St Thomas More Catholic Academy
FAITH | EXCELLENCE | RESPECT

Physics Curriculum Sequence – Key Stage 5

	KS4 prior learning	By the end of the term, students can:	Year 12 Term 1 - Measurements and their errors	Year 12 Term 2 - Electromagnetic radiation and quantum phenomena	Year 12 Term 3 - Mechanics	Year 13 Term 1 - Circular Motion	Year 13 Term 2 - Gravitational Fields	Year 13 Term 3 - Electromagnetic Induction
What we want our students to know and remember	Physicists explore the fundamental nature of almost everything we know of. They probe the furthest reaches of the earth to study the smallest pieces of matter. In the first year, students study the topics of: Measurements and their errors, Particles and radiation, Waves, Mechanics and energy and Electricity. This builds on the topics from GCSE of Energy, Electricity, Particle model of matter, Atomic Structure, Forces, Waves and Magnetism and Electromagnetism.	Define the key tier 3 **vocabulary**:	errors, range, uncertainty, systematic errors, random errors, accurate, accuracy, precision of measurement, linear, error bar, SI system, base unit	threshold frequency, wavelength, work function, ion, ionisation, electron volt, excitation, ground state, excited state, energy level, de-excitation, fluoresce, diffraction, de Broglie hypothesis, de Broglie wavelength,	scalar, vector, equilibrium, moments, principle of moments, centre of mass, couple, free body force diagram, displacement, speed, velocity, acceleration, acceleration of free-fall, projectile, friction, weight, gravitational field strength, inertia, drag force, terminal speed, motive force, thinking distance, braking distance, stopping distance, force, momentum, Newton's first law of motion, Newton's second law of motion, principle of conservation of momentum, energy, work, principle of conservation of energy, kinetic energy, potential energy, electromagnetic radiation, power, load, effort, useful energy, efficiency	Uniform circular motion, angular displacement, angular speed, centripetal acceleration, centripetal force,	gravitational field, line of force, field line, radial field, uniform field, gravitational potential energy, gravitational potential, equipotential, potential gradient, gravitational field strength, Kepler's third law, Newton's law of gravitation, universal constant of gravitation, escape velocity	electromagnetic induction, induced emf, Fleming's right-hand rule, dynamo rule, Lenz's law, magnetic flux density, magnetic flux, magnetic flux linkage, Faraday's law, back emf, step-up transformer, step-down transformer, eddy currents
			Year 12 Term 1 - Particles	Year 12 Term 2 - Electricity	Year 12 Term 3 - Materials	Year 13 Term 1 - Simple Harmonic Motion	Year 13 Term 2 - Electric Fields	Year 13 Term 3 - Radioactivity

			nucleon, proton number, atomic number, isotopes, mass number, nucleon number, nuclide, specific charge, strong nuclear force, alpha radiation, beta radiation, gamma radiation, neutrinos, antineutrinos, electromagnetic waves, electromagnetic radiation, photon, photoelectric effect, antimatter, positron, rest energy, antiparticles, annihilation, pair production, momentum, virtual photons, weak nuclear force, W bosons, electron capture, muon, pion, kaon, mesons, antimuon, hadrons, leptons, baryons, quarks, antiquarks, muon neutrino, electron neutrino, lepton number, strangeness, antibaryons, conservation rules	charge carriers, potential difference, resistance, Ohm's Law, resistivity, superconductor, critical temperature, light-dependent resistor, positive temperature coefficient, negative temperature coefficient, internal resistance, electromotive force, potential divider,	density, Hooke's Law, elastic limit, elasticity, stress, pascal, strain, Young modulus, yield point, elastic limit, plastic deformation, ultimate tensile stress, breaking stress, brittle, ductile, limit of proportionality	Equilibrium, displacement, amplitude, free vibration, time period, frequency, angular frequency, phase difference, simple harmonic motion, damped, periodic force, forced vibrations, resonance, resonant frequency	electrons, electrical conductors, free electrons, electrically insulating materials, gold leaf electroscope, line of force, field line, electric field strength, electric potential, equipotentials, potential gradient, Coulomb's law	alpha, beta, gamma, nucleus, atomic number, photons, count, rate, ionising radiation, proton, neutron, positron, intensity, nuclide, atomic mass unit, X-rays, half-life, activity, decay constant, strong nuclear force, excited state, ground state, metastable state, de Broglie wavelength, annihilate, pair production, electron capture, binding energy, mass defect, nuclear fission, nuclear fusion, induced fission, chain reaction, reactor core, control rods, coolant, heat exchanger, moderator, thermal nuclear reactor, critical mass
			Year 12 Term 1 - Progressive and stationary waves			Year 13 Term 1 - Thermal Physics	Year 13 Term 2 - Capacitance	Year 13 Term 3 - Turning Points
			electromagnetic waves, longitudinal waves, transverse waves, plane-polarised, unpolarised, displacement, amplitude, wavelength, cycle, period, frequency, phase difference, radians, wavefronts, refraction, stationary waves, progressive waves, interference, coherence, superposition, fundamental mode of vibration, node, antinode			thermal energy, thermal equilibrium, Celsius scale, absolute scale, absolute zero, specific heat capacity, melting point, boiling point, latent heat of fusion, latent heat of vaporisation, sublimation, pressure, Boyle's law, Charles' law, Brownian motion, Avogadro constant, mole, molarity, molar mass, ideal gas, molar gas constant, ideal gas equation, Boltzmann constant, pressure law, root mean square speed, kinetic theory equation	time constant, dielectric, polarised, relative permittivity, dielectric constant	electron, specific charge, wave-particle duality, photon theory of light, special relativity, quantum theory
			Year 12 Term 1 - Refraction, diffraction and interference				Year 13 Term 2 - Magnetic Fields	

			refractive index, critical angle, total internal reflection, optical fibres, endoscopes, modal, dispersion, coherence, Young's fringes, laser, diffraction grating				line of force, motor effect, Fleming's left-hand rule, magnetic flux density, hall probes	
	KS4 prior learning	**By the end of the term, students can:**	Year 12 Term 1 - Measurements and their errors	Year 12 Term 2 - Electromagnetic radiation and quantum phenomena	Year 12 Term 3 - Mechanics	Year 13 Term 1 - Circular Motion	Year 13 Term 2 - Gravitational Fields	Year 13 Term 3 - Electromagnetic Induction
		Recall the **knowledge**:	To recognise that a system of measurement depends on the selection of several base units. To recall the base units of the SI system. To name and use standard prefixes. To be able to convert between different units for the same quantity. To recognise the terms: precision, repeatability, reproducibility, and accuracy. To be able to estimate absolute uncertainties and to calculate fractional and percentage uncertainties. To be able to combine absolute and percentage uncertainties. To be able to use error bars on graphs. To understand and to use orders of magnitude. To derive estimates using knowledge of physics.	Description of the photoelectric effect. Explanation of threshold frequency in terms of the photon model. Explanation of work function and stopping potential. The photoelectric equation. Ionisation and excitation. Application in the fluorescent tube. The electron volt. Line spectra as evidence of discrete energy levels. Calculation of the frequency of emitted photons. Electron diffraction as a demonstration that particles possess wave properties. The photoelectric effect as a demonstration that electromagnetic waves have a particulate nature. The de Broglie wavelength.	The nature of scalar and vector quantities. Addition of vectors by calculation or scale drawing. The resolution of vectors into two components. The conditions for equilibrium for two or three coplanar forces acting at a point. Definition of the moment of a force about a point. A couple as a pair of equal and opposite coplanar forces. The equation for the moment of a couple. The principle of moments. The centre of mass and its position in a uniform regular solid. Definitions of displacement, speed, velocity, acceleration. Representation by graphical methods of uniform and non-uniform acceleration. Significance of areas of velocity – time and acceleration – time graphs and gradients of displacement – time and velocity – time graphs. The equations for uniform acceleration: $v=u+at$; $s=((u+v)/t)t$; $s=ut+1/2\ at^2$; $v^2=u^2+2as$ The acceleration due to gravity, g. Independent effect of	Motion in a circular path at constant speed implies there is an acceleration and requires a centripetal force. Magnitude of angular speed $\omega = v / r = 2\pi f$ Radian measure of angle. Centripetal acceleration $a = v2/r = \omega 2r$ The derivation of the centripetal acceleration formula will not be examined. Centripetal force $F = mv2/r= m\omega 2r$	Gravity as a universal attractive force acting between all matter. Magnitude of force between point masses: $F = (Gm_1 m_2)/r^2$ where G is the gravitational constant. Representation of a gravitational field by gravitational field lines. g as force per unit mass as defined by $g = F/m$ Magnitude of g in a radial field given by $g = GM/r^2$ Understanding of definition of gravitational potential, including zero value at infinity. Understanding of gravitational potential difference. Work done in moving mass m given by $\Delta W = m\Delta V$ Equipotential surfaces. Idea that no work is done when moving along an equipotential surface. V in a radial field given by $V = - GM/r$ Significance of the negative sign. Graphical representations of variations of g and V with r. V related to g by: $g = -\Delta V/\Delta r$ ΔV from area under graph of g against r. Orbital period and speed related to radius of circular orbit; derivation	Simple experimental phenomena. Faraday's and Lenz's laws. Magnitude of induced emf = rate of change of flux linkage; $\varepsilon= N \Delta \phi / \Delta t$ Applications such as a straight conductor moving in a magnetic field. emf induced in a coil rotating uniformly in a magnetic field: $\varepsilon = BANw \sin wt$ Sinusoidal voltages and currents only; root mean square, peak and peak-to-peak values for sinusoidal waveforms only. $I_{(rms)}=I_0/\sqrt{2}$; $V_{(rms)}=V_0/\sqrt{2}$ Application to the calculation of mains electricity peak and peak-to-peak voltage values. Use of an oscilloscope as a dc and ac voltmeter, to measure time intervals and frequencies, and to display ac waveforms. The transformer equation: $N_s/N_p =V_s/V_p$ Transformer efficiency: efficiency = 〖I_s V〗_s/〖I_p V〗_p Production of eddy currents. Causes of inefficiencies in a transformer.

