Science Department – Year 12 Physics

Shirley High Curriculum Map

To develop a working knowledge of base units, measurement instrumentation and errors.
To introduce students to the fundamental properties of matter, em radiation and quantum phenomena and the importance of international collaboration.
To extend knowledge of waves by considering refraction, diffraction, superposition and interference.
To introduce and develop vector knowledge and increase understanding of forces, energy, linear motion and momentum.
To consider the bulk properties and tensile strengths of materials.
To build on and develop GCSE knowledge of current electricity and develop practical skills.
To extend knowledge of circular motion.

	Autumn 1	Autumn 2	Spring 1	Spring 2	Summer 1	Summer 2
	Theme/Topic/Skill:	Theme/Topic/Skill:	Theme/Topic/Skill:	Theme/Topic/Skill:	Theme/Topic/Skill:	Theme/Topic/Skill:
	Measurements and their errors. AS Topic 1 Particles AS Topic 2	Radiation AS Topic 2 Waves section 1 AS Topic 3	Waves section 2 AS Topic 3 Materials AS Topic 4	Mechanics AS Topic 4	Electricity AS topic 5	Circular motion A level Topic 6
Why Now?	Measurement and error is a continuous study for any student of physics. It underpins all practical work. Knowledge of error and how to quantify and estimate in practical work is a required throughout the course. It leads on from GCSE work. **Note depending on the cohort it may be that the teacher would choose to move to the materials section of Topic 4 here as it makes use of the skills taught in the unit and reviews many GCSE concepts.**	Students studied the atom and Nuclear physics at GCSE, as well as the electromagnetic spectrum. This unit leads on to consider the fundamental properties of matter and quantum phenomena. In turn it leads to an understanding of how new ideas develop in Physics and why international collaboration is so important in developing new experiments and theories in this research area. Students studied wave phenomena at GCSE the first section reviews wave properties and moves on to look at superposition and stationary waves and their importance in a variety of applications	Waves section 2 develops the work completed at GCSE on reflection, refraction and diffraction and looks interference. Materials is the second section of Topic 4 but it has strong links with Topic 1 and many of the skills are required to complete the practical work. At GCSE students have studied density, and Hooke's law. This unit builds on these principles and moves on to the study of the Young Modulus and stress strain graphs for a variety of materials	Mechanics is the first part of Topic 4. At GCSE students studied Forces, energy and momentum and started to consider vectors. The students review work on vectors and scalars, moments, motion in a straight line, momentum, work energy and power and extend these to an A level treatment.	Students studied current electricity, electricity in the home and electromagnetism at GCSE. This unit builds on the GCSE study and extends it. Practical skills are also developed. This Topic is important in the Electrical fields topic at A level. **This could be moved to Spring 1 as much of this is review and some cohorts may prefer to build on GCSE knowledge before tacking the difficult Particles topic.**	This unit builds on work completed in Topics 2 and 4. It requires knowledge of vectors, scalars, linear motion and Newton's laws. Students need to be familiar with the concept of Radians and how to use them. It is required for the gravitational fields A level unit.
