Key: ***Bold** writing shows development or progression from previous year. *<u>Underline</u> shows cross-over of key concepts with other end-points

Faculty: Science		**Subject: A'level Physics**	
End points	**Year 11**	**Year 12**	**Year 13**
Understanding of how all interactions in the Universe are reliant on forces being exchanged between two or more bodies, and that these force interactions are inextricable from the corresponding energy and momentum conservation within systems.		This section provides knowledge and understanding of key ideas used to describe and analyse the motion of objects in both one-dimension and in two-dimensions. It also provides learners with opportunities to develop their analytical and experimental skills. The motion of a variety of objects can be analysed using ICT or data-logging techniques (HSW3). Learners also have the opportunity to analyse and interpret experimental data by recognising relationships between physical quantities (HSW5). The analysis of motion gives many opportunities to link to How Science Works. Examples relate to detecting the speed of moving vehicles, stopping distances and freefall (HSW2, 9, 10, 11, 12). This section provides knowledge and understanding of the motion of an object when it experiences several forces and also the equilibrium of an object. Learners will also learn how pressure differences give rise to an upthrust on an object in a fluid. There are opportunities to consider contemporary applications of terminal velocity, moments, couples, pressure, and Archimedes principle (HSW6, 7, 9, 11, 12). Experimental work must play a pivotal role in the acquisition of key concepts and skills (HSW4).	There are many examples of objects travelling at constant speed in circles, e.g. planets, artificial satellites, charged particles in a magnetic field, etc. The physics in all these cases can be described and analysed using the ideas developed by Newton. The concepts in this section have applications in many contexts present in other sections of this specification, such as planetary motion in section 5.4.3 (HSW1, 2, 5, 9). This section provides knowledge and understanding of circular motion and important concepts such as centripetal force and acceleration. Oscillatory motion is all around us, with examples including atoms vibrating in a solid, a bridge swaying in the wind, the motion of pistons of a car and the motion of tides. (HSW1, 2, 3, 5, 6, 8, 9, 10, 12) This section provides knowledge and understanding of simple harmonic motion, forced oscillations and resonance.

		This section provides knowledge and understanding of Newton's laws – fundamental laws that can be used to predict the motion of all colliding or interacting objects in applications such as sport (HSW1, 2). Newton's law can also be used to understand some of the safety features in cars, such as air bags, and to evaluate the benefits and risks of such features (HSW9). Learners should be aware that the introduction of mandatory safety features in cars is a consequence of the scientific community analysing the forces involved in collisions and investigating potential solutions to reduce the likelihood of personal injury (HSW10, 11, 12). There are many opportunities for learners to carry out experimental work and analyse data using ICT techniques (HSW3).	This section provides knowledge and understanding of Newton's law of gravitation, planetary motion and gravitational potential and energy. Newton's law of gravitation can be used to predict the motion of orbiting satellites, planets and even why some objects in our Solar system have very little atmosphere with the opportunity to analyse evidence and look at causal relationships (HSW1, 2, 5, 7). Geostationary satellites have done much to improve telecommunications around the world. They are expensive; governments and industry have to make difficult decisions when building new ones. Learners have the opportunity to discuss the societal benefits of satellites and the risks they pose when accidents do occur (HSW9, 10).
	NC/Spec coverage	**NC/Spec coverage** • Motion • Forces in action • Newton's laws of motion and momentum	**NC/Spec coverage** • Gravitational fields • Electric fields • Circular motion • Oscillations
Understanding of how all matter is made up of tiny particles, significantly smaller than the cells studied in biology. The particles are always moving, have spaces between them,		**This section examines the physical properties of springs and materials.** **Learners can carry out a range of experimental work**	This section provides knowledge and understanding of temperature, matter, specific heat capacity and specific latent heat with contexts

