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**Knowledge Rich Curriculum Plan**

Science – Physics

Year 12



| **Science****Year 12 Physics**  | **Unit: Waves** |  |  |
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| **Lesson/Learning Sequence**  | **Intended Knowledge:***Students will know that…* | **Tiered Vocabulary**  | **Prior Knowledge:***In order to know this students, need to already know that…* |
| **Lesson:** **Progressive Waves** | * Students will know that waves are caused by oscillations and transfer energy without transferring matter.
* Students will know that a progressive wave is a wave that is moving outwards from the source
* Students will know that amplitude, A, is the maximum displacement of the particles from the equilibrium position, and is measured in metres
* Students will know that wavelength (lambda), is the length of one whole cycle, and is usually measured between two adjacent peaks or troughs. Wavelength has the units metres
* Students will know that the time period, T, is the time taken for one complete wave to happen. It is measured in seconds
* Students will know that frequency, f, is a measure of how many waves occur in every second. It is measured in Hz
* Students will know that time period and frequency are linked by the equation:

T = 1/f or f = 1/T* Students will know that wave speed, c, is calculated using the equation:

c = f x lambda* Students will know that phase difference between two waves depends on what fraction of a wavelength lies between them
* Students will know that phase difference is measured in radians, rad
* Students will know that the phase difference between two points half a wavelength apart is 1π radians
* Students will know that teh phase difference between two waves a whole wavelength apart is 2π radians
 | Progressive wave: a wave that is moving outwards from a sourceAmplitude: maximum displacementPhase difference: The number of wavelengths between two waves | * ***Students need to already know how to represent a wave using a diagram, and be able to correctly label wavelength and amplitude.***
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| **Lesson:** **Longitudinal and Transverse Waves** | * Students will know that in transverse waves the oscillations are perpendicular to the direction of ENERGY PROPAGATION
* Students will know that in longitudinal waves the osciallations are parallel to the direction of ENERGY PROPAGATION
* Students will know that when the particles are close together in a longitudinal wave we call it a compression
* Students will know that when the particles are spread apart in a longitudinal wave we call it a rarefaction
* Students will know that in a longitudinal wave a wavelength is the distance from one compression or rarefaction to the next
* Students will know that in a longitudinal wave the amplitude is the maximum distance the particle moves from its equilibrium position to the right or left
* Students will know that in transverse waves the wavelength is the distance from one peak or trough to the next
* Students will know that the amplitude is the maximum distance the particles move from its equilibrium position up or down.
* Students will know that an example of a longitudinal wave is a sound wave
* Students will know that examples of transverse waves include water waves and the electromagnetic spectrum
* Students will know that polarisation restricts the oscillations of a wave to one plane.
* Students will know that how to explain the properties of transverse waves using polarisation
* Students will know that applications of polarisation include TV aerials and Polaroid materials.
 |  | * ***Students need to already know how to label a transverse wave.***
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| **Lesson:** **Superposition and Stationary Waves** | * Students will know that superposition is the process by which two waves combine into a single wave form when they overlap.
* Students will know that when the waves overlap, the resultant wave depends on where the peaks of the waves are compared to each other
* Students will know how to apply ideas of superposition to determine the resultant wave.
* Students will know that when two similar waves travel in opposite directions they can superpose to form a stationary wave.
* Students will know that a node is a position on a stationary wave which doesn't vibrate. At this point the waves have combined to give a zero displacement.
* Students will know that an antinode is a position on a standing wave where there is a maximum displacement.
* Students will know that for a stationary wave:

amplitude is maximum at an antinode and zero at nodesAll parts of the wave have the same frequencyAll points between two adjacent nodes are in phaseThere is no energy translation* The waveform doesn't move forward
* Students will know that the first stationary wave that occurs is the first harmonic, and this occurs when the string is vibrating at the fundamental frequency of the string
* Students will know that the first harmonic contains 2 nodes and 1 antinode. The frequency is the same as the fundamental frequency and the wavelength is equal to twice the length of the string
* Students will know that the first harmonic can be calculated using the equation from the data booklet
* Students will know that the second harmonic has 3 nodes and 2 antinodes. The frequency is twice the fundamental frequency, and the wavelength is equal to the length of the string
* Students will know the third harmonic has 4 nodes and 3 antinodes. The frequency is three times the fundamental frequency and the wavelength is equal to 2/3 the length of the string
* Students will know the fourth harmonic has 5 nodes and 4 antinodes. The frequency is 4 x the fundamental frequency, and the wavelength is half the length of the string
 | Superposition: when two waves combine into a single wave form when they overlap. | * ***Students need to already know that frequency is the number of waves per second, and the wavelength is the distance between one point on a wave and the same point on the adjacent wave***
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| **Lesson:** **Waves Required Practical 1** | * Students will know how to investigate the variation of the frequency of a stationary wave on a string with length, tension and mass per unit length of the string
 |  | * ***Students will need to already know that a stationary wave is formed when two similar waves travel in opposite directions and superpose***
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| **Lesson:** **Refraction** | * Students will know that the refractive index of a material is a measure of how easy it is for light to travel through it.
* Students will know that the refractive index of materials can be calculated using:

