	Term 1	Term 2	Term 3	Term 4	Term 5 and 6
Theme/Big Idea	**Topic 8, 9 and 11** Nuclear and Particle Physics, Thermodynamics and Nuclear Radiation		**Topic 13** Oscillations	**Topic 12 and 10** G-Fields and Space	**Revision**
Content What are they learning? (including keywords)	**Topic 1, Working as a physicist- taught throughout** **Topic 8** Define and use proton number (Z) and nucleon number (A). Understand how Rutherford's alpha scattering experiment led to the nuclear model of the atom. Describe thermionic emission and the release of electrons from metals. Understand how particle accelerators and detectors are used to investigate matter. Analyse the motion of charged particles in magnetic fields. Interpret particle tracks in detectors such as cloud chambers. Understand high-energy particle collisions. Use Einstein's mass-energy relationship $E=mc^2$ Understand matter-antimatter annihilation and energy production. Classify particles using the Standard Model. Understand the properties of: Quarks, Leptons, Hadrons, Baryons,Mesons Describe fundamental interactions and exchange particles. Understand antimatter and antiparticles.		Understand that the condition for simple harmonic motion is $F = -kx$, and hence understand how to identify situations in which simple harmonic motion will occur use the equations: $a = -\omega^2 x$ $x = A\cos\omega t$ $v = -A\omega \sin\omega t$, $a = -A\omega^2 \cos\omega t$ $T = 1/f = 2\pi/\omega$ $\omega = 2\pi f$ as applied to a simple harmonic oscillator use equations for a simple harmonic oscillator $T = 2\pi\sqrt{\frac{m}{k}}$ and a simple pendulum	understand that a gravitational field is defined as a region where a mass experiences a force understand that gravitational field strength is defined as $g = F/m$ use the equation $F = \frac{Gm_1m_2}{r^2}$ (Newton's law of universal gravitation) derive and use the equation $g = \frac{Gm}{r^2}$ for the gravitational field due to a point mass use the equation $V_{grav} = \frac{-Gm}{r}$ for a radial gravitational field compare electric fields with gravitational fields	

	Apply conservation laws in particle interactions, including: Charge, Baryon number, Lepton number, Energy and momentum Write and interpret particle interaction equations. **TOPIC 9** Distinguish between heat, temperature, and internal energy. Internal energy is the total kinetic and potential energy of all particles in a substance. Understand absolute zero and the Kelvin temperature scale. Calculate energy transfers using specific heat capacity: $\Delta E=mc\Delta\theta$ Calculate energy required for changes of state using specific latent heat: $\Delta E=mL$ Explain why temperature remains constant during melting and boiling despite energy being supplied. Understand methods of thermal energy transfer: Conduction, Convection, Radiation Describe matter using the kinetic theory of gases. Explain gas pressure in terms of molecular collisions. Apply the gas laws: Boyle's Law ($pV=constant$)	$T=2\pi\sqrt{\frac{l}{g}}$ draw and interpret a displacement – time graph for an object oscillating and know that the gradient at a point gives the velocity at that point draw and interpret a velocity–time graph for an oscillating object and know that the gradient at a point gives the acceleration at that point understand what is meant by resonance apply conservation of energy to damped and undamped oscillating systems understand the distinction between free and forced oscillations understand how the amplitude of	apply Newton's laws of motion and universal gravitation to orbital motion be able to use the luminosity equation, $I=\frac{L}{4\pi d^2}$ understand how astronomical distances can be determined using trigonometric parallax understand how astronomical distances can be determined using measurements of intensity received from standard candles (objects of known luminosity) be able to sketch and interpret a simple Hertzsprung-Russell diagram that relates stellar luminosity to surface temperature understand how to relate the Hertzsprung-Russell diagram to the life cycle of stars understand how the movement of a source of waves relative to an observer/detector gives rise to a shift in	

	Charles' Law (*V/T=constant*) Pressure Law (*p/T=constant*) Use the ideal gas equation: *pV=nRT* *pV=NkT* Relate temperature to the average kinetic energy of gas molecules: *(½)m⟨c²⟩=(3/2)kT* Understand the assumptions and limitations of the ideal gas model. Understand what a black body is. Explain how all objects emit and absorb electromagnetic radiation. Use Wien's Law to relate temperature to peak wavelength. Use the Stefan-Boltzmann Law to calculate radiated power. Apply these ideas to stars and other thermal emitters. **TOPIC 11** understand the concept of nuclear binding energy use the equation $\Delta E = c^2\Delta m$ in calculations of nuclear mass (including mass deficit) and energy use the atomic mass unit (u) to express small masses and convert between this and SI units understand the processes of nuclear fusion and fission with reference to the binding energy per nucleon curve	a forced oscillation changes at and around the natural frequency of a system and know, qualitatively, how damping affects resonance understand how damping and the plastic deformation of ductile materials reduce the amplitude of oscillation	frequency (Doppler effect) be able to use the equations for redshift $z = \frac{\Delta\lambda}{\lambda} \approx \frac{\Delta f}{f} \approx \frac{v}{c}$ for a source of electromagnetic radiation moving relative to an observer and v = H_0d for objects at cosmological distances understand the controversy over the age and ultimate fate of the universe associated with the value of the Hubble constant and the possible existence of dark matter	

