IB Physics Syllabus

Enhanced representation of the official content syllabus from the IB Subject Guide.

[2014 (first assessment 2016) spec]

SL Content Recommended teaching hours: 150
HL Content Recommended teaching hours: +90

"..." means I was too lazy to copy the full thing from the official IB subject guide.

I **bolded** key words/phrases in the descriptions to make it easier to glance over. I also grouped and named subunits by topic wherever appropriate (Topic column).

#	Topic	Essential Idea	Understandings	Applications	Guidance	DB Reference
UNIT 1: Measurements & Uncertainties						
1.1	Measurements in Physics	Since 1948, the Système International d'Unités (SI) has been used as the preferred language of science and technology across the globe and reflects current best measurement practice.	Fundamental SI Units Scientific Notation & Metric Multipliers Significant Figures Orders of Magnitude Estimation			
1.2	Uncertainties & Errors	Scientists aim towards designing experiments that can give a "true value" from their measurements, but due to the limited precision in measuring devices, they often quote their results with some form of uncertainty.	**Errors**: Random & Systematic **Uncertainties**: Absolute, Fractional & Percentage Error Bars Uncertainty of Gradient & Intercepts			
1.3	Vectors & Scalars	Some quantities have direction and magnitude, others have magnitude only, and this understanding is the key to correct manipulation of quantities. This sub topic will have broad applications across multiple fields within physics and other sciences	**Types of Quantities**: Vector & Scalar Combination and Resolution of Vectors			
UNIT 2: Mechanics						
2.1	Motion	Motion may be described and analyzed by the use of graphs and equations.	Distance & Displacement Speed & Velocity Acceleration Graphs describing motion Equations of motion for Uniform Acceleration Projectile Motion Fluid Resistance & Terminal Speed			
2.2	Forces	Classical physics requires a force to change a state of motion, as suggested by	Objects as Point Particles Free-body Diagrams			

		Newton in his laws of motion.	Translational Equilibrium Newton's Laws of Motion Solid Friction			
2.3	Work Energy & Power	The fundamental concept of energy lays the basis upon which much of science is built.	**Types of Energy**: Kinetic, Gravitational potential & Elastic potential Work Done as energy transfer Power as Rate of energy transfer Principle of Conservation of Energy Efficiency			
2.4	Momentum & Impulse	Conservation of momentum is an example of a law that is never violated.	Newton's Second Law expressed in terms of rate of change of momentum **Graphs**: Impulse—time & Force—time Conservation of Linear Momentum **Collisions**: Elastic, Inelastic & Explosions			
UNIT 3: Thermal						
3.1	Thermal Concepts	Thermal physics deftly demonstrates the links between the macroscopic measurements essential to many scientific models with the microscopic properties that underlie these models.	Molecular Theory of solids, liquids & gases Temperature (including Absolute Temperature) Internal Energy Specific Heat Capacity Phase Change Specific Latent Heat			
3.2	Modelling a Gas	The properties of ideal gases allow scientists to make predictions of the behavior of real gases.	Pressure Equation of State for an idea gas Kinetic Model of an ideal gas Mole, Molar Mass & the Avogadro Constant Differences between Real and Ideal Gases			
UNIT 4: Waves						
4.1	Oscillations	A study of oscillations underpins many areas of physics with simple harmonic motion (SHM), a fundamental oscillation that appears in various natural phenomena.	Simple Harmonic Oscillations Time Period, Frequency, Amplitude, Displacement & Phase Difference Conditions for SHM			
4.2	Travelling Waves	There are many forms of waves available to be studied. A common characteristic of all travelling waves is that they carry	Travelling Waves Wavelength, Frequency, Period & Wave Speed			

		energy, but generally the medium through which they travel will not be permanently disturbed.	Transverse & Longitudinal waves Nature of EM waves Nature of Sound waves			
4.3	Wave Characteristics	All waves can be described by the same sets of mathematical ideas. Detailed knowledge of one area leads to the possibility of prediction in another.	Wavefronts & Rays Amplitude & Intensity Superposition Polarization			
4.4	Wave Behavior	Waves interact with media and each other in a number of ways that can be unexpected and useful.	Reflection & Refraction Snell's Law, Critical Angle & Total Internal Reflection Diffraction through a Single-slit and around objects Interference Patterns Double-slit interference Path Difference			
4.5	Standing Waves	When travelling waves meet they can superpose to form standing waves in which energy may not be transferred.	Nature of Standing Wave Boundary Conditions Nodes & Antinodes			
UNIT 5: Electromagnetism						
5.1	Electric Fields	When charges move an electric current is created.	Charge Electric Field Coulomb's Law Electric Current Direct Current (DC) Potential Difference			
5.2	Heating Effect of Electric Currents	One of the earliest uses for electricity was to produce light and heat. This technology continues to have a major impact on the lives of people around the world.	Circuit Diagrams Kirchoff's Circuit Laws Heating effect of current and its consequences Resistance as $R = \frac{V}{I}$ Ohm's Law Resistivity (of material) Power Dissipation			
5.3	Electric Cells	Electric cells allow us to store energy in a chemical form.	Cells Internal Resistance Secondary Cells Terminal Potential Difference Electromotive Force (EMF)			
5.4	Magnetic Effects of Electric Currents	The effect scientists call magnetism arises when one charge moves in the vicinity of another moving charge.	Magnetic Fields Magnetic Force			
UNIT 6: Circular Motion & Gravitation						

