Diploma Programme Year Plan

Name of the DP subject	PHYSICS	
Level	**Higher** ☐ **Standard** ☐	
YEAR 1		
UNIT	**TOPIC/CONCEPT**	**ASSESSMENT COMPONENTS**
A: SPACE, TIME & MOTION	A.1 KINEMATICS 9 hours: SL and HL ▪ that the motion of bodies through space and time can be described and analysed in terms of position, velocity, and acceleration ▪ velocity is the rate of change of position, and acceleration is the rate of change of velocity ▪ the change in position is the displacement ▪ the difference between distance and displacement ▪ the difference between instantaneous and average values of velocity, speed and acceleration, and how to determine them ▪ the equations of motion for solving problems with uniformly accelerated motion as given by	**Formative Assessment** • Observation of practical skills and ability to follow steps and show working • Questioning • Graph Analysis • Discussion of the methodology of the calculations and what workingis necessary: class, small group, pair, individual, teacher-led, student-led. • Think, pair, share • Quiz • Worksheets and past paperquestions **Summative Assessment**

	$$s = \frac{u+v}{2}t$$ $$v = u + at$$ $$s = ut + \frac{1}{2}at^2$$ $$v^2 = u^2 + 2as$$ ▪ motion with uniform and non-uniform acceleration ▪ the behaviour of projectiles in the absence of fluid resistance, and the application of the equations of motion resolved into vertical and horizontal components ▪ the qualitative effect of fluid resistance on projectiles, including time of flight, trajectory, velocity, acceleration, range and terminal speed.	Multiple choice and free responsequestions on the topic **Peer and self- assessment** Students will be expected to checktheir own work at times, marking themselves and making corrections. At other times, they will share their answers and working as well as provide and receive feedback from their peers
	A.2 FORCES AND MOMENTUM 10 hours: SL and HL ▪ State newton's three laws of motion ▪ Forces as interactions between bodies ▪ Represent forces acting on a body ▪ find the resultant force on a system using a free-body diagram ▪ Understand the nature and use of the following contact forces; frictional force, normal force, tension, restoring force, viscous drag force and buoyant force.	**Formative Assessment** • Observation of practical skills and ability to follow steps and show working • Questioning • Construction free body diagrams to depict and illustrate various forces. • Discussion of the methodology of the calculations and what workingis necessary: class, small group, pair, individual, teacher-led, student-led. • Think, pair, share • Quiz • Worksheets and past

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- Understand the nature and use of the following field forces; gravitational force, electric force and magnetic force.
- Define linear momentum as given by $p = mv$ remains constant unless the system is acted upon by a resultant external force
- Explain that a resultant external force applied to a system constitutes an impulse J as given by $J = F\Delta t$ where, F is the average resultant force and Δt is the time of contact
- State that the applied external impulse equals the change in momentum of the system
- Differentiate between the elastic and inelastic collisions of two bodies.
- Explain that circular motion is caused by a centripetal force acting perpendicular to the velocity.

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paperquestions

Summative Assessment

Multiple choice and free responsequestions on the topic

Peer and self- assessment

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A.3 WORK, ENERGY AND POWER

8 hours: SL and HL

- State the principle of the conservation of energy
- Recognize that work done by a force is equivalent to a transfer of energy
- Construct a Sankey diagram to represent energy transfers.
- Understand that work W done on a body by a constant force depends

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	on the component of the force along the line of displacement as given by $W = Fs \cos \vartheta$ ▪ Explain that mechanical energy is the sum of kinetic energy, gravitational potential energy and elastic potential energy. ▪ that in the absence of frictional, resistive forces, the total mechanical energy of a system is conserved ▪ Justify that if mechanical energy is conserved, work is the amount of energy transformed between different forms of mechanical energy in a system, such as: kinetic energy, gravitational potential energy, elastic potential energy ▪ That power developed P is the rate of work done, or the rate of energy transfer, as given by ▪ Efficiency η in terms of energy transfer or power as given by $\eta = \frac{useful\ work\ out}{total\ work\ in} = \frac{useful\ power\ out}{total\ power\ in}$ ▪ Energy density of the fuel sources.	