	understand the mechanism of nuclear fusion and the need for very high densities of matter and very high temperatures to bring about and maintain nuclear fusion understand that there is background radiation and how to take appropriate account of it in calculations understand the relationships between the nature, penetration, ionising ability and range in different materials of nuclear radiations (alpha, beta and gamma) write and interpret nuclear equations given the relevant particle symbols understand the spontaneous and random nature of nuclear decay determine the half-lives of radioactive isotopes graphically and be able to use the equations for radioactive decay and derive and use the corresponding log equations Explain why very high temperatures are required. Discuss fusion as the energy source of stars.			
KEYWORDS	Nucleon number Annhilation Antimatter Alpha scattering Quark Lepton Ideal gas Black body Isotopes Radioactivity Alpha (α) Beta (β) Gamma (γ) Activity Half-life Binding Energy Fission/Fusion	Oscillation Simple Harmonic Motion (SHM) Displacement Amplitude Period (T) Frequency (f) Angular Frequency (ω) Phase Difference Damping Resonance	Gravitational constant (G) Inverse-square law Gravitational potential Orbital speed Kepler's third law Escape velocity Parallax Parsec Light-year Luminosity Intensity Standard Candle H-R Diagram Red Shift Hubble's Law	

Skills How are they learning it?	**CORE PRACTICAL 12:** Calibrate a thermistor in a potential divider circuit as a thermostat. **CORE PRACTICAL 13:** Determine the specific latent heat of a phase **CORE PRACTICAL 14:** Investigate the relationship between pressure and volume of a gas at fixed temperature. change. **CORE PRACTICAL 15**: Investigate the absorption of gamma radiation by lead.	**CORE PRACTICAL 16:** Determine the value of an unknown mass using the resonant frequencies of the oscillation of known masses.	Work with standard form and very large numbers Calculate distances in light-years and parsecs Apply the inverse square law Compare observations with theoretical models Evaluate the reliability of different methods for measuring cosmic distances	
Key Questions	What is the structure of the atom and how was it discovered? How do particle accelerators and detectors reveal the nature of matter? How are energy and mass related? What are the fundamental particles that make up the universe? Which conservation laws govern particle interactions and decay? How is thermal energy transferred and how does it change the temperature or state of a substance? How does the kinetic theory of gases explain temperature, pressure, and internal energy? How do the gas laws describe the behaviour of ideal gases? How do objects emit and absorb thermal radiation? What makes a nucleus stable or unstable?	What conditions must be met for an object to undergo Simple Harmonic Motion (SHM)? How are displacement, velocity, acceleration, frequency, and period related in SHM? What determines the period of different oscillating systems? How is energy transferred and	What is a gravitational field, and how is gravitational field strength related to gravitational force? How does Newton's law of gravitation explain the force between two masses? How can gravitational field strength and gravitational potential be calculated for planets, stars, and other spherical bodies? How do objects move in circular	

	What are the properties of alpha, beta and gamma radiation? How is radioactive decay modelled mathematically? How is energy related to nuclear processes? What are the similarities and differences between fission and fusion?	conserved during an oscillation? How do resonance and damping affect oscillating systems?	orbits, and why are satellites able to remain in orbit around planets? How is energy transferred and conserved in gravitational fields, including changes in gravitational potential energy and escape velocity? How can we measure the distances to stars and galaxies? How are a star's luminosity, intensity, and distance related? How do stars change throughout their life cycles? What does the Hertzsprung-Russell (H-R) diagram tell us about stars? What evidence shows that the Universe is expanding and how might it evolve?	

Assessment (specific assessed piece(s); milestone(s))	**Peer assessment** – HWK practical question **Summative 1** – Topic 2, 6 and 8 test **CPAC assessments –** Core practicals 12 and 13.	**Peer assessment** – HWK practical question **Summative 2** – Topic 4, 5, 9 and 11 test **Summative 3** – A2 Paper 1 **2 CPAC assessments –** Core practicals 14 and 15	**Peer assessment** – HWK practical question **Summative 4** – Topic 4, 5 and 13 **2 CPAC assessment –** Core practical 16	**Peer assessment** – HWK practical question **Summative 5** – A2 Paper 2	