Fundamental Concepts	Measurements and their errors SI units and their interconversion, prefixes Key terms in Physical measurements, uncertainty and error bars. Standard form and estimation. Particles Topic Constituents of the atom, stable and unstable nuclei, nuclear particles; interactions and classification, Quarks and antiquarks.	Radiation AS topic 2 Electromagnetic radiation and quantum phenomena, electron collisions and the wave-particle duality. Waves section 1 Progressive waves and their properties, superposition and stationary waves.	In Waves section 2 Diffraction at a double and single slit using monochromatic and white light, path difference and coherence, Refraction at plane surfaces. Snell's law, TIR and its uses in communication and medicine. Materials Topic 4 part 2. Bulk properties of solids, Hooke's law, behaviour of spring systems, Young modulus	Mechanic Topic 4 part 1 Review of the following topics and extension. Scalars and vectors, moments, motion along a straight line Projectile motion, Newton's laws, momentum and collision types. Work, energy and power	Definitions of current, charge, PD and resistance, IV characteristics of components. Resistivity and superconductors. DC circuits, resistance, energy and power, the potential divider, EMF and internal resistance.	Motion in a circle, acceleration and velocity, Radian measure, angular speed, centripetal force
Students will…	Learn to use a Vernier, micrometer and travelling microscope. Students explain the difference between precision and accuracy, explain the difference between repeatability and reproducibility. Students can estimate uncertainties in measurements and are able to calculate percentage uncertainties from absolute uncertainties and are able to combine absolute and percentage uncertainties. Students can use error bars on graphs to estimate uncertainties in gradients and intercepts. Make order of magnitude estimates. Particles topic 2 Demonstrate knowledge of simple atomic models and isotopes and data, the strong nuclear force, alpha and beta decay and equations. Understand the difference between matter and antimatter, know what affects the energy of photons, know and apply the pair production process and annihilation. **Produce Feynman diagrams.** Classify hadrons, baryons and mesons, demonstrate knowledge of leptons and classification of strange particles. Know properties and structure and strangeness of quarks and antiquarks, quark structure of neutrons, protons, antiprotons, antineutrinos, pions and kaons. Demonstrate knowledge of beta + and – decay.	Apply quantitative and qualitative knowledge and understanding of the photoelectric effect. Analyse, interpret and evaluate scientific ideas and evidence for the wave particle duality. Demonstrate knowledge and understanding of line and continuous spectra and the fluorescent tube and the concept of the electron volt, knowledge of discrete energy levels. Demonstrate knowledge of electron diffraction, and the diffraction tube and the de Broglie wavelength. Understand all the key wave terminology, for transverse and longitudinal waves including em waves and polarisation. Demonstrate knowledge of production and different form of standing waves. Understand harmonics.	Demonstrate knowledge and understanding of path difference, interference and fringe patterns for monochromatic and white light. Analyse scientific information to determine applications of the diffraction grating. Demonstrate knowledge of refractive index and links to wave speed and Snells' law, link to understanding and knowledge of fibre optic cables and cladding and pulse broadening and absorption. Materials part 2 Demonstrate knowledge and application of Hooke's law and elastic limit, density tensile stress and strain and Young modulus for materials. Interpret data in several forms to identify, plastic, fracture and brittle behaviour. Understand the energy changes in a spring and link to ethical transport design.	Mechanics part 1 Demonstrate knowledge, understanding, graphical and trigonometrical ability to deal with scalars and vectors including resolving. Demonstrate knowledge and understanding of moment of a force, couple and the principle of moments. Demonstrate knowledge and understanding of displacement, speed, instantaneous and average velocity and acceleration graphically and numerically. Demonstrate knowledge and understanding of projectile motion including independence of horizontal and vertical motion and the effect of friction on motion. Demonstrate knowledge and understanding of Newton's 3 laws of motion and apply to practical situations. Demonstrate knowledge and understanding of momentum and conservation in collisions. Make links to impulse, impact force and contact time. Demonstrate knowledge and understanding of work done including $W = F s \cos\theta$ $P = \frac{\Delta W}{\Delta t} = Fv$ and energy transfer, and conservation of energy.	Demonstrate and apply knowledge and understanding of current, charge, potential difference and resistance including current voltage characteristics. Demonstrate knowledge and understanding of resistivity including the effects of temperature on conductors and thermistors and superconductivity. Demonstrate knowledge and understanding of series and parallel circuits to analyse them and the effect of resistors and cells in series and parallel. Understand the power equations and demonstrate knowledge of conservation of energy. Use circuit knowledge to explain the potential divider circuit and give its uses in sensing. Understand the concept of the internal resistance of cells and the link to emf.	Demonstrate knowledge and understanding of circular motion as an accelerated motion, apply knowledge and understanding of forces to identify centripetal forces. Demonstrate understanding of the relationship between degrees and radians. Derive, apply and recall $\omega = v / r = 2\pi f$, $a = v^2/r = \omega^2 r$, $F = mv^2/r = m\omega^2 r$, to
Language for Life (Key terms/Vocabulary)	Si, prefix, suffix, precision, repeatability, reproducibility, accuracy, absolute and percentage uncertainty. Proton, neutron, electron, nucleon, nuclide, isotope,	Photoelectric effect, threshold frequency, work function, ionisation, excitation, fluorescent, electron volt, spectra,	Path difference, coherence, interference, diffraction, monochromatic, fringes, Young's two slits, laser, maxima, minima, diffraction grating.	Scalar, vector, resolution, components, coplanar, perpendicular, horizontal, moment, couple, centre of mass, displacement, speed, velocity, acceleration, gravity,	Current, charge, Coulomb, potential difference, Volt, Ampere, resistance, Ohm, ohmic and non-ohmic conductor, semiconductor, diode, thermistor, LDR, LED,	Scalar, vector, degree, radian, centripetal force, centripetal acceleration.

