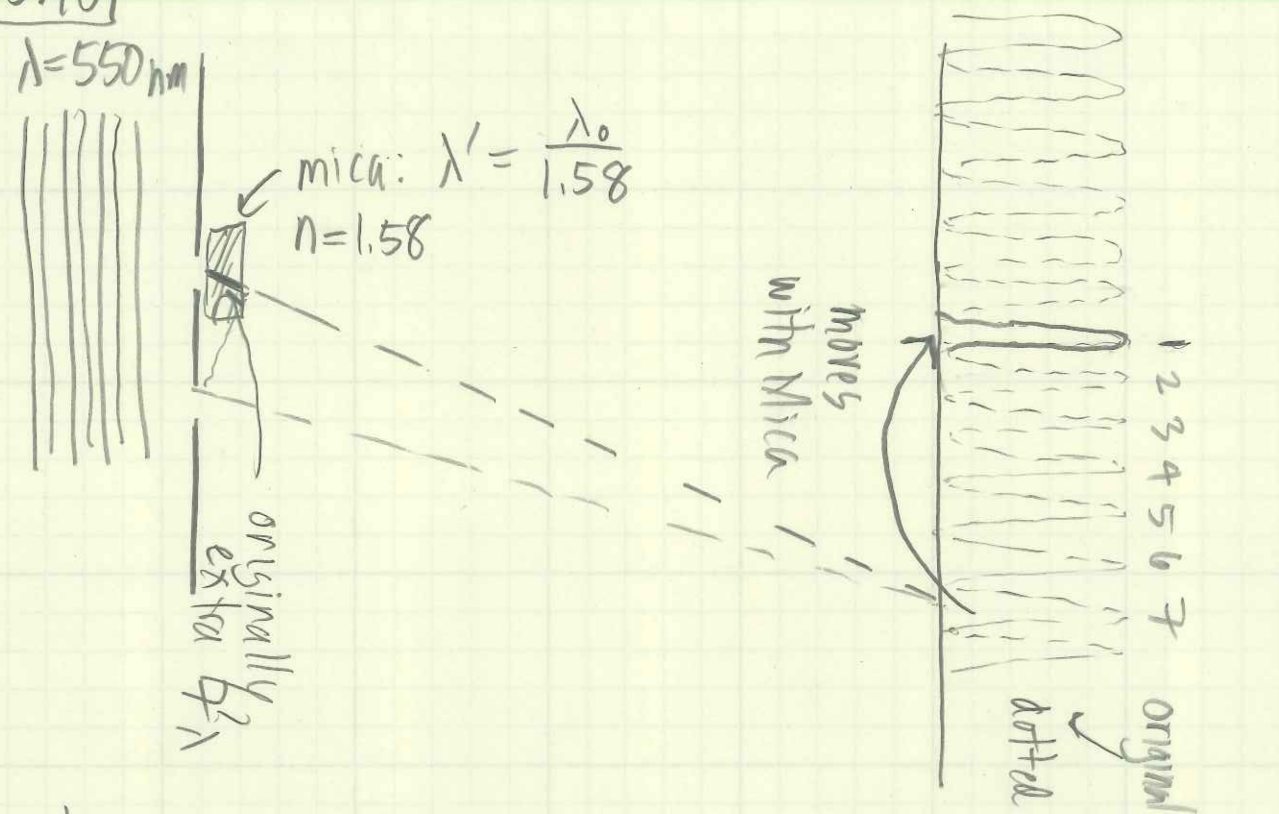
45.10



with mica: must get seven extra wavelengths over no mica:

