Spec reference	Spec point	Additional guidance
Wave Motion 4.4.1	Describe the main features of, and compare and contrast, longitudinal waves with transverse waves.	Know definitions of each.
	Define the terms: ***displacement, amplitude, wavelength, period, phase difference, frequency*** and ***speed*** of a wave	
	Interpret oscilloscope traces to determine frequency, amplitude etc.	Interpret time bases (e.g. $msdiv^{-1}$) and amplitude from scale (Volts div^{-1})
	Use the equation f = 1/T and use it to derive the wave equation: $v = f\lambda$	
	Interpret graphical representations of waves: displacement-position and displacement-time graphs.	By interpolating data, deduce time period, wavelength, displacement, amplitude, calculate wave speed from formula, deduce particle velocity using gradient (displacement/time graphs).
	Reflection, refraction and diffraction.	Define diffraction and describe the optimal situation for diffraction to occur (gap size ≈ λ).
	Polarisation, including techniques and procedures used to observe polarising effects using microwaves and light	Describe unpolarised and polarised waves. Describe how light becomes polarised: Using polarising filters. By reflection. Describe how polarised microwaves behave when

		passed through metal bars (grill) – absorption producing alternating current in the metal conductor when plane of oscillation of the electric vector is parallel to the bar or transmission at 90°. High level: Description of *why* partial absorption and transmission occurs using idea of components.
Electromagnetic Waves 4.4.2	Know the general properties of electromagnetic waves. Orders of magnitude of wavelengths of parts of the spectrum from radio to gamma waves. Refraction of light: refractive index n = c/v Snell's law: nsinΘ = constant at a boundary Describe techniques and procedures to investigate refraction at the surface of a rectangular or semi-circular block. Define the critical angle and the conditions necessary. sinC = 1/n at a material/air boundary.	Uses and dangers. e.g. Radio >1m Microwaves 10cm IR 10^{-6}m Visible 400-700nm UV 1nm X-rays 0.1nm Gamma 10^{-11}m Description of set up Graphical method – $\sin\Theta_1$ against $\sin\Theta_2$ – gradient = n (if from air into boundary. When Θ_1 = c, angle of refraction = 90° Boundary conditions: $n_2<n_1$

	Describe the conditions required for total internal reflection.	angle of incidence > critical angle.
Superposition of Waves **Interference**	(a) (i) the principle of superposition of waves. (ii) techniques and procedures used for superposition experiments using sound, light and microwaves (b) graphical methods to illustrate the principle of superposition (c) interference, coherence, path difference and phase difference (d) constructive interference and destructive interference in terms of path difference and phase difference (e) two-source interference with sound and microwaves (f) Young double-slit experiment using visible light	When 2 waves meet, the resultant displacement is the sum of the instantaneous displacements of the 2 waves. Loudspeaker and signal generator, Young's slits, microwave generator. Adding displacements graphically. Define terms. Interference – the change in displacement that occurs when waves superpose. Description in terms of phase difference and path difference where constructive or destructive interference occurs. $\lambda = ax/D$ – this equation can be applied to situations involving sound and microwaves. PAG – how to carry out the practical with techniques designed to reduce uncertainty.

Stationary Waves	(a)stationary (standing) waves using microwaves, stretched strings and air columns	Idea that stationary waves are formed when 2 waves with the ***same frequency*** and wavelength ***travelling in opposite directions superpose***, to form regions of constructive interference, i.e. maxima (antinodes) and destructive interference, i.e. minima (nodes). Idea of path difference leading to constructive interference in the context of 2 waves travelling in opposite directions.
	(b) graphical representations of a stationary wave (c) similarities and the differences between stationary and progressive waves (d) nodes and antinodes (e)(i) stationary wave patterns for a stretched string fundamental mode of vibration (1st harmonic) and subsequent harmonics. Air columns in closed and open tubes. ii) techniques and procedures used to determine the speed of sound in air by formation of	Amplitude distance graphs. Displacement time graphs. In terms of phase difference, energy transfer and amplitude of oscillation. Identify and explain the formation of. Setting up of the stationary wave via superposition between incident and reflected waves from the fixed ends. Explanation of the harmonics that fit on as a multiple of the fundamental frequency. Superposition between incident and reflected sound waves at fixed/open ends. Antinode always located at an open end, node at a closed

	stationary waves in a resonance tube PAG5 (f) the idea that the separation between adjacent nodes (or antinodes) is equal to λ/2, where λ is the wavelength of the progressive wave	end, and the harmonics that then follow and how they relate to the fundamental frequency. My PAG