Interference of light

Interference is the superposition of two or more waves resulting in the modification of the wave intensity.

Interference will be sustained if it is by two or more *coherent* waves of same frequency.

Interference resulting in maximum intensity is known as constructive interference.

Interference resulting in minimum intensity is known as destructive interference.

Nature of Interference depends on the path difference or phase difference between the interfering waves.

constructive interference.

Path difference is

integral multiple of wavelength $\delta = n\lambda$

(Phase difference $\varphi = 2n\pi$)

Nature of Interference depends on the path difference or phase difference between the interfering waves.

destructive interference.

Path difference is

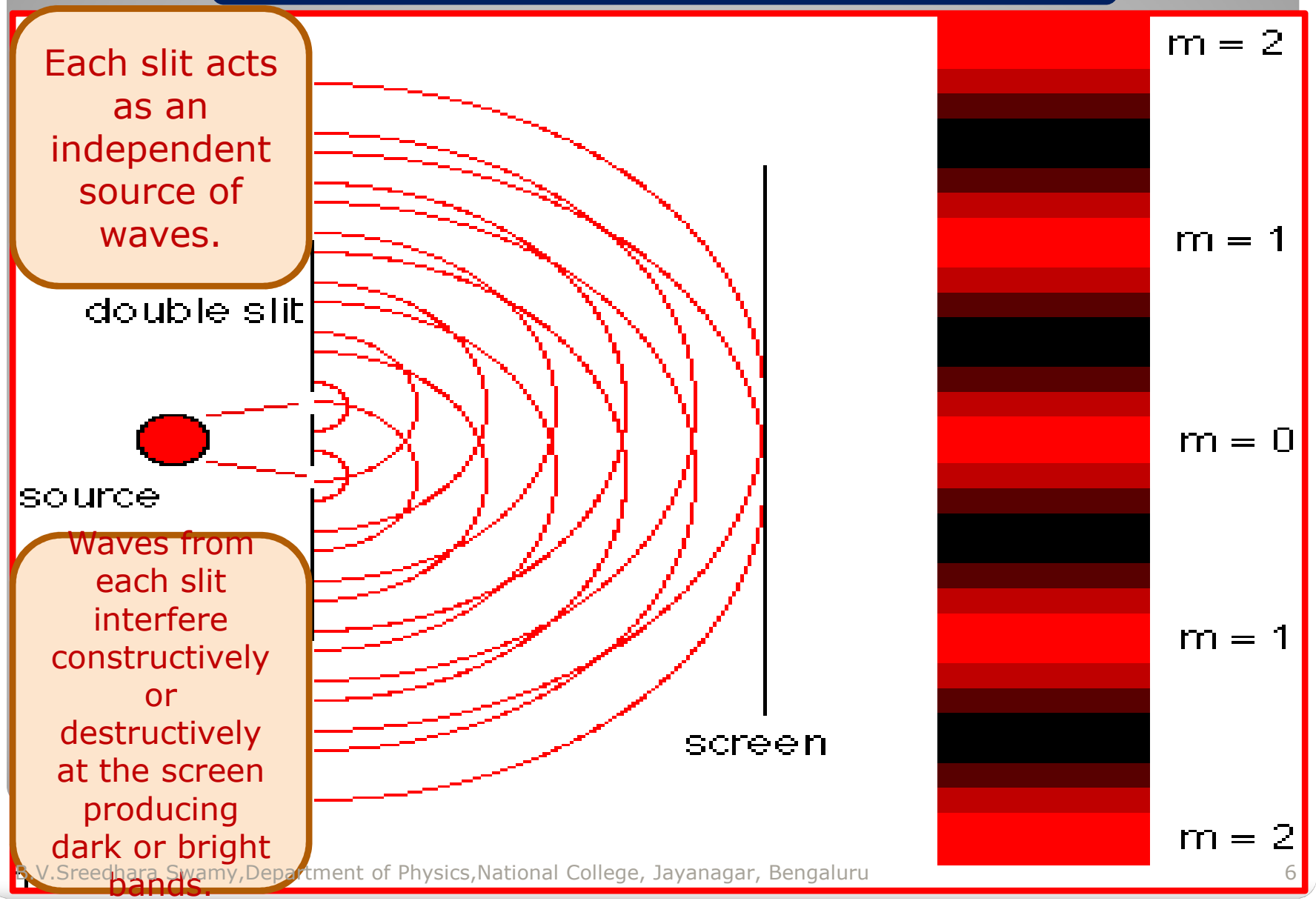
Odd integral multiple of half of the wavelength $\delta = (2n+1)\lambda/2$