					motion in horizontal and vertical directions of a uniform gravitational field. A qualitative treatment of friction. Qualitative treatments of lift and drag forces. A qualitative treatment of the effects of air resistance on the trajectory of a projectile. The factors affecting the maximum speed of a vehicle. Knowledge and application of the three laws of motion. Use of the equation; $F = ma$ Define momentum. The conservation of linear momentum in one dimension. Force as rate of change of momentum. Define impulse and its relationship to the area under a force time graph. The relationship between impact forces and contact time. Distinguish between elastic an inelastic collisions. Apply the conservation of momentum to explosions. The relationship between energy transferred and work done: $W=Fs\cos\theta$ Rate of doing work is equal to the rate of energy transfer: $P=\Delta W/\Delta t=Fv$ The significance of the area under a force displacement graph. Efficiency as the ratio of useful output power to input power. The principle of conservation of energy. Kinetic energy and gravitational potential energy. Quantitative and qualitative applications of energy conservation.		of; $T2 \propto r3$ Energy considerations for an orbiting satellite. Total energy of an orbiting satellite. Escape velocity. Synchronous orbits. Use of satellites in low orbits and geostationary orbits, to include plane and radius of geostationary orbit.	Transmission of electrical power at high voltage including calculations of power loss in transmission lines.

			Year 12 Term 1 - Particles	Year 12 Term 2 - Electricity	Year 12 Term 3 - Materials	Year 13 Term 1 - Simple Harmonic Motion	Year 13 Term 2 - Electric Fields	Year 13 Term 3 - Radioactivity
			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. Specific charge of the proton and the electron, and of nuclei and ions. Proton number Z, nucleon number A, nuclide notation. Students should be familiar with the $^{A}_{Z}X$ notation. Meaning of isotopes and the use of isotopic data. Meaning of isotopes and the use of isotopic data. 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. For every type of particle, there is a corresponding antiparticle. Knowledge of particle antiparticle pairs and a comparison of their properties. The photon model of electromagnetic radiation. The energy of photons. The mechanisms of annihilation of matter and antimatter and pair production.	Electric current is the rate of flow of charge. Potential difference is the work done per unit charge. The definition of resistance. The current – voltage characteristics for an ohmic conductor, a semiconductor diode and a filament lamp. Ohm's law as a special case where current is directly proportional to voltage under constant physical conditions. Resistivity, $\rho = RA/L$ Experiment to determine the resistivity of a wire. Description of the qualitative effect of temperature on the resistance of metal conductors. The effect of temperature on a negative temperature coefficient thermistor. Application of thermistors in temperature sensors. Superconductivity as a property of certain materials which have zero resistivity at or below the critical temperature. Applications of superconductors. Combining resistors in series and in parallel. The relationship between currents, voltages and resistances in series and parallel circuits. Cells in series and identical cells in parallel. The energy and power equations: $E = VIt$; $P = VI = I^2 R = V^2/R$ The conservation of charge and energy in dc circuits. The potential divider used to supply constant or variable potential	The definition of density. Hooke's law and the elastic limit. The force extension equation: $F = k\Delta l$ Definitions of tensile stress and tensile strain. The meaning of breaking stress. Elastic strain energy: energy stored $= \frac{1}{2} F\Delta l$ Description of plastic behaviour, fracture and brittle behaviour related to force – extension graphs. Interpretation of stress – strain curves. Application of energy conservation to examples involving elastic strain energy and energy to deform. The transformation of spring energy to kinetic and gravitational potential energy. Appreciation of energy conservation issues in the context of ethical transport design. The definition of the Young modulus. Experiment to determine the Young modulus using a stress – strain graph.	Analysis of characteristics of simple harmonic motion (SHM). Condition for SHM: $a \propto -x$ Defining equation: $a = -\omega^2 x$ $x = A\cos(\omega t)$ and $v = \pm\omega\sqrt{A^2 - x^2}$ 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. Maximum speed $v_{max} = \omega A$ Maximum acceleration $a_{max} = \omega^2 A$ Study of mass-spring system: $T = 2\pi\sqrt{m/k}$ Study of simple pendulum: $T = 2\pi\sqrt{l/g}$ Questions may involve other harmonic oscillators (e.g. liquid in U-tube) but full information will be provided in questions where necessary. Variation of E_k, E_p, and total energy with both displacement and time. Effects of damping on oscillations. Required practical 7: Investigation into simple harmonic motion using a mass–spring system and a simple pendulum. Qualitative treatment of free and forced vibrations. Resonance and the effects of damping on the sharpness of resonance. Examples of these effects in mechanical systems and situations involving stationary waves.	Force between point charges in a vacuum: $F = \frac{1}{4\pi\varepsilon_0}\frac{Q_1 Q_2}{r^2}$ Permittivity of free space, ε_0. Appreciation that air can be treated as a vacuum when calculating force between charges. For a charged sphere, charge may be considered to be at the centre. Representation of electric fields by electric field lines. Electric field strength. E as force per unit charge defined by $E = F/Q$ Magnitude of E in a uniform field given by $E = V/d$ Derivation from work done moving charge between plates: $Fd = Q\Delta V$ Trajectory of moving charged particle entering a uniform electric field initially at right angles. Magnitude of E in a radial field given by $E = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2}$ Understanding of definition of absolute electric potential, including zero value at infinity, and of electric potential difference. Work done in moving charge Q given by $\Delta W = Q\Delta V$ Equipotential surfaces. No work done moving charge along an equipotential surface. Magnitude of V in a radial field given by $V = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r}$ Graphical representations of variations of E and V with r. V related to E by $E = \Delta V / \Delta r$	Qualitative study of Rutherford scattering. Appreciation of how knowledge and understanding of the structure of the nucleus has changed over time Their properties and experimental identification using simple absorption experiments; applications eg to relative hazards of exposure to humans. Applications also include thickness measurements of aluminium foil paper and steel. Inverse-square law for γ radiation: $I = k/x^2$ Experimental verification of inverse-square law. Applications, eg to safe handling of radioactive sources. Background radiation; examples of its origins and experimental elimination from calculations. Appreciation of balance between risk and benefits in the uses of radiation in medicine. Required practical 12: Investigation of the inverse-square law for gamma radiation. Random nature of radioactive decay; constant decay, probability of a given nucleus; $\Delta N/\Delta t = -\lambda N$; $N = N_o e^{-lt}$ Use of activity, $A = \lambda N$ Modelling with constant decay probability. $A = A_o e^{-lt}$ Half-life equation: $T_{½} = \ln 2/\lambda$ Determination of half-life from graphical decay data including decay curves and log graphs. Applications eg relevance to storage of radioactive

			The four fundamental interactions. The fundamental interactions in terms of exchange particles. The weak interaction. Diagrams to represent the fundamental interactions. Hadrons are subject to the strong interaction. There are two classes of hadrons. Baryon number and its conservation. The proton as the only stable baryon. The pion as the exchange particle of the strong nuclear force. The decay of kaons into pions. Examples of leptons and their antiparticles. Lepton number and its conservation. The decay of muons into electrons. Strange particles and their production through the strong interaction and their decay through the weak interaction. Strangeness and its conservation in strong interactions. Strangeness does not have to be conserved in the weak interaction. Properties of quarks and antiquarks. Combinations of quarks and antiquarks required for baryons, antibaryons and mesons. Change of quark nature in b- and b+ decay. Application of conservation laws for charge, baryon number, lepton number and strangeness for particle interactions. Conservation of energy and momentum in interactions.	difference from a power supply. The use of variable resistors, light dependent resistors and thermistors in potential divider circuits. The definition of emf. Circuit equation when cells have appreciable internal resistance. $\epsilon = I(R+r)$ Terminal pd			Δ V from the area under graph of E against r.	waste, radioactive dating, etc. Graph of N against Z for stable nuclei. Possible decay modes of unstable nuclei including α, β+, β− and electron capture. Changes in N and Z caused by radioactive decay and representation in simple decay equations. Questions may use nuclear energy level diagrams. Existence of nuclear excited states; γ ray emission; application eg use of technetium-99m as a γ source in medical diagnosis. Estimate of radius from closest approach of alpha particles and determination of radius from electron diffraction. Knowledge of typical values for nuclear radius. Students will need to be familiar with the Coulomb equation for the closest approach estimate. Dependence of radius on nucleon number: R = R0A1/3 derived from experimental data. Interpretation of equation as evidence for constant density of nuclear material. Calculation of nuclear density. Students should be familiar with the graph of intensity against angle for electron diffraction by a nucleus Appreciation that E = mc2 applies to all energy changes. Simple calculations involving mass difference and binding energy. Atomic mass unit, u. Conversion of units; 1 u = 931.5 MeV. Fission and fusion

								processes. Simple calculations from nuclear masses of energy released in fission and fusion reactions. Graph of average binding energy per nucleon against nucleon number. Students may be expected to identify, on the plot, the regions where nuclei will release energy when undergoing fission/fusion. Appreciation that knowledge of the physics of nuclear energy allows society to use science to inform decision making. Fission induced by thermal neutrons; possibility of a chain reaction; critical mass. The functions of the moderator, control rods, and coolant in a thermal nuclear reactor. Details of particular reactors are not required. Students should have studied a simple mechanical model of moderation by elastic collisions. Factors affecting the choice of materials for the moderator, control rods and coolant. Examples of materials used for these functions. Fuel used, remote handling of fuel, shielding, emergency shut-down. Production, remote handling, and storage of radioactive waste materials. Appreciation of balance between risk and benefits in the development of nuclear power.
			Year 12 Term 1 - Progressive and stationary waves			Year 13 Term 1 - Thermal Physics	Year 13 Term 2 - Capacitance	Year 13 Term 3 - Turning Points

