Programme of study for Year 12 A-LEVEL Physics

Autumn (1st term)	Autumn (2nd term)	Spring (1st term)	Spring (2nd Term)	Summer (1st term)	Summer (2nd term)
Topics: GCSE to A-Level progression **Measurements and their errors.** **Particles and radiation:** Matter and radiation Quarks and leptons Electromagnetic radiation and quantum phenomenon Skills(students should be able to do): Use of dimensional analysis to predict relationships between quantities eg the speed of a wave, v, in water in terms of depth, d, and g Extend to estimates outside physics. AO1: Demonstration of knowledge of simple models of the atom. AO2: Demonstrate knowledge and understanding isotopes and analyse isotope data. AO1: Demonstration of knowledge of strong nuclear force.	Topics: **Waves** **Optics** Skills(students should be able to do): AO1: Demonstration of knowledge and understanding of the terms amplitude, frequency, period, wavelength, phase and phase difference. AO2: Apply knowledge and understanding of the equation c= fL to calculate wavelengths and frequencies. 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.	Topics: **Mechanics:** Forces in equilibrium On the move AO1: Demonstration of knowledge and understanding of vector and scalar quantities. AO2: Apply knowledge and understanding of how vectors can be combined. AO2: Apply knowledge and understanding of how vectors can be resolved. AO1: Demonstration of knowledge and understanding of the moment of a force and a couple. 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. AO1: Demonstration of knowledge and understanding	Topics: **Mechanics (continued):** Newton's laws of motion Force and Momentum Work, energy and power Skills(students should be able to do): AO1: Demonstration of knowledge and understanding of Newton's laws of motion. AO2: Apply knowledge and understanding of Newton's laws in practical situations. AO3: Analyse, interpret and evaluate evidence from investigation of Newton's second law. AO2: AO1: Apply knowledge and understanding of situations involving Newton's third law. AO1: Demonstration of knowledge and understanding of momentum.	Topics: **Materials** **Electricity:** Electric current DC circuits Skills(students should be able to do): AO1: Demonstration of knowledge and understanding of the meaning of density. AO2: Apply knowledge and understanding of density in calculations. AO1: Demonstration of knowledge and understanding of Hooke's Law and elastic limit. MS3.1: Translate information between graphical, numerical and algebraic form when investigating elastic behaviour. AO1: Demonstration of knowledge and understanding of tensile stress and tensile strain. AO1: Demonstration of knowledge and	Topic: End of Year 12 exams **Further mechanics:** Circular motion Thermal Physics Skills(students should be able to do): 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. AO1: Demonstrate knowledge and understanding of specific heat and specific latent heat. AO2: Apply knowledge and understanding of scientific ideas to solve problems involving transfer of thermal energy.

AO2: Apply knowledge and understanding of scientific ideas, processes, techniques and procedures when handling quantitative data. AO2: Apply knowledge and understanding of alpha and beta decay to analyse and complete equations representing the decay. AO1: Demonstration of knowledge of matter and antimatter. AO2: Apply knowledge and understanding of the factors affecting the energy of photons. AO1: Demonstration of knowledge of the process of pair production. AO1: Demonstration of knowledge of the process of annihilation. AO1: Demonstration of knowledge of the fundamental interactions. AO2: Apply knowledge and understanding of conservation laws in particle interactions. AO2: Apply knowledge and understanding in	AO2: Apply knowledge and understanding of the polarisation to explain applications. AO3: Analyse, interpret and evaluate scientific information, ideas to identify applications of polarisation. AO1: Demonstration of knowledge and understanding of standing waves including the meaning of nodes and antinodes. AO2: Apply knowledge and understanding in calculations of the frequencies of the first harmonic. AO2: Apply knowledge and understanding of waves to explain the formation of standing waves. AO1: Demonstration of knowledge and understanding of different examples of stationary waves AO1: Demonstration of knowledge and understanding of path difference and coherence.	displacement, speed, velocity and acceleration. AO2: Apply knowledge and understanding of displacement, speed, velocity and acceleration in calculations. AO1: Demonstration of knowledge and understanding of motion graphs. 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. AO1: Demonstration of knowledge and understanding of projectile motion. AO2: Apply knowledge and understanding of the independence of horizontal and vertical motion when considering projectiles.	AO2: Apply knowledge and understanding of the conservation of momentum in the analysis of collisions. AO1: Demonstration of knowledge and understanding of impulse. 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. AO1: Demonstration of knowledge and understanding elastic and inelastic collisions. Skills(students should be able to do): AO1: Demonstration of knowledge and understanding the relationship between work done and energy transfer. AO2: Apply knowledge and understanding of work done using the appropriate equation.	understanding of plastic behaviour, fracture and brittle behaviour. 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. AO3: Analyse, interpret and evaluate evidence when considering energy conservation in the context of ethical transport design. AO1: Demonstration of knowledge and understanding of the Young modulus. AO2: Apply knowledge and understanding of the Young modulus in calculations. AO1: Demonstration of knowledge and understanding of	