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

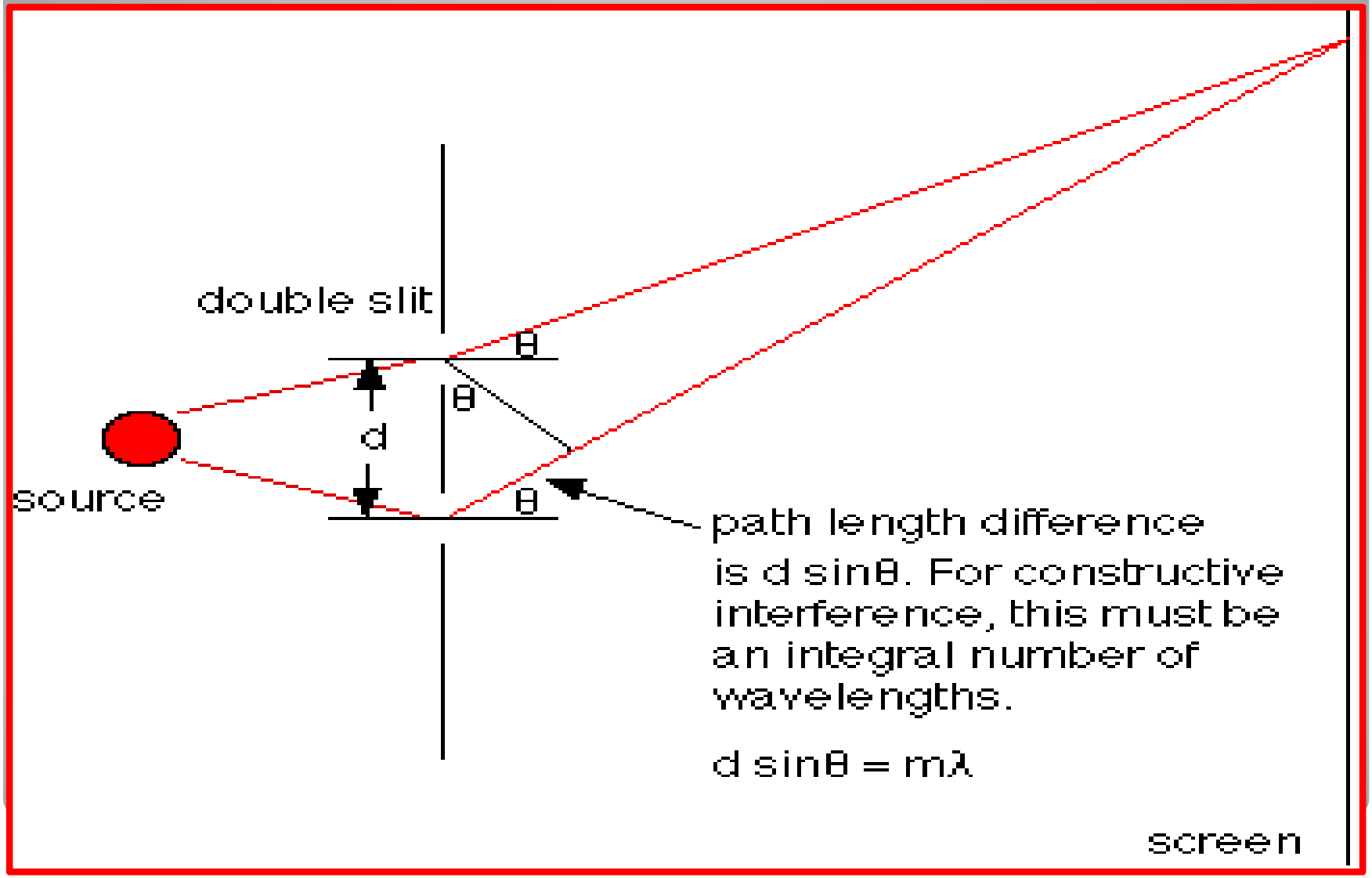
Conditions for SUSTAINED interference pattern.

