ARNOLD LODGE
4 - 18 yrs Co-educational Independent Day School

Key Stage 5: Curriculum Map

A Level Physics (2022/2023)

A Level Physics Overview (Year 12)

In A Level Physics pupils will explore the particle nature of matter and quantum phenomena. They will study progressive and stationary waves and their applications. Through an understanding of the laws of motion they will be able to apply their knowledge to problems involving moving objects. Pupils will study the properties of materials in order to determine the most appropriate material for a given purpose. They will learn to build and analyse a range of electrical circuits. The Pupils will support their learning of theory through the completion of a number of required practicals. Pupils will be encouraged to apply their understanding to past exam questions throughout the lessons and their self-study revision.

It is expected that A Level students will complete a minimum of 7 hours extra self-study outside of their lesson time. This may be in the form of research, homework or completion of past papers. Teachers will set the pupils adequate homework to help individuals focus their time.

In Physics there will be a minimum of two assessments per half term to identify any gaps in knowledge/understanding that pupils may have and ensure that they are identified and resolved as soon as possible to ensure maximum progression.

Topic of Learning		Half-Termly Overview: Knowledge and Skills	Sample Assessments
HT1	**Particles** **Constituents of Atoms**	**By the end of the unit, pupils should be able to:** • Know the simple model of the atom, including the proton, neutron and electron. Charge and mass of the proton, neutron and electron in SI units and relative units. • The atomic mass unit (amu) is included in the A-level Nuclear physics section. • Specific charge of the proton and the electron, and of nuclei and ions. • Proton number Z, nucleon number A, nuclide notation.	.

	Stable and Unstable Nuclei	• Meaning of isotopes and the use of isotopic data. • Know the strong nuclear force; its role in keeping the nucleus stable; short-range attraction up to approximately 3 fm, very-short range repulsion closer than approximately 0.5 fm. • Unstable nuclei; alpha and beta decay. • Equations for alpha decay, β− decay including the need for the neutrino. • The existence of the neutrino was hypothesised to account for conservation of energy in beta decay.	Mid Term Assessment – Constituents of the Atom and Particle Interactions
	Particles anti-particles and photons	• Know that for every type of particle, there is a corresponding antiparticle. • Compare particle and antiparticle masses, charge and rest energy in MeV. • know that the positron, antiproton, antineutron and antineutrino are the antiparticles of the electron, proton, neutron and neutrino respectively. • Know the photon model of electromagnetic radiation, the Planck constant. $E = h f$ • Describe annihilation and pair production and the energies involved.	
	Particle Interactions	• Know the four fundamental interactions: gravity, electromagnetic, weak nuclear, strong nuclear. (The strong nuclear force may be referred to as the strong interaction.) • Know the concept of exchange particles to explain forces between elementary particles. • Know the electromagnetic force; virtual photons as the exchange particle.	

	Classifications of Particles	• Know the weak interaction limited to β−and β+ decay, electron capture and electron–proton collisions; W+ and W− as the exchange particles. • Use simple diagrams to represent the above reactions or interactions in terms of incoming and outgoing particles and exchange particles. • Know hadrons are subject to the strong interaction. • Know the two classes of hadrons: baryons (proton, neutron) and antibaryons (antiproton and antineutron) mesons (pion, kaon). • Baryon number as a quantum number. • Conservation of baryon number. • The proton is the only stable baryon into which other baryons eventually decay. • The pion as the exchange particle of the strong nuclear force. • The kaon as a particle that can decay into pions. • Leptons: electron, muon, neutrino (electron and muon types only) and their antiparticles. • Lepton number as a quantum number; conservation of lepton number for muon leptons and for electron leptons. • The muon as a particle that decays into an electron. • Know the properties of strange particles: Strange particles as particles that are produced through the strong interaction and decay through the weak interaction (eg kaons). Strangeness (symbol s) as a quantum number to reflect the fact that strange particles are always created in pairs.	

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	Quarks and Antiquarks **Applications of Conservation Laws**	Conservation of strangeness in strong interactions. Strangeness can change by 0, +1 or -1 in weak interactions. • Know the properties of quarks and antiquarks: charge, baryon number and strangeness. Combinations of quarks and antiquarks required for baryons (proton and neutron only), antibaryons (antiproton and antineutron only) and mesons (pion and kaon only). Knowledge of up (u), down (d) and strange (s) quarks and their antiquarks. The decay of the neutron. Change of quark character in $\beta-$ and in $\beta+$ decay. • Apply the laws conservation laws for charge, baryon number, lepton number and strangeness to particle interactions. The necessary data will be provided in questions for particles outside those specified. • recognise that energy and momentum are conserved in interactions.	End of HT1 assessment – Particle Physics
HT2	**Electromagnetic radiation and Quantum Phenomena** **The photoelectric Effect** **Collisions of electrons with Atoms**	**By the end of the unit, pupils should be able to:** • Describe the photon explanation of threshold frequency. Work function, stopping potential. Photoelectric equation: $h\,f =$ work function + Ek (max Ek (max is the maximum kinetic energy of the photoelectrons. • Explain ionisation and excitation; understanding of ionisation and excitation in the fluorescent tube.	