	A.4 Rigid Body Mechanics 7 hours: HL ONLY • Define the torque τ of a force about an axis as given by $\tau = Fr \sin \theta$ • State that bodies in rotational equilibrium have a resultant torque of zero • Justify that an unbalanced torque applied to an extended, rigid body will cause angular acceleration. • Understand that the rotation of a body can be described in terms of angular displacement, angular velocity and angular acceleration. • State the equations of motion for uniform angular acceleration. • Argue that the moment of inertia I depends on the distribution of mass of an extended body about an axis of rotation • Recall that the moment of inertia for a system of point masses is given by $I = \Sigma mr2$ • Explain newton's second law for rotation as given by $\tau = I\alpha$ where τ is the average torque • Show that an extended body rotating with an angular speed has an angular momentum L as given by $L = I\omega$ • Explain that angular momentum remains constant unless the body is acted upon by a resultant torque	**Formative Assessment** • 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 paperquestions **Summative Assessment** Multiple choice and free responsequestions on the topic **Peer and self- assessment** Students will be expected to checktheir own work at times, marking themselves and making corrections. At other times, they will share their answers and working as well as provide and receive feedback from their peers

	A.5 Galilean and Special Relativity 8 hours: HL ONLY • Describe the photoelectric effect as evidence of the particle nature of light • Justify that photons of a certain frequency, known as the threshold frequency, are required to release photoelectrons from the metal • Explain what is meant by reference frames • Identify that Newton's laws of motion are the same in all inertial reference frames and this is known as Galilean relativity • Understand that in Galilean relativity the position x' and time t' of an event are given by $x' = x–vt$ and $t' = t$ • Justify that Galilean transformation equations lead to the velocity addition equation as given by $u' = u–v$ • Argue the two postulates of special relativity • Explain that the postulates of special relativity lead to the Lorentz transformation equations for the coordinates of an event in two inertial reference frames. • proper time interval and proper length • Define the terms time dilation and length contraction • Investigate the relativity of simultaneity • Use space–time diagrams • Explain that the angle between the world line of a moving particle and the time axis on a space–time diagram is related to the particle's speed • Justify that muon decay experiments provide experimental evidence for time dilation and length contraction	**Formative Assessment** • Observation of simulations • Questioning • Discussion of the methodology of the calculations and what workingis necessary: class, small group, pair, individual, teacher-led, student-led. • Think, pair, share • Quiz • Worksheets and past paperquestions **Summative Assessment** Multiple choice and free responsequestions on the topic **Peer and self- assessment** Students will be expected to checktheir own work at times, marking themselves and making corrections. At other times, they will share their answers and working as well as provide and receive feedback from their peers

UNIT	TOPIC/CONCEPT	ASSESSMENT COMPONENTS
D.1 GRAVITATIONAL FIELDS 5 hours: SL and HL	• gravitational field lines. • Newton's universal law of gravitation as given by $F = G\frac{m_1 m_2}{r^2}$ for bodies treated as point masses. • conditions under which extended bodies can be treated as point masses. • that gravitational field strength g at a point is the force per unit mass experienced by a small point mass at that point as given by $g = \frac{F}{m} = G\frac{M}{r^2}$ • Kepler's three laws of orbital motion	**Formative assessment** ▪ Students practice drawing field lines and using appropriate equations to solve problems. ▪ Clearly state the laws of gravitation and the law of orbital motion. ▪ 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 **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
7 hours: HL ONLY	**GRAVITATIONAL POTENTIAL** • that the gravitational potential energy E_p of a system is the work done to assemble the system from infinite separation of the components of the system • the gravitational potential energy for a two-body system as given by $E_p = -G\frac{m_1 m_2}{r^2}$ where r is the separation between the centre of mass of the two bodies. • that the gravitational potential V_g at a point is the work done per unit mass in bringing a mass from infinity to that point as given by	

	$V_g = -G\frac{M}{r}$ • the gravitational field strength g as the gravitational potential gradient as given by $g = \frac{\Delta V_g}{\Delta r}$ • the work done in moving a mass, m in a gravitational field as given by $W = m\Delta V_g$ • equipotential surfaces for gravitational fields • the relationship between equipotential surfaces and gravitational field lines • the escape speed v_{esc} at any point in a gravitational field as given by $v_{esc} = \sqrt{\frac{2GM}{r}}$ • the orbital speed, $v_{orbital}$ of a body orbiting a large mass as given by $v_{orbital} = \sqrt{\frac{GM}{r}}$ • the qualitative effect of a small viscous drag force due to the atmosphere on the height and speed of an orbiting body.	as well as provide and receive feedback from their peers
D.2 Electric and Magnetic Fields 8 hours: SL and HL	• the direction of forces between the two types of electric charge • Coulomb's law as given by $F = k\frac{q_1 q_2}{r^2}$ for charged bodies treated as point charges where $k = \frac{1}{4\pi\varepsilon_0}$ • the conservation of electric charge • Millikan's experiment as evidence for quantization of electric charge • that the electric charge can be transferred between bodies using friction, electrostatic induction and	**Formative Assessment:** A quiz will be used to identify strengths and weaknesses beforethe test. **Summative assessment** Students will sit an end of unit test based on past paper questions once the chapter is complete. **Peer and self -assessment**

