

Wave Optics Overview



Wavefront

- **Definition:** The locus of all particles vibrating in the same phase.

Forms of Wavefront

1. Cylindrical Wavefront

- **Source:** Linear light source
- **Effective Distance:** Finite
- **Intensity:** $I \propto \frac{1}{r}$
- **Amplitude:** $A \propto \frac{1}{\sqrt{r}}$

2. Plane Wavefront

- **Source:** Light source at a large distance
- **Effective Distance:** Infinite
- **Intensity and Amplitude:** Independent of distance

3. Spherical Wavefront

- **Source:** Point light source
- **Effective Distance:** Finite
- **Intensity:** $I \propto \frac{1}{r^2}$
- **Amplitude:** $A \propto \frac{1}{r}$

Huygens' Principle

- **Concept:** Each point on the primary wavefront is the source of secondary wavelets.
- **Key Points:**
 - The locus of secondary wavelets in the forward direction determines the new wavefront's position at any subsequent time.
 - Wave propagation and wavefront direction are mutually perpendicular.

Drawbacks of Wave Theory

- Cannot explain phenomena like:
 - **Photoelectric effect**
 - **Compton effect**
 - **Raman effect**
- The idea of a hypothetical medium (ether) in a vacuum lacks scientific substantiation.

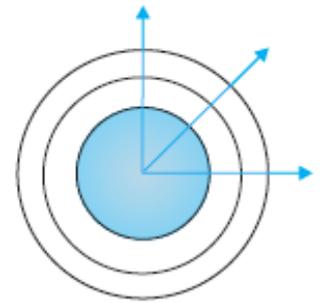


FIGURE 10.1 (a) A diverging spherical wave emanating from a point source. The wavefronts are spherical.

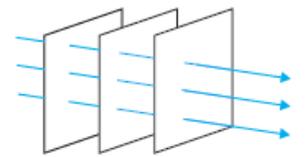


FIGURE 10.1 (b) At a large distance from the source, a small portion of the spherical wave can be approximated by a plane wave.

Coherent Sources of Light

- Sources emit light of the same wavelength and frequency with a constant or zero phase difference.

Superposition of Waves

- **Principle:** When two waves overlap, the resultant displacement is the algebraic sum of their individual displacements.

Wave Optics

- **Definition:** Describes the relationship between waves and light rays.

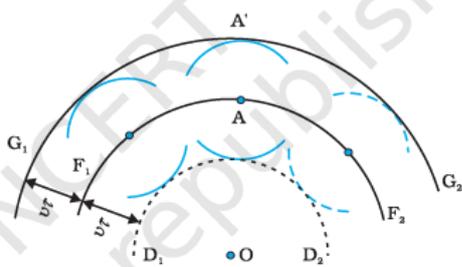


FIGURE 10.2 F_1F_2 represents the spherical wavefront (with O as centre) at $t = 0$. The envelope of the secondary wavelets emanating from F_1F_2 produces the forward moving wavefront G_1G_2 . The backwave D_1D_2 does not exist.

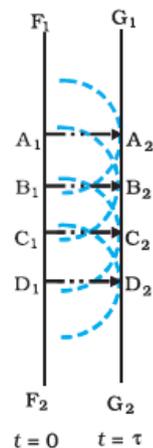


FIGURE 10.3 Huygens geometrical construction for a plane wave propagating to the right. F_1F_2 is the plane wavefront at $t = 0$ and G_1G_2 is the wavefront at a later time τ . The lines A_1A_2 , B_1B_2 ... etc., are normal to both F_1F_2 and G_1G_2 and represent rays.