# Wave Optics

Here is the detailed breakdown of the information on **Interference** from the provided image:

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## Coherent Sources of Light

- **Definition**: Sources of light emitting light of the same wavelength and frequency with a zero or constant phase difference.

## Superposition of Waves

- When two similar waves propagate simultaneously, the resulting displacement is:

$$\bar{y} = \bar{y_1} + \bar{y_2}$$

## Interference of Light

- Redistribution of energy due to the superposition of waves.

## Types of Interference

1. **Constructive Interference**
   - **Phase Difference** ($\delta$): $\delta = 2n\pi$
   - **Path Difference** ($\Delta x$): $\Delta x = 2n(\lambda/2)$
   - **Time Interval Between Two Waves** ($\Delta t$): $\Delta t = 2n \cdot \frac{T}{2}$
   - **Resultant Amplitude**: $A = a_1 + a_2$
   - **Resultant Intensity**: $I = \left(\sqrt{I_1} + \sqrt{I_2}\right)^2$

2. **Destructive Interference**
   - **Phase Difference** ($\delta$): $\delta = (2n-1)\pi$
   - **Path Difference** ($\Delta x$): $\Delta x = (2n-1) \cdot \lambda/2$
   - **Time Interval Between Two Waves** ($\Delta t$): $\Delta t = (2n-1) \cdot \frac{T}{2}$
   - **Resultant Amplitude**: $A = a_1 - a_2$
   - **Resultant Intensity**: $I = \left(\sqrt{I_1} - \sqrt{I_2}\right)^2$

## Resultant Wave for Two Interfering Waves

- For two waves, $y_1 = a_1 \sin \omega t$ and $y_2 = a_2 \sin(\omega t + \phi)$ meeting at a point:
  - **Resultant Wave**: $y = A \sin(\omega t + \phi)$
  - **Resultant Amplitude**:

$$A = \sqrt{a_1^2 + a_2^2 + 2a_1 a_2 \cos \phi}$$

- **Resultant Intensity**: $I \propto (\text{amplitude})^2$
- **Angle Relation**:

$$\tan\theta = \frac{a_2 \sin\phi}{a_1 + a_2 \cos\phi}$$

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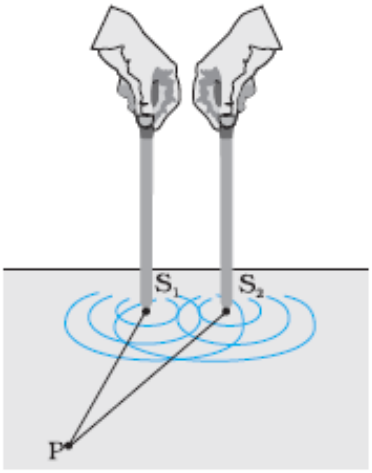
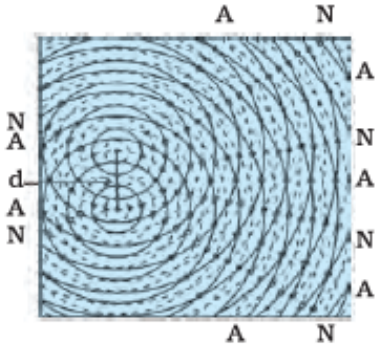
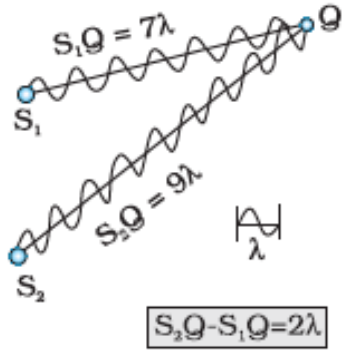



(a)

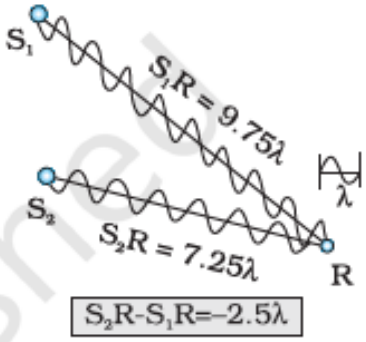



(b)

**FIGURE 10.8** (a) Two needles oscillating in phase in water represent two coherent sources. (b) The pattern of displacement of water molecules at an instant on the surface of water showing nodal N (no displacement) and antinodal A (maximum displacement) lines.




(a)




(b)

**FIGURE 10.9** (a) Constructive interference at a point Q for which the path difference is $2\lambda$. (b) Destructive interference at a point R for which the path difference is $2.5\,\lambda$.

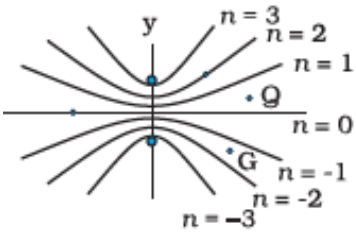



**FIGURE 10.10** Locus of points for which $S_1P - S_2P$ is equal to zero, $\pm\lambda$, $\pm 2\lambda$, $\pm 3\lambda$.