			Define the terms amplitude, frequency, period, wavelength, phase and phase difference. Use the equation c= fl The nature of longitudinal and transverse waves. Electromagnetic waves as examples of transverse waves. Speed of electromagnetic waves. Polarisation as a feature of transverse waves. Applications of polarisers. Stationary waves on strings. The meaning of nodes and antinodes in relation to standing waves. The equation for the frequency of the first harmonic for first harmonic. The formation of a stationary wave by two waves of the same frequency travelling in opposite directions. Graphical explanation for the formation of stationary waves. Examples of stationary waves including those formed on strings and those produced using sound waves or microwaves.			Calculations involving transfer of energy. For a change of temperature: $Q = mc\Delta\theta$ where c is specific heat capacity. Calculations including continuous flow. For a change of state $Q = ml$ where l is the specific latent heat. Gas laws as experimental relationships between p, V, T and the mass of the gas. Concept of absolute zero of temperature. Ideal gas equation: $pV = nRT$ for n moles and $pV = NkT$ for N molecules. Work done = $p \Delta V$ Avogadro constant N_A, molar gas constant R , Boltzmann constant k . Molar mass and molecular mass. Required practical 8: Investigation of Boyle's law (constant temperature) and Charles's law (constant pressure) for a gas. Brownian motion as evidence for existence of atoms. Explanation of relationships between p, V and T in terms of a simple molecular model. Students should understand that the gas laws are empirical in nature whereas the kinetic theory model arises from theory. Assumptions leading to $pV = \frac{1}{3} N m (c_{rms})^2$ including derivation of the equation and calculations. A simple algebraic approach involving conservation of momentum is required. Appreciation that for an ideal gas internal energy is kinetic energy of the atoms. Use of average molecular	Definition of capacitance: $C = Q/V$ Dielectric action in a capacitor $C = A\varepsilon_0\varepsilon_r/d$ Relative permittivity and dielectric constant. Describe the action of a simple polar molecule that rotates in the presence of an electric field. Interpretation of the area under a graph of charge against pd. $E = \frac{1}{2} QV = \frac{1}{2}CV^2 = \frac{1}{2} Q^2 / C$ Graphical representation of charging and discharging of capacitors through resistors. Corresponding graphs for Q, V and I against time for charging and discharging. Interpretation of gradients and areas under graphs where appropriate. Time constant RC. Calculation of time constants including their determination from graphical data. Time to halve, $T_{½} = 0.69RC$ Quantitative treatment of capacitor discharge, $Q = Q_0 e^{-t/RC}$ Use of the corresponding equations for V and I. Quantitative treatment of capacitor charge, $Q = Q_{max} (1-e^{-t/RC})$ 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 .	Production of cathode rays in a discharge tube. The principle of thermionic emission. Work done on an electron accelerated through a pd V ; $\frac{1}{2}mv^2 = eV$ Determination of the specific charge of an electron, e/m_e, by any one method. Significance of Thomson's determination of e/m_e . Comparison with the specific charge of the hydrogen ion. Condition for holding a charged oil droplet, of charge Q , stationary between oppositely charged parallel plates. $QV / d = mg$ Motion of a falling oil droplet with and without an electric field; terminal speed to determine the mass and the charge of the droplet. Stokes' Law for the viscous force on an oil droplet used to calculate the droplet radius. $F = 6\pi\eta r v$ Significance of Millikan's results. Quantisation of electric charge. Comparison with Huygens' wave theory in general terms. The reasons why Newton's theory was preferred. Explanation for fringes in general terms, no calculations are expected. Delayed acceptance of Huygens' wave theory of light. Nature of electromagnetic waves. Maxwell's formula for the speed of electromagnetic waves in a vacuum, $c = 1/\sqrt{\varepsilon_0\mu_0}$ where μ_0 is the permeability of free

						kinetic energy 〖1/2 m (c_rms)〗^2 = 3/2 kT = 3RT/(2N_A) Appreciation of how knowledge and understanding of the behaviour of gas has changed over time.		space and ε0 is the permittivity of free space. Students should appreciate that ε0 relates to the electric field strength due to a charged object in free space and μo relates to the magnetic flux density due to a current-carrying wire in free space. Hertz's discovery of radio waves including measurements of the speed of radio waves. Fizeau's determination of the speed of light and its implications. The ultraviolet catastrophe and black-body radiation. Planck's interpretation in terms of quanta. The failure of classical wave theory to explain observations on photoelectricity. Einstein's explanation of photoelectricity and its significance in terms of the nature of electromagnetic radiation. de Broglie's hypothesis: $p = h / \lambda$; $\lambda = h / \sqrt{2meV}$ Low-energy electron diffraction experiments; qualitative explanation of the effect of a change of electron speed on the diffraction pattern. Estimate of anode voltage needed to produce wavelengths of the order of the size of the atom. Principle of operation of the transmission electron microscope (TEM). Principle of operation of the scanning tunnelling microscope (STM). Principle of the Michelson–Morley interferometer. Outline of the experiment as a means of detecting absolute motion. Significance of the failure

								to detect absolute motion. The invariance of the speed of light The concept of an inertial frame of reference. The two postulates of Einstein's theory of special relativity: • physical laws have the same form in all inertial frames • the speed of light in free space is invariant. Proper time and time dilation as a consequence of special relativity. Time dilation: $t = t_o \sqrt{(1 - v^2 / c^2)}$ Evidence for time dilation from muon decay. Length of an object having a speed v; $l = l_o \sqrt{(1 - v^2 / c^2)}$ Equivalence of mass and energy, $E = mc^2$; $E = m_oc^2 / \sqrt{(1 - v^2 / c^2)}$ Graphs of variation of mass and kinetic energy with speed. Bertozzi's experiment as direct evidence for the variation of kinetic energy with speed.
			Year 12 Term 1 - Refraction, diffraction and interference				Year 13 Term 2 - Magnetic Fields	

			Path difference and coherence. Demonstrate interference and diffraction using a laser as a source of monochromatic light. The Young's double slit experiment. The equation for fringe spacing. Fringe spacing: $w=\lambda D/s$ Production of interference. The interference pattern produced by white light. Interference patterns produced by sound and electromagnetic waves. Appreciation of how knowledge and understanding of the nature of electromagnetic radiation has changed over time. The appearance of the diffraction pattern from a single slit using monochromatic and white light. A qualitative treatment of the variation of the width of the central diffraction maximum and slit width. Using a plane diffraction grating with light at normal incidence. The derivation of the grating equation: $d\sin\theta=n\lambda$ Applications of the diffraction grating. Defining refractive index in terms of wave speed in different media. Snell's law of refraction at a boundary: $n_1 \sin\theta_1 = n_2 \sin\theta_2$ Total internal reflection: $\sin\theta_c = n_1/n_2$ Step index optic fibres including the function of the cladding. Material and modal dispersion and the consequences of pulse broadening and absorption.				Force on a current-carrying wire in a magnetic field: $F = BIl$ when field is perpendicular to current. Fleming's left hand rule. Magnetic flux density B and definition of the tesla. Required practical 10: Investigate how the force on a wire varies with flux density, current and length of wire using a top pan balance Force on charged particles moving in a magnetic field, $F = BQv$ when the field is perpendicular to velocity. Direction of force on positive and negative charged particles. Circular path of particles; application in devices such as the cyclotron. Magnetic flux defined by $\phi = BA$ where B is normal to A. Flux linkage as $N\phi$ where N is the number of turns cutting the flux. Flux and flux linkage passing through a rectangular coil rotated in a magnetic field: flux linkage $N\phi = BAN\cos\theta$ 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.	