and adding heat to them makes them move faster. How the particles are arranged and move dictates the state and properties of the macroscopic substances we interact with every day.		**to enhance their knowledge and skills, including the management of risks and analysis of data to provide evidence for relationships between physical quantities. There are opportunities to consider the selection of appropriate materials for practical applications (HSW5, 6, 8, 9, 12).**	involving heat transfer and change of phase (HSW1, 2, 5, 7). Experimental work can be carried out to safely investigate specific heat capacity of materials (HSW4). It also provides an opportunity to discuss how Newton's laws can be used to model the behaviour of gases (HSW1) and significant opportunities
	NC/Spec coverage	**NC/Spec coverage** • Materials	**NC/Spec coverage** • Thermal physics
Understanding that the atoms that contribute to particle theory are themselves composed of even smaller particles. The compositions and arrangements of these smaller particles dictates the chemical properties of substances, and changing these can lead to drastic and unexpected energy changes.			This section provides knowledge and understanding of the atom, nucleus, fundamental particles, radioactivity, fission and fusion. Nuclear power stations provide a significant fraction of the energy needs of many countries. They are expensive; governments have to make difficult decisions when building new ones. The building of nuclear power stations can be used to evaluate the benefits and risks to society (HSW9). Ethical, environmental and decision making issues may also be discussed (HSW10 and HSW12). The development of the atomic model also addresses issues of scientific

			development and validation (HSW7, 11).
	NC/Spec coverage	**NC/Spec coverage**	**NC/Spec coverage** • Quantum physics • Nuclear and particle physics
Understanding that all particles carry an abstract quantity labelled as energy that can be stored in different stores, which can be transferred between stores or between systems but is always conserved. In some forms energy cannot be observed and has the potential to do work; in others it causes movement of particles or whole systems.		Words like energy, power and work have very precise meaning in physics. In this section the important link between work done and energy is explored. Learners have the opportunity to apply the important principle of conservation of energy to a range of situations. The analysis of energy transfers provides the opportunity for calculations of efficiency and the subsequent evaluation of issues relating to the individual and society (HSW2, 5, 8, 9, 10, 11, 12).	
	NC/Spec coverage	**NC/Spec coverage** • Work, energy and power	**NC/Spec coverage**
Understanding that energy can be transferred through media in the form of waves, with no net transfer of matter. Waves can interact with matter and with one another in a multitude of ways with predictable, if unintuitive, outcomes.		**This section provides knowledge and understanding of wave properties, electromagnetic waves, superposition and stationary waves. The wavelength of visible light is too small to be measured directly using a ruler.** **However, superposition experiments can be done in the laboratory to determine wavelength of visible light using a laser and a double slit.** **There are opportunities to discuss how the double-slit experiment demonstrated the wave-like behaviour of light (HSW7).** **The breadth of the topic covering sound waves and the electromagnetic spectrum provides scope for learners to appreciate the wide**	This section provides knowledge and understanding of X-rays, CAT scans, PET scans and ultrasound scans. This section shows how the developments in medical imaging have led to a number of valuable non-invasive techniques used in hospitals. Not all hospitals in this country are equipped with complex scanners. Learners have the chance to discuss

		ranging applications of waves and their properties. (HSW1, 2, 5, 8, 9, 12) **This section provides knowledge and understanding of photons, the photoelectric effect, de Broglie waves and wave–particle duality. In the photoelectric effect experiment, electromagnetic waves are used to eject surface electrons from metals. The electrons are ejected instantaneously and their energy is independent of the intensity of the radiation. The wave model is unable to explain the interaction of these waves with matter. This single experiment led to the development of the photon model and was the cornerstone of quantum physics. Learners have the opportunity to carry out internet research into how the ideas of quantum physics developed (HSW1, 2, 7) and how scientific community validates the integrity**	the ethical issues in the treatment of humans and the ways in which society uses science to inform decision making (HSW10 and 12).
	NC/Spec coverage	**NC/Spec coverage** • Waves • Quantum physics	**NC/Spec coverage** • Medical imaging
Understanding that the two fields of electricity and magnetism are fundamentally and invariably linked, and as a result, the flow of electrically charged objects results in the existence of corresponding magnetic fields.		**The aim of this module is to ultimately introduce key ideas of quantum physics. Electromagnetic waves (e.g. light) have a dual nature. They exhibit both wave and particle-like behaviour. The wave–particle dual nature is also found to be characteristic of all particles (e.g. electrons). Before any sophisticated work can be done on quantum physics, learners need to appreciate what electrons are and how they behave in electrical circuits. A basic understanding of wave properties is also required.** **In this module, learners will learn about electrons, electric current, electrical circuits, wave properties, electromagnetic waves and, of course, quantum physics.**	This section introduces the basic properties of capacitors and how they are used in electrical circuits. The use of capacitors as a source of electrical energy is then developed. This section introduces the mathematics of exponential decay, which is also required for the decay of radioactive nuclei in 6.4. This section provides knowledge and understanding of capacitors and exponential decay.