	Energy levels and photon emission **Wave Particle Duality**	• convert eV into J and vice versa. • Describe line spectra (eg of atomic hydrogen) as evidence for transitions between discrete energy levels in atoms. $h f = E1 - E2$ • know that electron diffraction suggests that particles possess wave properties and the photoelectric effect suggests that electromagnetic waves have a particulate nature. de Broglie wavelength = h mv where mv is the momentum. • to explain how and why the amount of diffraction changes when the momentum of the particle is changed. • Appreciate how knowledge and understanding of the nature of matter changes over time. • Appreciate that such changes need to be evaluated through peer review and validated by the scientific community. • Describe the oscillation of the particles of the medium; • Use the terms:amplitude, frequency, wavelength, speed, phase, phase difference, $c = f$ L $f = 1/T$ • Know that phase difference may be measured as angles (radians and degrees) or as fractions of a cycle.	Mid Term Assessment – Electromagnetic radiation and quantum phenomena
	Waves **Progressive Waves** **Longitudinal and Transverse Waves**	• Describe the nature of longitudinal and transverse waves. • Know the direction of displacement of particles/fields relative to the direction of energy propagation and that all electromagnetic waves travel at the same speed in a vacuum. • Explain polarisation as evidence for the nature of transverse waves. • Describe applications of polarisers to include Polaroid material and the alignment of aerials for transmission and reception.	

	Principle of superposition and stationary waves **Interference** **Diffraction**	• Describe the formation of stationary waves by two waves of the same frequency travelling in opposite directions. Nodes and antinodes on strings. • Use the equation for the frequency of the first harmonic. • Explain interference in terms of path difference. • Explain the term coherence. • Describe Young's double-slit experiment: the use of two coherent sources or the use of a single source with double slits to produce an interference pattern. • Use the equation: Fringe spacing, $w = LD/s$ • Describe the production of interference pattern using white light. • Show awareness of safety issues associated with using lasers. • Appreciate how knowledge and understanding of nature of electromagnetic radiation has changed over time. • Describe the appearance of the diffraction pattern from a single slit using monochromatic and white light. • Plane transmission diffraction grating at normal incidence. • Derive the diffraction grating equation • Describe applications of diffraction gratings. • Know the Refractive index of a substance, $n = c/ cs$ • Snell's law of refraction for a boundary	**Required practical 1:** Investigation into the variation of the frequency of stationary waves on a string with length, tension and mass per unit length of the string.

	Refraction	• Total internal reflection • Describe the construction of fibre optics including the function of the cladding. • Explain the terms material and modal dispersion.	**Required practical 2:** Investigation of interference effects to include the Young's slit experiment and interference by a diffraction grating. End of Term Assessment – Wave
HT3	**Mechanics** **Scalars and Vectors** **Moments** **Motion along a straight line**	**By the end of the unit, pupils should be able to:** • Describe the nature of scalars and vectors. • Add vectors by calculation or scale drawing. • Resolve vectors into two components at right angles to each other. • Describe the conditions for equilibrium for two or three coplanar forces acting at a point. • Appreciate the meaning of equilibrium in the context of an object at rest or moving with constant velocity. • Define the moment of a force about a point. Moment defined as *force* × *perpendicular distance from the point to the line of action of the force.* • Define a couple as a pair of equal and opposite coplanar forces. Moment of couple defined as *force* × *perpendicular distance between the lines of action of the forces.* • Know the principle of moments. • Know that the position of the centre of mass of uniform regular solid is at its centre. • Define: Displacement, speed, velocity, acceleration. $v = \Delta s / \Delta t$ $a = \Delta v / \Delta t$	Mid Term Assessment – Force Energy and Momentum **Required practical 3**: Determination of g by a freefall method.

