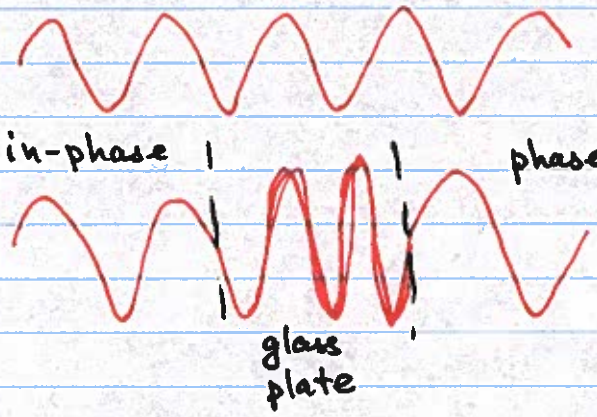
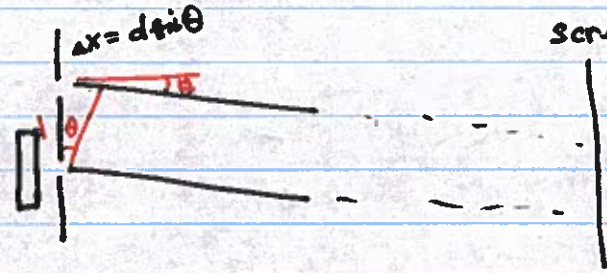
Interference example

When light travels through glass, it travels slower $v = c/n$



$+\pi$ phase shift



distance difference

$\Delta x = d\sin\theta$ (as before)

phase difference

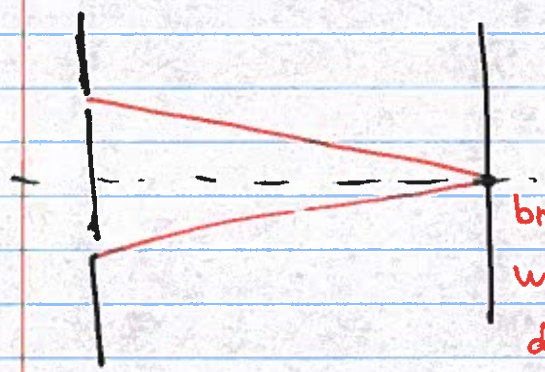
$$\varphi = \frac{2\pi}{\lambda}\Delta x + \text{extra phase from the plate}$$

In the example

$$\varphi = \frac{2\pi}{\lambda} d\sin\theta + \pi$$

extra π phase means constructive interference become destructive and vice versa

So bright and dark spot change places



bright if no waveplate (same path)
with π-phase change -
destructive interference, dark spot

Diffraction grating: different colors

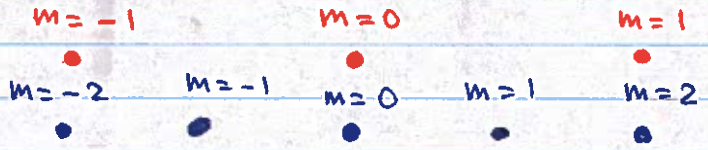
Maxima (global maxima) occurs when all slits contribute constructively

Each beam has extra phase $\frac{2\pi}{\lambda} d\sin\theta = 2\pi m$ for constructive

$$\frac{d\sin\theta_m}{\lambda} = m \qquad \sin\theta_m = m\frac{\lambda}{d}$$

The longer is the wavelength λ, the larger is the angle b/w the maxima

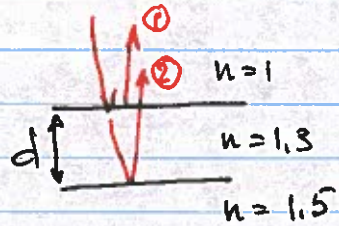
Central peak $\theta = 0$, for all colors
$m = 0$



$\lambda = 800nm$

$\lambda = 400nm$

Thin film interference



$\lambda_0 = 600nm$

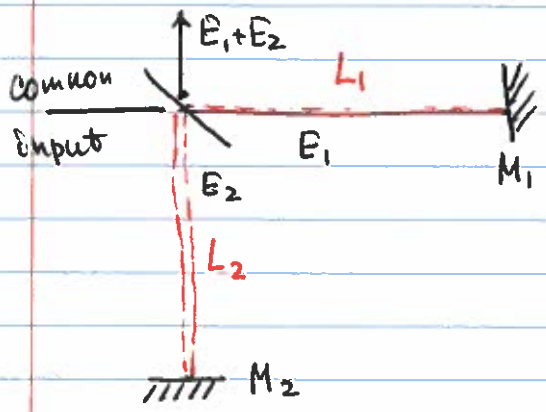
extra π-phase on either surface, so cancels out!

$\varphi = \frac{2\pi n}{\lambda_0} \cdot 2d = \pi$ for destructive interference

$4n \cdot d = \lambda_0$

$d = \lambda_0/4n = 115nm$

Optical interferometer



At the beamsplitter

input: $E_1 = E_0$ $E_2 = E_0$

↓ ↓

travels $2L_1$ travels $2L_2$

↓

output $E_1 = E_0 e^{i2kL_1}$ $E_2 = E_0 e^{i2kL_2}$

total $E_0 e^{i2kL_1} + E_0 e^{i2kL_2} =$

$= E_0 e^{i2k\frac{L_1+L_2}{2}} \left[e^{ik\Delta L} + e^{-ik\Delta L} \right]$

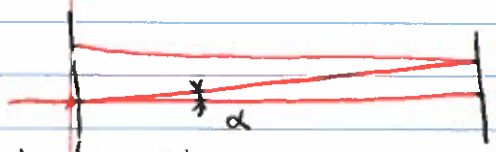
$\Delta L = L_1 - L_2$

$= 2E_0 e^{ik(L_1+L_2)} \cos k\Delta L$

Power $\propto |E_{tot}|^2 \propto \cos^2 k\Delta L$ $k\Delta L = \pi m$ bright

$k = \frac{2\pi}{\lambda}$ $k\Delta L = \pi/2 + \pi m$ dark

Diverent light



beamsplitter location

Extra distance travelled: $2L_{1,2}\sin\alpha = 2L_{1,2}\alpha$

$L_{1,2} \to L_{1,2} + \alpha L_{1,2}$

Normal incidence: $\Delta L = L_1 - L_2$

Angled beam: $\Delta L(\alpha) = L_1 - L_2 + \alpha(L_1 - L_2)$

if $\alpha(L_1 - L_2) = \lambda/2, 3\lambda/2, \ldots$ etc

the bright circle changed to the dark one and vice virsa