1. Interfering light waves should be of same frequency.
2. The two sources must be coherent.
3. Interfering light waves should travel almost in the same direction.
4. Interfering light waves should be of almost same amplitude.
5. The two sources producing the coherent light must be narrow.

YOUNG'S DOUBLE SLIT EXPERIMENT



YOUNG'S DOUBLE SLIT EXPERIMENT: Theory



YOUNG'S DOUBLE SLIT EXPERIMENT: Theory

For P to be a bright point constructive interference should take place.

$d \sin\theta = n\lambda$. since $\sin\theta = x/D$

$xd/D = n\lambda$ or $x = n\lambda D/d$

the next bright point is $x' = (n+1)\lambda D/d$

distance between two successive bright spots(fringes) is $x' - x = \beta$

width between two successive bright fringes is $\beta = \lambda D/d$

YOUNG'S DOUBLE SLIT EXPERIMENT: Theory

For P to be a dark point destructive interference should take place.

$d \sin\theta = (2n+1)\lambda/2$. since $\sin\theta = x/D$

$xd/D = (n+1/2)\lambda$ or $x = (n+1/2)\lambda D/d$

next dark point is $x' = (n+1+1/2)\lambda D/d$

distance between two successive bright spots(fringes) is $x' - x = \beta$

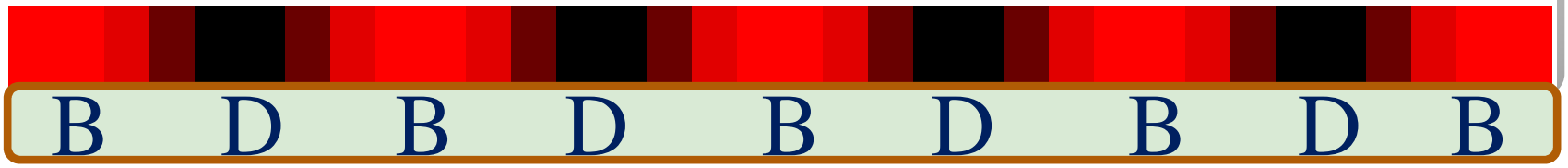
width between two successive dark fringes is $\boldsymbol{\beta = \lambda D/d}$

YOUNG'S DOUBLE SLIT EXPERIMENT: Theory

Width between two successive bright fringes or dark fringes is same

$\beta = \lambda D/d$

bright and dark fringes are separated by equal distance.



Coherent sources

If two light sources emitting light waves with the same phase or having a constant phase difference are called coherent sources.

Two light sources are said to be coherent if they emit light waves of the same frequency with same phase or a constant phase difference.

Coherent sources

NOTE:

Two independent sources cannot emit light with constant phase difference as their emission is extremely random. Thus they can not be coherent sources

coherent sources from a single source are obtained in **two** distinct ways.

