Beths Grammar School KS5 Physics Curriculum Map

Term **OCR A Level Physics A**	**INTENT** **Substantive Knowledge** This is the specific, factual content for the topic, which should be connected into a careful sequence of learning.	**IMPLEMENTATION** **Disciplinary Knowledge (Skills)** This is the action taken within a particular topic in order to gain substantive knowledge.	**IMPACT** **Assessment opportunities** What assessments will be used to measure student progress? Evidence of how well students have learned the intended content.
Autumn Term 1A Year 13	**Module 5.3 Oscillations** **Intent** Why is this taught now? Oscillations build on the concepts and principles introduced in circular motion. This will help students to understand concepts of periodic motion such as frequency, period and amplitude and the relationship between angular velocity and angular acceleration which is an important concept in oscillatory motion Simple harmonic motion, the equations of simple harmonic motion, graphical analysis, of simple harmonic motion, energy of a simple harmonic motion, damping, resonance	Demonstrate and apply their knowledge and understanding of: • displacement, amplitude, period, frequency, angular frequency and phase difference • angular frequency ω; $\omega = \frac{2\pi}{T}$ or $\omega = 2\pi f$ • simple harmonic motion; defining equation $a = -\omega^2 x$ • solutions to the equation $a = -\omega^2 x$, e.g. $x = A \cos \omega t$ or $x = A \sin \omega t$ • velocity: $v = \pm \omega \sqrt{(A^2 - x^2)}$ hence $v_{max} = \omega A$ • graphical methods to relate the changes in displacement, velocity and acceleration during simple harmonic motion. • the interchange between kinetic and potential energy during simple harmonic motion • energy–displacement graphs for a simple harmonic oscillator. • the period of a simple harmonic oscillator is independent of its amplitude (isochronous oscillator) • techniques and procedures used to determine the period/frequency of simple harmonic oscillations. • the effects of damping on an oscillatory system • forced and damped oscillations for a range of systems (continued in Topic 5.3.6).	Classwork and homework tasks. In class teacher assessment through Q & A Knowledge recall activity. Teacher assessment during lesson. Practice exam-styled questions. Use online physics self-assessment website (Isaac Physics, Seneca) All students will sit a similar standard formal assessment on topics covered in year 12.

		• free and forced oscillations • resonance; natural frequency • amplitude–driving frequency graphs for forced oscillators • practical examples of forced oscillations and resonance.	
	Module 6.2 Electric fields **<u>Intent</u>** Why is this taught now? Students need to have some knowledge about capacitors before studying electric fields because capacitors are devices that store electric charge and energy in an electric field. This will help students understand practical applications of electric fields in real life applications like capacitors. Electric fields, Coulombs law, uniform electric fields, electric potential and electric potential energy.	Demonstrate and apply their knowledge and understanding of: • the concept of electric fields as being one of a number of forms of field giving rise to a force • electric fields being due to charges • modelling a uniformly charged sphere as a point charge at its centre • electric field lines to map electric fields • electric field strength; $E = \frac{F}{Q}$ • Coulomb's law; $F = \frac{Qq}{4\pi\varepsilon_0 r^2}$ for the force between two point charges • electric field strength $E = \frac{Q}{4\pi\varepsilon_0 r^2}$ for a point charge • similarities and differences between the gravitational field of a point mass and the electric field of a point charge. • uniform electric field strength; $E = \frac{V}{d}$ • parallel plate capacitors; permittivity; $C = \frac{\varepsilon_0 A}{d}$; $C = \frac{\varepsilon A}{d}$; $\varepsilon = \varepsilon_r \varepsilon_0$ • motion of charged particles in a uniform electric field. • electric potential at a point as the work done in bringing unit charge from infinity to the point; electric potential being zero at infinity	