No Mica: $\frac{t}{\lambda_0} = N_0$

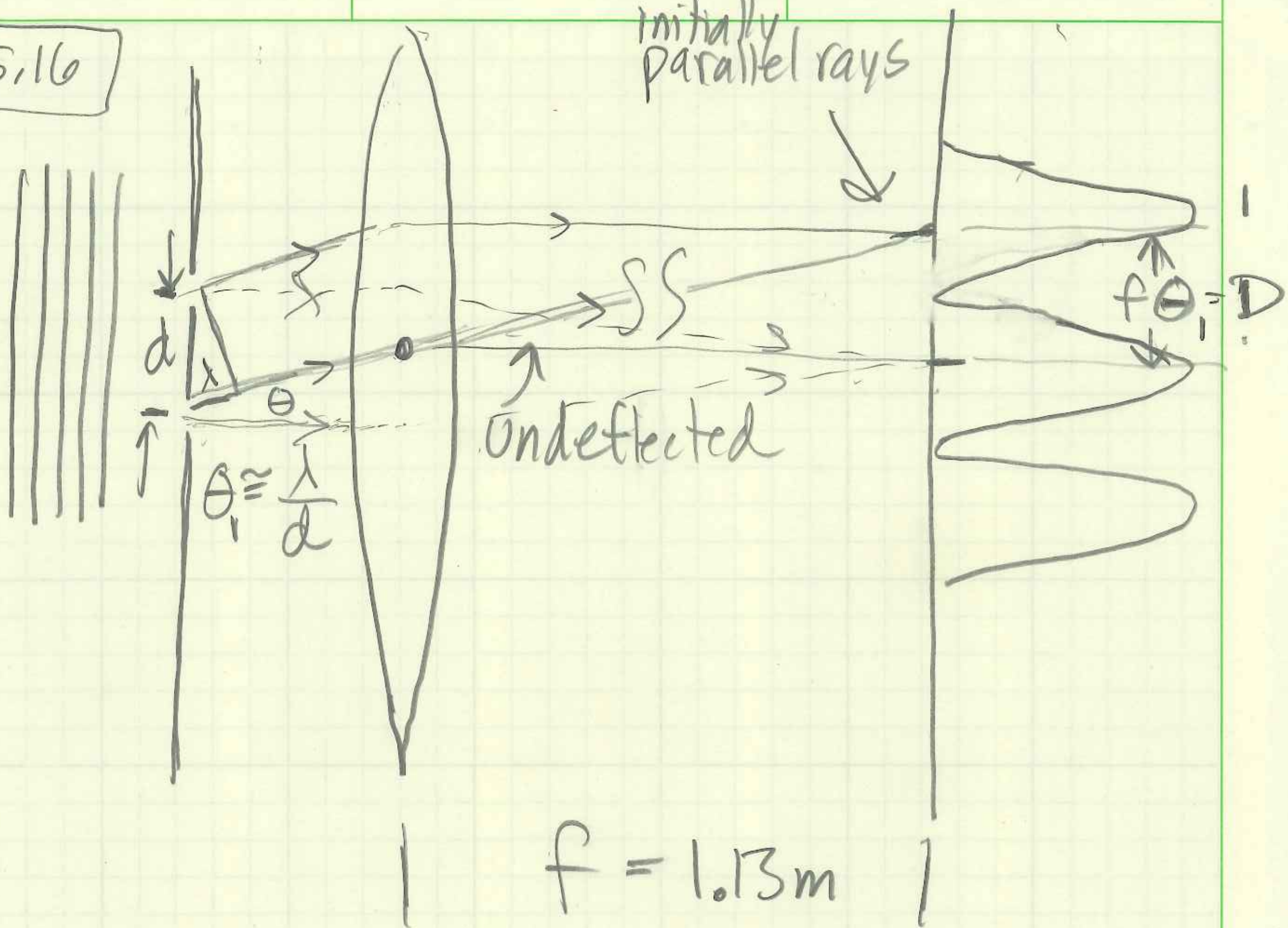
with Mica: $\frac{t}{\lambda'} = \frac{nt}{\lambda_0} = N_0 + 7 = \frac{t}{\lambda_0} + 7$

so $\frac{(n-1)t}{\lambda_0} = 7$

$t = \frac{7\lambda_0}{(n-1)} = \frac{7 \cdot 550 \cdot 10^{-9}\,m}{(1.58-1)}$

$\boxed{t = 6.64\,\mu m}$

$\boxed{45.16}$



$$D = f\theta_1 = \frac{f\lambda}{d} = \frac{1.13 \times 589 \cdot 10^{-9}\ m^2}{0.18 \cdot 10^{-3}\ m}$$

$$\boxed{D = 3.70\ mm}$$

$\boxed{45.18}$ (a) $1 \times 10^{-8}\,s = 10\,ns \rightarrow$ light goes 10 feet