the importance of conservation laws when constructing Feynman diagrams. 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. AO1: Demonstration of knowledge of leptons. AO1: Demonstration of knowledge of the classification of strange particles. AO2: Apply knowledge and understanding of how strangeness does not have to be conserved in the weak interaction. AO1: Demonstration of knowledge and understanding of quark and antiquark properties. AO2: Apply knowledge and understanding of quark properties to deduce quark structures.	AO2: Apply knowledge and understanding of path difference to determine whether interference is constructive or destructive. 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. AO3: Analyse scientific information, ideas and evidence about the nature of light. AO1: Demonstration of knowledge and understanding of the main features of a single slit diffraction pattern. AO2: Apply knowledge and understanding of interference patterns to explain the diffraction pattern produced by a plane diffraction grating.	AO3: Analyse, interpret and evaluate evidence from motion in a fluid experiments. AO1: Demonstration of knowledge and understanding of the nature of frictional forces. AO2: Apply knowledge and understanding of the effects of frictional forces on the motion of a projectile.	AO2: Apply knowledge and understanding of the formulae for gravitational potential energy and kinetic energy. AO1: Demonstration of knowledge and understanding of the principle of conservation of energy.	electric current, potential difference and resistance. AO2: Apply knowledge and understanding of electric current, potential difference and resistance. AO1: Demonstration of knowledge and understanding of current-voltage characteristics of various components. AO2: Apply knowledge and understanding of current-voltage characteristics. AO1: Demonstration of knowledge and understanding of resistivity. AO2: Apply knowledge and understanding of resistivity in calculations. 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	

AO1: Demonstration of knowledge and understanding of beta plus and beta minus decay. AO2: Apply knowledge and understanding of conservation laws to analyse decay equations. AO1: Demonstration of knowledge and understanding of beta. AO2: Apply knowledge and understanding of the photoelectric effect both qualitatively and quantitatively. AO3: Analyse, interpret and evaluate scientific ideas and evidence to see why the wave model of light does not explain the photoelectric effect. AO1: Demonstration of knowledge and understanding of nature of line spectra. AO1: Demonstration of knowledge and understanding of the structure of the fluorescent tube. AO2: Apply knowledge and understanding of the electron volt to	AO2: Apply knowledge and understanding of path difference to derive the diffraction grating equation. AO2: Apply knowledge and understanding of the diffraction grating equation in calculations. AO3: Analyse scientific information to determine applications of the diffraction grating. AO1: Demonstration of knowledge and understanding of refractive index and its relationship to wave speed. AO1: Demonstration of knowledge and understanding of Snell's law. AO2: Apply knowledge and understanding of Snell's law in calculations. AO1: Demonstration of knowledge and understanding of total internal reflection and critical angle. AO2: Apply knowledge and understanding in calculations involving the critical angle.			negative temperature coefficient thermistor. AO3: Analyse and interpret how thermistors are used in temperature sensors. AO1: Demonstration of knowledge and understanding of superconductivity. AO3: Analyse and interpret the applications of superconductors. AO1: Demonstration of knowledge and understanding of series and parallel electric circuits. AO2: Apply knowledge and understanding in the analysis of electric circuits. AO1: Demonstration of knowledge and understanding of how cells combine in series and in parallel. AO2: Apply knowledge and understanding of the power equations and apply these in the analysis of electric circuits AO1: Demonstration of knowledge and understanding of the	