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What we want our students to do	Physics, like all sciences, is a practical subject. Throughout the course students will carry out practical activities including: investigating interference and diffraction of laser light, measuring acceleration due to gravity, investigating systems that oscillate, investigation of the links between temperature, volume and pressure, safe use of ionising radiation, investigating magnetic fields. These practicals will give students the skills and confidence needed to investigate the way things behave and work. It will also ensure that if students choose to study a Physics-based subject at university, they will have the practical skills needed to carry out successful experiments in their degree.	Demonstrate excellence in these **skills**:	Know that base units are needed in a system of measurement Demonstrate that they can convert between different units of the same quantity, eg J and eV, J and kW h. Explain the difference between precision and accuracy. Explain the difference between repeatability and reproducibility. Estimate uncertainties in measurements Calculate percentage uncertainties from absolute uncertainties. Combine absolute and percentage uncertainties. Use error bars on graphs to estimate uncertainties in gradients and intercepts. Make order of magnitude estimates.	Describe the photoelectric effect. Recognise that the threshold frequency cannot be explained by the wave model of light and can deduce an explanation of threshold frequency in terms of the photon model. Explain the terms work function and stopping potential. Analyse the photoelectric effect using the photoelectric equation and calculate the maximum kinetic energy of emitted electrons. Deduce that the emitted electrons have a range of kinetic energies up to the maximum value calculated using the photoelectric equation. Describe the processes of excitation and ionisation Explain how excitation and ionisation apply in the fluorescent tube. Define the electron volt Convert energies from eV to J and vice versa. Demonstrate how line spectra implies discrete energy levels in atoms. Calculate the frequencies of emitted photons using the energies associated with different discrete energy levels. Identify that electron diffraction provides evidence of particles having wave properties. Analyse the photoelectric effect and deduce that it demonstrates the particulate nature of electromagnetic waves. Calculate the wavelength of a particle using the de Broglie equation. Explain how and why the	Distinguish between scalar and vector quantities including velocity/speed, mass, force/weight, acceleration, displacement/distance. Add two vectors by constructing an appropriate scale drawing. Calculate the sum of two vectors. Resolve a vector into two perpendicular components. Recognise the conditions for two or three coplanar forces acting at a point to be in equilibrium. Apply the conditions for equilibrium in the context of an object at rest or moving at constant velocity. Define and calculate the moment of a force. Describe a couple and calculate the moment of a couple. State the principle of moments. Apply and use the principle to analyse the forces acting on a body in equilibrium. Explain what is meant by the centre of mass. Define displacement, speed, velocity and acceleration. Distinguish between velocity and speed. Calculate velocities and accelerations. Calculate both instantaneous and average velocities. Draw graphs to represent motion. Recognise the significance of the areas of velocity – time and acceleration – time	Understand and explain why circular motion is an accelerated motion and needs a centripetal force. Recall and use equations: ω = v / r= 2π f, a = v2/r = ω2r, F = mv2/r= mω2r, to solve circular motion problems. Use radian as a measure of angle and convert between radians and degrees. Identify and calculate centripetal forces in contexts such as a mass whirled on a string and a car rounding a bend.	Understand that gravity is a force that acts between all matter, is always attractive and is a vector quantity. Calculate the force between masses using Newton's Law of gravitation. Understand and describe the concept of a force field. Sketch gravitational fields around objects and near the surface of the Earth. Recall the definition of gravitational field strength and use the gravitational field strength equations, g = F/m; g = GM/r^2 Define gravitational potential. Recall and understand zero value at infinity. Understand and apply the concept of potential difference including through calculations. Draw equipotential surfaces on field line diagrams and understand and apply the concept that potential difference along an equipotential line is zero. Use the equations: ΔW = mΔV; V = – GM/r; g = – ΔV/Δr to solve problems. Understand the significance of the negative sign. Sketch and interpret graphs to show the variation of g and V with r. Recall and use the relationship V = – GM/r and the concept that ΔV is found from area under graph of g against r. Derive; T2 ∝ r3 Describe the energy considerations for an	Recognise situations in which electromagnetic induction will occur. Recall Faraday's and Lenz's Laws. Calculate the emf induced by electromagnetic induction in scenarios such as a straight conductor moving in a magnetic field or a coil rotating in a magnetic field. Use the transformer and efficiency equations to solve problems related to structure and operation of transformers. Explain how Eddy currents form in transformers and how this leads to inefficiency. Describe the role of transformers in the transmission of power. Use electrical power equations to calculate power losses in transmission lines. Know the meaning of the terms root mean square and peak-to-peak value. Use the equations I_(rms)=I_0/√2 and V_(rms)=V_0/√2 to calculate root mean square values or peak values. Use of an oscilloscope to display dc and ac voltage signals and find rms and peak values.

				amount of diffraction changes when the momentum of a particle is changed.	graphs. Recognise the significance of the gradients of displacement – time and velocity – time graphs. Recall the equations of uniform acceleration and can apply them in calculations. Involving motion in straight lines. Analyse experiments to determine the acceleration due to gravity using a graphical method Explain how the motion of a projectile can be analysed by treating its horizontal and vertical motion independently. Analyse the motion of a projectile by considering the effect of gravity on horizontal and vertical motion. Describe friction quantitatively. Explain the nature of lift and drag forces. Describe the effects of air resistance on the trajectory of a projectile. Explain why falling objects can reach a terminal speed. Discuss the factors that affect the maximum speed of a vehicle. Recall the three laws of motion and apply them in appropriate situations. Construct and use free-body diagrams. Use the equation linking force and acceleration in calculations. Recognise that the equation can only be used in situations where the mass is constant. Define momentum and recall the unit for momentum. Discuss the conservation of linear momentum and apply it in calculations involving collisions in one dimension.		orbiting satellite and provided with structure solve problems. Describe the meaning of the term escape velocity and given appropriate data calculate escape velocities. Describe Synchronous orbits and the use of satellites in low orbits and geostationary orbits, including plane and radius of geostationary orbit.	

					Relate force to rate of change of momentum. Define impulse. Deduce the effect on impact forces of contact times. Distinguish between elastic and inelastic collisions. Apply momentum conservation to explosions. Recognise that when work is done energy is transferred. Calculate the work done including situations where the force is not acting in the direction of displacement. Calculate the rate of doing work. Analyse situations in which the force acting is variable. Recall that the work done or energy transferred is equal to the area under a force displacement graph. Calculate efficiency as a ratio and as a percentage. Recall the principle of the conservation of energy. Calculate kinetic and gravitational potential energy. Describe energy changes involving kinetic, gravitational potential energy and work done against friction.			
			Year 12 Term 1 - Particles	Year 12 Term 2 - Electricity	Year 12 Term 3 - Materials	Year 13 Term 1 - Simple Harmonic Motion	Year 13 Term 2 - Electric Fields	Year 13 Term 3 - Radioactivity

			Describe a model of the atom including protons, neutrons and electrons. Identify the charge and mass of the proton, neutron and electron in SI and relative units. Define specific charge and calculate the specific charges of the proton and the electron and of nuclei and ions. Identify the unit of specific charge. Define proton number and nucleon number and recognise nuclear notation. Explain the meaning of isotopes. Analyse isotopic data. Describe the strong nuclear force and its role in keeping the nucleus stable. Recognise that the strong nuclear force has a short range attraction and a very short range repulsion. Associate distance below 0.5 fm with repulsion and between 0.5 and 3.0 fm with attraction. Describe alpha decay and beta decay. Illustrate alpha beta decay using equations. Deduce why the neutrino is necessary in beta decay. Recall that every particle has a corresponding antiparticle. Contrast the properties of particles and antiparticles. Give examples of particle antiparticle pairs. Describe the photon model of electromagnetic radiation. Calculate the energy of photons from wavelength and frequency. Describe the processes of annihilation and pair production. Name the four	Recognise that current is the rate of flow of charge. Recognise that potential difference is the work done per unit charge. Recognise the equation defining resistance and can apply it in calculations. Interpret current – voltage graphs and distinguish between the characteristics for an ohmic conductor, a semiconductor diode and a filament lamp. Recognise that Ohm's law is a special case for a component with constant resistance. Define resistivity and use the resistivity equation in calculations. Describe an experiment to determine the resistivity of a wire. Describe the effect of temperature on the resistance of metal conductors. Describe the effect of temperature on a negative temperature coefficient thermistor. Describe application of thermistors including temperature sensors. Explain what is meant by a superconductor. Describe how superconductors can be used to produce strong magnetic fields and to reduce energy losses in the transmission of electric power. Calculate the total resistance for combinations of series and parallel resistors. Analyse series and parallel circuits. Analyse circuits involving combinations of cells in series and identical cells in parallel. Calculate the energy and power in electric circuits.	Define density and do calculations using the density equation. State Hooke's law and explain what is meant by the elastic limit. Apply the force extension equation and recognise that the constant, k, is known as the stiffness or the spring constant. Demonstrate that they recognise the meanings of tensile stress and tensile strain. Explain what breaking stress means. Calculate elastic strain energy. Recognise that the energy stored is equal to the area under a force – extension graph. Explain what is meant by plastic behaviour, fracture and brittle behaviour. Analyse stress – strain curves. Apply energy conservation to examples involving elastic strain energy and energy to deform. Analyse the energy changes taking place in an oscillating spring. Appreciate the importance of energy conservation in transport design. Define the Young modulus and use it in calculations. Describe a method to determine the Young modulus.	Recall the condition for SHM : $a \propto -x$ Solve problems using the equations of SHM : $x = A\cos(\omega t)$ and $v = \pm\omega\sqrt{A^2 - x^2}$ $v_{max} = \omega A$ $a_{max} = \omega^2 A$ Recognise and use the concept of the gradient of the x – t graph leading to the v – t graph, and the gradient of the v - t graph leading to the a – t for SHM. Given appropriate structure and support students should be able to derive the equations for mass-spring and simple pendulum. Use the mass-spring and pendulum equations to solve SHM problems. Recognise other harmonic oscillators and apply knowledge and understanding of mass-spring and pendulum to solve problems in different contexts. Describe the energy changes that take place in SHM and sketch graphs of variation of E_k, E_p and total energy with displacement and time. Describe the effects of damping on oscillations including sketching appropriate graphs of damped systems. Recognise free and forced vibrations and describe the difference between them. Sketch a typical frequency response curve for a forced vibration to show the sharpness of response and the effect of damping	Understand the meaning of ε_0 and that air can approximately be treated as a vacuum. Use electric field lines to sketch electric field patterns. Define electric field strength. Use the equations $F = \frac{1}{4\pi\varepsilon_0}\frac{Q_1 Q_2}{r^2}$; $E = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2}$; $E = F / Q$ and $E = V / d$ to solve electric field problems. Derive $Fd = Q\Delta V$ Sketch and describe the trajectory of a moving charged particle entering a uniform electric field initially at right angle. Define absolute electric potential and explain the significance of the zero value at infinity. Understand and use the concept of potential difference. Sketch and use equipotential diagrams. Recognise and use the idea that no work is done by a moving charge on an equipotential surface. Use the equation $V = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r}$ Sketch and use graphs showing the variations of E and V with r. Recognise and use the relationships $E = \Delta V / \Delta r$ and ΔV is the area under graph of E against r	Describe the results of the Rutherford scattering experiment and explain how they lead to the nuclear model of the atom. Understand that the model of the atom has changed over time. Recall the properties of α, β and γ radiation. Describe a simple absorption experiment that could be used to identify the different types of radiation including correction for background radiation. Apply knowledge and understanding of properties of radiation and inverse square law to explain safe handling of radioactive sources and applications in industry and medicine. To include evaluation of the balance of risks and benefits of applications. Use the inverse square law to calculate distances and intensities. Describe an experiment to confirm the inverse square law including correction for background radiation. Recognise and understand the random nature of radioactive decay. Use the equations $\Delta N/\Delta t = -\lambda N$; $N = N_o e^{-\lambda t}$; $A = \lambda N$; $T_{½} = \ln 2/\lambda$; $A = A_o e^{-\lambda t}$ to solve radioactive decay problems in a variety of contexts. Determination of half-life from graphical data. Apply knowledge and understanding of half-life to explain considerations such as the safe storage of radioactive waste and radioactive dating of rocks. Sketch the graph of N against Z for stable