	strong nuclear force, alpha, beta , gamma decay, neutrino, antiparticle, photon, antimatter, annihilation, fundamental interactions, strong, weak, gravitational and electromagnetic, Feynman, hadron, baryon, pion, kaons, lepton, muon, strange particles, quark, antiquark.	discrete, electron diffraction, de Broglie. Amplitude, frequency, period, wavelength, phase, phase difference, transverse, longitudinal, polarisation, stationary wave, node, antinode, harmonic, radians	Density, area, volume, Hooke's law, elastic limit, tensile stress, tensile strain, breaking stress, plastic behaviour, fracture, brittle behaviour, energy stores, energy transfer,	friction, drag, projectile, momentum, elastic, inelastic, collision, conservation of energy and power, work, efficiency	resistivity, superconductor, resistors, series, parallel, electrical power, potential divider, electromotive force, internal resistance, terminals, variable resistor.	
Extended writing Opportunities	Past examination questions 5/6 marks Kerboodle worksheets and end of unit tests with long responses.	Past examination questions 5/6 marks Kerboodle worksheets and end of unit tests with long responses.	Past examination questions 5/6 marks Kerboodle worksheets and end of unit tests with long responses.	Past examination questions 5/6 marks Kerboodle worksheets and end of unit tests with long responses.	Past examination questions 5/6 marks Kerboodle worksheets and end of unit tests with long responses.	Past examination questions 5/6 marks Kerboodle worksheets and end of unit tests with long responses.
Maths Across the Curriculum	Conversion between quantities use of standard form. Principles of calculating uncertainties when errors are added, subtracted, multiplies or raised to a power. Understanding and drawing of error bars. Use of orders of magnitude. Solve algebraic equations. Draw graphs, solve annihilation equations. Analysis of decay equations.	Solve the photoelectric equation. Plot and interpret graphs of maximum kinetic energy of emitted electrons against frequency of incident light. Determine the intercept and gradient of the maximum kinetic energy against frequency graph to find a value for Planck's constant, threshold frequency and work function. Solve the equation relating the energy differences between levels to the frequencies and wavelengths of emitted photons. Waves Use the equation C=fλ Use of sin in wave modelling. Understanding of principles of Radians and calculation using radians and conversion to degrees.	Use trigonometry to derive and prove the equations for Young's two slit and single slit diffraction including approximations for small angles. Measure angles, use of the equations for refraction. Bulk properties of solids Use of Hooke's law equation and derivation of energy stored in an elastic system. Use of ratios in density calculations for alloys. Use of Young modulus equation, translate information between graphical, numerical and algebraic forms	Solve motion problems using the suvat equations in practical contexts. Find means. Apply trigonometry to resolve forces. Change the subject of equations. Apply concepts that underlie calculus. Use of sin,cos and 2D diagrams in projectile motion. Use, rearrange Newton's laws. Draw free body diagrams. Calculate areas under graphs for impulse. Knowledge and understanding of formulae for KE and GPE, calculate work done and efficiency.	Use and rearrangement of the equations for Ohm's law, current, charge, potential difference and power. Plotting current voltage characteristics in 4 quadrants. Derivation and use of resistivity equation. Use of equations for area of shapes, use of inverse in calculations. Plot experimental data and find the intercept and gradient of a graph, y=mx+c	Understand relationship between degrees and Radians. Derivation and use of $\omega = v/r = 2\pi f$, $a = v^2/r = \omega^2 r$, $F = mv^2/r = m\omega^2 r$, to
Links to careers/ aspirations	Measurement and understanding of errors required in all branches of engineering. Nuclear physics Medical physics	Nuclear physicist, radiographer Medical physicist Astrophysics	Lighting design and effects Mechanical engineering	Engineering Weapons engineer	Electrical engineering, electrician, medical physicist	Theme park designer, Space physics