perform calculations to convert energies in joules to electron volts. AO1: Demonstration of knowledge and understanding of discrete energy levels and how these lead to line spectra. AO2: Apply knowledge and understanding of discrete energy levels and the energies associated with them to calculate frequencies and wavelengths of emitted photons. AO1: Demonstration of knowledge and understanding of electron diffraction. AO1: Demonstration of knowledge and understanding of the dual nature of light. AO2: Apply of knowledge and understanding of the de Broglie equation to calculate the de Broglie wavelength.	AO1: Demonstration of knowledge and understanding of optic fibres and the importance of cladding. AO1: Demonstration of knowledge and understanding of material and modal dispersion.			conservation of energy in electric circuits. AO1: Demonstration of knowledge and understanding of the potential divider. AO2: Apply knowledge and understanding of using potential dividers in sensing circuits AO1: Demonstration of knowledge and understanding of emf and internal resistance. AO2: Apply knowledge and understanding of emf and internal resistance in circuit calculations.	
Key Learning Outcomes (students should know): •Students know that base units are needed in a system of measurement.	Key Learning Outcomes (students should know): •Define the terms frequency, period, amplitude and wavelength of a wave.	Key Learning Outcomes (students should know): •Students can distinguish between scalar and vector quantities including velocity/speed, mass,	Key Learning Outcomes (students should know): •Recall the three laws of motion and apply them in appropriate situations.	Key Learning Outcomes (students should know): •Define density and do calculations using the density equation.	Key Learning Outcomes (students should know): Understand and explain why circular motion is an accelerated motion and needs a centripetal force. Recall and use equations

•Students demonstrate that they can convert between different units of the same quantity, eg J and eV, J and kW h. •Students explain the difference between precision and accuracy. •Students explain the difference between repeatability and reproducibility. •Students can estimate uncertainties in measurements •Students are able to calculate percentage uncertainties from absolute uncertainties. •Students are able to combine absolute and percentage uncertainties. •Students can use error bars on graphs to estimate uncertainties in gradients and intercepts. Students are able to make order of magnitude estimates. •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	•Explain what is meant by phase and phase difference. •Use the equation $c = f\lambda$ 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.	force/weight, acceleration, displacement/distance. •Students can 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.	•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. •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.	•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.	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. Recall the definition of specific heat capacity and specific latent. Understand and apply the equation Q = mcΔθ 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.

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	•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.	•Calculate both instantaneous and average velocities. •Draw graphs to represent motion. •Recognise the significance of the areas of velocity – time and acceleration – time 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.	•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.	•Describe a method to determine the Young modulus. •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.	

radiation. •Calculate the energy of photons from wavelength and frequency. •Describe the processes of annihilation and pair production. •Name the four 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 beta- and beta+ 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	•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. •Understand the principles and consequences of pulse broadening and absorption.	•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.		•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. •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	

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. •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				which the internal resistance of the supply is not negligible. •Explain what is meant by terminal pd.	

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 β^- and β^+ 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. •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 amount of diffraction changes when the momentum of a particle is changed.					

End of Autumn 1st term assessment: PARTICLES AND RADIATION module graded test	End of Autumn 2nd term assessment: WAVES AND OPTICS module graded test	End of Spring term assessment: MECHANICS module graded test		End of year assessment to cover: Measurements and their errors. Matter and radiation Quarks and leptons Electromagnetic radiation and quantum phenomenon Newton’s laws of motion Forces in equilibrium On the move Force and Momentum Waves Work, energy and power Optics Materials	Summer term assessment: ELECTRICITY module graded test
Building understanding: Rationale / breakdown for your sequence of lessons: AQA A-level Physics is a natural progression from the GCSE course and there are many familiar topics that are taken a stage further. Some topics, such as mechanics, are studied in greater detail while others, such as particle physics, broaden the GCSE experience and include a greater use of mathematics so that the qualitative understanding becomes quantitative.	**Building understanding: Rationale / breakdown for your sequence of lessons:** GCSE studies of wave phenomena are extended through a development of knowledge of the characteristics, properties, and applications of travelling and stationary waves. Topics treated include refraction, diffraction, superposition and interference.	**Building understanding: Rationale / breakdown for your sequence of lessons:** Vectors and their treatment were introduced by development of the student’s knowledge and understanding of forces, energy and momentum. The mechanics section continues with a study of materials considered in terms of their bulk properties and tensile strength. As with earlier topics, this section and also the following section on Electricity provides a good starting point for	**Building understanding: Rationale / breakdown for your sequence of lessons:** Both GCSE and A-level assume knowledge of F = ma, but at A-level all three of Newton's laws are required. GCSE content is restricted to motion in a straight line and definitions of velocity and acceleration, including graphical representation for uniform straight line motion to determine acceleration and distance travelled. At A-level, all suvat equations and displacement are defined	**Building understanding: Rationale / breakdown for your sequence of lessons:** Both GCSE and A-level include an understanding of Hooke’s law and expressions in terms of a spring constant, k (or stiffness at A-level). Mathematical expressions of force and extension: F=ke (GCSE) and F=kΔL (A-level) including elastic, strain and potential energy stored are also included. At A-level the concept of elastic limit, plastic behaviour, breaking stress, fracture and brittle	**Building understanding: Rationale / breakdown for your sequence of lessons:** Circular motion prior knowledge: Vectors and Scalars. Linear motion. Newton’s laws of motion. Both GCSE and A-level require knowledge of centripetal forces, their origins and how these forces depend on mass, speed and radius. The equation F = mv2r and the link v = ωr are only required at A-level. Thermal energy transfer

