

## Wave Optics Review

### General Background

- Light is a wave, proved by Young's Double slit experiment
- For interference to occur the light must be coherent, (note: two different light are NOT coherent)

### Double Slit Interference

- Multiple of a  $\lambda$  is the path difference
- Dark Fringe (Destructive interference, minima)

$$\left(m + \frac{1}{2}\right)\lambda = d \sin \theta$$

- Bright Fringe (Constructive interference, maxima)

$$m \lambda = d \sin \theta$$

- $d$  = distance between slit
- $L$  = distance to screen
- $y$  = distance from 0 line to any dark/light band
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- As  $\lambda$  increases  $y$  increases
- As  $d$  increases  $y$  decreases
- As  $l$  increases  $y$  increases
- $\tan \theta = \frac{y}{L}$
- If  $\theta$  is small (Less than  $10^\circ$ )

$$\sin \theta \cong \tan \theta$$

$$\frac{y}{L} = \frac{m\lambda}{d}$$

### Diffraction Gratings

- Many parallel slits in a small region
- Bright bands are sharp with large dark bands between them
- $m\lambda = d \sin \theta$
- $d$  = distance between slits (the lines)
- $\frac{1}{d}$  = number of lines per unit length

### Single slit diffraction

#### Minima (dark bands)

$$\sin \theta = \frac{m\lambda}{D}$$
$$\tan \theta = \frac{y}{L}$$

$D$  = width of slit

- 2 times the distance from center line to 1<sup>st</sup> dark fringe is the width of the 0<sup>th</sup> order maxima

### Thin Film Interference

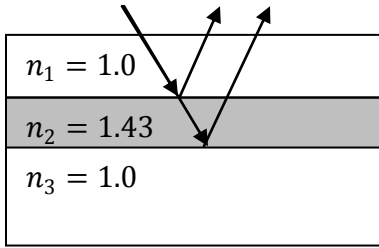
See pg. 2 for thin film cases and equations

#### Assumptions

- Film is of constant thickness
- The light hits the surface almost **perpendicular** to its surface
- The light reflects from the top and bottom of the film
- Ray #2 travels further than Ray #1
- $\frac{1}{2}\lambda$  phase change upon reflection from low  $n$  to high  $n$  (reflects back inverted)
- **Path difference** is  $2t$
- Questions to ask:
  1. Is it changing phase? (Low  $n \rightarrow$  high  $n$  it will; otherwise no)
  2. Is the interference constructive or destructive?
  3. What does the thickness need to be to cause appropriate interference? ( $\lambda$  or  $\frac{1}{2}\lambda$ )

## Thin Film Interference Cases and Equations

### Case I - One Phase Change



Ray 1 - Inverts

Ray 2 - Does not invert (because  $n_3 < n_2$ )

**Constructive Interference**

$$\left(m + \frac{1}{2}\right) \lambda_f = 2t$$

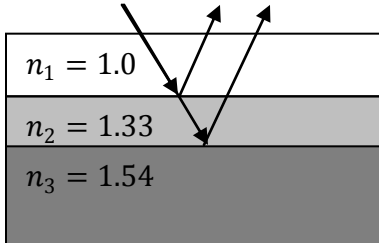
**Destructive Interference**

$$m \lambda_f = 2t$$

Where  $m$  is a positive integer

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### Case II - Two Phase Changes



Ray 1 - Inverts

Ray 2 - Inverts (because  $n_3 > n_2$ )

**Constructive Interference**

$$m \lambda_f = 2t$$

**Destructive Interference**

$$\left(m + \frac{1}{2}\right) \lambda_f = 2t$$

Where  $m$  is a positive integer