Cultural Capital	Why was specific charge important in JJ Thompson's work? What is happening in decay series? Who was Feynman and why was he important? How annihilation of matter and antimatter used in PET scans? What is the Higg's boson and why is it so important in the standard model?	What are the uses of line spectra in astrophysics? Can protons or neutrons be diffracted? Why do electron microscopes have a much greater resolution than optical microscopes? How is the speed of light measured? What effect does motion of a light source have on the speed? How are standing waves used in musical instruments?	How do the spectra from prisms and diffraction gratings differ? Can a clock ever work on an elastic band? Why is Young's modulus so important in engineering and how is it measured in commercial labs?	Are the centre of mass and centre of gravity always in the same position? What is the average velocity of a cyclist of constant velocity a quarter of the way round a track of circumference 400m? Are there other examples of the monkey and hunter problem? Explain the importance of cycle helmets.	What uses superconducting materials and what are the operational and long term issues with superconductivity? How are potential dividers used in neonatal units? Why must car batteries have a very low internal resistance?	What forces do you experience when travelling round a corner at constant speed?
Practical Application of Skills	A range of measurement practicals for students to familiarise themselves with key new equipment and give the opportunity to estimate uncertainties eg link between time period and length for a pendulum. Demonstrate α and β in a cloud chamber if available, and absorption.	Demonstration of the photoelectric effect, line spectra from discharge tubes using spectroscopes or diffraction gratings. Demonstration of electron diffraction tube if available and compare with a laser. Generate and measure waves in a tray or a ripple tank including the effect of water depth. Use a slinky to model waves. Demonstrate and investigate polarisation of light and microwaves using microwave generator kit. Required practical investigate the variation of frequency of stationary waves on a string with length, tension and mass per unit length. Demonstrate standing waves on strings, sound waves and microwaves.	Demonstration of interference with a double slit and laser. Required practical investigation of interference effects to include Young's slit experiment and interference by diffraction grating. Interference of white light and monochromatic sources. Interference of sound waves. Demonstration and investigation of the single slit diffraction pattern including changing slit width, investigate diffraction gratings. Investigate refraction and Snell's law for transparent materials ,using several methods, investigate TIR and determine critical angle in a semi circular block. Demonstrate optical fibres if available. Materials part 2 Investigate elastic behaviour of a variety of materials. Investigate behaviour of springs in series and parallel. Find densities of a variety of objects. Required practical Determination of Young modulus by any simple method.	Mechanics, materials section 1 Investigation of the parallelogram of forces for three masses using a pulley system. Investigation on resolving forces with toy cars and change of slope angle. Experimental investigation of moments, determination of centre of mass of irregular card shape. Use light gates or ticker timers to obtain data for trollies on slopes or on an air track Required practical determination of g by free fall using a g ball. Investigate projectile motion eg monkey and hunter experiment, consider the effects of air resistance. Investigate air resistance and terminal velocity, investigate motion through viscous fluid. Investigation of Newton's second law using trollies or air track. Investigate momentum using trollies. Investigate personal power and the efficiency of a motor. Investigate energy changes in a bouncing ball.	Investigation of current voltage characteristics of components, construct a variety of circuits and measure current and voltage using multimeters. Required practical Determination of the resistivity of a wire using a micrometre, ammeter and voltmeter. Investigate thermistors. Investigate potential divider circuits. Required practical Investigation of the emf and internal resistance of electric cells and batteries by measuring the variation of the terminal pd with current in it.	Experiment with whirling bung and bucket on a string. Helium balloon in a car experiment