

Interference of Light

Introduction



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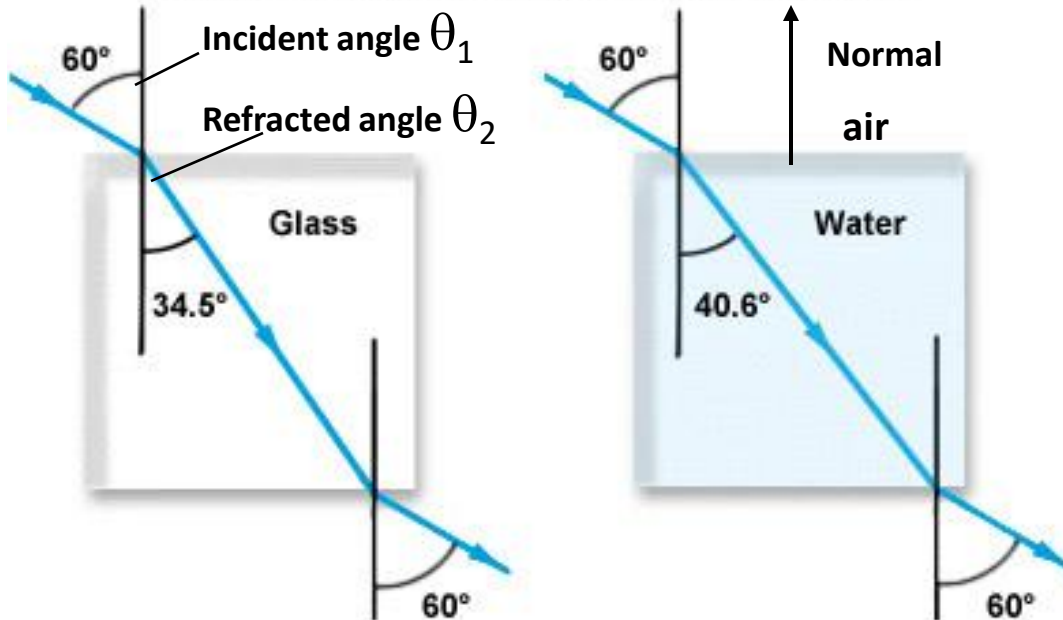
Introduction

- Definition - When two waves are simultaneously excited **under certain conditions**, the wave superimpose to produce on a screen alternate darkness and brightness. This phenomenon is known as Interference.

Refraction of Light

Light path bends at interface between two transparent media of Different indices of refraction (densities)

Light Refraction Through Glass and Water



Snell's Law

$$\frac{\sin\theta_1}{\sin\theta_2} = \frac{v_1}{v_2} = \frac{N_2}{N_1}$$

Materials	N
Air	1.0003
Water	1.33
Lucite	1.47
Immersion oil	1.515
Glass	1.52
Zircon	1.92
Diamond	2.42

N - Refractive index of material

$$N = \frac{c}{v}$$

- Speed of light in vacuum
- Velocity of light in material

$$N \geq 1$$

under certain conditions

- 1) Two waves must be Monochromatic in nature.
- 2) Two waves must be coherent.
- 3) Two waves must be nearly equal amplitude.
- 4) Amplitude of the waves should be small.



**Single
Wavelength
: Single
Color**

Two waves must be coherent.

