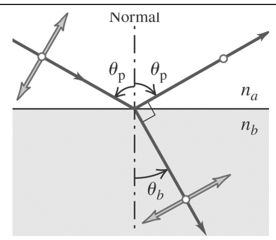
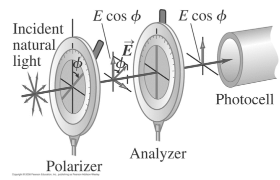
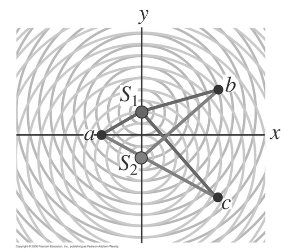


Polarization by reflection
$\tan\theta_p = n_b/n_a$



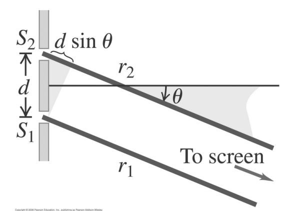
Outgoing light polarized at filter angle
If polarized in: $I = I_o \cos^2\phi$
If unpolarized in: $I = \frac{1}{2} I_o$

2-source interference (general)

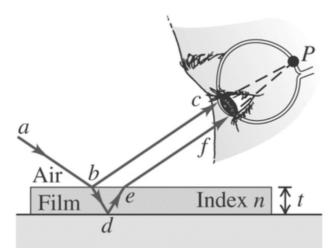


Path difference: Δs
Constructive: $\Delta s = m\lambda$
Destructive: $\Delta s = (m + \frac{1}{2})\lambda$

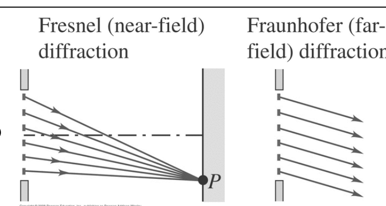
2-source interference (far-field)
(far-field: $R > 10d$)
Constructive Interference:
$d\sin\theta = m\lambda$ for $m = 0, \pm 1, \pm 2, ..$
Destructive Interference:
$d\sin\theta = (m + \frac{1}{2})\lambda$ for $m = 0, \pm 1, \pm 2, ..$
Bright fringes (small θ : $d > 10\lambda$):
$y_m = m\frac{R\lambda}{d}$ for $m = 0, \pm 1, \pm 2, ...$



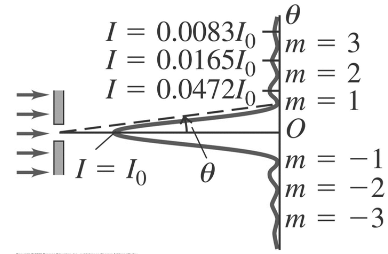
Thin film interference if **NO** relative phase shift
Constructive Interference: $2t = m\lambda_{film}$ for $m = \pm 1, \pm 2, ..$
Destructive Interference: $2t = (m + \frac{1}{2})\lambda_{film}$ for $m = 0, \pm 1, \pm 2, ..$
Thin film interference **WITH** half-cycle phase shift
Constructive Interference: $2t = (m + \frac{1}{2})\lambda_{film}$ for $m = 0, \pm 1, \pm 2, ..$
Destructive Interference: $2t = m\lambda_{film}$ for $m = \pm 1, \pm 2, ..$
HALF-CYCLE phase shift will occur for reflections
at interface where n increases.
WARN: λ_{film} is wavelength IN MEDIUM, so $\lambda_{film} = \lambda_o / n_{film}$



Diffraction : waves pass through aperture or around an edge.
· Fresnel: nearby source or observer.
· Fraunhofer (typical case): source and observer far away (relative to size of slit)



Single Slit Diffraction (far-field: $R > 10D$**)**
monochromatic waves (light, etc), slit width D
DARK fringes at: $\sin\theta = m\frac{\lambda}{D}$ for $m = \pm 1, \pm 2, ..$
Small angles: $y_m = m\frac{R\lambda}{D}$ for $m = \pm 1, \pm 2, ..$
$I(\theta) = I_o snc^2(\beta/2)$ where $snc(x) \equiv \frac{\sin x}{x}$ and $\beta = \frac{2\pi D \sin\theta}{\lambda}$
Intensity at BRIGHT fringes: $I_m \approx \frac{I_o}{(m+\frac{1}{2})^2\pi^2}$ for $m = 1, 2, 3..$



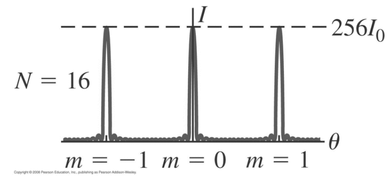
Diffraction Grating (far-field)

large number of parallel slits separated by d

Sharp BRIGHT fringes at: $d \sin\theta = m\lambda$ for $m = 0, \pm 1, \pm 2, ..$

Small angles: $y_m = m\frac{R\lambda}{d}$ for $m = 0, \pm 1, \pm 2, ..$

Same effect with REFLECTION grating formed from tiny thin strips of reflecting material (d now being distance between centers of reflecting strips)



Rayleigh resolution limit (Note: $\sin\theta \approx \theta$ if θ is small and in radians)

single slit of width D : $\sin\theta = \lambda/D$ circular aperture of diameter D : $\sin\theta = 1.22\lambda/D$

Miscellaneous

Speed of sound in air: $v \approx 343\ m/s$ Speed of sound in water: $v \approx 1500\ m/s$

Speed of light in vacuum: $v = c = 2.998 \times 10^8\ m/s$ ($c = 3 \times 10^8\ m/s$ is good enough)

Light year: $1\ LY = 9.461 \times 10^{15}\ m$

Energy: $1\ eV = 1.602 \times 10^{-19}\ J$ $K = \frac{1}{2}mv^2$

Typical indices of refraction: $n_{air} = 1.00$, $n_{water} = 1.33$, $n_{glass} = 1.5\ to\ 1.8$

Visible light: 390 nm to 750 nm (see table below)

Audible range (humans): $f = 20\ Hz$ to $f = 20,000\ Hz$

Nanometer: $1\ nm = 10^{-9}\ m$ Frequency, wavelength and wave speed: $v = \lambda/T = \lambda f$.

Arc-length: $s = r\theta$ (angle in radians)

Quadratic equation: if $ax^2 + bx + c = 0$ then $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

Far Field : $R > 10d$ or $R > 10D$ with R being the distance away from the slit/aperture/grating

Small Angle : $d > 10\lambda$ or $D > 10\lambda$

(We didn't develop near-field equations for single slit or diffraction gratings, so it's OK to use the far-field equations for those.)

Light	
Wavelength λ (nm)	Color
< 390	(ultraviolet)
$390 - 435$	Violet
$435 - 500$	Blue
$500 - 520$	Cyan
$520 - 565$	Green
$565 - 590$	Yellow
$590 - 625$	Orange
$625 - 750$	Red
> 750	(infrared)

FM radio: λ around 2.78 m to 3.41 m

AM radio: λ around 176 m to 555 m

Digital TV: λ around 40 cm