Year 13 Physics Learning Journey

When?	Knowledge	Understanding	Assessment
Topic 17 Motion in a circle **Topic 18 – Simple Harmonic Motion**	**Topic 17 Motion in a circle** **Be able to:** • **Define and explain centripetal force** • **Calculate angular speed** • **Calculate centripetal acceleration** • **Calculate centripetal force** **Topic 18 – Simple Harmonic Motion** **Be able to:** • **State characteristic features of simple harmonic motion** • **State the condition for shm** • **Graphical representations linking x, v, a and t** • **Calculate maximum speed** • **Calculate maximum acceleration**	Students will carry out a range of practicals during the topic, some of which will be formally assessed for the practical endorsement qualification. **Topic 17 Motion in a circle** • Estimate the acceleration and centripetal force in situations that involve rotation. **Topic 18 – Simple Harmonic Motion** • Sketch relationships between x, v, a and a − t for simple harmonic oscillators. • Students should recognise the use of the small-angle approximation in the derivation of the time period for examples of approximate SHM. • Investigation of the factors that determine the resonant frequency of a driven system.	Topic 17 Motion in a Circle Test Topic 18 Simple Harmonic Motion Test

Topic 4 – Gravitational fields	**Topic 4 Gravitational fields** **Be able to:** • **Concept of a force field** • **Representation by gravitational field lines** • **Define g** • **Define and explain gravitational potential** • **Calculate work done in a moving mass** • **Calculate gravitational potential V** • **Define Gravity** • **Calculate the force between two point masses** • **Calculate the magnitude of g in a radial field** • **Describe relation of orbital period and speed to radius of circular orbit** • **Consider energy for an orbiting satellite** • **Significance of a geosynchronous orbit**	Students will carry out a range of practicals during the topic, some of which will be formally assessed for the practical endorsement qualification. **Topic 4 Gravitational fields** • Students can estimate the gravitational force between a variety of objects • Students should recognise that a force field can be represented as a vector, the direction of which must be determined by inspection • Students use graphical representations to investigate relationships between v, r and g • Estimate various parameters of planetary orbits, eg kinetic energy of a planet in orbit. • Use logarithmic plots to show relationships between T and r for given data **Topic 5 – Electric Fields** • Students can estimate the magnitude of the electrostatic force between various charge configurations • Students can investigate the patterns of various field configurations using conducting paper (2D) or electrolytic tank (3D). • Understanding of definition of absolute electric potential, including zero value at infinity, and of electric potential difference	Topic 4 Gravitational fields Test Topic 5 Electric Fields Test
Topic 5 Electric Fields	**Topic 5 – Electric Fields** **Be able to:** • **Define electric field strength, E** • **Represent electric field lines** • **Calculate E in a uniform field** • **Calculate work**		

	done in moving charge • **Calculate the force between charged particles using Coulomb's law** • **Compare electric and gravitational fields** • **Define and explain absolute electric potential** • **Calculate V in radial field** • **Calculate E in radial field**		
Topic 19 – Thermal physics	**Topic 19 Thermal physics** **Be able to:** • **Calculating the change in energy** • **Calculate for the change of temperature (specific heat capacity)** • **Calculating the change in energy** • **Calculate for the change of state (specific latent heat)** • **Calculating the change in energy** • **Calculate for the change of state (specific latent heat)**	Students will carry out a range of practicals during the topic, some of which will be formally assessed for the practical endorsement qualification. **Topic 19 Thermal physics** • Investigate the factors that affect the change in temperature of a substance using an electrical method or the method of mixtures. • Students should be able to identify random and systematic errors in the experiment and suggest ways to remove them. • Investigate, with a data logger and temperature sensor, the change in temperature with time of a substance undergoing a phase change when energy is supplied at a constant rate **Topic 6 – Capacitors** • Determine the relative permittivity of a dielectric	Topic 19 Thermal Physics Test Topic 6 Capacitors Test
Topic 6-			

