Diploma Programme Course Outline

Name of the DP subject	**Physics**
Level	**Higher ☐ Standard ☐**

YEAR 2

UNIT	**TOPIC/CONCEPT TERM 1: Aug 2022 – Dec 2022**			**ASSESSMENT COMPONENTS**
Unit 7: Atomic, Nuclear and Particle Physics **14 Hours for Both SL and HL**	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	Formative assessments: • Observation of practical skills and ability to follow steps and show working • Questioning • Discussion of the methodology of the calculations and what working is necessary: class, small group, pair, individual, teacher-led, student-led. • Think, pair, share • Quiz • Worksheets and past paper questions
	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	Peer and self – assessment: • Students will be expected to check their own work at times, marking themselves and making corrections. At other times, they will share their answers and working and give and receive feedback from their peers.
Unit 8: Energy Production **8 Hours for Both SL and HL**	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	

Unit 12: Quantum and Nuclear Physics **16 Hours for HL Only**	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 • Tunneling, potential barrier and factors affecting tunneling probability	• Students will be expected to check their own work at times, marking themselves and making corrections. At other times, they will share their answers and working and give and receive feedback from their peers. Summative assessments: * Multiple choice and free response questions on the topic. **SL: Unit 7 & 8.** **HL: Unit 7, 8 & 12**
	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	
UNIT	**TOPIC/CONCEPT TERM 2: Jan 2023 – April 2023**			**ASSESSMENT COMPONENTS**
Option A: Relativity **15 Hours for SL and HL**	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	• Students will be expected to check their own work at times, marking themselves and making corrections. At other times, they will share their answers and
	Lorentz transformations	A.2	• The two postulates of special relativity • Clock synchronization	

			• The Lorentz transformations • Velocity addition • Invariant quantities (space time interval, proper time, proper length and rest mass) • Time dilation • Length contraction • The muon decay experiment	working and give and receive feedback from their peers.
	Space time diagrams	A.3	• Space time diagrams • World lines • The twin paradox	
Additional HL Relativity Topics **10 More Hours for HL**	Relativistic mechanics (HL ONLY)	A.4	• Total energy and rest energy • Relativistic momentum • Particle acceleration • Electric charge as an invariant quantity • Photons • MeV	• Students will be expected to check their own work at times, marking themselves and making corrections. At other times, they will share their answers and working and give and receive feedback from their peers.
	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**	Rigid bodies and rotational dynamics	B.1	• Torque • Moment of inertia • Rotational and translational equilibrium • Angular acceleration • Equations of rotational motion for angular acceleration • Newton's second law applied to angular motion	• Students will be expected to check their own work at times, marking themselves and making corrections. At other

			• Conservation of angular momentum	times, they will share
	Thermodynamics	B.2	• The first law of thermodynamics • The second law of thermodynamics • Entropy • Cyclic processes and pV diagrams • Isovolumetric, isobaric, isothermal, adiabatic processes • Carnot cycle • Thermal efficiency	their answers and working and give and receive feedback from their peers.
Additional HL Engineering Physics Topics **10 More Hours for HL**	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	• Students will be expected to check their own work at times, marking themselves and making corrections. At other times, they will share their answers and working and give and receive feedback from their peers.
	Forced vibrations and resonance (HL ONLY)	B.4	• Natural frequency of vibration • Q factor and damping • Periodic stimulus and the driving frequency • Resonance	

Option C: Imaging **15 Hours for SL and HL**	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	• Students will be expected to check their own work at times, marking themselves and making corrections. At other times, they will share their answers and working and give and receive feedback from their peers.
	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 fibers • Step-index fibers and graded-index fibers • Total internal reflection and critical angle • Waveguide and material dispersion in optic fibers • Attenuation and the decibel (dB) scale	
Additional HL Imaging Topics **10 More Hours for HL**	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**	Stellar quantities	D.1	• Objects in the universe • The nature of stars • Astronomical distances • Stellar parallax and its limitations • Luminosity and apparent brightness	• Students will be expected to check their own work at times, marking themselves and making corrections. At other times, they will share
	Stellar characteristics and	D.2	• Stellar spectra • Hertzsprung–Russell (HR) diagram	

	stellar evolution		• 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	their answers and working and give and receive feedback from their peers.
	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**	Stellar processes (HL ONLY)	D.4	• The Jeans criterion • Nuclear fusion • Nucleosynthesis off the main sequence • Type Ia and II supernovae	Mock Exams: (Covering all units) Paper 1: Multiple questions Paper 2: Open-end questions Paper 3: Experimental & Options based open-end questions
	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	

All Diploma Programme courses are designed as two-year learning experiences.