		• electric potential $V = \frac{Q}{4\pi\varepsilon_0 r}$ at a distance r from a point charge; changes in electric potential • capacitance $C = 4\pi\varepsilon_0 R$ for an isolated sphere • force–distance graphs for a point or spherical charge; work done being area under graph • electric potential energy $E = Vq = \frac{Qq}{4\pi\varepsilon_0 r}$ at a distance r from a point charge Q.	
Autumn Term 1B Year 13	**Module 5.4 Gravitational fields** **<u>Intent</u>** Why is this taught now? Students need to have some knowledge about oscillations before moving on to gravitational fields. This will help them understand how forces and fields influence motion of objects and how these concepts ate interconnected in physics. Gravitational fields, newton's law of gravitation, the motion of planets and satellites, gravitational and gravitational potential energy	Demonstrate and apply their knowledge and understanding of: • gravitational fields being due to objects having mass • gravitational field lines used to map gravitational fields • gravitational field strength: $g = \frac{F}{m}$ • the concept of gravitational fields as one of a number of forms of field giving rise to a force (continued in Topic 5.4.2) • gravitational field strength being uniform close to the surface of the Earth and numerically equal to the acceleration of free fall (continued in Topic 5.4.2). • Newton's law of gravitation: $F = -\frac{GMm}{r^2}$ for the force between two point masses • gravitational field strength: $g = -\frac{GM}{r^2}$ for a point mass • the concept of gravitational fields as being one of a number of forms of field giving rise to a force (continued from Topic 5.4.1) • modelling the mass of a spherical object as a point mass at its centre • gravitational field strength as being uniform close to the surface of the Earth and numerically equal to the acceleration of free fall (continued from Topic 5.4.1).	Classwork and homework tasks. In class teacher assessment through Q & A Knowledge recall activity. Teacher assessment during lesson. Practice exam-styled questions. Use online physics self-assessment website (Isaac Physics, Seneca) All students will sit a similar standard formal module test.

		• Kepler's three laws of planetary motion • the equation $T^2 = \left(\frac{4\pi^2}{GM}\right)r^3$ • the centripetal force on a planet provided by the gravitational force between it and the Sun • the relationship for Kepler's third law $T^2 \propto r^3$ applied to systems other than our Solar System • geostationary orbit; uses of geostationary satellites. • gravitational potential at a point as the work done in bringing unit mass from infinity to the point; gravitational potential is zero at infinity • gravitational potential: $V_g = -\frac{GM}{r}$ at a distance r from a point mass M; changes in gravitational potential • gravitational potential energy: $E = mV_g = -\frac{GMm}{r}$ at a distance r from a point mass M • force–distance graphs for point or spherical masses; work done is area under graph • escape velocity.	

	Module 6.3 Electromagnetism **<u>Intent</u>** Why is this taught now? Electromagnetism builds on the principles and concepts of electric fields. By learning electric fields first, students will gain a better understanding of how electric currents and magnetic field are related in electromagnetism. It also helps students to build upon their knowledge and make connections between electricity and magnetism. Magnetic fields, magnetic flux and magnetic flux density, forces on a current carrying wire, motions of charged particles in a magnetic and electric fields, electromagnetic induction, Faraday's and Lenz's law, the a.c. generator, transformers	Demonstrate and apply their knowledge and understanding of: • magnetic fields being due to moving charges or permanent magnets • magnetic field lines to map magnetic fields • magnetic field patterns for a long straight current-carrying conductor, a flat coil and a long solenoid. • magnetic flux density; the unit tesla • magnetic flux φ; the unit weber; $\varphi = BA\cos\theta$ • Fleming's left-hand rule • force on a current-carrying conductor; $F = BIL\sin\theta$ • techniques and procedures used to determine the uniform magnetic flux density between the poles of a magnet using a current-carrying wire and digital balance. • force on a charged particle travelling at right angles to a uniform magnetic field; $F = BQv$ • charged particles moving in a uniform magnetic field; circular orbits of charged particles in a uniform magnetic field • charged particles moving in a region occupied by both electric and magnetic fields; velocity selector. • magnetic flux linkage • magnetic flux φ; the unit weber; $\varphi = BA\cos\theta$ • Faraday's law of electromagnetic induction and Lenz's law • e.m.f. = −rate of change of magnetic flux linkage; $\varepsilon = -\frac{\Delta(N\phi)}{\Delta t}$ (continued in Topic 6.3.7) • techniques and procedures used to investigate magnetic flux using search coils. • e.m.f. = −rate of change of magnetic flux linkage; $\varepsilon = -\frac{\Delta(N\phi)}{\Delta t}$ (continued from Topic 6.3.6)	