6.1	Circular Motion	A force applied perpendicular to its displacement can result in circular motion.	Period, Frequency, Angular Displacement & Angular Velocity Centripetal Force Centripetal Acceleration			
6.2	Newton's Law of Gravitation	The Newtonian idea of gravitational force acting between two spherical bodies and the laws of mechanics create a model that can be used to calculate the motion of planets.	Newton's Law of Gravitation Gravitational Field Strength			
UNIT 7: Atomic Nuclear & Particle Physics						
7.1	Discrete Energy & Radioactivity	In the microscopic world energy is discrete.	Discrete Energy & Discrete energy Levels Transitions between energy levels Radioactive Decay Fundamental Forces (and their properties) Alpha Particles, Beta Particles & Gamma Rays Half-life Absorption Characteristics of decay particles Isotopes Background Radiation			
7.2	Nuclear Reactions	Energy can be released in nuclear decays and reactions as a result of the relationship between mass and energy.	Unified Atomic Mass Unit (u) Mass Defect & Nuclear Binding Energy Nuclear Fission & Fusion			
7.3	Structure of Matter	It is believed that all the matter around us is made up of fundamental particles called quarks and leptons. It is known that matter has a hierarchical structure with quarks making up nucleons, nucleons making up nuclei, nuclei and electrons making up atoms and atoms making up molecules. In this hierarchical structure, the smallest scale is seen for quarks and leptons (10^{-18} m).	Fermions: Quarks & Leptons & their Antiparticles Hadrons: Baryons & Mesons Conservation Laws: Charge, Baryon Number, Lepton Number & Strangeness Nature and Range of: Strong, Weak & EM Forces Exchange Particles: W, Z, gluons & photons Feynman Diagrams (Quark) Confinement The Higgs Boson			
UNIT 8: Energy production						
8.1	Energy Sources	The constant need for new energy sources implies decisions that may have a serious effect on the environment. The finite	Specific Energy & Energy Density of fuels Sankey Diagrams Primary energy sources			

		quantity of fossil fuels and their implication in global warming has led to the development of alternative sources of energy. This continues to be an area of rapidly changing technological innovation.	Electricity as a secondary and versatile form of energy Renewable & Non-renewable sources			
8.2	Thermal Energy Transfer	For simplified modelling purposes the Earth can be treated as a black-body radiator and the atmosphere treated as a grey-body.	Conduction, Convection & (thermal) Radiation Black-body Radiation Albedo & Emissivity The Solar Constant Greenhouse Effect Energy balance in the Earth surface-atmosphere system			
AHL 9: Wave Phenomena						
9.1	Simple Harmonic Motion	The solution of the harmonic oscillator can be framed around the variation of kinetic and potential energy in the system.	The defining equation of SHM Energy Changes			
9.2	Single-slit Diffraction	Single-slit diffraction occurs when a wave is incident upon a slit of approximately the same size as the wavelength.	Nature of single-slit Diffraction	Describe effect of slit width on diffraction pattern Determine position of first interference minimum Describe qualitatively single-slit diffraction patterns produced from white light / range of monochromatic sources	Only rectangular slits need to be considered Diffraction around an object does not need to be considered (it is in unit 4) Be aware of approximate ratios of intensities of successive maxima ...	
9.3	Interference	Interference patterns from multiple slits and thin films produce accurately repeatable patterns.	Young's Double-slit Experiment Modulation (enveloping) of two-slit interference pattern by one-slit diffraction effect Multiple-slit / Diffraction Grating interference patterns Thin Film Interference	Describe qualitatively two-slit interference patterns, including single-slit modulation Sketch & interpret intensity graphs of two-slit interference patterns Use the diffraction grating equation Describe conditions necessary for constructive and destructive interference from thin films, including boundary phase change and effect of refraction		
9.4	Resolution	Resolution places an absolute limit on the extent to which an optical or other system can separate images of objects.	Size of a Diffracting Aperture Resolution of simple monochromatic Two-source Systems	Use the Rayleigh criterion for light emitted by two sources diffracted at a single slit Resolvance of diffraction gratings	Proof of the diffraction grating resolvance equation is not required	
9.5	Doppler Effect	The Doppler effect describes the phenomenon of wavelength/frequency shift when relative motion occurs.	Doppler Effect (for sound & light waves)	Sketch and interpret the Doppler effect for relative motion between source and observer Describe situations were the Doppler effect can be utilized Use frequency/velocity/wavelength change formulas	For EM wave, the approximate (non-relativistic) equation should be used for all calculations ...	
AHL 10: Fields						
10.1	Describing Fields	Electric charges and masses each influence the space around	Fields: Gravitational & Electrostatic			

		them and that influence can be represented through the concept of fields.	Potentials: Gravitational & Electric Field Lines Equipotential Surfaces			
10.2	Fields at Work	Similar approaches can be taken in analyzing electrical and gravitational potential problems.	(Field) Potential & Potential Energy Potential Gradient (field strength) Potential Difference Escape Speed Orbital Motion, Orbital Speed & Orbital (potential + kinetic) Energy Forces and Inverse-square Law behavior			

