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 13)

In A Level Physics, pupils will continue to build on the principles and concepts that they learnt in Year 12. 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	**Periodic Motion** • Circular Motion • Simple Harmonic Motion • Forced Vibrations and Resonance	**By the end of the unit, pupils should know or be able to:** • Describe how motion in a circular path at constant speed implies there is an acceleration and requires a centripetal force. • Calculate angular speed and use the radian as measure of angle • Calculate centripetal acceleration • Analyse the characteristics of SHM • Know the condition for SHM • Define the equation for acceleration • Graphical representations linking the variations of x, v and a with time. • Appreciation that the $v - t$ graph is derived from the gradient of the $x - t$ graph and that the $a - t$ graph is derived from the gradient of the $v - t$ graph. • Calculate maximum speed and acceleration	. **Required practical 7:** Investigation into simple harmonic motion using a mass–spring system and a simple pendulum. Mid Term Assessment – Periodic motion

	Thermal Physics • Thermal Energy Transfer • Ideal gases	• Describe a Qualitative treatment of free and forced vibrations. • Explain Resonance and the effects of damping on the sharpness of resonance. • Give examples of these effects in mechanical systems and situations involving stationary waves • Internal energy is the sum of the randomly distributed kinetic energies and potential energies of the particles in a body. • The internal energy of a system is increased when energy is transferred to it by heating or when work is done on it (and vice versa), eg a qualitative treatment of the first law of thermodynamics. • Appreciate that during a change of state the potential energies of the particle ensemble are changing but not the kinetic energies. • Perform calculations involving transfer of energy. • Use the equations for specific heat capacity including continuous flow • Use equation for a change of state $Q = ml$ where l is the specific latent heat. • Know the Gas laws as experimental relationships between p, V, T and the mass of the gas. • Understand the Concept of absolute zero of temperature. • Use the Ideal gas equation: $pV = nRT$ for n moles and $pV = NkT$ for N molecules. *Work done* = $p\Delta V$ • Know the Avogadro constant *NA*, molar gas constant R, Boltzmann constant k • Use Molar mass and molecular mass. • Describe Brownian motion as evidence for existence of atoms. • Explain the relationships between p, V and T in terms of a simple molecular model. • Understand that the gas laws are empirical in nature whereas the kinetic theory model arises from theory. • Know the assumptions leading to $pV = 1/3Nm$ crms 2 including derivation of the equation and calculations. • Know a simple algebraic approach involving conservation of momentum. • Appreciate that for an ideal gas internal energy is kinetic energy of the atoms.	**Required practical 8:** Investigation of Boyle's law (constant temperature) and Charles's law (constant pressure) for a gas. End of HT1 assessment – Thermal Physics

		• Use *average molecular kinetic energy* = 1/2*m* crms 2 = 3/2*kT* = 3/2*RTNA* • Appreciate how knowledge and understanding of the behaviour of a gas has changed over time	
HT2	**Electric Fields** • Coulombs law • Electric Field Strength • Electric Potential	**By the end of the unit, pupils should be able to:** • Know the equation for the Force between point charges in a vacuum: • Know the Permittivity of free space • Appreciate that air can be treated as a vacuum when calculating force between charges. • Know that for a charged sphere, charge may be considered to be at the centre. • Represent electric fields by electric field lines. • Define E as force per unit charge defined by E = FQ • Know the magnitude of E in a uniform field given by E = Vd • Derive from work done moving charge between plates: Fd = QΔV • Describe the trajectory of moving charged particle entering a uniform electric field initially at right angles. • Know how to calculate the magnitude of E in a radial field • Understand the definition of absolute electric potential, including zero value at infinity, and of electric potential difference. • Know that Work done in moving a charge Q is given by ΔW = QΔ V • Describe an equipotential surfaces. • Understand that no work done moving charge along an equipotential surface. • Know the equation for magnitude of V in a radial field • Interpret graphical representations of variations of E and V with r. • Know V is related to E by E = Δ V Δ r • Calculate ΔV from the area under graph of E against r.	Mid Term Assessment – Electric Fields