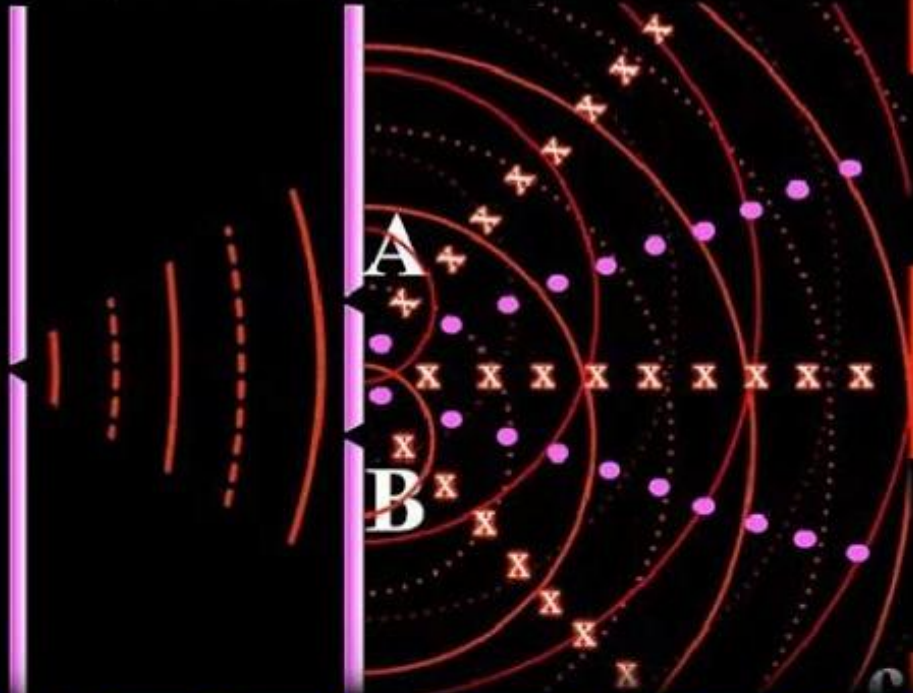
- Means Two Waves Are Having Same Phase with respect to each other.
- One Monochromatic to illuminate barrier containing two small slits.
- Light Emitting from two slits is coherent
- Two slits used to separate original beams into two parts.