$\boxed{L = 3 \text{ meters}}$ ← $10 \times 30\,cm = 300\,cm$

(b) $\Delta(\text{path}) = 10 - 5 = 5$ meters

$\boxed{\Delta(\text{path}) > L \text{ so, fringes wash out}}$

$\boxed{45.24}$

$$y_1 = 10 \sin\omega t = A_1 \sin(\omega t) = \mathrm{Im}(A_1 e^{i\omega t})$$

$$y_2 = 14 \sin(\omega t + 26^\circ) = \mathrm{Im}(A_2 e^{i(\omega t + \phi_2)})$$

$$y_3 = 4.7 \sin(\omega t - 41^\circ) = \mathrm{Im}(A_3 e^{i(\omega t + \phi_3)})$$

$$y_1 + y_2 + y_3 = \mathrm{Im}(A_1 e^{i\omega t}) + \mathrm{Im}(A_2 e^{i(\omega t + \phi_2)}) + \mathrm{Im}(A_3 e^{i(\omega t + \phi_3)})$$

$$= \mathrm{Im}\left(A_1 e^{i\omega t} + A_2 e^{i(\omega t + \phi_2)} + A_3 e^{i(\omega t + \phi_3)}\right)$$

$$= \mathrm{Im}\left(e^{i\omega t}\underbrace{(A_1 + A_2 e^{i\phi_2} + A_3 e^{i\phi_3})}_{\text{this adds up to } A_{tot} e^{i\phi_{tot}}}\right)$$

$$A_{tot} \cos\phi_{tot} = A_1 \underbrace{\cancel{\cos\phi_1}}_{1} + A_2 \cos\phi_2 + A_3 \cos\phi_3$$

$$= 10 + 14 \cos(26^\circ) + 4.7 \cos(-41^\circ)$$

$$A_{tot} \cos\phi_{tot} = 10 + 12.58 + 3.55 = 26.13$$

$$A_{tot} \sin\phi_{tot} = A_1 \underbrace{\cancel{\sin\phi_1}}_{0} + A_2 \sin\phi_2 + A_3 \sin\phi_3$$

$$= 14 \sin(26^\circ) + 4.7 \sin(-41^\circ)$$

$$= 6.14 - 3.08 = 3.05$$

$$\tan\phi_{tot} = \frac{A_{tot} \sin\phi_{tot}}{A_{tot} \cos\phi_{tot}} = \frac{3.05}{26.13} = 0.116, \quad \boxed{\phi_{tot} = 6.66^\circ}$$

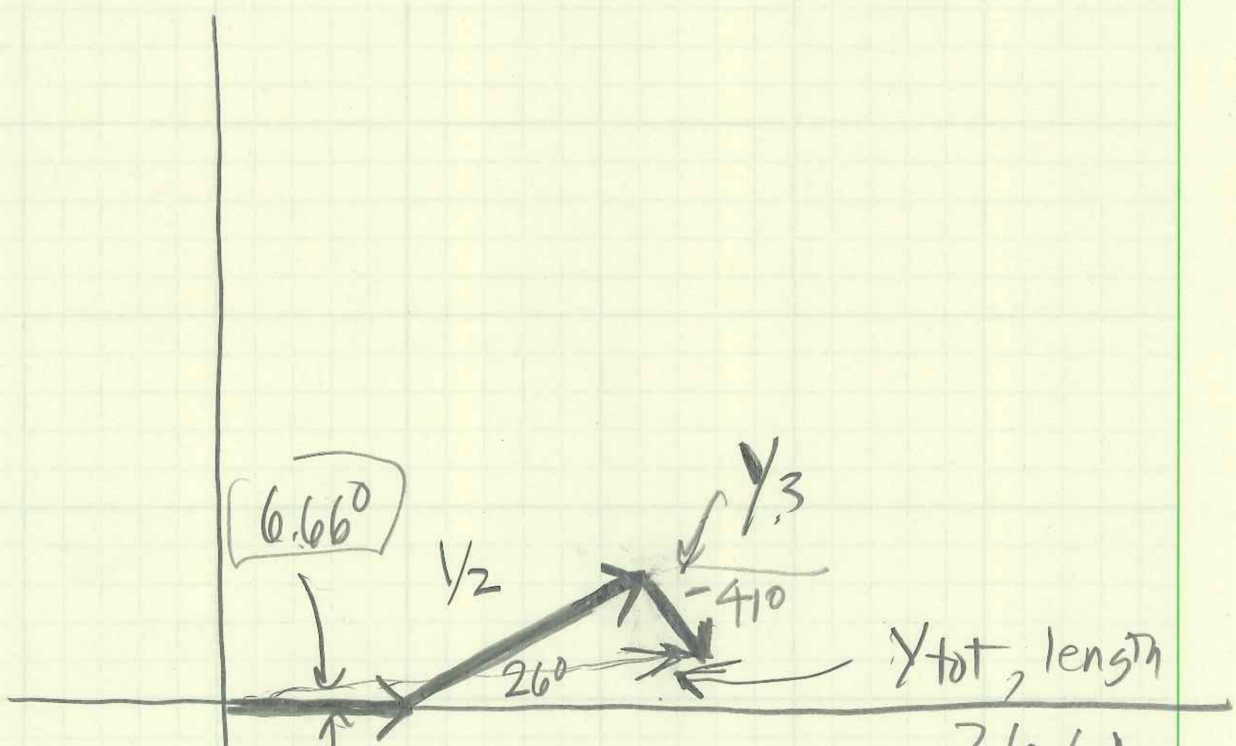
$$A_{tot} = \frac{A_{tot}\sin\phi_{tot}}{\sin\phi_{tot}} = \frac{3.05}{\sin(6.66^\circ)} = 26.31$$