Capacitors	**Topic 6 – Capacitors** **Be able to:** • **Define capacitance** • **Derivation of E = ½ QV** • **Interpretation of area under the graph of Q against V.** • **Graphical representation of charging/discharging capacitor** • **Calculate/determine time constant 'RC'** • **Quantitative treatment of capacitor discharge**	using a parallel-plate capacitor. • Investigate the relationship between C and the dimensions of a parallel-plate capacitor eg using a capacitance mete • Graphical representation of charging and discharging of capacitors through resistors. Corresponding graphs for Q, V and I against time for charging and discharging	
Topic 20- Gases	**Topic 20-Gases** **Be able to:** • **Describe gas laws as experimental relationships between p, V, T and m**	Students will carry out a range of practicals during the topic, some of which will be formally assessed for the practical endorsement qualification. **Topic 20-Gases** • Gas laws as experimental relationships between p,	Topic 20 Gases Test Topic 7 magnetic fields Test Topic 8 Electromagnetic Induction Test

	• **Concept of absolute zero** • **Define and explain ideal gas equation** • **Describe the difference between molar mass and molecular mass** • **Explain the relationship between p, V, and T using a simple molecular model** • **Derivation and assumptions leading to the kinetic theory equation** • **Calculate the average molecular KE**	V, T and the mass of the gas • Students should understand that the gas laws are empirical in nature whereas the kinetic theory model arises from theory • Appreciation of how knowledge and understanding of the behaviour of a gas has changed over time **Topic 7 – Magnetic Fields** • Investigate how the force on a wire varies with flux density, current and length of wire using a top pan balance • Convert between 2D representations and 3D situations • Investigate, using a search coil and oscilloscope, the effect on magnetic flux linkage of varying the angle between a search coil and magnetic field direction **Topic 8 – Electromagnetic induction** • Applications such as a straight conductor moving in a magnetic field • Use of an oscilloscope as a dc and ac voltmeter, to measure time intervals and frequencies, and to display ac waveforms • Investigate relationships between currents, voltages and numbers of coils in transformers	
Topic 7 – Magnetic Fields **Topic 8 - Electromagnetic induction**	**Topic 7 – Magnetic Fields** **Be able to:** • **Calculate force on charged particles/a current-carrying wire in a magnetic field** • **State Fleming's left-hand rule** • **Define magnetic flux density and tesla**		

	• **Application in devices such as cyclotrons** • **Define magnetic flux** **Topic 8 – Electromagnetic induction** **Be able to:** • **Describe simple experimental phenomena** • **State and explain Faraday's and Lenz's laws** • **Calculate the magnitude of induced emf as equal to rate of change of flux linkage** • **Define and calculate flux linkage** • **Applications such as a moving straight conductor** • **Calculate emf induced in a coil rotating uniformly in magnetic field** • **Describe the operation of a transformer** • **Use the transformer equation** • **Calculate the efficiency of a**		

	transformer		
A.1.3 Stars	**A.1.3 Stars** **Be able to:** • **Describe relation between brightness and apparent magnitude** • **Describe relation between intensity and apparent magnitude** • **Measure m from photographic plates** • **Define parsec and light year** • **Define M in relation to m** • **State Stefan's law and Wien's displacement law** • **Describe general shape of black-body curves** • **Use Wein's law to estimate temperature** • **Use Stefan's law to estimate temperature** • **State the inverse-square law and its assumptions** • **Description of main classes: O, B, A, F, G, K and M**	Students will carry out a range of practicals during the topic, some of which will be formally assessed for the practical endorsement qualification. **A.1.3 Stars** • General shape of black-body curves, use of Wien's displacement law to estimate black-body temperature of sources • Students should be familiar with the light curve of typical type 1a supernovae • Calculation of the radius of the event horizon for a black hole, Schwarzschild radius • Use of type 1a supernovae as standard candles to determine distances. Controversy concerning accelerating Universe and dark energy • Students should be familiar with the position of the Sun on the HR diagram **Topic 9 Radioactivity** • Appreciation of how knowledge and understanding of the structure of the nucleus has changed over time. • Appreciation of balance between risk and benefits in the uses of radiation in medicine • Investigation of the inverse-square law for gamma radiation • Investigate the decay equation using a variety of approaches (including the use of experimental data, dice simulations etc) and a variety of analytical methods. **Topic 10 –Nuclear Energy** • Existence of nuclear excited states; γ ray	Topic A.1.3 Stars Test Topic 9 Radioactivity Test Topic 10 Nuclear Energy Test