			fundamental interactions. Describe the fundamental interactions in terms of exchange particles. Identify the virtual photon as the exchange particle in the electromagnetic interaction. Distinguish between b- and b+ decay identifying them both as examples of the weak interaction. Analyse electron capture and electron positron collisions as examples of the weak interaction and identify the appropriate exchange particle (W+ or W-) in each case. Draw simple diagrams to represent interactions. Associate hadrons with the strong interaction. Classify hadrons into baryons and mesons. Differentiate between baryons and mesons in terms of baryon number and are able to demonstrate baryon number conservation in interactions. Explain that the proton is the only stable hadron and that all other baryons eventually decay into protons. Identify the pion as the exchange particle of the strong nuclear force. Recognise and describe kaon decay. Identify leptons and how they can interact through the weak interaction. Identify the lepton numbers of electrons, muons and neutrinos and demonstrate lepton number conservation in examples of the weak interaction. Describe the decay of muons into electrons. Identify strange particles and describe their production and decay.	Explain how energy and charge are conserved in electric circuits. Demonstrate that they understand how a potential divider can provide a constant or variable potential difference from a power supply. Describe how variable resistors, light dependent resistors and thermistors can be used in potential divider circuits. Define emf with reference to cells. Understand and perform calculations for circuits in which the internal resistance of the supply is not negligible. Explain what is meant by terminal pd.				nuclei. Identify and explain regions of the graph that correspond to possible decay modes, Generate and/or complete simple decay equations. Describe the existence of nuclear excited states and applications. Understand and describe how closest approach and electron diffraction give an estimate size for nuclear radius. Use the Coulomb Law to carry out closest approach calculations. Use the equation R = R0A1/3 to relate the radius of different nuclei to nucleon number. Given appropriate data calculate nuclear densities. Recall the order of magnitude radius for the nucleus. Understand that E = mc2 applies to all energy changes. Define and understand the term binding energy. Calculate mass difference / binding energy using appropriate units including fission and fusion reactions. Describe fission and fusion processes including how knowledge of these processes informs energy supply choices. Sketch the graph of average binding energy per nucleon against nucleon number and explain regions where fission and fusion will release energy. Describe the process of induced fission, chain reactions and the meaning of critical mass. Describe and explain the functions of the moderator (including use

			Demonstrate the conservation of strangeness in strong interactions. Explain that strangeness does not have to be conserved in the weak interaction. Recognise charge, baryon number and strangeness as properties of quarks and antiquarks. Analyse the quark structure of protons, neutrons, antiprotons, antineutrons, pions and kaons. Identify the change in quark character in b- and b+ decay. Apply the conservation laws for charge, baryon number, lepton number and strangeness for particle interactions. Recall that momentum and energy are conserved in interactions.					of a model of elastic collisions), control rods and coolant and the choice of material used for each. Describe the safety considerations in nuclear power stations including the handling and storage of radioactive waste. Describe and evaluate the arguments for and against nuclear power.
			Year 12 Term 1 - Progressive and stationary waves			Year 13 Term 1 - Thermal Physics	Year 13 Term 2 - Capacitance	Year 13 Term 3 - Turning Points

			Define the terms frequency, period, amplitude and wavelength of a wave. Explain what is meant by phase and phase difference. Use the equation c= fl in calculations. Distinguish between longitudinal and transverse waves. Recognise that electromagnetic waves are transverse and all examples of electromagnetic waves travel at the same speed in a vacuum. Describe the polarisation of transverse waves. Describe applications of polarisers. Explain what is meant by a stationary wave. Define the terms node and antinode. Calculate the frequency of the first harmonic produced by a stationary wave on a string. Describe the formation of a stationary wave by two waves of the same frequency travelling in opposite directions. Use graphs to demonstrate the formation of standing waves. Describe the formation of standing waves produced by microwaves and sound waves.			Recall the definition of specific heat capacity and specific latent. Understand and apply the equation $Q = mc\Delta\theta$ to solve thermal energy transfer problems including in continuous flow. Understand and apply the equation Q = ml to solve thermal energy transfer problems where there is a change of state. Recall the gas laws that give the relationships between p, V and T and the mass of a gas. Express these in words, algebraically and graphically. Understand the concept of absolute zero of temperature and how the gas laws lead to the existence of this temperature. Derive the equation Work done = $p \Delta V$ Understand and use the terms: Avogadro constant, molar mass, molecular mass. Use the gas law equations Work done = $p \Delta V$ to solve problems on the behaviour of gases. Describe Brownian motion and understand how it provides evidence for the existence of atoms. Explain 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 of the kinetic theory and the derivation of $pV = 1/3\ N m\ (c_{rms})^2$ Use the equations of the kinetic theory to solve problems.	Define capacitance. Use the equations: $C = A\varepsilon_0\varepsilon_r/d$; $E = ½\ QV = ½\ CV^2 = ½\ Q^2 / C$ to solve problems. Understand and use the terms relative permittivity and dielectric constant. Describe the action of a simple polar molecule that rotates in the presence of an electric field. Find and interpret the area under a graph of charge against PD Sketch graphs of Q, V and I against time to show charging and discharging of capacitors through different resistances. Find and interpret the area and gradient of graphs representing the discharge of capacitors. Recall the use the concept of Time Constant RC. Solve problems including the use of the equations : $T_{½} = 0.69RC$; $Q = Q_0 e^{(-t/RC)}$; $Q = Q_{max} (1-e^{(-t/RC)})$	Describe the production of cathode rays in a discharge tube. Describe the principle of thermionic emission. Understand that the energy of an electron accelerated through an electric field depends on the potential difference. Calculate the work done on an accelerated electron using: $1/2mv^2 = eV$ Describe how the specific charge of an electron can be found. Recall and understand the significance of Thomson's determination of e/m for an electron. Compare the specific charge of an electron and a hydrogen ion. Understand and explain the conditions for holding a charged oil droplet stationary in an electric field. Understand and explain the procedure and measurements needed to find the electronic charge including use of the relationships: QV / d = mg $F = 6\pi\eta r u$ Describe and explain the significance of Milikan's results – quantisation of electric charge. Describe and understand the key features of Newton's corpuscular theory including explanation of reflection and refraction. Comparison of Huygen's wave theory. Describe and appreciate the reasons why Newton's theory was preferred. Describe the nature of electromagnetic waves. Appreciation that ε_0 relates to the electric field strength due to a charged object in free

						Describe how knowledge and understanding of gaseous behaviour has changed over time.		space and μo relates to the magnetic flux density due to a current-carrying wire in free space. Describe and understand Hertz's experiment to show the existence of and then measure the speed of electromagnetic waves. Understand the significance of this result. Describe Fizeau's determination of the speed of light and the implication of the result. Describe the ultraviolet catastrophe in terms of black body radiation. Recall that Planck's interpretation using quanta solved the ultraviolet catastrophe. Understand and describe Einstein's explanation of photoelectricity and it significance in demonstrating particle properties of electromagnetic radiation. Recall de Broglie's hypothesis $p = h / \lambda$ Describe electron diffraction as evidence of the wave-like nature of the electron. Explain, qualitatively, the changes in diffraction pattern observed when changing the speed of the electrons. Solve problems using the equations: $p = h / \lambda$; $\lambda = h / \sqrt{2meV}$ including estimating the voltage needed to produce wavelengths of the order of the size of an atom. Understand the principle of the Michelson–Morley experiment as an interferometer. Describe and explain the experiment as a means of detecting absolute motion. Describe and explain the significance of failure to detect absolute motion.

								Understand and use the terms proper time and time dilation. Use the equation t = to √ (1 − v2 / c2) to solve problems. Understand and use the term length contraction. Use the equation l = lo √ (1 − v2 / c2) to solve problems. Describe and interpret the results of Bertozzi's experiment. Understand and use the concept of the equivalence of mass and energy including sketching graphs of the variation of mass and kinetic energy with speed and calculations using E = mc2 ; E = moc2 / √ (1 − v2 / c2)
			Year 12 Term 1 - Refraction, diffraction and interference				Year 13 Term 2 - Magnetic Fields	

			Explain the meaning of path difference and coherence. Describe the Young's double slit experiment and calculate fringe spacing using data from the experiment. Distinguish between the fringe patterns produced by monochromatic and white light. Analyse different examples of the double slit experiment using both electromagnetic and sound waves. Explain how knowledge and understanding of the nature of electromagnetic radiation has changed over time. Describe the diffraction patterns produced using a single slit with monochromatic light and contrast this with the pattern produced by white light. Discuss the effect on the width of the central maximum when the slit width is varied. Describe the use of the plane diffraction grating. Use the grating equation in calculations. Describe uses of the diffraction grating such as the analysis of spectra. Define refractive index in terms wave speed in different media. Recall that the refractive index of air is approximately 1. Use Snell's law to calculate angles when light crosses a boundary between two media, Describe total internal reflection and distinguish this from partial reflection. Calculate critical angles using refractive indices. Describe the step index optic fibre.				Be able to predict the direction of a force on a current carrying wire. Use the equation $F=BIl$ to calculate the force on a current carrying wire or magnetic flux density. Describe an investigation to investigate the relationship between magnetic flux density, current and length of a wire. Apply the equation $F = BQv$ to problems where a charge particle is moving in a magnetic field. Explain how the force on the charged particle leads to circular motion in devices such as the cyclotron. Be able to define flux and flux linkage. Use the relationships $\phi = BA$ and $N\phi = BAN\cos\theta$ to calculate flux linkage in common contexts such as a conductor dropped in a uniform magnetic field or a rectangular coil in an electric motor.	