		• the simple a.c. generator • a simple laminated iron-cored transformer; $\frac{n_s}{n_p} = \frac{V_s}{V_p} = \frac{I_p}{I_s}$ for an ideal transformer • techniques and procedures used to investigate transformers.	
Spring Term 2A Year 13	**Module 5.1 Thermal physics** **<u>Intent</u>** Why is this taught now? This is taught in year 2 because students would have already developed a strong foundation in physics are better prepared to tackle more advanced concepts. Temperature, solids, liquids and gases, internal energy, Brownian motion, specific heat capacity, specific latent heat, the amount of substance, the kinetic theory and pressure of gases, investigating gases, the ideal gas equation, the Boltzmann constant.	Demonstrate and apply their knowledge and understanding of: • thermal equilibrium • absolute scale of temperature (i.e. the thermodynamic scale) that does not depend on property of any particular substance • temperature measurements both in degrees Celsius (°C) and in kelvin (K) • $T(\text{K}) \approx \theta(°\text{C}) + 273$ • absolute zero (0 K) as the lowest limit for temperature; the temperature at which a substance has minimum internal energy (continued in topic 5.1.3). • solids, liquids and gases in terms of the spacing, ordering and motion of atoms or molecules • the simple kinetic model for solids, liquids and gases. • internal energy as the sum of the random distribution of kinetic and potential energies associated with the molecules of a system • absolute zero (0 K) as the lowest limit for temperature; the temperature at which a substance has minimum internal energy • increase in the internal energy of a body as its temperature rises	Classwork and homework tasks. In class teacher assessment through Q & A Knowledge recall activity. Teacher assessment during lesson. Practice exam-styled questions. Use online physics self-assessment website (Isaac Physics, Seneca) A formal trial exam will be sat by all students. Students will be examined on all module covered.

		• changes in the internal energy of a substance during change of phase; constant temperature during change of phase (continued in Topic 5.1.6). • Brownian motion in terms of the kinetic model of matter and a simple demonstration using smoke particles suspended in air. • specific heat capacity of a substance; the equation $E = mc\Delta\theta$ • an electrical experiment to determine the specific heat capacity of a metal or a liquid • techniques and procedures used for an electrical method to determine the specific heat capacity of a metal block and a liquid. • changes in the internal energy of a substance during change of phase; constant temperature during change of phase • specific latent heat of fusion and specific latent heat of vaporisation; $E = mL$ • an electrical experiment to determine the specific latent heat of fusion and vaporisation • techniques and procedures used for an electrical method to determine the specific latent heat of a solid and a liquid. • amount of substance in moles; Avogadro constant $N_A = 6.02 \times 10^{23}$ mol^{-1}. • model of kinetic theory of gases • pressure in terms of this model • internal energy of an ideal gas • the equation $pV = \frac{1}{3}Nm\overline{c^2}$, where N is the number of particles (atoms or molecules) and $\overline{c^2}$ is the mean square speed • root mean square (r.m.s.) speed; mean square speed. • techniques and procedures used to investigate pV = constant (Boyle's law) and $\frac{p}{T}$ = constant (continued in Topic 5.1.10)	

		• an estimation of absolute zero using variation of gas temperature with pressure. • the equation of state of an ideal gas $pV = nRT$, where n is the number of moles. • the Boltzmann constant; $k = \frac{R}{N_A}$ • $pV = NkT$; $\frac{1}{2}m\overline{c^2} = \frac{3}{2}kT$	
	Module 6.4 Nuclear and particle physics **<u>Intent</u>** Why is this taught now? The topic is taught after electromagnetism, because it serves as a foundation for understanding the behaviour of particles and nuclei at subatomic levels. It students build on their existing knowledge and skill, making it easier to grasp more complex and abstract concepts. The nuclear atom, the strong nuclear force, nuclear decay, nuclear density, fundamental particles, radioactivity, radioactive decay,	Demonstrate and apply their knowledge and understanding of: • the alpha particle scattering experiment; evidence of a small, charged nucleus • a simple nuclear model of the atom; protons, neutrons and electrons • relative sizes of atom and nucleus • proton number; nucleon number; isotopes; notation $^{A}_{Z}X$ for the representation of nuclei. • strong nuclear force; short-range nature of the force; attractive to about 3 fm and repulsive below about 0.5 fm. • the radius of nuclei; $R = r_0A^{\frac{1}{3}}$ where r_0 is a constant and A is the nucleon number • mean densities of atoms and nuclei. • particles and antiparticles; electron–positron, proton–antiproton; neutron–antineutron and neutrino–antineutrino	