	Capacitors • Capacitance • Parallel Plate Capacitor • Energy stored by a capacitor • Capacitor charge and discharge	• Know the definition of capacitance • Know the dielectric action in a capacitor • Know the relative permittivity and dielectric constant. • Describe the action of a simple polar molecule that rotates in the presence of an electric field. • Interpret the area under a graph of charge against pd. • E = 1/2QV = 1/2CV2 = 1/2 Q2 /C • Graphically represent charging and discharging of capacitors through resistors. Corresponding graphs for Q, V and I against time for charging and discharging. • Interpret gradients and areas under graphs where appropriate. • Calculate the Time constant RC, including their determination from graphical data. • Know that time to halve, T½ = 0.69RC • Use the equations for capacitor charge and discharge	**Required practical 9:** Investigation of the charge and discharge of capacitors. Analysis techniques should include log-linear plotting leading to a determination of the time constant, RC End of Term Assessment – Capacitors and Gravitational Fields
	Gravitational Fields • Newton's Law • Gravitational field strength • Gravitational potential • Orbits of planets and satellites	• Represent a gravitational field by gravitational field lines. • Define g as force per unit mass as defined by g = Fm Magnitude of g in a radial field given by g = GM/ r2 • Understand the definition of gravitational potential, including zero value at infinity. • Understand gravitational potential difference. • Know that work done in moving mass m given by ΔW = mΔV • Describe equipotential surfaces and use the idea that no work is done when moving along an equipotential surface. • Know that V in a radial field given by V = − GM/r and understand the significance of the negative sign. • Graphically represent variations of g and V with r. • Know that V is related to g by: g = − Δ V Δ r • Calculate Δ V from area under graph of g against r. • Know the orbital period and speed is related to radius of circular orbit; derivation of T2 ∝ r3 • Explain the energy considerations for an orbiting satellite. • Calculate Total energy of an orbiting satellite. • Calculate Escape velocity. • Describe a Synchronous orbit. • Describe the use of satellites in low orbits and geostationary	

		orbits, to include plane and radius of geostationary orbit.	
HT3	**Magnetic Fields** • Magnetic flux density • Moving charges in a magnetic Field • Magnetic flux and flux linkage • Electromagnetic induction • Alternating currents • Operation of a transformer **Nuclear Physics** • Rutherford scattering • Types of radiation • Radioactive decay • Nuclear instability • Nuclear radius • Mass and energy • Induced fission • Safety aspects	**By the end of the unit, pupils should be able to:** • Know the Force on a current-carrying wire in a magnetic field: $F = BIl$ when field is perpendicular to current. • Use Fleming's left hand rule. • Define magnetic flux density B and definition of the tesla • Define flux linkage • Calculate flux and flux linkage passing through a rectangular coil rotated in a magnetic field: • Use the equation for flux linkage • Define and use Faraday's and Lenz's laws. • Know that magnitude of induced emf = rate of change of flux linkage • Apply to a straight conductor moving in a magnetic field. • Calculate the emf induced in a coil rotating uniformly in a magnetic field • Calculate for Sinusoidal voltages and currents only; root mean square, peak and peak-to-peak values for sinusoidal waveforms only. • Apply to the calculation of mains electricity peak and peak-to-peak voltage values. • Use an oscilloscope as a dc and ac voltmeter, to measure time intervals and frequencies, and to display ac waveforms. • Know the transformer equation: $Ns\ Np = Vs\ Vp$ • Calculate transformer efficiency = $ISVS\ IPVP$ • Describe the production of eddy currents. • Describe the causes of inefficiencies in a transformer. • Describe the transmission of electrical power at high voltage including calculations of power loss in transmission lines. • Describe Rutherford scattering. • Appreciate how knowledge and understanding of the structure of the nucleus has changed over time. • Know the properties of radiation and experimental identification using simple absorption experiments; applications e.g. to relative hazards of exposure to humans.	**Required practical 10:** Investigate how the force on a wire varies with flux density, current and length of wire using a top pan balance. **Required practical 11:** Investigate, using a search coil and oscilloscope, the effect on magnetic flux linkage of varying the angle between a search coil and magnetic field direction. Mid Term Assessment – Magnetic Fields **Required practical 12:** Investigation of the inverse-square law for gamma radiation. End of HT3 Assessment – Nuclear Physics