n = c / csn = refractive indexc = speed of light in a vacuumcs = speed of light in the material* Students will know that light can travel through air at a speed very close to c, which means the refractive index of air is 1
* Students will know that when light travels through a denser material, it bends towards the normal
* Students will know that when light enters a less dense material it bends away from the normal
* Students will know that less dense materials have lower refractive indexes
* Students will know how to explain why light bends as it enters a different medium
* Students will know that when two materials touch the boundary between them will have a refractive index dependent on the refractive indices of the two materials.
* Students will know how to use Snell's law
 |  | * ***Students need to already know that when light travels through a different medium it can slow down or speed up, depending on the density of the material***
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| **Lesson:** **Total Internal Reflection** | * Students will know that when light travels from one material to another the majority of the light refracts, but a small proportion of the light also reflects off the boundary and stays in the first material.
* Students will know that when incident ray strikes the boundary at an angle less than the critical angle, the light refracts into the second material
* Students will know that when incident ray strikes the boundary at an angle equal to the critical angle, all the light is sent along the boundary between the materials.
* Students will know that when incident ray strikes the boundary at an angle greater than the critical angle all the light is reflected and none refracts. This is known as total internal reflection
* Students will know that the critical angle can be determined using equations from the data booklet
* Students will know that an optical fibre is a thin piece of flexible glass, and that light can travel down it due to total internal reflection
* Students will know uses of optical fibres include communication and medical endoscopes.
* Students will know that cladding is added to the outside of an optical fibre to reduce the amount of light that is lost. This is done by giving the light rays a second chance at total internal reflection.
* Students will know that absorption of energy by the material int he fibre can cause the amplitude of the signal to be reduced.
* Students will know that dispersion within optical fibres can degrade the signal.
* Students will know that modal dispersion is where light enters the fibre at different angles, and so takes different paths (which take different amounts of time to travel). To get around this a single-mode fibre can be used, which only lets light take one path
* Students will know that material dispersion is when light that travels down the optical fibre has different wavelengths, causing some to reach the end of the fibre faster than others. This can be overcome by using monochromatic light
* Students will know that pulse broadening is caused by dispersion. This is when the signal is broader at the end of the fibre compared to the beginning.
 |  | * ***Students need to already know that refraction is caused by light slowing down through certain materials.***
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| **Lesson:** **Interference** | * Students will know that interference is a special case of superposition where the waves that combine are coherent.
* Students will know that during interference the waves overlap and form a repeating interference pattern of maxima and minima areas.
* Students will know that coherence is where waves have the same frequency, wavelength, polarisation and amplitude to each other, whilst also being in constant phase.
* Students will know that an example of a coherent source would be a laser
* Students will know that constructive interference occurs when the path difference between the waves is a whole number of wavelengths.
* Students will know that destructive interference is where the path difference between the waves is a half number of wavelengths.
* Students will know that Young's double-slit experiment involved the use of two coherent sources (or a single source with double slits) to produce an interference pattern.
* Students will know that in Young's double-slit experiment constructive interference produces bright areas, while deconstructive interference produces dark areas.
* Students will know that the areas described are called interference fringes
* Students will know that there is a central bright fringe directly behind the midpoint between the slits, with more fringes evenly spaced and parallel to the slits
* Students will know how to use the fringe spacing equation, w = lambdaD / s, where:

w = fringelambda = wavelengthD = distance to the screens = separation of the source* Students will know how to apply ideas of interference to electromagnetic and sound waves
 | Interference: superposition between two coherent waves. | * ***Students need to already know that wavelength is the distance between a point on a wave and the same point on the adjacent wave***
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| **Lesson:** **Diffraction** | * Students will know that when waves pass through a gap they spread out, and that this is called diffraction
* Students will know the amount of diffraction depends on the size of the wavelength compared to the size of the gap.
* Students will know that diffraction patterns consist of a central maximum that is twice as wide as the others and by far the brightest, following outer fringes that are dimmer and of equal width.
* Students will know that diffraction grating is a series of narrow, parallel slits.
* Students will know that:
* The zero-order maximum (n=0) has no path difference, and the waves arrive in phase and interfere constructively.
* The first-order maximum (n=1) has a path difference of 1 wavelength between neighbouring waves, and they arrive in phase and interfere constructively
* The second-order maximum (n=2) has a path difference of 2 wavelengths between neighbouring waves, and they arrive in phase and interfere constructively.
* Students will know how to use the diffraction grating equation from the data booklet.
 |  | * ***Students need to already know that wavelength is measured in metres.***
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| **Lesson:** **Required Practical 2** | * Students will know how to investigate interference effects, including Young's slit experiment and interference by diffraction grating
* Students will know how to use a laser safely
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