$$= \frac{A_{tot}\cos\phi_{tot}}{\cos\phi_{tot}} = \frac{26.13}{\cos(6.66^\circ)} = 26.31$$

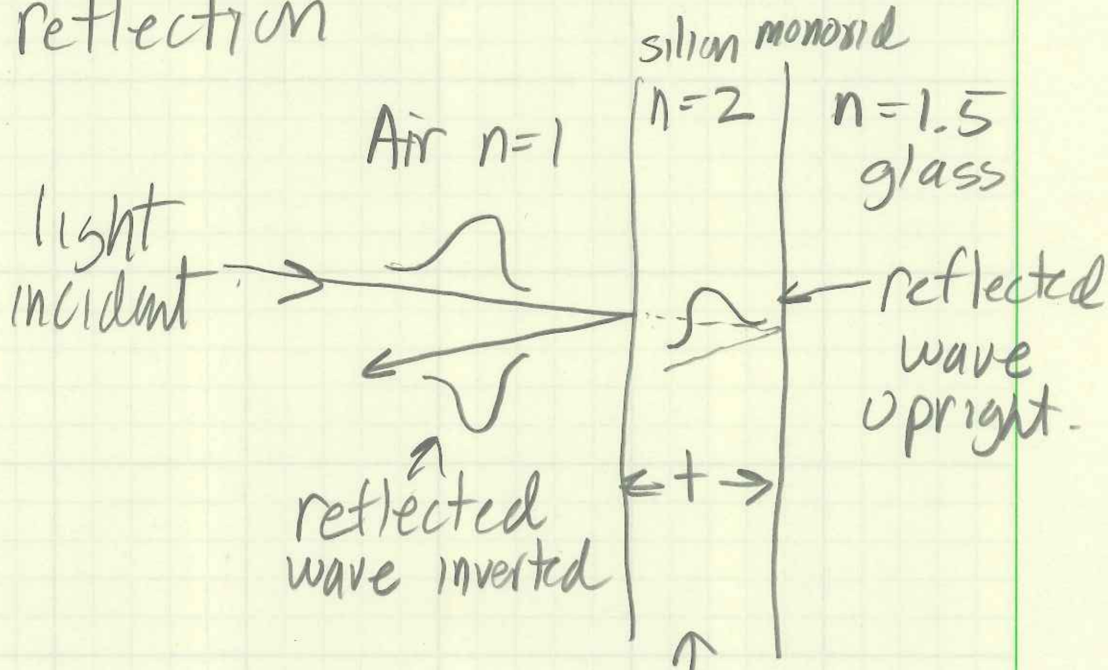
$$= \sqrt{A_{tot}^2\sin^2\theta_{tot} + A_{tot}^2\cos^2\theta_{tot}} = \sqrt{3.05^2+26.13^2}$$

$$= 26.31$$

Graphically...