		• Know applications also include thickness measurements of aluminium foil paper and steel. • Know the inverse-square law for γ radiation: *I* = *k* *x*2 • Describe the experimental verification of inverse-square law. • Apply to safe handling of radioactive sources. • Describe background radiation; examples of its origins and experimental elimination from calculations. • Appreciate the balance between risk and benefits in the uses of radiation in medicine. • Know the random nature of radioactive decay; constant decay probability of a given nucleus; • Use the nuclear decay equation • Model with constant decay probability. • Use the half-life equation: • Determine the half-life from graphical decay data including decay curves and log graphs. • Apply to relevance of storage of radioactive waste, radioactive dating etc. • Interpret the graph of N against Z for stable nuclei. • Describe possible decay modes of unstable nuclei including α, β+, β− and electron capture. • Explain changes in N and Z caused by radioactive decay and representation in simple decay equations. • Know the existence of nuclear excited states; γ ray emission; application eg use of technetium-99m as a γ source in medical diagnosis. • Estimate the radius from closest approach of alpha particles and determination of radius from electron diffraction. • Know typical values for nuclear radius. • Know *R* = *R0A*1/3 derived from experimental data. • Interpret the equation as evidence for constant density of nuclear material. • Calculate nuclear density. • Be familiar with the graph of intensity against angle for electron diffraction by a nucleus. • Appreciate that *E* = *mc*2 applies to all energy changes, • Perform simple calculations involving mass difference and binding energy. • Describe fission and fusion processes.	

		• Perform simple calculations from nuclear masses of energy released in fission and fusion reactions. • Describe the graph of average binding energy per nucleon against nucleon number. • Identify, on the plot, the regions where nuclei will release energy when undergoing fission/fusion. • Appreciate that knowledge of the physics of nuclear energy allows society to use science to inform decision making. • Know that fission is induced by thermal neutrons; possibility of a chain reaction; critical mass. • Know the functions of the moderator, control rods, and coolant in a thermal nuclear reactor. • Describe a simple mechanical model of moderation by elastic collisions. • Know the factors affecting the choice of materials for the moderator, control rods and coolant. Examples of materials used for these functions. • Describe the fuel used, remote handling of fuel, shielding, emergency shut-down. Production, remote handling, and storage of radioactive waste materials. • Appreciate the balance between risk and benefits in the development of nuclear power.	
HT4	**Optional Topic** To be chosen from: • Astrophysics • Engineering Physics • Turning Points	Dependent on the topic chosen, pupils will study the relevant content based on their strengths and interests as an optional topic. For 2022/23, pupils will study Engineering which includes: **Rotational dynamics** • Concept of moment of inertia • Rotational kinetic energy • Rotational motion • Torque and angular acceleration • Angular momentum • Work and power **Thermodynamics and engines** • First law of thermodynamics • Non-flow processes • The p–V diagram • Engine cycles	

		• Second Law and engines • Reversed heat engines **Turning points in physics** • The discovery of the electron • Cathode rays • Thermionic emission of electrons • Specific charge of the electron • Principle of Millikan's determination of the electronic charge, **Wave-particle duality** • Newton's corpuscular theory of light • Significance of Young's double slits experiment • Electromagnetic waves • The discovery of photoelectricity • Wave–particle duality • Electron microscopes **Special relativity** • The Michelson-Morley experiment • Einstein's theory of special relativity • Time dilation • Length contraction • Mass and energy	
HT5	**Exam Prep/Revision**	Revision will be targeted to the needs of the individuals in the class.	
HT6	**Examinations**	**Examinations**	External A Level Physics Examination

Key Stage 5: Curriculum Map