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<tr><td></td><td>by contact, including the role of grounding (earthing)
• the electric field strength as given by $E = \frac{F}{q}$
• electric field lines
• the relationship between field line density and field strength
• the uniform electric field strength between parallel plates as given by $E = \frac{V}{d}$
• magnetic field lines.</td><td rowspan="2">Students will be expected to checktheir own work at times, marking themselves and making corrections. At other times, they will share their answers and working as well as provide and receive feedback from their peers</td></tr>
<tr><td>6 hours: HL only</td><td>• the electric potential energy E_p in terms of work done to assemble the system from infinite separation
• the electric potential energy for a system of two charged bodies as given by $E_p = k\frac{q_1 q_2}{r}$
• that the electric potential is a scalar quantity with zero defined at infinity
• that the electric potential V_e at a point is the work done per unit charge to bring a test charge from infinity to that point as given by $V_e = \frac{kQ}{r}$
• the electric field strength E as the electric potential gradient as given by $E = -\frac{\Delta V_e}{\Delta r}$
• the work done in moving a charge q in an electric field as given by $W = q\Delta V_e$
• equipotential surfaces for electric fields
• the relationship between equipotential surfaces and electric field lines.</td></tr>
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D.3 Motion in Electromagnetic Fields 6 hours SL and HL	• the motion of a charged particle in a uniform electric field • the motion of a charged particle in a uniform magnetic field • the motion of a charged particle in perpendicularly orientated uniform electric and magnetic fields • the magnitude and direction of the force on a charge moving in a magnetic field as given by $F = qvBsin\theta$ • the magnitude and direction of the force on a current-carrying conductor in a magnetic field as given by $F = BIL\sin\theta$ • the force per unit length between parallel wires as given by $\frac{F}{L} = \mu_0 \frac{I_1 I_2}{2\pi r}$	**Formative assessments** ▪ 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 paperquestions **Summative assessment** ▪ There will be an end of chapter testbased on past paper questions. **Peer and self- assessment** Students will be expected to checktheir own work at times, marking themselves and making corrections. At other times, they will share their answers and working as well as provide and receive feedback from their peers
D4. Induction 6 hours: HL only	• magnetic flux **Φ** as given by **Φ** = *BA* cos *ϑ* • that a time-changing magnetic flux induces an emf *ε* as given by Faraday's law of induction $\varepsilon = -N\frac{\Delta\Phi}{\Delta t}$ • that a uniform magnetic field induces an emf in a straight conductor moving perpendicularly to it as given by *ε* = *BvL* • that the direction of induced emf is determined by Lenz's law and is a consequence of energy conservation • that a uniform magnetic field induces a sinusoidal varying emf in a coil rotating within it	

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<tr><th>UNIT</th><th>TOPIC/CONCEPT</th><th>ASSESSMENT COMPONENTS</th></tr>
<tr><td>E.1 Structure of the atom
6 hours: SL and HL</td><td>• the Geiger–Marsden–Rutherford experiment and the discovery of the nucleus
• nuclear notation $^{A}_{Z}X$ where A is the nucleon number, Z is the proton number and X is the chemical symbol
• that emission and absorption spectra provide evidence for discrete atomic energy levels
• that photons are emitted and absorbed during atomic transitions
• that the frequency of the photon released during an atomic transition depends on the difference in energy level as given by $E = hf$
that emission and absorption spectra provide information on the chemical composition.</td><td rowspan="2">Formative Assessment
• Questioning
• Presentations: individual, paired,group
• Think, pair, share
• Quiz
• Worksheets and past paperquestions

Summative assessment:
• Multiple choice and free responsequestions on the topic.

