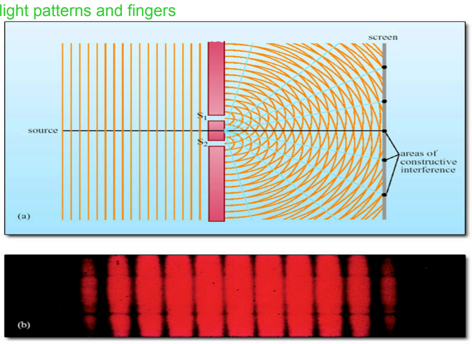
# Chapter 27

## Diffraction and Interference of light

demo - light patterns and fingers

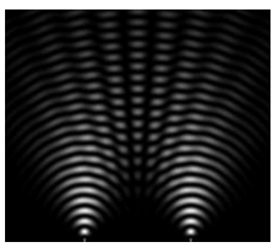



## Wave Review

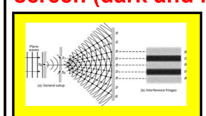
- **Superposition** = addition of mulitple wave amplitudes
- **constructive interference** = two crests or two troughs combine = BRIGHT = MAX
- **destructive interference** = crest and trough combine = DARK = MIN

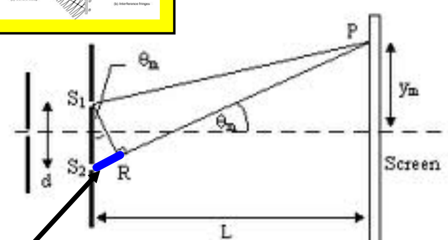
## For COHERENT, IN PHASE light sources:

- Max
  - > antinode
  - > **$\Delta L = m\lambda$**
- Min
  - > done
  - > **$\Delta L = (m+1/2)\lambda$**



**Young's Experiment - coherent, in phase light passed through two slits forming an interference pattern on a screen (dark and light fringes)** *demo hair and laser*





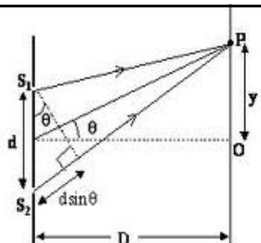

**d = distance between slits**

**L = distance to screen**

**y = distance between fringes**

path length difference = **$\Delta L = d\sin\theta$**

## Young Experiment Equations




**$d\sin\theta = m\lambda$** (max, bright)

*** NOTE m = 0 = central bright)***

**$d\sin\theta = (m+1/2)\lambda$** (min, dark)

**$\tan\theta = y/L$**

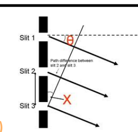
$\tan\theta = y/L = m\lambda/d = \sin\theta$ (for VERY small angles)

so....

**$y/L = m\lambda/d$** (max).....*EQ sheet uses x for y*

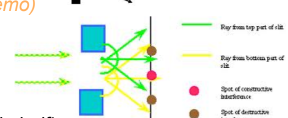
## Multiple slits

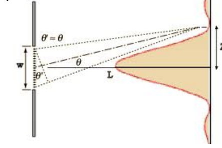
- BRIGHTER..same equations
- Called Diffraction Grating *(demo)*



## Single slit

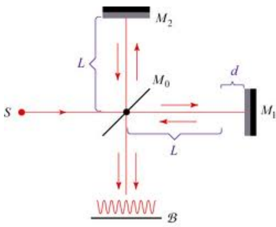
- max/min reversed
- wave interferes with itself (splits in half)
- Use W instead of d
- **$W\sin\theta = (m+ 1/2)\lambda$** = max
- **$W\sin\theta = m\lambda$** = min