**To Produce
Two
Coherent
Waves**



source

S



max

min

max

min

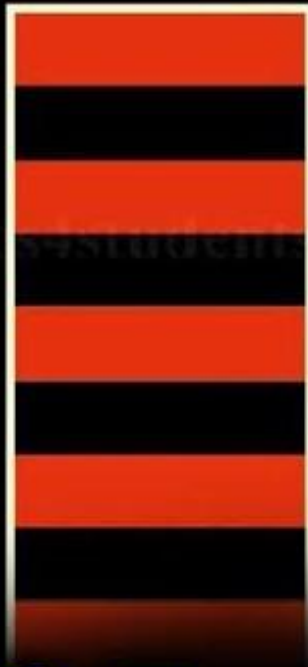
max

min

max

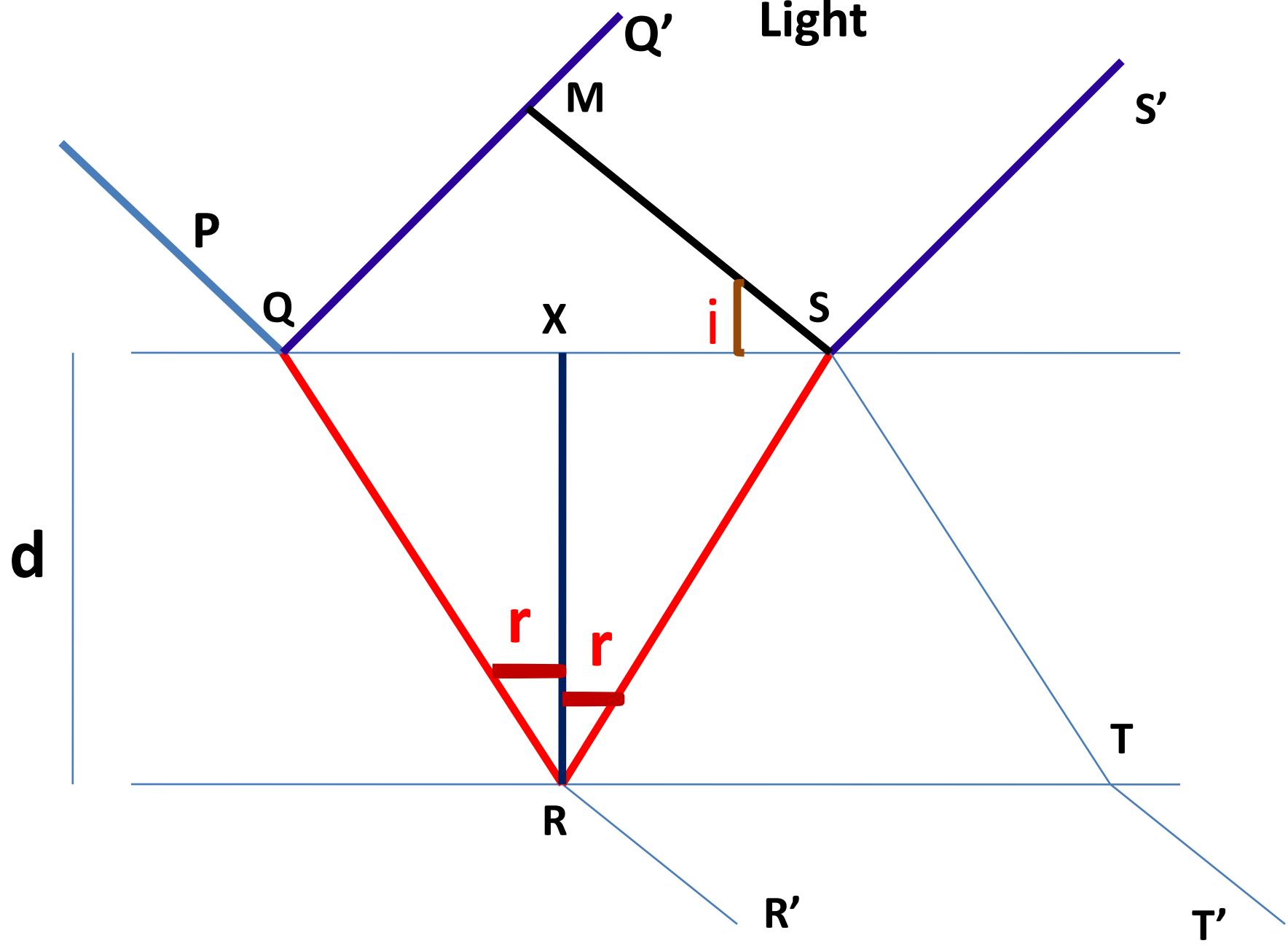
min

max



INTERFERENCE OF LIGHT

Interference in Thin Film due to Reflected Light



- Path Difference =

$$\mu (QR + RS) - QM$$

From Geometry

$$\triangle QRX \quad \text{Cos } r = XR / QR$$

$$QR = d / \text{Cos } r$$

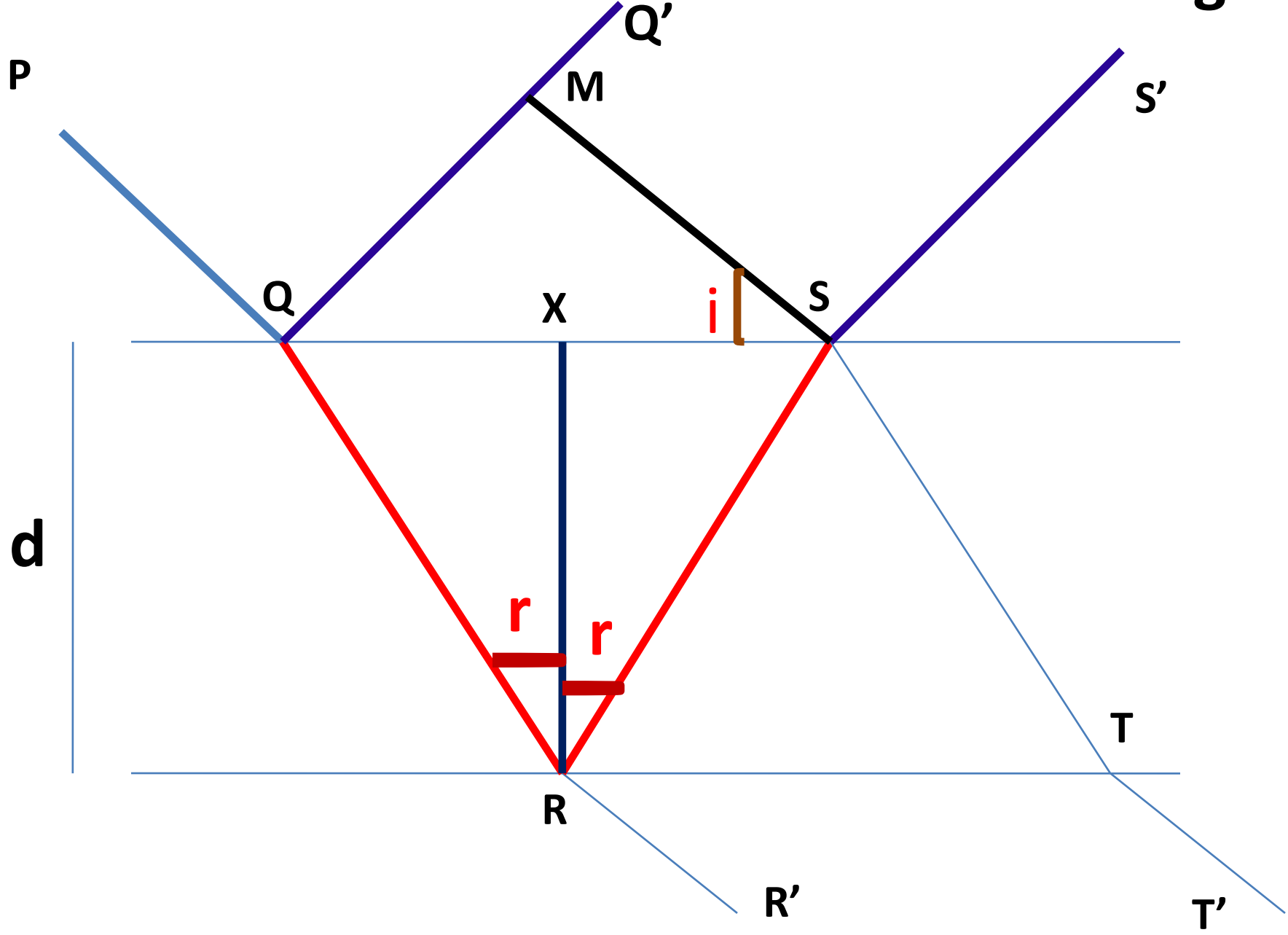
$$\triangle XRS \quad \text{Cos } r = XR / RS$$

$$RS = d / \text{cos } r$$

$$\triangle QMS \quad \text{Sin } i = QM / QS$$

$$QM = QS \text{ Sin } i$$

Interference in Thin Film due to Reflected Light



▲ QRX

$$\sin r = QX / QR$$

$$QX = QR \sin r$$

▲ XRS

$$\sin r = XS / RS$$

$$XS = RS \sin r$$

$$QM = (XQ + XS) \sin i$$

$$= (QR \sin r + RS \sin r) \sin i$$

$$QM = 2 QR \sin r \sin i$$

