**Chapter 13 Specification sheet: P13 Electromagnetic waves**

**The electromagnetic spectrum, light, infrared, microwaves and radio waves.**

|  |  |
| --- | --- |
| 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 |  |
| Electromagnetic waves are transverse waves that transfer energy from the source of the waves to an absorber. |  |
| Electromagnetic waves form a continuous spectrum and all types of electromagnetic wave travel at the same velocity through a vacuum (space) or air. |  |
| The waves that form the electromagnetic spectrum are grouped in terms of their wavelength and their frequency. |  |
| Going from long to short wavelength (or from low to high frequency) the groups are: radio, microwave, infrared, visible light (red to violet), ultraviolet, X-rays and gamma rays. |  |
| Our eyes only detect visible light and so detect a limited range of electromagnetic waves. |  |
| Give examples that illustrate the transfer of energy by electromagnetic waves. |  |
| (HT only) Different substances may absorb, transmit, refract or reflect electromagnetic waves in ways that vary with wavelength. |  |
| Electromagnetic waves have many practical applications. For example:  • radio waves – television and radio  • microwaves – satellite communications, cooking food  • infrared – electrical heaters, cooking food, infrared cameras  • visible light – fibre optic communications |  |
| (HT only) Students should be able to give brief explanations why each type of electromagnetic wave is suitable for the practical application. |  |

**Communications**

|  |  |
| --- | --- |
| (HT only) Different substances may absorb, transmit, refract or reflect electromagnetic waves in ways that vary with wavelength. |  |
| Construct ray diagrams to illustrate the refraction of a wave at the boundary between two different media. |  |
| (HT only) Radio waves can be produced by oscillations in electrical circuits. |  |
| (HT only) When radio waves are absorbed they may create an alternating current with the same frequency as the radio wave itself, so radio waves can themselves induce oscillations in an electrical circuit. |  |
| Electromagnetic waves have many practical applications. For example:  • radio waves – television and radio  • microwaves – satellite communications, cooking food  • visible light – fibre optic communications |  |

**Ultraviolet waves, X-rays, gamma rays and X-rays in medicine**

|  |  |
| --- | --- |
| Changes in atoms and the nuclei of atoms can result in electromagnetic waves being generated or absorbed over a wide frequency range. |  |
| Gamma rays originate from changes in the nucleus of an atom. |  |
| Ultraviolet waves, X-rays and gamma rays can have hazardous effects on human body tissue. |  |
| The effects depend on the type of radiation and the size of the dose. |  |
| Radiation dose (in sieverts) is a measure of the risk of harm resulting from an exposure of the body to the radiation. |  |
| 1000 millisieverts (mSv) = 1 sievert (Sv)  (You will **not** be required to recall the unit of radiation dose.) |  |
| Ultraviolet waves can cause skin to age prematurely and increase the risk of skin cancer. |  |
| X-rays and gamma rays are ionising radiation that can cause the mutation of genes and cancer. |  |
| 4.6.2.4 Uses and applications of electromagnetic waves  • ultraviolet – energy efficient lamps, sun tanning  • X-rays and gamma rays – medical imaging and treatments. |  |