The Particle Physics topics introduces students both to fundamental properties of matter, and to electromagnetic radiation and quantum phenomena. Simple 'Bohr model' of an atom in terms of protons, neutrons, electrons, and the relative masses of these particles is common to both GCSE and A-level. The idea of neutrality (number of electrons = number of protons) and ions and isotopes. 'Atomic number' is used at GCSE and 'proton number, Z' is used at A-level. 'Mass number' is referred to in GCSE and 'nucleon number' in A-level. For A-level only, evidence for the nucleus (Rutherford) and specific charge of nuclei, ions and protons/electrons and the concept of a nuclide with symbolic representation. XAZ including masses and the amu. Through a study of the particle physics topics students become aware of the way new ideas develop and evolve in physics. They will appreciate the importance		students who prefer to begin by consolidating work. Both GCSE and A-level specifications require the definition of a moment and the principle of moments, including the idea of equilibrium/stability. A-level introduces the concept of parallel opposite forces forming a couple. The outcome of resultant forces through vector addition and the concept of equilibrium (resultant force=zero) is common to both GCSE and A-level for parallel forces, including acceleration in the direction of the resultant force. At A-level, the calculation of the resultant of two forces at 90 ° and resolution of forces are treated mathematically.	and the use of Δ for changes in V=ΔsΔt is introduced, including non-uniform acceleration. The acceleration due to gravity (g) and its measurement is an A-level requirement. Projectile motion is analysed mathematically taking account of air resistance. Both GCSE and A-level define momentum and conservation of momentum, including the concept of a 'closed system', for collisions and explosions. At A-level, linear momentum in one dimension is specified and involves the understanding that force results from a momentum change per second. The idea of impulse ('force × time') including an appreciation of impact forces and contact times is introduced and for constant and variable forces, the area under a force-time graph is used for momentum change. There is also consideration at A-level for both elastic (conservation of KE) and	behaviour are included with the use of stress and strain graphs. The area under a force-extension graph is equated to energy stored as E=1/2FΔL and also the transformation of energy in a mass and spring system between KE and PE. Use of stress and strain curves to determine the Young modulus and its measurement is at A-level only. The electricity topics build on and develop earlier study of these phenomena from GCSE. It provides opportunities for the development of practical skills at an early stage in the course and lays the groundwork for later study of the many electrical applications that are important to society. Both GCSE and A-level include circuit symbols; the terms, I, Q, V; and the definitions of current, voltage (PD), and work done in a circuit. The concept of resistance (R=VI), and I-V characteristics for ohmic and non ohmic components, and	prior knowledge: States of matter. Heat transfer mechanisms (conduction, convection and radiation). Basic kinetic theory. There is use of Q = mcΔT in both the GCSE and A-level specifications. Definition of c and measurement as well as ideas about cooling by evaporation also appear in both. A-level also deals with quantitative appreciation of latent heat and Q = mL for fusion and evaporation.