			Understand the principles and consequences of pulse broadening and absorption.					
	KS4 prior learning	**By the end of the term, students can:**	Year 12 Term 1 - Measurements and their errors	Year 12 Term 2 - Electromagnetic radiation and quantum phenomena	Year 12 Term 3 - Mechanics	Year 13 Term 1 - Circular Motion	Year 13 Term 2 - Gravitational Fields	Year 13 Term 3 - Electromagnetic Induction
Key assessment questions:			Why is accuracy important? What is the difference between accurate and precise?	How are line spectra used to measure the rotational speeds of stars? How do line spectra provide evidence of the Big Bang? Is there experimental evidence for the diffraction of protons or neutrons? Why do electron microscopes have a much better resolving power than optical microscopes?	Are the centre of mass and centre of gravity of a body always in the same position? What is the average velocity of a cyclist who cycles at a constant speed of 20 m s^{-1}, around a circular track of circumference 400 m when they are a quarter of the way around the track? How is the equation, F=ma, modified when mass is changing? Prove that an object of mass, m, must be stationary after an elastic collision with a stationary object also of mass m.	What forces do you experience when travelling round a corner at constant speed?	What is the Newton's third law reaction force to your weight? How does the gravitational field around a star change as it evolves through its life cycle? What is the best choice for the zero point of reference for potential energy? Is it better to launch a rocket from the poles or the equator?	How is electricity made? What range of voltage does the mains supply? What factors would need to be considered when designing a transformer? Why is the mains ac and not dc?

			Year 12 Term 1 - Particles	Year 12 Term 2 - Electricity	Year 12 Term 3 - Materials	Year 13 Term 1 - Simple Harmonic Motion	Year 13 Term 2 - Electric Fields	Year 13 Term 3 - Radioactivity
			Why was specific charge important in the discovery of the electron by J.J. Thomson? Identify a radioactive decay series and analyse the types of decay taking place that lead to the series. How is annihilation of matter and antimatter used in forming a PET scan? What is the Higg's boson and why is it so important to the standard model?	What is the resistance between A and B? Why is it important for car batteries to have very low internal resistances?	What materials are used in construction? Why do we use certain materials? Do we need to consider cost?	What characteristics do oscillating systems share? How should a suspension system work to give the smoothest possible ride? Is it possible to shatter a glass with your voice alone?	Design an experiment to confirm the Coulomb law.	What evidence do we have for atomic structure? Is the nuclear model of the atom viable? What is the nature of radiation? Which is the most dangerous type of radiation? Full body scans for asymptomatic people: a good or a bad thing? How long do we have to wait until a radioactive source is safe? What aspects of radioactive decay are predictable? How do we know the size of an atom and the nucleus within? Is a mug of hot coffee more massive than a mug of cold coffee? Which element has the most stable nucleus? What is a critical mass? Is nuclear energy the answer to our energy needs?
			Year 12 Term 1 - Progressive and stationary waves			Year 13 Term 1 - Thermal Physics	Year 13 Term 2 - Capacitance	Year 13 Term 3 - Turning Points
			How do we measure the speed of light? What affect does the motion of a light source have on the speed of light emitted from the source? What are the consequences of this?			Explain how you can put out a candle with moist fingers (800 °C) but putting your hand in boiling water is very dangerous (100 °C). What is the best scale for measuring temperature? Suggest and explain conditions under which the kinetic theory would fail to describe the behaviour of a gas?	What features are desirable in the design of a capacitor? Outline the similarities and differences between radioactive decay and capacitor charge and discharge.	How do we 'weigh' the electron? If the charge of an electron is quantised what other quantities in the universe share this behaviour? Is light a wave or a particle? What evidence do we have to inform our decision? Is light a wave or a particle? How do we know? What is the smallest object we can see? How fast does the light from a moving lamp travel at? Is it possible to time-travel? Why is not possible to travel faster than the speed of light?

			Year 12 Term 1 - Refraction, diffraction and interference				Year 13 Term 2 - Magnetic Fields	
			How does the spectrum from a diffraction grating differ from that produced by a prism?				How can we change electrical energy into kinetic energy? How can we quantify the strength of a magnetic field? How can the movement of charged particles be controlled? What are the applications of controlling the movement of charged particles?	
	KS4 prior learning	**By the end of the term, students can:**	Year 12 Term 1 - Measurements and their errors	Year 12 Term 2 - Electromagnetic radiation and quantum phenomena	Year 12 Term 3 - Mechanics	Year 13 Term 1 - Circular Motion	Year 13 Term 2 - Gravitational Fields	Year 13 Term 3 - Electromagnetic Induction
Disciplinary Rigour		What makes your subject different to other subjects? What are the expectations for students in your subject area in the KS5 qualification specification?	MS0.2 MS0.1 MS1,1 MS1.4 MS1.5 MS2.2 MS3.4 PS1.2 PS2.1 PS2.2 PS2.3 PS3.1 PS3.3	AO1: Demonstration of knowledge and understanding of beta. AO1: Demonstration of knowledge and understanding of nature of line spectra. AO1: Demonstration of knowledge and understanding of the structure of the fluorescent tube. AO1: Demonstration of knowledge and understanding of discrete energy levels and how these lead to line spectra. AO1: Demonstration of knowledge and understanding of electron diffraction. AO1: Demonstration of knowledge and understanding of the dual nature of light. AO2: Apply knowledge and understanding of the photoelectric effect both qualitatively and quantitatively. AO2: Apply knowledge and understanding of the electron volt to perform	AO1: Demonstration of knowledge and understanding of vector and scalar quantities. AO1: Demonstration of knowledge and understanding of the moment of a force and a couple. AO1: Demonstration of knowledge and understanding displacement, speed, velocity and acceleration. AO1: Demonstration of knowledge and understanding of motion graphs. AO1: Demonstration of knowledge and understanding of projectile motion. AO1: Demonstration of knowledge and understanding of the nature of frictional forces. AO1: Demonstration of knowledge and understanding of Newton's laws of motion. AO1: Demonstration of knowledge and understanding of	AO1: Demonstrate knowledge and understanding of circular motion as an accelerated motion. AO2: Apply knowledge and understanding of forces to identify and calculate centripetal forces. MS4.7: Understand the relationship between degrees and radians and translate from one to the other in circular motion problems. ATc: Use methods to increase accuracy of measurements, such as timing over multiple rotations in circular motion experiment.	AO1: Demonstrate knowledge and understanding of the concept of gravitational fields. AO1: Demonstrate knowledge and understanding of Newton's Law of gravitation. AO1: Demonstrate knowledge and understanding of the concept of gravitational potential when solving problems. AO1: Demonstrate knowledge and understanding of satellites and their orbits when relating observed orbits to uses. AO2: Apply knowledge and understanding of gravitational field strength to solve problems in different contexts. AO2: Apply knowledge and understanding of gravitational potential when explaining energy considerations in the orbit of satellites.	AO1: Demonstrate knowledge and understanding of how changing flux linkage produces an emf. AO1: Demonstrate knowledge and understanding of rms and peak values. AO1: Demonstrate knowledge and understanding of construction and operation of a transformer. AO2: Apply knowledge and understanding of scientific ideas to explain electromagnetic braking. AO3: Analyse and interpret data from oscilloscope display to find rms and peak values. AO3: Analyse, interpret and evaluate data from building transformer practical. MS0.3: Use ratios in transformer problems. MS2.1: Understand and use the symbols: $=$, $<$, $<<$, $>>$, $>$, $\propto$, $\approx$, Δ MS3.1: Translate

				calculations to convert energies in joules to electron volts. AO2: Apply knowledge and understanding of discrete energy levels and the energies associated with them to calculate frequencies and wavelengths of emitted photons. AO2: Apply of knowledge and understanding of the de Broglie equation to calculate the de Broglie wavelength. AO3: Analyse, interpret and evaluate scientific ideas and evidence to see why the wave model of light does not explain the photoelectric effect. MS0.2: Recognise expressions in decimal and standard form when applying the photoelectric equation. MS0.2: Recognise expressions in decimal and standard form when using energies in electron volts. MS0.1, 0.2, 2.4: Solve the equation relating the energy differences between levels to the frequencies and wavelengths of emitted photons. MS1.1, 2.3: Use prefixes when expressing wavelength values. MS2.3: Substitute numerical values into the photoelectric equation. MS2.4: Solve the photoelectric equation to determine maximum kinetic energies of electrons. PS3.2: Process and analyse data from photoelectric experiments. MS3.2: Plot maximum kinetic energy against frequency of incident light. MS3.4: Determine the	momentum. AO1: Demonstration of knowledge and understanding of impulse. AO1: Demonstration of knowledge and understanding elastic and inelastic collisions. AO1: Demonstration of knowledge and understanding the relationship between work done and energy transfer. AO1: Demonstration of knowledge and understanding of the principle of conservation of energy. AO2: Apply knowledge and understanding of how vectors can be combined. AO2: Apply knowledge and understanding of how vectors can be resolved. AO2: Apply knowledge and understanding of the moment equation by using in calculations. AO2: Apply knowledge and understanding of the principle of moments in calculations. AO2: Apply knowledge and understanding of displacement, speed, velocity and acceleration in calculations. AO2: Apply knowledge and understanding in the analysis of motion graphs. AO2: Apply knowledge and understanding of the equations for uniform acceleration. AO2: Apply knowledge and understanding of motion graphs and the equations of uniform acceleration to determine g. AO2: Apply knowledge and understanding of the independence of horizontal and vertical		MS1.4: Make order of magnitude calculations for gravitational forces between objects. MS3.8, 3.9: Students use graphical representations to investigate relationships between v, r and g.	information between graphical, numerical and algebraic forms. MS3.5: Calculate rate of change from a graph showing a linear relationship. ATh: Use signal generator and oscilloscope, including volts/division and time-base. PS2.3: Evaluate results of transformer experiment and draw conclusions about efficiency.