	radioactive decay equations and half-life, radioactive dating, mass energy conversion, nuclear fission, nuclear fusion.	• corresponding particles and antiparticles having the same mass; electron and positron having opposite charge; proton and antiproton having opposite charge • classification of hadrons; proton and neutron as examples of hadrons; all hadrons are subject to the strong nuclear force • classification of leptons; electron and neutrino as examples of leptons; all leptons are subject to the weak nuclear force • the simple quark model of hadrons in terms of up (u), down (d) and strange (s) quarks and their respective antiquarks • the quark model of the proton (uud) and the neutron (udd) • charges of the up (u), down (d), strange (s), anti-up ($\bar{u}$) , anti-down ($\bar{d}$) and the anti-strange ($\bar{s}$) quarks as fractions of the elementary charge e • decay of particles in terms of the quark model. • radioactive decay; spontaneous and random nature of decay (continued in Topic 6.4.7) • α-particles, β-particles and γ-rays; nature, penetration and range of these radiations • techniques and procedures used to investigate the absorption of α-particles, β-particles and γ-rays by appropriate materials. • nuclear decay equations for alpha, beta-minus and beta-plus decays; balancing nuclear transformation equations • beta-minus (β^-) decay; beta-plus (β^+) decay • β^- decay in terms of a quark model; $d \rightarrow u + {}^{0}_{-1}e + \nu$ • β^+ decay in terms of a quark model; $u \rightarrow d + {}^{0}_{-1}e + \nu$ • balancing of quark transformation equations in terms of charge. • activity of a source; decay constant λ of an isotope; $A = \lambda N$ • the equations $A = A_0e^{-\lambda t}$ and $N = N_0e^{-\lambda t}$, where A is the activity and N is the number of undecayed nuclei • radioactive decay; spontaneous and random nature of decay (continued from Topic 6.4.5)	

		• half-life of an isotope; $\lambda_{t1/2} = \ln(2)$ • graphical methods and spreadsheet modelling of the equation $\frac{\Delta N}{\Delta T} = -\lambda N$ for radioactive decay • techniques and procedures used to determine the half-life of an isotope such as protactinium • simulation of radioactive decay using dice. • radioactive dating, e.g. carbon dating. • Einstein's mass–energy equation; $\Delta E = \Delta mc^2$ • energy released (or absorbed) in simple nuclear reactions (continued in Topics 6.4.10 and 6.4.11) • creation and annihilation of particle–antiparticle pairs • mass defect; binding energy; binding energy per nucleon • binding energy per nucleon against nucleon number curve; energy changes in reactions • binding energy of nuclei using $\Delta E = \Delta mc^2$ and masses of nuclei. • energy released (or absorbed) in simple nuclear reactions (continued from Topic 6.4.9) • induced nuclear fission; chain reaction • balancing nuclear transformation equations (continued in Topic 6.4.11) • the basic structure of a fission reaction; components – fuel rods, control rods and moderator • the environmental impact of nuclear waste. • energy released (or absorbed) in simple nuclear reactions (continued from Topic 6.4.10) • nuclear fusion; fusion reactions and temperature • balancing nuclear transformation equations (continued from Topic 6.4.10).	
Spring Term 2B			

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Year 13	**Module 5.5 Astrophysics and cosmology** **<u>Intent</u>** Why is this taught now? This is taught after thermal physics, because thermal physics provides the basis for understanding concept in astronomy. Thermal physics deals with the study of heat, temperature, and energy transfer in systems and the behaviour of gases. This knowledge is essential for understanding the physical processes that occur in stars, planets, and other celestial objects, where temperature and energy play crucial roles in determining their structure and behaviour. The structure of the universe, stars formation and life cycle, electromagnetic radiation from stars, Wien's law and Stefan's law, astronomical distances, the doppler effect and red shift, the microwave background and the cosmological principle, the evolution and expansion of the universe, dark matter and dark energy.	Demonstrate and apply their knowledge and understanding of: • the terms planets, planetary satellites, comets, solar systems, galaxies and the Universe • the formation of a star from interstellar dust and gas in terms of gravitational collapse, fusion of hydrogen into helium, radiation and gas pressure (continued in Topic 5.5.2). • the formation of a star from interstellar dust and gas in terms of gravitational collapse, fusion of hydrogen into helium, radiation and gas pressure (continued from Topic 5.5.1) • the evolution of a low-mass star like our Sun into a red giant and white dwarf; planetary nebula • the characteristics of a white dwarf; electron degeneracy pressure; the Chandrasekhar limit • the evolution of a massive star into a red supergiant and then either a neutron star or a black hole; supernova • the characteristics of a neutron star and a black hole • the Hertzsprung–Russell (HR) diagram as a luminosity–temperature plot; main sequence; red giants; red super giants; white dwarfs. • the energy levels of electrons in isolated gas atoms • the idea that energy levels have negative values • emission spectral lines from hot gases in terms of emission of photons and transition of electrons between discrete energy levels • the equations $hf = \Delta E$ and $\frac{hc}{\lambda} = \Delta E$ • different atoms having different spectral lines which can be used to identify elements within stars • continuous spectra, emission line spectra and absorption line spectra	Classwork and homework tasks. In class teacher assessment through Q & A Knowledge recall activity. Teacher assessment during lesson. Practice exam-styled questions. Use online physics self-assessment website (Isaac Physics, Seneca) All students will sit a similar standard formal module test.