of international collaboration in the development of new experiments and theories in this area of fundamental research.			inelastic collisions, with calculations. This builds on the idea of equilibrium (balanced forces: mg and resistive forces). Both GCSE and A-level require a knowledge of why there is a terminal speed(velocity), that fluid resistance depends on speed and how drag forces can be useful. Interpretation of υ-t graphs for objects falling under gravity with drag forces present is also included. Lift forces are considered only at A-level. Both GCSE and A-level define momentum and conservation of momentum, including the concept of a 'closed system', for collisions and explosions. At A-level, linear momentum in one dimension is specified and involves the understanding that force results from a momentum change per second. The idea of impulse ('force × time') including an appreciation of impact forces and contact times is	series/parallel circuits is common to both. At A-level, the potential divider/potentiometer is introduced as a control mechanism, as are cells in series and parallel. Conservation of charge and energy in a DC circuit and the equation for resistors in parallel are considered only at A-level, as is resistivity and superconductors. GCSE and A-level have common equations for power and energy. At GCSE the equation is restricted to P=IV, and knowledge of kW, kWh. At A-level the power equation is also defined as P=I2R and P= V2/R.	

			introduced and for constant and variable forces, the area under a force-time graph is used for momentum change. There is also consideration at A-level for both elastic (conservation of KE) and inelastic collisions, with calculations. Both GCSE and A-level specifications require knowledge of the terms work, energy and power (including the Joule and kW) as well as the conservation of energy including the equation for work done. Both specifications involve a definition of power in terms of energy/work transformed per second and the equations for PE and KE. A-level also considers work done against resistive forces. For 'non parallel force and displacement' A-level considers when work is done or not done by a force ($W = Fs \cos\theta$) and power in respect of force and velocity ($P=\Delta W \Delta t= Fv$), and that the area under a force-displacement graph is work done for		

			both constant and variable forces. In optics, most specification content is common so that an appreciation of total internal reflection, optical fibres and lasers is assumed. At A-level the critical angle is related to refractive index by Sinθc = ratio of two refractive indices. A-level deals in slightly more detail for optical fibres with a step index.		
Home – Learning: Past exam questions	Home – Learning: Past exam questions	Home – Learning: Past exam questions	Home – Learning: Past exam questions	Home – Learning: Past exam questions	Home – Learning: Past exam questions
Reading / literacy: Use of ionising radiation, including detectors.	Reading / literacy: Research and compile a presentation about the electromagnetic spectrum.	Reading / literacy: Read about how standing waves are used in musical instruments.	Reading / literacy: Extended writing on the applications of interference in waves and optics.	Reading / literacy: Research some of the uses of superconductors.	Reading / literacy: Discussing the use of circular motion in fairground rides and sport.
Numeracy: Substitute numerical values into algebraic equations to calculate specific charge. Solve algebraic equations involving masses and charges of nuclei and ions. Substitute numerical values into algebraic equations to calculate energies of photons using frequency and wavelength.	Numeracy: MS2.3: Substitute numerical values into equation for frequency of first harmonic. MS4.5: Use sin in the modelling of a transverse wave. MS2.2: Change the subject of the fringe separation equation to determine the wavelength of light.	Numeracy: MS1.2: Find arithmetic means from data from the determination of g. MS3.9: Apply the concepts underlying calculus by solving equations involving rates of change in the experiment to determine g. MS2.2, 2.3: Use algebraic equations for moments, couples and	Numeracy: MS2.2, 2.3: Substitute numerical values into a conservation of momentum equation and change the subject of the equation. MS0.3: Use ratios, fractions and percentages in efficiency calculations.	Numeracy: MS0.3: Use of ratios in density calculations. MS4.3: Calculate volumes of regular solids. MS3.1: Translate information between graphical, numerical and algebraic form when investigating elastic behaviour. AO1: Demonstration of knowledge and	Numeracy: MS4.7: Understand the relationship between degrees and radians and translate from one to the other in circular motion problems. 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.

Solve algebraic equations to calculate energy of photons from frequency and wavelength.	MS4.5: Use of sine in diffraction grating equation.	the principle of moments.		understanding of tensile stress and tensile strain. MS3.8: Understand the significance of the area between the curve and the x-axis on a force extension graph.	Students should be able to identify random and systematic errors in the experiment and suggest ways to remove them.
Enrichment / opportunities to develop cultural capital (including careers, WRL and SMSC): Attend lectures at London Universities and Institutions to enrich learning about a wide variety of Science, technology and engineering topics of which Physics makes a major contribution.					