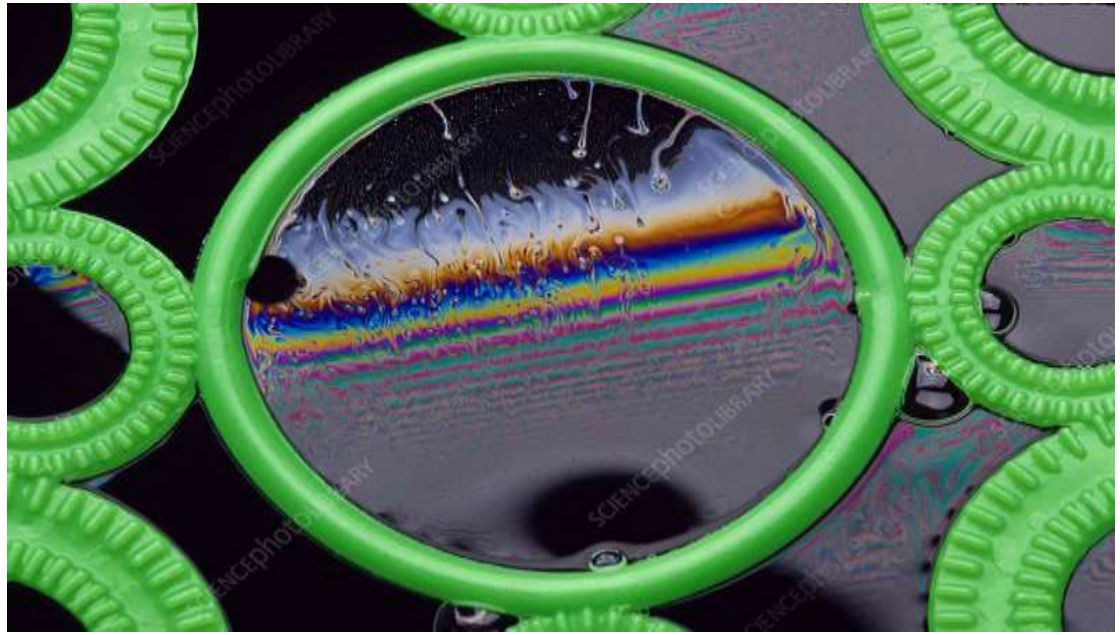
Interference of light

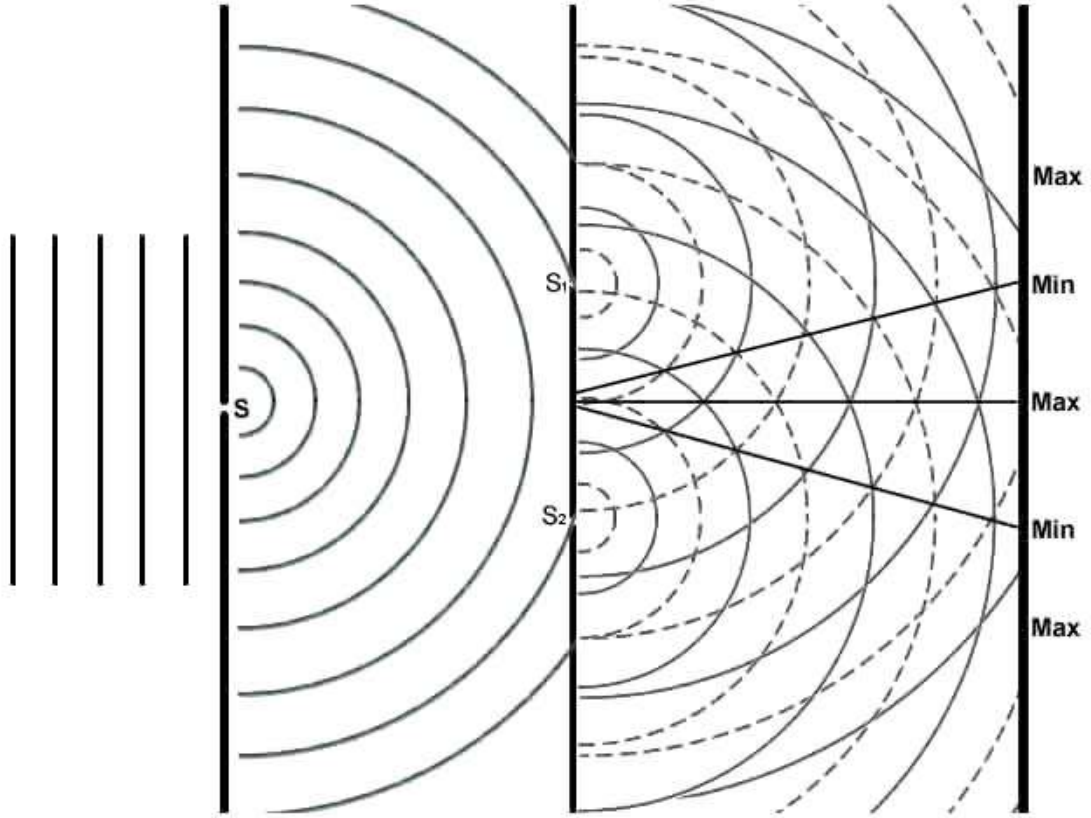


What is light?

- Light is a form of energy. It travels from one place to another place in a straight line. There are various phenomena take place in light like reflection, refraction, diffraction, polarization, etc. There are some theories to explain phenomena of light. These are as follows:

- In 1637,the corpuscular theory of Newton provided explanation some of the phenomena of light. This theory states that light is made up of small discrete particles called ‘corpuscles’ which travel in a straight line with a finite velocity and possess impetus.
- In 1678 Huygens proposed that every point that a luminous disturbance meets turns into a source of the spherical wave itself. In 1802 Thomos Young double slit experiment also supported the wave theory for the light . The phenomena which are eye-witness of wave nature are – **Reflection**, **Refraction** , **Interference** , **Diffraction** , **Polarisation.** This theory was universally accepted till the discovery of Photo electric effect and Compton Effect. The above two effects could not be resolved on the basis of the wave-theory.
- Ultimately the above two phenomena could only be explained on the basis of Planck’s hypothesis which again agrees with the particle nature of the radiation. Hence the wave theory and particle theory both were accepted for the light radiation, as each have enough experimental support.

Figure shows Interference between two light waves (wavefronts) coming from S1 and S2.



What is Interference of light

Definition: When two wave or more light waves emitted from coherent sources travel simultaneously and reunite in a given direction, the resultant displacement at any point on the screen modified. As a result, at some points on the screen resultant intensity increases while at some places, the intensity goes down. This modification in the intensity is known as interference. The points where waves arriving from coherent sources meet- in phase appear bright and those where waves meet in opposite phase appear dark. Overall pattern on the screen consist of alternate bright and dark fringes. This is known as fringe- pattern.

Conditions for Interference:

To obtain a well defined interference pattern. The two sources must satisfy the following requirements:

1. Two sources must have a constant-phase relationship. This is the fundamental requirement without which interference can not be obtained. Such two sources can be obtained by deriving from a single source.

2. The frequency and amplitude of the two waves should also be equal. If the amplitudes are unequal, we can never get minima of zero intensity.

