### Waves Summary Notes

**Waves transfer energy**
The higher the amplitude the greater the energy of the wave.

\[ f \text{=} \text{no. of waves produced per second} \]

\[ T \text{=} \text{time for 1 wave to pass a point} \]

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**Transverse Wave:**
The particles of the medium transmitting the wave travel at right angles to the direction of energy travel. e.g. E.M. waves

**Longitudinal Wave:**
The particles of the medium carrying the wave move parallel to the direction of energy travel. e.g. sound

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**Properties of waves**
- reflection
- refraction
- diffraction

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**Wave Speed**

\[ v = f \lambda \]

\[ v = \frac{d}{t} \]

**Wave Speed**

\[ \text{wave speed} = \text{frequency} \times \text{wavelength} \]

\[ \text{wave speed} = \frac{\text{distance wave travels}}{\text{time taken}} \]

**Law of reflection**

\[ \text{angle of incidence} = \text{angle of reflection} \]

where all angles are measured from the normal

**Refraction**

occurs when light enters a material which is more optically dense the wave speed and wavelength reduce but frequency remains the same. Usually this is accompanied by a change in direction of the wave. Diffraction - bending of waves passing through a gap or around a barrier, when waves diffract there is no change to the wavelength.

**Diffraction**

- Long waves diffract more than short waves.

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When waves diffract through a large gap only the edges of the waves change bend

Through a narrow gap, smaller than \( 1\lambda \) the waves emerge as semi-circles

Long waves diffract more than short waves which is why long wave radio signals can be detected at the bottom of a hill, but shorter wavelength signals cannot be detected.
All members of the EM-spectrum are transverse waves and travel at $3 \times 10^8$ m s$^{-1}$ in straight lines in air. EM spectrum waves can be refracted, reflected and diffracted.

Light colours, red, orange, yellow, green, blue, indigo, and violet; red light long $\lambda$ and low $f$ blue light short $\lambda$ and high $f$.

<table>
<thead>
<tr>
<th>Type of EM Waves</th>
<th>Application</th>
<th>Detector</th>
<th>Source</th>
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</table>
| Radio & TV       | communication (under the sea, in space, radio and TV)
Watching TV programmes, films, listening to the news | Aerial | transmitter, outer space, electronic circuits |
| Microwaves       | Heating food through microwave ovens, communications | Aerial | electronic circuits magnetron, transmitters, outer space |
| Infra Red        | detector in security lighting, remote controls (e.g. TV) | Photodiode, thermocouple, thermistor, heat-sensitive papers, black-bulb thermometer | warm objects, sun, |
| Visible          | humans vision, photography, laser surgery, | Photodiode / photographic film / diode / CCD | Stars, candles, light bulbs, electronic devices (eg LED), sun |
| Ultra violet     | detecting forged bank notes, causing white shirts to look cleaner? Sterilising medical instruments | Human skin / causes fluorescence (glowing) in some objects / fluorescent materials | Fluorescent tubes, very hot objects, sun, gas discharge, lamps |
| X-Ray            | detecting broken bones, checking suitcases at the airport, | Photodiode / photographic film | X-ray machines, stars, very fast electrons hitting a metal target |
| Gamma Rays       | medical tracers to detect cancer, killing bacteria, sterilizing instruments, detecting broken pipes underground | / photographic film / Geiger Muller Tube and counter / Photodiode | Radioactive nuclei, outer space (colliding neutron stars) |

https://www.youtube.com/watch?v=bjOGNVH3D4Y

[Diagram of electromagnetic spectrum]