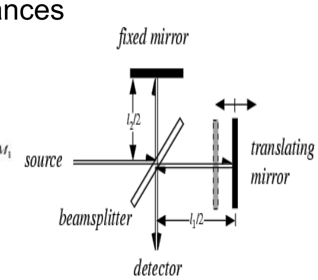




## Interferometer

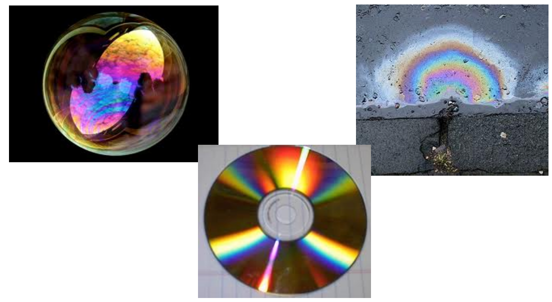
- Device using light interference to measure VERY small distances



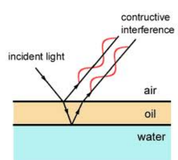

## Thin Film Interference

*demo karo syrup, sea shell, polarizer and cellophane*

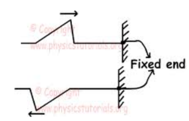


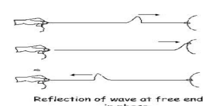
## Thin Film Interference

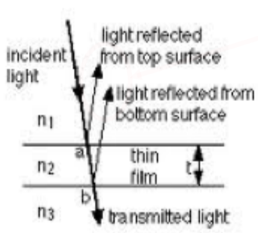
- Due to different n's in different media
- Dependent on
  > n
  > angle
  > reflection from different surfaces




- If reflects off **BIGGER n** = fixed = **shifts** wave from crest to trough
- If reflects off **smaller n** = free = **no shift**



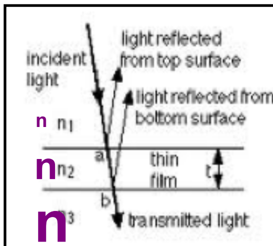




These waves make interference pattern

If in phase = max for that color λ

If out of phase = min for that color λ




**if $n_2 > n_1$ = "fixed end" = shifts = out of phase with incident light**

**if $n_3 > n_2$ = "fixed end" = shifts = out of phase with incident light = in phase with other reflected wave**

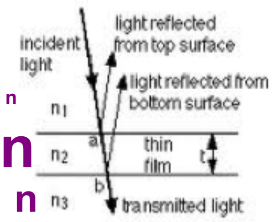
**PLD = ΔL = 2tn (because it reflects AND slows down by factor of n)**

**$2tn = m\lambda$** (MAX...keeps IN PHASE)

**$2tn = (m + 1/2)\lambda$** (MIN...shifts OUT OF PHASE)

color disappears = min when **$t = \lambda/4n$**

*****notice the quarter for a min*****




if $n_2 > n_1$ = "fixed end" = shifts = out of phase with incident light

if $n_2 > n_3$ = "fixed end" = shifts = out of phase with incident light = in phase with other reflected wave

PLD = $\Delta L$ = 2tn (because it reflects AND slows down by factor of n)

**$2tn = (m+1/2)\lambda$** (MAX...puts it BACK in Phase)

**$2tn = m\lambda$** (MIN...keeps out of phase)

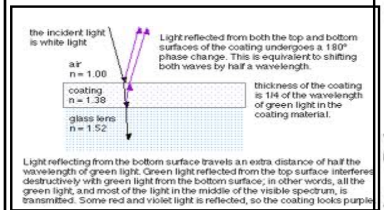
color disappears = min when **$t = \lambda/2n$**

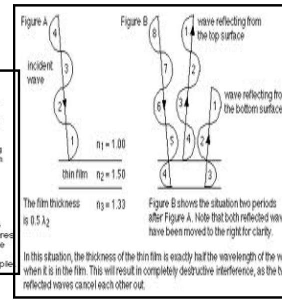
***notice "no order, no quarter" for a min***

$\lambda_{film} = \lambda/n$.....so can also write equations as

**$t = \lambda_{film}/2$** (no order min)

**$t = \lambda_{film}/4$** (order min)




## Bragg Equation

- Used to determine thickness between atoms in layered crystal lattice
- Like thin film, light refects off atoms
- **$m\lambda = 2d\sin\theta$**