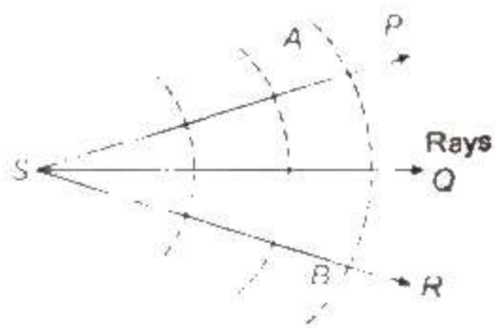

S = source of light.
AB = wavefront and SP SQ
and SR are rays of light

Huygen's Wave Theory

Light travel in a medium in the form of wavefront.

A wavefront is the locus of all the particles vibrating in same phase.

All particles on a wavefront behaves as a secondary source of light, which emits secondary wavelets.

The envelope of secondary wavelets represents the new position of a wavefront.

When source of light is a point source,the wavefront is spherical.

Amplitude (A) is inversely proportional to distance (x) i.g., $A \propto 1 / x$.

$\therefore$ Intensity $(I) \propto (\text{Amplitude})^2$

When SOurce of light is linear, the wavefront is cylindrical.

Amplitude $(A) \propto 1 / \sqrt{x}$

$\therefore$ Intensity $\propto (\text{Amplitude})^2 \propto 1 / x$

Huygen's Principle

(i) Every point on given wavefront (called primary wavefront) acts as a fresh source of new disturbance called secondary wavelets.

(ii) The secondary wavelets travels in all the directions with the speed of light in the medium.

(iii) A surface touching these secondary wavelets tangentially in the forward direction at any instant gives the new (secondary) wave front of that instant.

de-Broglie wave equation is $\lambda = h / p = h / mv$

where h denotes Planck's constant.

Superposition of Waves

When two similar waves propagate in a medium simultaneously, then at any point the resultant displacement is equal to the vector sum of displacement produced by individual waves.

$y = y_1 + y_2$

Interference of Light

When two light waves of similar frequency having a zero or constant phase difference propagate in a medium simultaneously in the same direction, then due to their superposition maximum intensity is obtained at few points and minimum intensity at other few points.

This phenomena of redistribution of energy due to superposition of waves is called interference of light waves.

The interference taking place at points of maximum intensity is called **constructive interference**.

The interference taking place at points of minimum intensity is **destructive interference**.

Fringe Width

The distance between the centres of two consecutive bright or dark fringes is called the fringe width.

The angular fringe width is given by $\theta = \lambda / d$.

where λ is the wavelength of light d is the distance between two coherent sources.

Conditions for Constructive and Destructive Interference

For Constructive Interference

Phase difference, $\varphi = 2n\pi$

Path difference, $\Delta x = n\lambda$

where, n = 0, 1, 2, 3,…

For Destructive Interference

Phase difference, $\varphi = (2n - 1)\pi$

Path difference, $\Delta x = (2n - 1)\pi / 2$

where, n = 1, 2, 3, …

If two waves of exactly same frequency and of amplitude a and b interfere, then amplitude of resultant wave is given by

$R = \sqrt{a^2 + b^2 + 2ab \cos \varphi}$

where φ is the phase difference between two waves.

$R_{max} = (a + b)$

$R_{min} = (a - b)$

Intensity of wave

$\therefore I = a^2 + b^2 + 2ab \cos \varphi$

$= I_1 + I_2 + 2 \sqrt{I_1 I_2} \cos \varphi$

where I_1 and I_2 are intensities of two waves.

$\therefore I_1 / I_2 = a^2 / b^2 = \omega_1 / \omega_2$

Where ω_1 and ω_2 are width of slits.

Energy remains conserved during interference.

Interference fringe width

$\beta = D\lambda / d$

where, D = distance of screen from slits, λ = wavelength of light and d = distance between two slits.

Distance of nth bright fringe from central fringe $x_n = nD\lambda / d$

Distance of nth dark fringe from central fringe $x'_n = (2n - 1) D\lambda / 2d$

Coherent Sources of Light

The sources of light emitting light of same wavelength, same frequency having a zero or constant phase difference are called coherent sources of light.