	Projectile Motion **Newton's Laws of Motion** **Momentum**	• Understand the sgnificance of areas of velocity–time and acceleration–time graphs and gradients of displacement–time and velocity–time graphs for uniform and non-uniform acceleration eg graphs for motion of bouncing ball. • Apply the equations for uniform acceleration: $v = u + at$ $s = u + v 2 t$ $s = ut + at2 2$ $v2 = u2 + 2as$ • Describe the independent effect of motion in horizontal and vertical directions of a uniform gravitational field. • Describe the term terminal speed. • Understand that air resistance increases with speed. • Understand the effect of air resistance on the trajectory of a projectile and on the factors that affect the maximum speed of a vehicle • Know and apply the three laws of motion in appropriate situations. $F = ma$ for situations where the mass is constant. • Apply the equation: momentum = mass × velocity • Apply the law of Conservation of linear momentum. • Define force as the rate of change of momentum, $F = \Delta mv/ \Delta t$ • Impulse = change in momentum $F\Delta t = \Delta mv$, where F is constant.	

	Work Energy and Power **Conservation of Energy**	• Know the significance of the area under a force–time graph. • Apply law of conservation of momentum to elastic and inelastic collisions; explosions. • Appreciate momentum conservation issues in the context of ethical transport design. • Apply the equation: Energy transferred, $W = Fs\cos$ □ *rate of doing work = rate of energy transfer,* $P = \Delta W / \Delta t = Fv$ • Know the significance of the area under a force–displacement graph. • Apply the equation: efficiency = useful output power/ input power • Explain the principle of conservation of energy. $\Delta E_p = mg\Delta h$ and $E_k = 1/2mv^2$	End of HT3 Assessment – Mechanics
HT4	**Materials** **Bulk Properties of Solids**	**By the end of the unit, pupils should be able to:** • Apply the equation: Density, $p = m/V$ • Define: Hooke's law, elastic limit, $F = k\Delta L$, k as stiffness and spring constant. • Define: Tensile strain and tensile stress. • Define: Elastic strain energy, breaking stress. *energy stored* = $1/2F\Delta L$ = *area under force−extension graph* • Describe plastic behaviour, fracture and brittle behaviour linked to force–extension graphs.	

	The Young Modulus	• Describe quantitative and qualitative applications of energy conservation to examples involving elastic strain energy and energy to deform. • Interpret simple stress–strain curves. • Define the Young Modulus of a material • Apply the equation: *Young modulus = tensile stress / tensile strain = FL/AΔ L* • Use stress–strain graphs to find the Young modulus.	Mid Term Assessment – Bulk properties of materials **Required practical 4:** Determination of the Young modulus by a simple method End of half term Assessment - Materials
HT5	**Electricity** **Basics of Electricity** **Current-Voltage Characteristics** **Resistivity**	**By the end of the unit, pupils should be able to:** • Define electric current as the rate of flow of charge; potential difference as work done per unit charge. $I = \Delta Q / \Delta t$, $V = WQ$ • Define Resistance as $R = VI$ • Describe current – voltage characteristics for an ohmic conductor, semiconductor diode, and filament lamp. • Describe Ohm's law as a special case where $I \propto V$ under constant physical conditions. • Define resistivity: resistivity = $RA\ L$ • Describe the qualitative effect of temperature on the resistance of metal conductors and thermistors. • Describe applications of thermistors to include temperature sensors and resistance–temperature graphs. • Describe superconductivity as a property of certain materials	**Required Practical 5:** Determination of resistivity of a wire using a micrometer, ammeter and voltmeter.

	Circuits **Potential Divider** **EMF and internal Resistance**	which have zero resistivity at and below a critical temperature which depends on the material. • Describe applications of superconductors to include the production of strong magnetic fields and the reduction of energy losses in the transmission of electrical power • Calculate resistance of combinations of resistors: *in series*, RT = R1 + R2 + R3 + … *in parallel*, 1 RT = 1 R1 + 1 R2 + 1 R3 + … • Calculate Energy and Power in a circuit *Energy and power equations*: *E = IVt*; *P = IV = I2R = V2 R* • Describe the relationships between currents, voltages and resistances in series and parallel circuits, including cells in series and identical cells in parallel. • Explain the conservation of charge and conservation of energy in dc circuits • Describe how the potential divider is used to supply constant or variable potential difference from a power supply. • Define the terms: Terminal pd and emf • Understand and perform calculations for circuits in which the internal resistance of the supply is not negligible.	**Required practical 6:** Investigation of the emf and internal resistance of electric cells and batteries by measuring the variation of the terminal pd of the cell with current in it. End of Half Term Assessment: Circuits
HT6	**Examinations**	. **Examinations**	External AS Physics Examination

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