Physics 4C

Chapter 35: Interference

If two waves exist at the same point in space at the same time, they will interfere with each other.

The Principle of Linear Superposition: When two or more waves are present simultaneously at the same place, the resultant disturbance is the sum of the disturbances from the individual waves.

⇒ Overlapping waves do not alter the travel of the other wave.
⇒ The individual waves move independently of one another.
Interference

Constructive Interference

Destructive Interference

Interference of Light Waves

⇒ Constructive interference occurs when the difference in path length is an integer number of wavelengths.

⇒ Destructive interference occurs when the difference in path length is an odd integer number of half wavelengths.

Interference

⇒ Sound waves, like any waves, can interfere with each other.

Constructive Interference

Destructive Interference
**Interference of Sound Waves**

Constructive Interference

Destructive Interference

⇒ **Constructive interference** occurs when the condensations (or the rarefactions) from two sound waves overlap.

⇒ **Destructive interference** occurs if the condensation from one sound wave overlaps the rarefaction from another sound wave.

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**Interference**

⇒ When a wave hits a hard boundary like a wall that is too rigid to shake, the wave will reflect back.

⇒ The reflected wave undergoes a phase change that is equivalent to \( \frac{1}{2} \) a wavelength.

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**Thin-Film Interference**

**Reflections at a Boundary**
A wave reflected from a hard boundary undergoes a phase change equivalent to $1\frac{1}{2}$ a wavelength.

**Huygen’s Principle**

**Huygen’s principle**: Every point on a wave front acts as a point source of tiny wavelets that move forward with the same speed as the wave; the wave front at a later instant is the surface that is tangent to the wavelets.
Huygen’s Principle

Diffraction: the bending of a wave around an obstacle or the edges of an opening.

⇒ It is because of diffraction that we can hear around corners.

⇒ The extent to which a wave bends around the edges of an opening is determined by the ratio of $\lambda/a$. *The narrower the slit, the greater the diffraction.*
Young's Double Slit Experiment
⇒ The horizontal solid line is $I_0$, the intensity on the screen when one of the slits is covered up.
⇒ If the waves from the two sources (slits) were incoherent (phase relation changes with time), there would be no fringe pattern and the intensity would have the uniform value $2I_0$ for all points on the screen.

Interference cannot create or destroy energy; it merely redistributes it over the screen. Thus the average intensity on the screen must be the same $2I_0$ regardless of whether the sources are coherent.