**Specification sheet: P12 Wave properties**

**The nature of waves**

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| Waves may be either transverse or longitudinal.  The ripples on a water surface are an example of a transverse wave. |  |
| Describe the difference between longitudinal and transverse waves. |  |
| Sound waves travelling through air are longitudinal. |  |
| Longitudinal waves show areas of compression and rarefaction. |  |
| Describe evidence that, for both ripples on a water surface and sound waves in air, it is the wave and not the water or air itself that travels. |  |
| Electromagnetic waves form a continuous spectrum and all types of electromagnetic wave travel at the same velocity through a vacuum (space) or air. |  |

**The properties of waves**

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| Describe wave motion in terms of their amplitude, wavelength, frequency and period. |  |
| The amplitude of a wave is the maximum displacement of a point on a wave away from its undisturbed position. |  |
| The wavelength of a wave is the distance from a point on one wave to the equivalent point on the adjacent wave |  |
| The frequency of a wave is the number of waves passing a point each second. |  |
| *period* = 1/*frequency*  *T* = 1/*f*  period, *T*, in seconds, s  frequency, *f*, in hertz, Hz |  |
| The wave speed is the speed at which the energy is transferred (or the wave moves) through the medium. |  |
| All waves obey the wave equation:  *wave speed* = *frequency* × *wavelength*  *v* = *f λ*  wave speed, *v*, in metres per second, m/s  frequency, *f*, in hertz, Hz  wavelength, *λ*, in metres, m |  |
| Identify amplitude and wavelength from given diagrams |  |
| Describe a method to measure the speed of sound waves in air |  |
| Describe a method to measure the speed of ripples on a water surface. |  |

**Reflection, refraction and more about waves (HT only)**

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| Different substances may absorb, transmit, refract or reflect electromagnetic waves in ways that vary with wavelength. |  |
| Some effects, for example refraction, are due to the difference in velocity of the waves in different substances.  Construct ray diagrams to illustrate the refraction of a wave at the boundary between two different media **(HT and FT)** |  |
| Use wave front diagrams to explain refraction in terms of the change of speed that happens when a wave travels from one medium to a different medium. |  |

**Sound waves and the uses of ultrasound (Physics only)**

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| A typical value for the speed of sound in air is 330 m/s. |  |
| Sound waves can travel through solids causing vibrations in the solid. |  |
| Within the ear, sound waves cause the ear drum and other parts to vibrate which causes the sensation of sound. |  |
| The conversion of sound waves to vibrations of solids works over a limited frequency range. This restricts the limits of human hearing. |  |
| Describe, with examples, processes which convert wave disturbances between sound waves and vibrations in solids. Examples may include the effect of sound waves on the ear drum |  |
| Explain why such processes only work over a limited frequency range and the relevance of this to human hearing. |  |
| The range of normal human hearing is from 20 Hz to 20 kHz. |  |
| Explain in qualitative terms, how the differences in velocity, absorption and reflection between different types of wave in solids and liquids can be used both for detection and exploration of structures which are hidden from direct observation. |  |
| Ultrasound waves have a frequency higher than the upper limit of hearing for humans. |  |
| Ultrasound waves are partially reflected when they meet a boundary between two different media. |  |
| The time taken for the reflections to reach a detector can be used to determine how far away such a boundary is. This allows ultrasound waves to be used for both medical and industrial imaging |  |
| Echo sounding, using high frequency sound waves is used to detect objects in deep water and measure water depth. |  |

**Seismic waves (Physics only)**

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| Explain qualitatively, how the differences in velocity, absorption and reflection between different types of wave in solids and liquids can be used both for detection and exploration of structures which are hidden from direct observation. |  |
| Seismic waves are produced by earthquakes. P-waves are longitudinal, seismic waves. P-waves travel at different speeds through solids and liquids. |  |
| S-waves are transverse, seismic waves. S-waves cannot travel through a liquid. |  |
| P-waves and S-waves provide evidence for the structure and size of the Earth’s core. |  |
| Be aware that the study of seismic waves provided new evidence that led to discoveries about parts of the Earth which are not directly observable. |  |