(Since $QR = RS = d / \cos r$)

$$QM = 2 d / \cos r * \sin r \sin i$$

$$\begin{aligned}
\text{Path Diff.} &= \mu \left(\frac{d}{\cos r} + \frac{d}{\cos r} \right) - 2 \frac{d}{\cos r} \sin r \sin i \\
&= 2 \mu \frac{d}{\cos r} - 2 \frac{d}{\cos r} \sin r \mu \sin r \\
&\hspace{15em} (\mu = \frac{\sin i}{\sin r}) \\
&= 2 \mu \frac{d}{\cos r} - 2 \mu \frac{d}{\cos r} \sin^2 r \\
&= 2 \mu \frac{d}{\cos r} (1 - \sin^2 r) \\
&= 2 \mu \frac{d}{\cos r} * \cos^2 r \\
&= 2 \mu \frac{d}{\cos r}
\end{aligned}$$

$$\text{Total P. D.} = 2 \mu \frac{d}{\cos r} \pm \frac{\lambda}{2}$$

i) For Bright region or maxima:

$$\text{P. D.} = n \lambda$$

$$2 \mu d / \cos r \pm \lambda/2 = n \lambda$$

$$2 \mu d / \cos r = (2n \pm 1) \lambda/2 ;$$

$$n=0,1,2,3\dots$$

$$\text{P. D.} = \text{Odd multiple of } \lambda/2$$

ii) For Dark region or minima:

$$\text{P. D.} = (2n \pm 1) \lambda/2$$

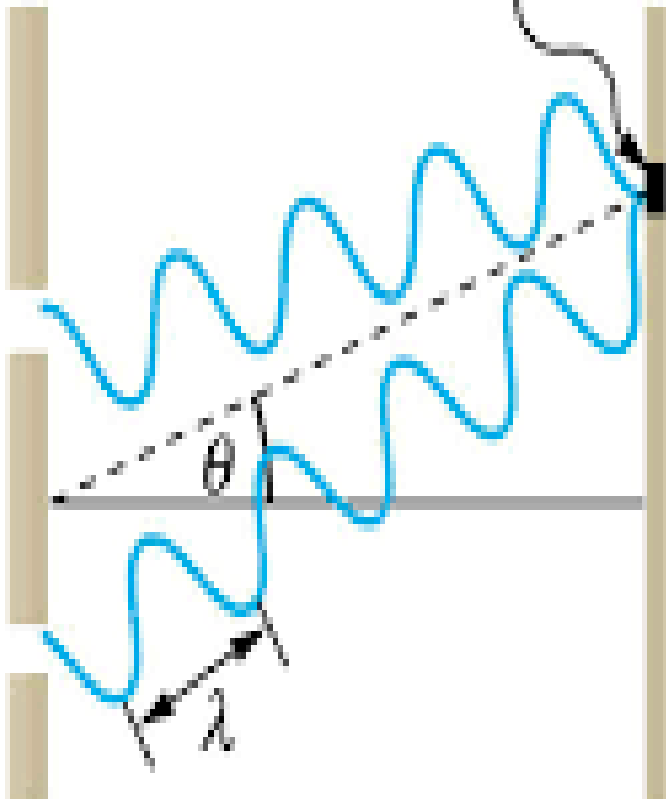
$$2 \mu d / \cos r \pm \lambda/2 = (2n \pm 1) \lambda/2$$

$$2 \mu d / \cos r = n \lambda ;$$

$$n=0,1,2,3\dots$$

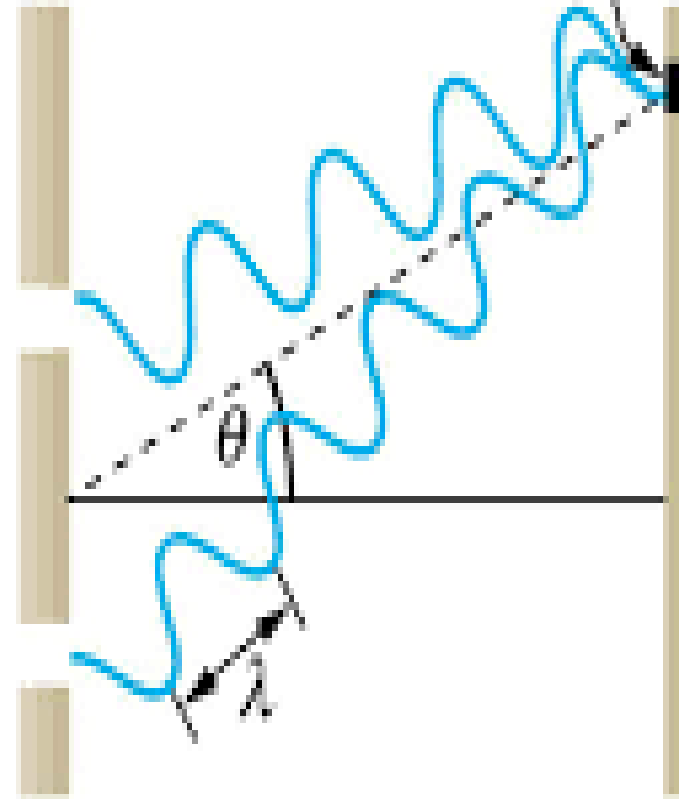
P. D. = Odd multiple of λ

Dark
(destructive
interference)



(a)

Bright
(constructive
interference)



(b)