3. The original source must be monochromatic i.e. it will emit out the wave of single wavelength.

4. The two sources producing interference a must be in the same state of polarization.

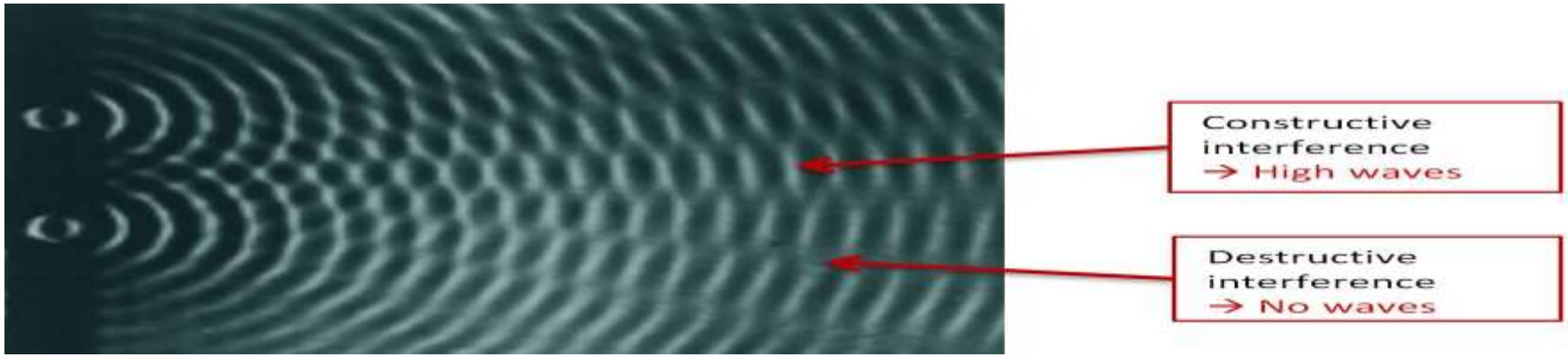
Why two independent sources cannot produce interference:

- To answer this we have to examine how the light is produced in a system. The emission of light involves transition of individual atoms from the excited state to the ground state emitting out one photon at one time which are of course not synchronized and therefore when we try to observe interference effect from two independent sources we could not observe it.

Interference can occur in two ways:

1. **Constructive Interference**: When two light waves superimpose in such a way that intensity of resultant light is more than the sum of intensities of the two individual waves.
2. **Destructive Interference**: When two light waves superimpose in such a way that intensity of resultant light is less than the sum of intensities of the two individual waves.

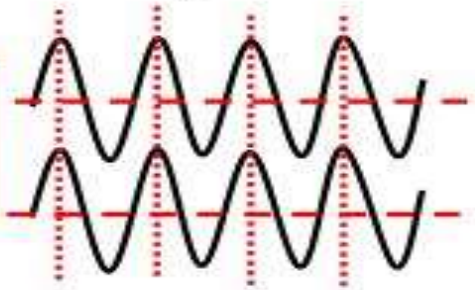
Figure shows interference between two water waves.



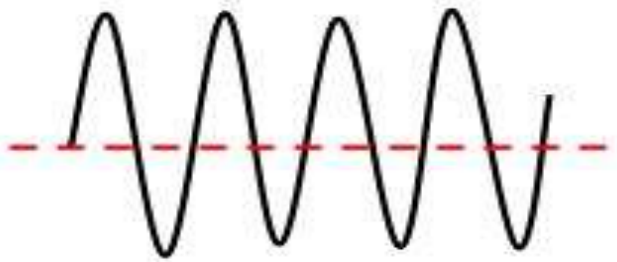
interference of light

when two light waves are combined, interference can occur → more light intensity or less light intensity

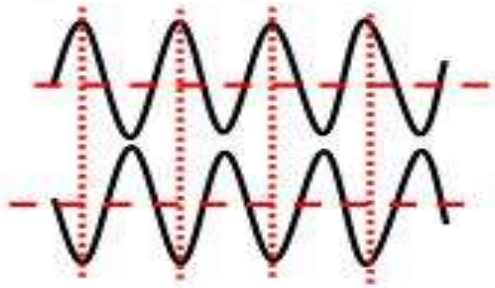
constructive interference



reinforcement

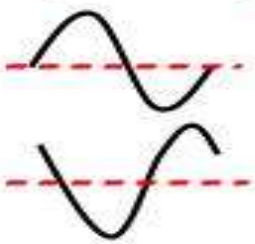


destructive interference



cancellation

in-between case



partial cancellation