Topic 9 Radioactivity	**Describe the H-R diagram, general shape: main sequence, dwarfs and giants**	emission; application eg use of technetium-99m as a γ source in medical diagnosis	
	• **Describe stellar evolution – path of star similar to sun on H-R diagram**	• Students may be expected to identify, on the plot, the regions where nuclei will release energy when undergoing fission/fusion	
	• **Define properties of supernovae, neutron stars and black holes**	• Simple calculations involving mass difference and binding energy	
	• **Use of supernovae as standard candles**	• Simple calculations from nuclear masses of energy released in fission and fusion reactions	
		• Students study a simple mechanical model of moderation by elastic collisions	
	• **Describe supermassive black holes**	• Appreciation of balance between risk and benefits in the development of nuclear power.	
	• **Calculate the radius of an event horizon for a black hole**		
	Topic 9 Radioactivity **Be able to:** • **Qualitative study of Rutherford scattering** • **Describe α, β and γ radiation properties and experimental identification** • **Define and explain the inverse square law for γ radiation** • **Describe the experimental verification of the inverse square law** • **Describe the random**		

Topic 10 Nuclear Energy	**nature of radioactive decay**
	• **Calculate the constant decay probability**
	• **Calculate the half-life**
	• **Calculate the activity**
	• **Determination of above from graphical decay data**
	
	Topic 10 –Nuclear Energy
	Be able to:
	    • **Apply $E=mc^2$ to all energy changes**
	    • **Calculate mass difference and binding energy**
	    • **Interpret graph of average binding energy per nucleon against nucleon number**
	    • **Describe fission and fusion processes**
	    • **Calculate energy released in fission and fusion reactions**
	    • **Describe induced fission by thermal neutrons**
	    • **Explain the functions of the moderator, control rods and the coolant in a thermal nuclear reactor**		

	• **Describe the safety aspects**		
A.1.4 **A.1.1**	**A.1.4 Cosmology** **Be able to:** • **Calculate red-shift, frequency and wavelength given v << c** • **State Hubble's law and use to estimate age of universe** • **Qualitative treatment of Big Bang theory** • **Describe quasars** **A.1.1 Lenses and optical telescopes** **Be able to:** • **Use of lenses-principal focus, focal length of converging lenses** • **Draw ray diagrams for formation of images by converging lenses** • **Draw ray**	Students will carry out a range of practicals during the topic, some of which will be formally assessed for the practical endorsement qualification. **A.1.4 Cosmology** • Calculations on binary stars viewed in the plane of orbit • Qualitative treatment of Big Bang theory including evidence from cosmological microwave background radiation, and relative abundance of hydrogen and helium **A.1.1 Lenses and optical telescopes** • Relative merits of reflectors and refractors including a qualitative treatment of spherical and chromatic aberration • Similarities and differences of radio telescopes compared to optical telescopes. Discussion should include structure, positioning and use, together with comparisons of resolving and collecting powers • Students should be familiar with the rad as the unit of angle	A.1.4 Cosmology Test A.1.1 Lenses and optical telescopes Test

	diagrams to show the image formation in normal adjustment • **Calculate angular magnification** • **Ray diagrams for concave/convex mirrors in reflecting telescopes** • **Description of merits of reflectors and refractors** • **State the diffraction pattern produced by circular aperture** • **Describe the use, structure and operation of CCD**		