				intercept and gradient of the maximum kinetic energy against frequency graph to find a value for Planck's constant, threshold frequency and work function. PS1.2: Demonstration using electron diffraction tube. PS3.1: Plot and interpret graphs of maximum kinetic energy of emitted electrons against frequency of incident light.	motion when considering projectiles. AO2: Apply knowledge and understanding of the effects of frictional forces on the motion of a projectile. AO2: Apply knowledge and understanding of Newton's laws in practical situations. AO2: AO1: Apply knowledge and understanding of situations involving Newton's third law. AO2: Apply knowledge and understanding of the conservation of momentum in the analysis of collisions. AO2: Apply knowledge and understanding impulse and relate this to the area under a force time graph. AO2: Apply knowledge and understanding of the relationship between impact force and contact time. AO2: Apply knowledge and understanding of the formulae for gravitational potential energy and kinetic energy. AO2: Apply knowledge and understanding of work done using the appropriate equation. AO3: Analyse, interpret and evaluate evidence from motion in a fluid experiments. AO3: Analyse, interpret and evaluate evidence from investigation of Newton's second law. Ata: Use analogue apparatus to measure heights and heights of rebound for a bouncing ball. ATk: Use ICT to model motion of rocket. ATd: Use stop watch or light gates in experiments investigating motion			

					MS0.3: Use ratios, fractions and percentages in efficiency calculations. MS0.4: Estimate energies derived from food consumption. MS0.5: Use calculators to find powers. MS0.6: Use of calculators to handle sin and cosine when resolving vectors. MS1.2: Find arithmetic means from data from the determination of g. MS2.2, 2.3: Use algebraic equations for moments, couples and the principle of moments MS2.2: Change the subject of the equations of uniform acceleration. MS2.2: Change the subject of equations calculating gravitational potential energy and kinetic energy MS2.2, 2.3: Substitute into and solve equations for uniform acceleration. PS2.3: Evaluate results from conservation of momentum experiments and draw conclusions. MS2.2, 2.3: Substitute numerical values into a conservation of momentum equation and change the subject of the equation. MS2.3: Substitute values into equation linking force, mass and acceleration. MS3.5: Calculate rate of change from motion graphs showing a linear relationship. MS3.6: Draw and use the slope of a tangent to a curve in motion graphs. MS3.7: Distinguish between instantaneous velocity and average velocity. MS3.9: Apply the concepts underlying calculus by solving equations involving rates			

					of change in the experiment to determine g. MS 4.1, 4.2: Use 2D representation of forces in a free-body diagram. MS4.2: 2D representation of coplanar forces. MS4.5: Use of sin and cos in problems involving the resolution of vectors MS0.6, 4.1, 4.2, 4.5: Use of sine and cos and 2D diagrams to represent projectile motion. PS1.1: Solve motion problems in a practical context. PS2.1, 2.3: Evaluate results from the motion of an object through a fluid. PS3.2: Process and analyse data from conservation of momentum experiments. PS3.3: Consider precision and accuracy of data in efficiency experiments. PS4.1, AT a,b,c: Knowledge and understanding of practical instruments needed to investigate Newton's second law. PS4.1: Know and understand the use of a wide range of experimental and practical instruments, equipment and techniques in efficiency experiments.			
			Year 12 Term 1 - Particles	Year 12 Term 2 - Electricity	Year 12 Term 3 - Materials	Year 13 Term 1 - Simple Harmonic Motion	Year 13 Term 2 - Electric Fields	Year 13 Term 3 - Radioactivity

			AO1: Demonstration of knowledge of simple models of the atom. AO1: Demonstration of knowledge of strong nuclear force. AO1: Demonstration of knowledge of matter and antimatter. AO1: Demonstration of knowledge of the process of pair production. AO1: Demonstration of knowledge of leptons. AO1: Demonstration of knowledge of the process of annihilation. AO1: Demonstration of knowledge of the fundamental interactions. AO1: Demonstration of knowledge of the classification of strange particles. AO1: Demonstration of knowledge of the classification of hadrons, baryons and mesons. AO2: Apply knowledge and understanding of how decay equations can be analysed to predict if they can occur. AO2: Demonstrate knowledge and understanding isotopes and analyse isotope data. AO2: Apply knowledge and understanding of scientific ideas, processes, techniques and procedures when handling quantitative data. AO2: Apply knowledge and understanding of how strangeness does not have to be conserved in the weak interaction. AO2: Apply knowledge and understanding of alpha and beta decay to analyse and complete equations representing the decay. AO2: Apply knowledge and understanding of the factors affecting the energy of photons.	AO1: Demonstration of knowledge and understanding of electric current, potential difference and resistance. AO1: Demonstration of knowledge and understanding of current-voltage characteristics of various c AO1: Demonstration of knowledge and understanding of resistivity AO1: Demonstration of knowledge and understanding of effect of temperature on the resistance of metal conductors. AO1: Demonstration of knowledge and understanding of effect of temperature on a negative temperature coefficient thermistor. AO1: Demonstration of knowledge and understanding of superconductivity. AO1: Demonstration of knowledge and understanding of series and parallel electric circuits. AO1: Demonstration of knowledge and understanding of how cells combine in series and in parallel. AO1: Demonstration of knowledge and understanding of the conservation of energy in electric circuits. AO1: Demonstration of knowledge and understanding of the potential divider. AO1: Demonstration of knowledge and understanding of emf and internal resistance. AO2: Apply knowledge and understanding of electric current, potential difference and resistance.	AO1: Demonstration of knowledge and understanding of the meaning of density. AO1: Demonstration of knowledge and understanding of Hooke's Law and elastic limit. AO1: Demonstration of knowledge and understanding of tensile stress and tensile strain. AO1: Demonstration of knowledge and understanding of plastic behaviour, fracture and brittle behaviour. AO1: Demonstration of knowledge and understanding of the Young modulus. AO2: Apply knowledge and understanding of density in calculations. AO2: Apply knowledge and understanding of plastic behaviour, fracture and brittle behaviour when relating them to force extension graphs. AO2: Apply knowledge and understanding in the interpretation of stress strain graphs. AO2: Apply knowledge and understanding in the description of the energy changes in masses attached to vibrating springs. AO2: Apply knowledge and understanding of the Young modulus in calculations. AO3: Analyse, interpret and evaluate evidence when considering energy conservation in the context of ethical transport design. ATa: Use appropriate analogue apparatus in the Young modulus experiment. ATc: Use methods to increase accuracy in the Young modulus experiment.	AO1: Demonstrate knowledge and understanding of resonance. AO1: Demonstrate knowledge and understanding of conditions for SHM by investigating different examples of oscillations. AO2: Apply knowledge and understanding of scientific ideas to derive the equations for the mass spring and pendulum systems. AO3: Analyse and interpret data from to reach conclusions on the relationship between x, v and a in a system executing SHM. AO3: Analyse and interpret data to reach conclusions on the relationship between variables in oscillating systems. ATk: Use ICT such as computer modelling, or data logger to collect data, or use of software to process data on SHM experiments. MS3.9: Apply the concepts underlying calculus by finding the velocity/acceleration from x –t / v – t graphs of SHM. MS 4.6 / AT b, c Students should recognise the use of the small-angle approximation in the derivation of the time period for examples of approximate SHM.	AO2: Apply knowledge and understanding of electric fields and circular motion to describe and explain the trajectory of a charge particle in a uniform electric field. ATf: correctly construct circuits from circuit diagrams using DC power supplies, cells, and a range of circuit components, including those where polarity is important when plotting equipotential lines. MS3.8: Δ V from the area under graph of E against r and be able to calculate it or estimate it by graphical methods as appropriate.	AO1: Demonstrate knowledge and understanding of Rutherford Scattering experiment. AO1: Demonstrate knowledge and understanding of decay processes. AO1: Demonstrate knowledge and understanding of the size of the nucleus and evidence for this. AO1: Demonstrate knowledge and understanding of binding energy, fission and fusion. AO1: Demonstrate knowledge and understanding of nuclear fission, fusion and the construction of a nuclear power station. AO1: Demonstrate knowledge and understanding of nuclear safety. AO2: Apply knowledge and understanding of the properties of radiation in medicine and industry. AO2: Apply knowledge and understanding of radioactive decay to the storage of radioactive waste and radioactive dating. AO2: Apply knowledge and understanding of Coulomb's Law and diffraction to calculate nuclear radii. AO2: Apply knowledge and understanding to calculate the energy released in nuclear fission and fusion. AO3: Analyse and interpret data from Rutherford Scattering experiment to draw a conclusion. AO3: Analyse, interpret and evaluate data from absorption and inverse-square law experiments to:

