3 | * Structure of optic fibres
* Step-index fibres and graded-index fibres
* Total internal reflection and critical angle
* Waveguide and material dispersion in optic fibres
* Attenuation and the decibel (dB) scale
 |

**Option C: Imaging—15 Hours for SL and HL**

**Additional HL Imaging Topics—10 More Hours for HL**

|  |  |  |
| --- | --- | --- |
| Subtopic | Subtopic Number | IB Points to Understand |
| Medical imaging(HL ONLY) | C.4 | * Detection and recording of X-ray images in medical contexts
* Generation and detection of ultrasound in medical contexts
* Medical imaging techniques (magnetic resonance imaging) involving nuclear magnetic resonance (NMR)
 |

**Option D: Astrophysics—15 Hours for SL and HL**

|  |  |  |
| --- | --- | --- |
| Subtopic | Subtopic Number | IB Points to Understand |
| Stellar quantities | D.1 | * Objects in the universe
* The nature of stars
* Astronomical distances
* Stellar parallax and its limitations
* Luminosity and apparent brightness
 |
| Stellar characteristics and stellar evolution | D.2 | * Stellar spectra
* Hertzsprung–Russell (HR) diagram
* Mass–luminosity relation for main sequence stars
* Cepheid variables
* Stellar evolution on HR diagrams
* Red giants, white dwarfs, neutron stars and black holes
* Chandrasekhar and Oppenheimer–Volkoff limits
 |
| Cosmology | D.3 | * The Big Bang model
* Cosmic microwave background (CMB) radiation
* Hubble's law
* The accelerating universe and redshift (z)
* The cosmic scale factor (R)
 |

**Additional HL Astrophysics Topics—10 More Hours for HL**

|  |  |  |
| --- | --- | --- |
| Subtopic | Subtopic Number | IB Points to Understand |
| Stellar processes(HL ONLY) | D.4 | * The Jeans criterion
* Nuclear fusion
* Nucleosynthesis off the main sequence
* Type Ia and II supernovae
 |
| Further cosmology(HL ONLY) | D.5 | * The cosmological principle
* Rotation curves and the mass of galaxies
* Dark matter
* Fluctuations in the CMB
* The cosmological origin of redshift
* Critical density
* Dark energy
 |