		• transmission diffraction gratings used to determine the wavelength of light • the condition for maxima $d \sin \theta = n\lambda$, where d is the grating spacing. • the use of Wien's displacement law $\lambda_{max} \propto \frac{1}{T}$ to estimate the peak surface temperature (of a star) • luminosity L of a star; Stefan's law $L = 4\pi r^2 \sigma T^4$ where σ is the Stefan constant • the use of Wien's displacement law and Stefan's law to estimate the radius of a star. • distances measured in astronomical units (AU), light-years (ly) and parsecs (pc) • stellar parallax; the parsec (pc) • the equation $p = \frac{1}{d}$, where p is the parallax in seconds of arc and d is the distance in parsec • the Doppler effect; Doppler shift of electromagnetic radiation • the Doppler equation $\frac{\Delta\lambda}{\lambda} \approx \frac{\Delta f}{f} \approx \frac{v}{c}$ for a source of electromagnetic radiation moving relative to an observer • Hubble's law: $v \approx H_0 d$ for receding galaxies, where H_0 is the Hubble constant • the model of an expanding Universe supported by galactic red shift • the Hubble constant H_0 in both km s^{-1} Mpc^{-1} and s^{-1} units • estimation for the age of the Universe: $t \approx H_0^{-1}$ • the cosmological principle: the Universe is homogeneous, isotropic and the laws of physics are universal (continued in Topic 5.5.8) • the Big Bang theory	

		- experimental evidence for the Big Bang theory from microwave background radiation at a temperature of 2.7 K (continued in Topic 5.5.8). - the cosmological principle: the Universe is homogeneous, isotropic and the laws of physics are universal (continued from Topic 5.5.7) - experimental evidence for the Big Bang theory from microwave background radiation at a temperature of 2.7 K (continued from 5.5.7) - the evolution of the Universe after the Big Bang to the present - the idea that the Big Bang gave rise to the expansion of space–time. - current ideas: the Universe is made up of dark energy, dark matter and a small percentage of ordinary matter.	
	Module 6.5 Medical imaging **<u>Intent</u>** Why is this taught now? X-rays, attenuation of x-rays, computerised axial tomography (CAT), the gamma camera,	Demonstrate and apply their knowledge and understanding of: - the basic structure of an X-ray tube; components – heater (cathode), anode, target metal and high voltage supply - the production of X-ray photons from an X-ray tube. - X-ray attenuation mechanisms; simple scatter, photoelectric effect, Compton effect and pair production - attenuation of X-rays; $I = I_0 e^{-\mu x}$, where μ is the attenuation (absorption) coefficient - X-ray imaging with contrast media; barium and iodine. - computerised axial tomography (CAT) scanning; components – rotating X-ray tube producing a thin fan-shaped X-ray beam, ring of detectors, computer software and display - advantages of a CAT scan over an X-ray image.	

	positron emission tomography (PET) scanning, ultrasound sound, acoustic impedance, the doppler effect	• medical tracers; technetium-99m and fluorine-18 (continued in Topic 6.5.5) • a gamma camera; components – collimator, scintillator, photomultiplier tubes, computer and display; formation of image • diagnosis using a gamma camera. • medical tracers; technetium-99m and fluorine-18 (continued from Topic 6.5.4) • positron emission tomography (PET) scanners; annihilation of positron–electron pairs; formation of images • diagnosis using PET scanning. • ultrasound; longitudinal wave with frequency greater than 20 kHz • piezoelectric effect; ultrasound transducer as a device that emits and receives ultrasound. • ultrasound A-scans and B-scans • acoustic impedance of a medium; $Z = \rho c$ • reflection of ultrasound at a boundary; $\frac{I_r}{I_0} = \frac{(Z_2 - Z_1)^2}{(Z_2 + Z_1)^2}$ • impedance (acoustic) matching; special gel used in ultrasound scanning. • the Doppler effect in ultrasound; speed of blood in the patient; $\frac{\Delta f}{f} = \frac{2v\cos\theta}{c}$ for determining the speed v of blood.	
Summer Term 3A Year 13	Review, catch up and Exam questions Practice **Intent** Why is this taught now?		

Beths Grammar School KS5 Physics Curriculum Map

	To close gaps in students' knowledge and prepare them for the exam.		
Summer Term 3B Year 13	**Intent** Why is this taught now?		
	External assessment (GCE Physics)		