			AO2: Apply knowledge and understanding of conservation laws in particle interactions. AO2: Apply knowledge and understanding in the importance of conservation laws when constructing Feynman diagrams. MS2.2, 2.4: Solve algebraic equations to calculate energy of photons from frequency and wavelength. MS2.3: Substitute numerical values into algebraic equations to calculate specific charge. MS2.3: Substitute numerical values into algebraic equations to calculate energies of photons using frequency and wavelength. MS2.3: Substitute numerical values into algebraic equations to calculate the frequencies of photons required for pair production. MS2.4: Solve algebraic equations involving masses and charges of nuclei and ions. MS2.4: Solve algebraic equations to calculate the frequency of the photons released during annihilation. PS2.2: Present masses in SI and relative units.	AO2: Apply knowledge and understanding of current-voltage characteristics. AO2: Apply knowledge and understanding of resistivity in calculations. AO2: Apply knowledge and understanding in the analysis of electric circuits. AO2: Apply knowledge and understanding of the power equations and apply these in the analysis of electric circuits. AO2: Apply knowledge and understanding of using potential dividers in sensing circuits. AO2: Apply knowledge and understanding of emf and internal resistance in circuit calculations. AO3: Analyse and interpret how thermistors are used in temperature sensors. AO3: Analyse and interpret the applications of superconductors. ATa,b,f,g: Construct circuits with various component configurations and measure currents and potential differences. ATb: Use digital meters. ATb, f: Construct circuits from a range of components. ATf: Construct and check circuits. ATb, f: Construct circuits from a range of components. ATe: Use micrometers to measure diameters of wires. ATf: Correctly construct circuits for experiments to determine internal resistance. ATf, g: Correctly design, connect and check circuits. ATb: Use multimeters.	ATe: Use micrometer to measure the diameters of wires. MS0.3: Use of ratios in density calculations. MS3.1: Translate information between graphical, numerical and algebraic form when investigating elastic behaviour. MS3.1: Translate information between graphical, numerical and algebraic form when investigating the Young modulus. MS3.4: Determine the slope of a stress strain graph to find the Young modulus. MS3.8: Understand the significance of the area between the curve and the x-axis on a force extension graph. MS4.3: Calculate volumes of regular solids. MS4.3: Calculate cross sectional areas of wires. PS2.2: Present data from the Young modulus experiment in appropriate ways.			• make judgements and reach conclusions • develop and refine practical design and procedures. AO3: Analyse, interpret and evaluate data on radioactive decay to make judgements and reach conclusions. AO3: Analyse, interpret and evaluate scientific information, ideas and evidence, including in relation to issues, to make judgements and reach conclusions on the development of nuclear power. ATk: Use ICT such as computer modelling, or data logger with a variety of sensors to collect data, or use of software to process data. ATl: Use ionising radiation, including detectors. MS0.1: Recognise and make use of appropriate units (eV, MeV and J) in binding energy calculations. MS1.3: Understand simple probability in radioactive decay. MS1.4: Make order of magnitude calculations in determining nuclear densities. MS2.1: Understand and use the symbols: $\propto$, Δ. MS3.1: Translate information between graphical, numerical and algebraic forms when dealing with radioactive decay. MS3.1: Translate information between graphical and numerical form with binding energy graph.

				MS0.3: Use fractions when combining resistors in parallel. MS0.3: Use ratios and fractions when analysing potential divider circuits. MS2.2: Change the subject of the power equations. MS2.3: Substitute numerical values into the potential divider equation. MS2.3: Substitute numerical values into the power equations. MS3.2: Plot a graph of voltage against current. MS3.1: Translate data from experiments to determine internal resistance into graphical form. MS3.2: Plot current voltage characteristics. MS3.3: Understand that the circuit equation including emf and internal resistance represents a linear relationship. MS3.4: Determine the intercept and slope of a linear graph. MS4.3: Calculate cross-sectional areas of wires. PS2.1: Apply scientific knowledge set in a practical context. PS2.2: Present data from experiments to determine internal resistance in appropriate ways. PS3.1: Plot and interpret current-voltage graphs. PS3.1: Plot and interpret the graph from experiments to determine internal resistance. PS4.1: Know and understand how to use a wide range of experimental and practical instruments when investigating potential divider circuits. PS4.1: Know and				

				understand how to use a wide range of experimental and practical instruments when investigating circuit. PS4.1: Know and use a wide range of practical equipment to determine the resistivity of the metal in a wire				
			Year 12 Term 1 - Progressive and stationary waves			Year 13 Term 1 - Thermal Physics	Year 13 Term 2 - Capacitance	Year 13 Term 3 - Turning Points
			AO1: Demonstration of knowledge and understanding of the terms amplitude, frequency, period, wavelength, phase and phase difference. AO1: Demonstration of knowledge and understanding of longitudinal and transverse waves. AO1: Demonstration of knowledge and understanding electromagnetic waves and their properties. AO1: Demonstration of knowledge and understanding of the polarisation of transverse waves. AO1: Demonstration of knowledge and understanding of standing waves including the meaning of nodes and antinodes. AO1: Demonstration of knowledge and understanding of different examples of stationary waves. AO2: Apply knowledge and understanding of the equation c= fl to calculate wavelengths and frequencies. AO2: Apply knowledge and understanding of the polarisation to explain applications. AO2: Apply knowledge and understanding in			AO1: Demonstrate knowledge and understanding of specific heat and specific latent heat. AO1: Demonstrate knowledge and understanding of the Ideal Gas equation. AO1: Demonstrate knowledge and understanding of Brownian motion and the development of kinetic theory. AO2: Apply knowledge and understanding of scientific ideas to solve problems involving transfer of thermal energy. AO2: Apply knowledge and understanding of mechanics to derive the kinetic theory equations. AO3: Analyse and interpret data from gas law experiments to find a value for absolute zero and evaluate this value. MS 1.5 / PS 2.3 / AT a, b, d, f: Investigate the factors that affect the change in temperature of a substance using an electrical method or the method of mixtures. Students should be able to identify random and systematic errors in the experiment and suggest ways to remove them. MS3.12: Sketch the relationship modelled by	AO1: Demonstrate knowledge and understanding of capacitor discharge by sketching graphs of Q, V and I against time. AO2: Apply knowledge and understanding of capacitors to solve problems in a variety of contexts. ATf: correctly construct circuits from circuit diagrams using DC power supplies, cells, and a range of circuit components, including those where polarity is important when plotting equipotential lines. ATg: design, construct and check circuits using DC power supplies, cells, and a range of circuit components. ATk: Use ICT in the form of computer modelling of capacitor discharge.	AO1: Demonstrate knowledge and understanding of the cathode ray tube. AO1: Demonstrate knowledge and understanding of the evidence for the electromagnetic nature of light. AO1: Demonstrate knowledge and understanding of the TEM and STM AO1: Demonstrate knowledge and understanding of Einstein's two relativity postulates. AO2: Apply knowledge and understanding of length contraction / time dilation to explain the observed properties of muons. AO3: Analyse, interpret and evaluate scientific information, ideas and evidence, to make judgements and reach conclusions about the quantisation of charge in the Milikan oil drop experiment.

			calculations of the frequencies of the first harmonic. AO2: Apply knowledge and understanding of waves to explain the formation of standing waves. AO3: Analyse, interpret and evaluate scientific information, ideas to identify applications of polarisation. ATi: Generate and measure waves. ATj: Use a light source and polarisers to investigate polarisation. MS2.3: Substitute numerical values into the wave equation. MS2.3: Substitute numerical values into equation for frequency of first harmonic. MS4.5: Use sin in the modelling of a transverse wave. PS3.2: Process and analyse data using a spreadsheet.			y = k/x, when dealing with an ideal gas. PS 1.1, 4.1 / AT k: Investigate, with a data logger and temperature sensor, the change in temperature with time of a substance undergoing a phase change when energy is supplied at a constant rate.		
			Year 12 Term 1 - Refraction, diffraction and interference				Year 13 Term 2 - Magnetic Fields	

			AO1: Demonstration of knowledge and understanding of path difference and coherence. AO1: Demonstration of knowledge and understanding of the difference in the fringe pattern produced by monochromatic and white light sources. AO1: Demonstration of knowledge and understanding of examples of interference of sound waves. AO1: Demonstration of knowledge and understanding of the main features of a single slit diffraction pattern. AO1: Demonstration of knowledge and understanding of total internal reflection and critical angle. AO1: Demonstration of knowledge and understanding of Snell's law. AO1: Demonstration of knowledge and understanding of refractive index and its relationship to wave speed. AO1: Demonstration of knowledge and understanding of material and modal dispersion. AO1: Demonstration of knowledge and understanding of optic fibres and the importance of cladding. AO2: Apply knowledge and understanding of path difference to determine whether interference is constructive or destructive. AO2: Apply knowledge and understanding of interference patterns to explain the diffraction pattern produced by a				AO1: Demonstrate knowledge and understanding of forces on charged particles in magnetic fields. AO1: Demonstrate knowledge and understanding of magnetic flux. AO2: Apply knowledge and understanding to predict direction of motion of a spinning motor. AO2: Apply knowledge and understanding to explain machines that use magnetic forces to guide the motion of charged particles. MS0.6: Use calculators to handle sin x , cos x , tan x when x is expressed in degrees or radians MS4.2: Visualise and represent 2D and 3D forms including two-dimensional representations of 3D objects. MS4.5: Use sin, cos and tan in physical problems ATa: Use appropriate analogue apparatus to record a range of measurements and to interpolate between scale markings. ATf: The construction of dc circuits with correct polarity. ATh: Use signal generator and oscilloscope, including volts/division and time-base.	

			plane diffraction grating. AO2: Apply knowledge and understanding of path difference to derive the diffraction grating equation. AO2: Apply knowledge and understanding in calculations involving the critical angle. AO2: Apply knowledge and understanding of the diffraction grating equation in calculations. AO2: Apply knowledge and understanding of Snell's law in calculations. AO3: Analyse scientific information, ideas and evidence about the nature of light. AO3: Analyse scientific information to determine applications of the diffraction grating. ATj: Use light source or laser to investigate interference. MS0.6, 4.5: Use of sine. MS2.2: Change the subject of the fringe separation equation to determine the wavelength of light. MS2.4: Solve algebraic equations to determine angles of refraction. MS2.4: Solve algebraic equations to determine critical angles. MS3.2 and 3.4: Plot graph to determine refractive index. MS4.1: Use of angles (incidence and refraction). MS4.5: Use of sine in diffraction grating equation. MS4.5: Use of sine. PS1.2: Apply scientific knowledge to explain the consequences of pulse broadening and absorption.					