Peer and self -assessment
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<tr><td>3 hours: HL only</td><td>• The relationship between the radius and the nucleon number for a nucleus as given by $R = R_0 A^{\frac{1}{3}}$ and implications for nuclear densities
• deviations from Rutherford scattering at high energies</td></tr>
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	• the distance of closest approach in head-on scattering experiments • the discrete energy levels in the Bohr model for hydrogen as given by $E = -\frac{13.6}{n^2} eV$ • that the existence of quantized energy and orbits arise from the quantization of angular momentum in the Bohr model for hydrogen as given by $mvr = \frac{nh}{2\pi}$	
E.2 Quantum Physics 8 hours: HL ONLY	• the photoelectric effect as evidence of the particle nature of light • that photons of a certain frequency, known as the threshold frequency, are required to release photoelectrons from the metal • Einstein's explanation using the work function and the maximum kinetic energy of the photoelectrons as given by Emax = hf–Φ where Φ is the work function of the metal • diffraction of particles as evidence of the wave nature of matter • that matter exhibits wave–particle duality • the de Broglie wavelength for particles as given by $\lambda = \frac{h}{p}$ • Compton scattering of light by electrons as additional evidence of the particle nature of light • that photons scatter off electrons with increased wavelength • the shift in photon wavelength after scattering off an electron as given by $\lambda_f - \lambda_i = \Delta\lambda = \frac{h}{m_e c}(1 - \cos\theta)$	**Formative Assessment** • Observation of practical skills and ability to follow steps and show working • Questioning • Discussion of the methodology of the calculations and what workingis necessary: class, small group, pair, individual, teacher-led, student-led. • Think, pair, share • Quiz • Worksheets and past paperquestions **Summative Assessment** Multiple choice and free responsequestions on the topic **Peer and self- assessment**

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E.3 Radioactive decay 7 hours: SL and HL	• isotopes • nuclear binding energy and mass defect • the variation of the binding energy per nucleon with nucleon number • the mass-energy equivalence as given by $E = mc^2$ in nuclear reactions • the existence of the strong nuclear force, a short-range, attractive force between nucleons • the random and spontaneous nature of radioactive decay • the changes in the state of the nucleus following alpha, beta and gamma radioactive decay • the radioactive decay equations involving α, β^-, β^+, γ • existence of neutrinos ν and antineutrinos ν • the penetration and ionizing ability of alpha particles, beta particles and gamma rays • the activity, count rate and half-life in radioactive decay • the changes in activity and count rate during radioactive decay using integer values of half-life • the effect of background radiation on count rate.	**Formative Assessment** ▪ Questioning ▪ Discussion of the methodology of thecalculations and what working is necessary: class, small group, pair, individual, teacher-led, student-led. ▪ Think, pair, share ▪ Quiz ▪ Worksheets and past paper questions **Peer and self -assessment** Students will be expected to check their own work at times, marking themselves and making corrections. Atother times, they will share their answers and working and give and receive feedback from their peers **PSOW** Radioactive decay/half-life

5 hours: HL only	• the evidence for the strong nuclear force • the role of the ratio of neutrons to protons for the stability of nuclides • the approximate constancy of binding energy curve above a nucleon number of 60 • that the spectrum of alpha and gamma radiations provides evidence for discrete nuclear energy levels • the continuous spectrum of beta decay as evidence for the neutrino • the decay constant λ and the radioactive decay law as given by • that the decay constant approximates the probability of decay in unit time only in the limit of sufficiently small λt • the activity as the rate of decay as given by $A = \lambda N = \lambda N_0 e^{-\lambda t}$ • the relationship between half-life and the decay constant as	

E.4 Fission 4 hours: SL and HL	• that energy is released in spontaneous and neutron-induced fission • the role of chain reactions in nuclear fission reactions • the role of control rods, moderators, heat exchangers and shielding in a nuclear power plant • the properties of the products of nuclear fission and their management.	**Formative Assessment:** ▪ Questioning ▪ Discussion of the methodology of the calculations and what workingis necessary: class, small group, pair, individual, teacher-led, student-led. ▪ Think, pair, share ▪ Quiz ▪ Worksheets and past paperquestions **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 theiranswers and working and give and receive feedback from their peers **Summative assessments** Multiple choice and free response questions on the topic
E.5 Fusion and stars 6 hours: SL and HL	• that the stability of stars relies on an equilibrium between outward radiation pressure and inward gravitational forces • that fusion is a source of energy in stars • the conditions leading to fusion in stars in terms of	**Formative Assessment** 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

	density and temperature • the effect of stellar mass on the evolution of a star • the main regions of the Hertzsprung–Russell (HR) diagram and how to describe the main properties of stars in these regions • the use of stellar parallax as a method to determine the distance *d* to celestial bodies as given by $d(parsec) = \frac{1}{p(arc-second)}$ • how to determine stellar radii.	Quiz Worksheets and past paper questions **Summative Assessment- Test** Multiple choice and free response questions on gravitational field and gravitational potential. **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

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