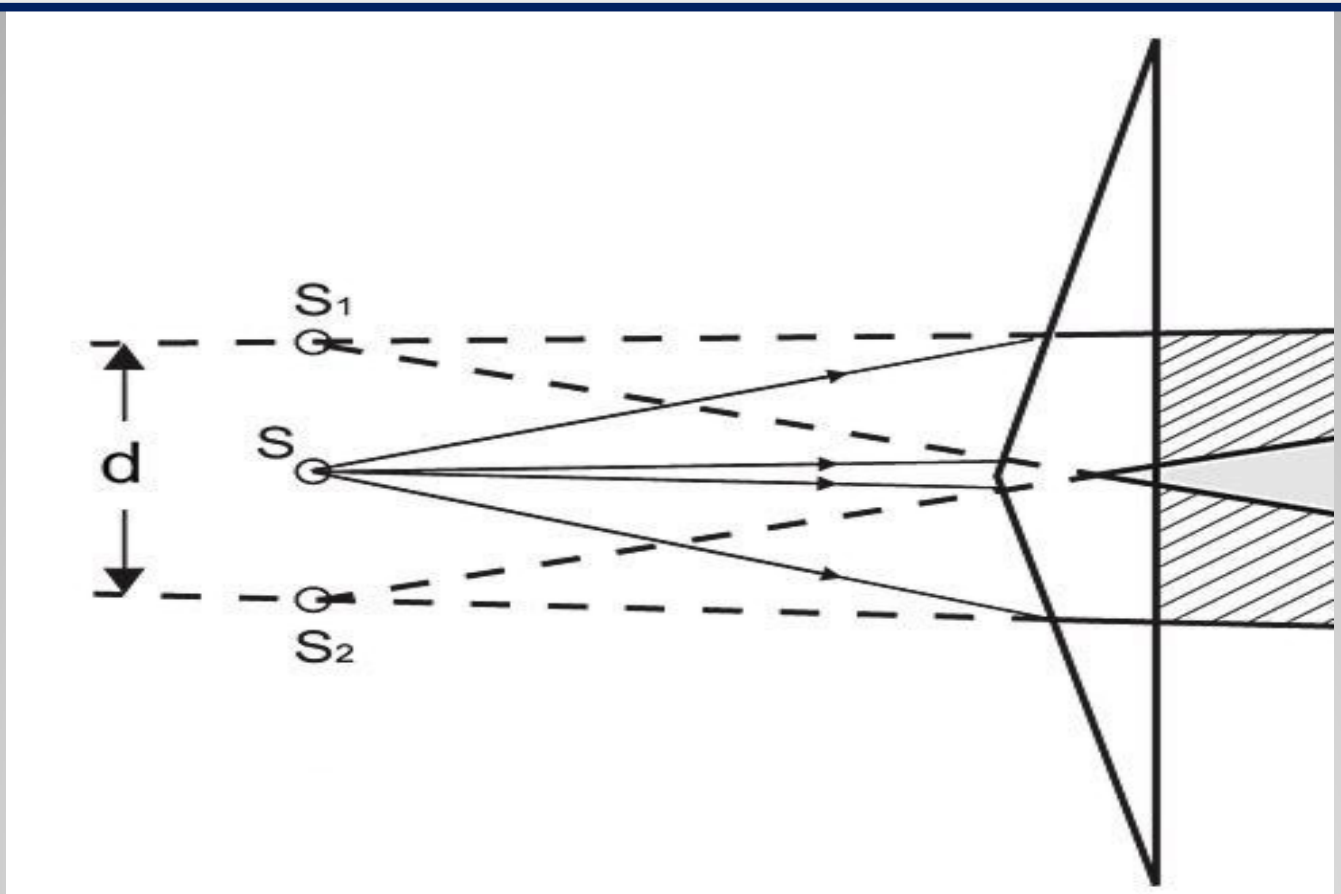
1. Coherent sources by division of wavefront:

In this method wavefront of a light source is divided into two or more parts through refraction.

Example:

Light passing through a biprism can produce two virtual images. The two virtual images act as coherent sources.

