

## Definitions and Concepts for CAIE Physics IGCSE

### Topic 3: Waves

*Definitions in **bold** are for extended students only*

#### 3.1 General Properties of Waves

**Amplitude:** The maximum displacement of a wave from its undisturbed (equilibrium) position.

**Diffraction:** It is the bending of waves around gaps or corners. **It occurs when the size of the aperture or obstacle is of the same order of magnitude as the wavelength of the incident wave.**

**Frequency:** The number of waves passing a given point in a second. It is the inverse of the wave's time period.

**Longitudinal waves:** Waves with oscillations that are parallel to the direction of travel/energy transfer.

**Reflection:** The bouncing back of a wave at a boundary.

**Refraction:** The changing of speed, and consequently the direction, of a wave as it changes medium. The wavelength of the wave will also change but the frequency remains constant.

**Speed of a wave:** The speed is the distance traveled by a given point on the wave in a given interval of time.

**Transverse waves:** Waves with oscillations that are perpendicular to the direction of travel/energy transfer.

**Vibration:** Is a mechanical phenomenon whereby oscillations occur about an equilibrium point.

**Water waves:** They are waves propagating on the water surface.

**Wave:** A process of energy transfer through oscillations, without matter being transferred with it.

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**Wavefront:** An imaginary surface representing points of a wave that are at the same point in their cycle.

**Wavelength:** The distance from a point on one wave to the same point on the adjacent wave (ie. peak to peak or trough to trough).

### 3.2 Light

#### 3.2.1 Reflection of Light

**Angle of incidence:** The angle which an incident line or ray makes with a perpendicular to the surface at the point of incidence.

**Angle of reflection:** The angle made by a reflected ray with a perpendicular to the reflecting surface.

**Optical image:** It is the apparent reproduction of an object, formed by a lens or mirror system from reflected, refracted, or diffracted light waves.

**Plane mirror:** It is a flat reflective surface. **The image formed by a plane mirror is always virtual, upright, and of the same shape and size as the object it is reflecting.**

#### 3.2.2 Refraction of Light

**Critical angle:** The angle of incidence beyond which all the wave is totally internally reflected when it meets a boundary.

**Optical fibres:** A thin flexible fibre with a glass core through which light signals can be transmitted along its axis, by the process of total internal reflection.

**Parallel:** Two lines that are always the same distance apart and never meet.

**Refractive Index:** The ratio of the speed of the wave in a vacuum to the speed of the wave in a given medium.

**Transparent:** A material allowing light to pass through.

**Total internal reflection:** The process of all a wave being reflected when it meets a boundary. It occurs when the angle of incidence is greater than the critical angle, and only when going from a higher refractive index to a lower one.

#### 3.2.3 Thin Lenses

**Diminished:** Made smaller or less.

**Enlarged:** Having become or been made larger.



**Focal length:** Is the distance between the centre of the lens and the principal focus.

**Focus:** Is the point where light rays originating from a point on the object converge.

**Long-Sightedness (Hyperopia):** A condition where near objects appear blurry because light focuses behind the retina, corrected with convex (converging) lenses.

**Magnifying glass:** It is a convex lens that lets the observer see a larger image of the object under observation.

**Principal focus:** Is the point where rays of light travelling parallel to the principal axis intersect the principal axis and converge.

**Real Image:** An image produced by light-rays physically converging. Real images are ones that can be projected onto a screen.

**Short-Sightedness (Myopia):** A condition where distant objects appear blurry because light focuses in front of the retina, corrected with concave (diverging) lenses.

**Single lens:** A lens that consists of a single piece of transparent material.

**Thin converging lens:** Lens that focuses the diverging, or blurred, light rays from a distant object by refracting (bending) the rays.

**Virtual image:** An image produced by the apparent, but not actual, divergence of light-rays. Virtual images cannot be projected onto a screen.

### 3.2.4 Dispersion of Light

**Dispersion:** Is defined to be the spreading of white light into its full spectrum of wavelengths.

**Glass prism:** Is a transparent optical element with flat, polished surfaces that refract light.

**Monochromatic light:** Is light where the optical spectrum contains only a single optical frequency.

**Spectrum:** Is the range of frequencies of electromagnetic radiation and their respective wavelengths and photon energies.

### 3.3 Electromagnetic Spectrum

**Electromagnetic spectrum:** A group of transverse waves that cover a large range of frequencies and wavelengths. The highest frequency waves in the spectrum are gamma-rays and the lowest are radio waves. **Speed of electromagnetic waves in a vacuum is  $3.0 \times 10^8$  m/s and is approximately the same in air.**

**Infrared:** Used for cooking food, thermal imaging and short range communications. It can



cause skin burns.

**Microwaves:** Used for satellite communications and for cooking food. They can cause internal heating of body cells.

**Radio Waves:** Used for television and radio signals. **They can be produced by oscillations in electrical circuits, or can induce these oscillations themselves.**

**Vacuum:** Space in which there is no matter

**Wavelength:** The distance from a point on one wave to the same point on the adjacent wave (ie. peak to peak or trough to trough).

**X-Rays:** Used for medical imaging and security scanners. They can cause cell damage and mutations.

### **3.4 Sound**

**Audible frequencies:** It is a periodic vibration whose frequency is in the band audible to the average human, the human hearing range, which is 20Hz to 20000Hz

**Compressions:** They are regions of high pressure due to particles being close together.

**Echo:** Is a distinct, reflected sound wave from a surface.

**Loudness:** A measure of the amplitude of the oscillations of a sound wave. The larger the amplitude, the louder the sound will be.

**Pitch:** A measure of the frequency of the oscillations of a sound wave. The higher the frequency, the higher the pitch of the sound.

**Rarefactions:** They are regions of low pressure due to particles being spread further apart.

**Sound waves:** The longitudinal waves responsible for sound. They are produced by vibrating sources and they require a medium to travel through, transmitted by the vibrations of the medium's particles.

**Speed of sound:** The speed of sound is the distance travelled per unit of time by a sound wave as it propagates through a medium.

**Ultrasound waves:** Waves that have a frequency higher than the upper limit of human hearing (20kHz).