		Learners have the opportunity to appreciate how scientific ideas of quantum physics developed over time (HSW7) and their validity rested on the foundations of experimental work (HSW1 and HSW2). **This short section introduces the ideas of charge and current. Understanding electric current is essential when dealing with electrical circuits. This section does not lend itself to practical work but to introducing important ideas. The continuity equation (I = Anev) is developed using these key ideas. This section concludes with categorising all materials in terms of their ability to conduct.** **This section provides knowledge and understanding of electrical circuits, internal resistance and potential dividers. LDRs and thermistors are used to show how changes in light intensity and temperature respectively can be monitored using potential dividers. Setting up electrical circuits, including potential divider circuits, provides an ideal way of enhancing experimental skills, understanding electrical concepts and managing risks when using power supplies (HSW4). Learners are encouraged to communicate scientific ideas using appropriate terminology (HSW8).** **This section provides ample opportunities for learners to design circuits and carry out appropriate testing for faults and there are opportunities to study the many applications of electrical circuits (HSW1, 2, 3, 5, 6,9, 12).**	Experimental work provides an excellent way to understand the behaviour of capacitors in electrical circuits and the management of safety and risks when using power supplies (HSW4). There are many opportunities for learners to use spreadsheets in the analysis and presentation of data (HSW3). The varied uses of capacitors give the opportunity for the consideration of their use in many practical applications (HSW2, 5, 6, 9) This section provides knowledge and understanding of Coulomb's law, uniform electric fields, electric potential and energy. This section provides knowledge and understanding of magnetic fields, motion of charged particles in magnetic fields, Lenz's law and Faraday's law. The application of Faraday's law may be used to demonstrate how science has benefited society with important devices such as generators and transformers. Transformers are used in the transmission of electrical energy using the national

			grid and are an integral part of many electrical devices in our homes. The application of Lenz's law allows discussion of the use of scientific knowledge to present a scientific argument (HSW1, 2, 3, 5, 6, 7, 8, 9, 11, 12).
	NC/Spec coverage	**NC/Spec coverage** • Charge and current • Energy, power and resistance • Electrical circuits	**NC/Spec coverage** • Capacitors • Electric fields • Electromagnetism
1. Understanding that physics uses models to approximate theories, (given assumptions), and that these are those that best fit the empirical evidence known at a given time, and an appreciation of the scientific method of approach to validating and testing theories.			The aim of this module is to show the impact Newtonian mechanics has on physics. The microscopic motion of atoms can be modelled using Newton's laws and hence provide us with an understanding of macroscopic quantities such as pressure and temperature. Newton's law of gravitation can be used to predict the motion of planets and distant galaxies. In the final section we explore the intricacies of stars and the expansion of the Universe by analysing the electromagnetic radiation from space. As such, it lends itself to the consideration of how the development of the scientific model is improved based on the advances

			in the means of observation (HSW1, 2, 5, 6, 7, 8, 9, 11). In this module, learners will learn about thermal physics, circular motion, oscillations, gravitational field, astrophysics and cosmology. This section provides knowledge and understanding of stars, Wien's displacement law, Stefan's law, Hubble's law and the Big Bang. Learners have the opportunity to appreciate how scientific ideas of the Big Bang developed over time and how its validity is supported by research and experimental work carried out by the scientific community (HSW2, 7, 8, 11).
	NC/Spec coverage	**NC/Spec coverage**	**NC/Spec coverage** • Astrophysics and cosmology
1. The ability to use a range of mathematical tools to calculate, manipulate, predict and represent physical systems and processes.			
	NC/Spec coverage	**NC/Spec coverage**	**NC/Spec coverage**