AHL 11: Induction

11.1	Electromagnetic Induction	The majority of electricity generated throughout the world is generated by machines that were designed to operate using the principles of electromagnetic induction.	Electromotive Force (EMF) Magnetic Flux & Flux Linkage Faraday's Law of Induction Lenz's Law			
11.2	Power Generation & Transmission	Generation and transmission of alternating current (ac) electricity has transformed the world.	Alternating Current (AC) Generators Average Power & Root-mean-square (RMS) values of current & voltage Transformers Diode bridges (AC rectifiers) Half-wave and Full-wave AC Rectification			
11.3	Capacitance	Capacitors can be used to store electrical energy for later use.	Capacitance Dielectric Materials Capacitors in Series & Parallel Resistor-capacity (RC) series Circuits Time Constant (τ)			

AHL 12: Quantum & Nuclear Physics

12.1	Interaction with Radiation	The microscopic quantum world offers a range of phenomena, the interpretation and explanation of which require new ideas and concepts not found in the classical world.	Photons Photoelectric Effect Matter Waves Pair Production & Annihilation Quantization of angular momentum in the Bohr model for hydrogen The Wave Function Uncertainty Principle for Energy-Time & Position-Momentum Tunneling, Potential Barrier & Factors	Discuss the photoelectric effect experiment and explain which features of the experiment cannot be explained by the classical wave theory of light Solve photoelectric problems both graphically and algebraically (formula) Discuss experimental evidence for matter waves, including electron wave experiments State order o magnitude estimates from the uncertainty principle	The order of magnitude estimates from the uncertainty principle may include estimates of the energy of the ground state of an atom, the impossibility of an electron existing within a nucleus, and the lifetime of an electron in a excited energy state Tunnelling to be treated qualitatively using the idea of continuity of wave functions	$E = hf$ $E_{\text{max}} = hf - \Phi$ $E = -\frac{13.6}{n^2}\text{eV}$ energy of hydrogen atom electron shells $mvr = \frac{nh}{2\pi}$ angular momentum of hydrogen atom electron $\text{P}(r) = \|\Psi\|^2 \Delta V$ probability that an electron will be found within a volume $\Delta x \Delta p \geq \frac{h}{4\pi}$

			affecting tunnelling probability			$\Delta E \Delta t \geq \frac{h}{4\pi}$
12.2	Nuclear Physics	The idea of discreteness that we met in the atomic world continues to exist in the nuclear world as well.	Rutherford Scattering and Nuclear Radius Nuclear Energy Levels The Neutrino The Law of Radioactive Decay & Decay Constant	Describe a scattering experiment including location of minimum intensity for the diffracted particles based on their de Broglie wavelength Explain deviations from Rutherford scattering in high energy experiments		
Option B: Engineering						
B.1	Rigid Bodies & Rotational Dynamics	The basic laws of mechanics have an extension when equivalent principles are applied to rotation. Actual objects have dimensions and they require the expansion of the point particle model to consider the possibility of different points on an object having different states of motion and/or different velocities.	Torque Momentum of Inertia Rotational & Translational Equilibrium Angular Acceleration Equations of rotational motion for uniform angular acceleration Newton's second law applied to angular motion Conservation of Angular Momentum			
B.2	Thermodynamics	The first law of thermodynamics relates the change in internal energy of a system to the energy transferred and the work done. The entropy of the universe tends to a maximum.	First Law of Thermodynamics Second Law of Thermodynamics Entropy Cyclic Processes & pV Diagrams Isovolumetric, Isobaric, Isothermal & Adiabatic Processes Carnot Cycle Thermal Efficiency			
B.3 (HL)	Fluids & Fluid Dynamics	Fluids cannot be modelled as point particles. Their distinguishable response to compression from solids creates a set of characteristics that require an in depth study.	Density & Pressure Buoyancy & Archimedes' Principle Pascal's Principle Hydrostatic Equilibrium The Idea Fluid Streamlines The Continuity Equation Bernoulli Effect & Equation Stoke's Law & Viscosity Laminar & Turbulent Flow & Reynold's Number			
B.4 (HL)	Forced Vibrations & Resonance	In the real world, damping occurs in oscillators and has implications that need to be considered	Natural Frequency of vibration Q Factor & Dampening Periodic Stimulus & Driving Frequency Resonance			