1. Coherent sources by division of wavefront:



Light coming from S_1 and S_2 are coherent

2. Coherent sources by division of amplitude

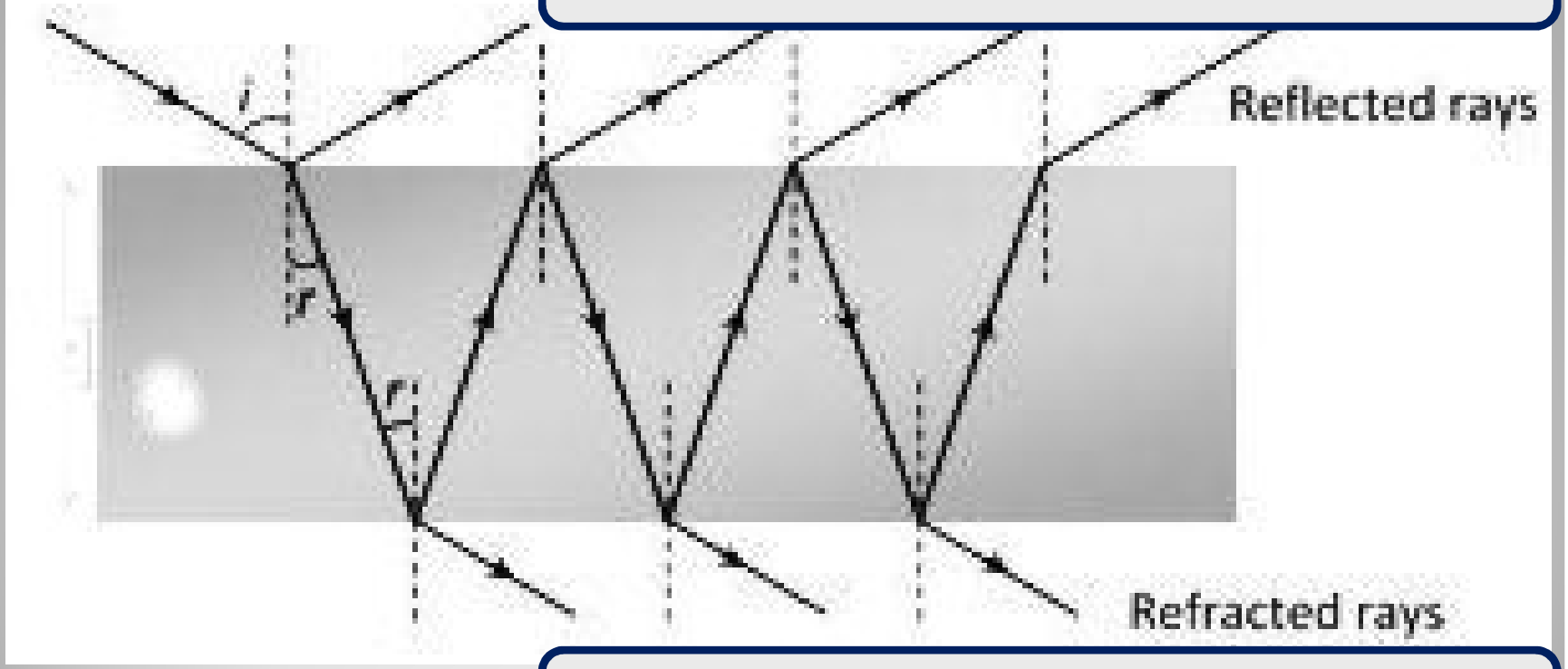
In this method wavefront of a light source is subjected to partial reflection and partial refraction.

Example:

:Light reflected by a thin film or refracted through a transparent thin film. We have here two sets of wavefronts moving in the same direction travelling in phase.

2. Coherent sources by division of amplitude

Reflected waves are coherent



Refracted waves are coherent

1.Interference is the property of

Longitudinal waves only
- Transverse waves only
- Both Longitudinal and transverse waves

2.Interference of two waves can happen when

- The two waves are monochromatic
- The two waves are coherent
- neither of the above conditions are satisfied

3.Coherent sources will have

- Zero phase difference
- constant phase difference
- any of the above

4.Two atoms of the sodium vapour source emitting light waves

- can never be coherent
- can be coherent always
- can be coherent only at a given instant

5.The constructive interference of two monochromatic light waves depends on

- Path difference between the waves
- Amplitude of the waves
- frequency of the waves

6.The destructive interference of two monochromatic light waves depends on

- Phase difference between the waves
- Intensity of the waves
- Wavelength of the waves

7.If mercury light is used instead of sodium light in a Young's double slit experiment

- Screen will be dark
- Screen will be bright
- Coloured fringes will appear with central bright fringe

8.fringe width in an Interference pattern with a monochromatic source due a double slit depends

Directly on the wavelength and inversely on slit separation
- Directly on the slit separation and inversely on wavelength
- Directly on the slit separation and wavelength

9. Example of obtaining coherent sources by division of wavefront is

- Biprism
- Light refracted through a thin transparent film
- None of the above

10.Example of obtaining coherent sources by division of amplitude is

- Biprism
- Light reflected from a thin film
- None of the above