$\boxed{45.30}$ Want interference maximom upon reflection



to wavelength thinking..

if this is.. extra $\lambda/2$) will get constructive interference... because Air/silicon monoxide barrier inverts.

$$\boxed{t = \frac{\lambda}{2} = \frac{\lambda_0}{n2} = \frac{560}{2.0 \times 2} = 140\,nm}$$

45.38

(a) Air-Oil gives inversion upon reflection

$n \sim 1$ $\quad n \sim 1.2$

Oil - Water does <u>not</u>

$n \sim 1.2$ $\quad n \sim 1.33$

so, get a <u>destructive</u> interference and a $\boxed{\text{dark region}}$

(b) First blue... $t_{1\,blue} = \frac{\lambda_{0\,blue}}{n} \frac{1}{2}$

Second " $\quad t_{2\,blue} = \left(1+\frac{1}{2}\right)\frac{\lambda_{0\,blue}}{n}$

Third blue $\quad t_{3\,blue} = \left(2+\frac{1}{2}\right)\frac{\lambda_{0\,blue}}{n}$

$$= 2.5 \cdot \frac{475\,nm}{1.2}$$

$$\boxed{\begin{aligned} t_{3\,blue} &= 989.6\,nm \\ &\simeq 1\,\mu m \end{aligned}}$$

(c) Dispersion due to variety of angles washes out the pattern

$\boxed{45.51}$ Light passes $\underline{\underline{\text{twice}}}$ through chamber

Total pathlength is $L = 2 \times 5.0$ cm

$\underline{\text{with air}}$: # wavelengths $= \dfrac{L}{(\lambda_0/n_{air})}$

$\underline{\text{no air}}$: # wavelengths $= \dfrac{L}{\lambda_0}$

air → no air, see $N = 60$ fringes,

$$\frac{n_{air} L}{\lambda_0} - \frac{L}{\lambda_0} = N$$

$$n_{air} = 1 + \frac{N \lambda_0}{L}$$

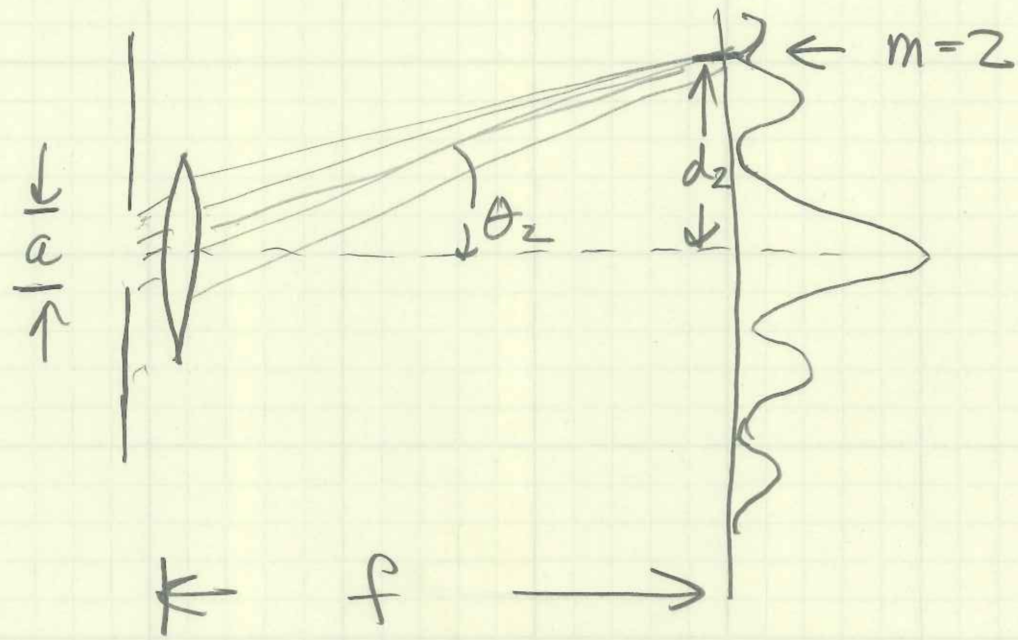
$$= 1 + \frac{60 \cdot 500 \cdot 10^{-9}}{2 \cdot 5 \cdot 10^{-2}}$$

$$= 1 + 30 \cdot 100 \cdot 10^{-7}$$

$$\boxed{n_{air} = 1 + 3 \cdot 10^{-4} = 1.0003}$$

$\boxed{46.6}$ $\alpha = \frac{\phi}{2} \cong \frac{\pi a}{\lambda}\theta = m\pi$ (p. 974)

undeflected ray: $d = f\theta$



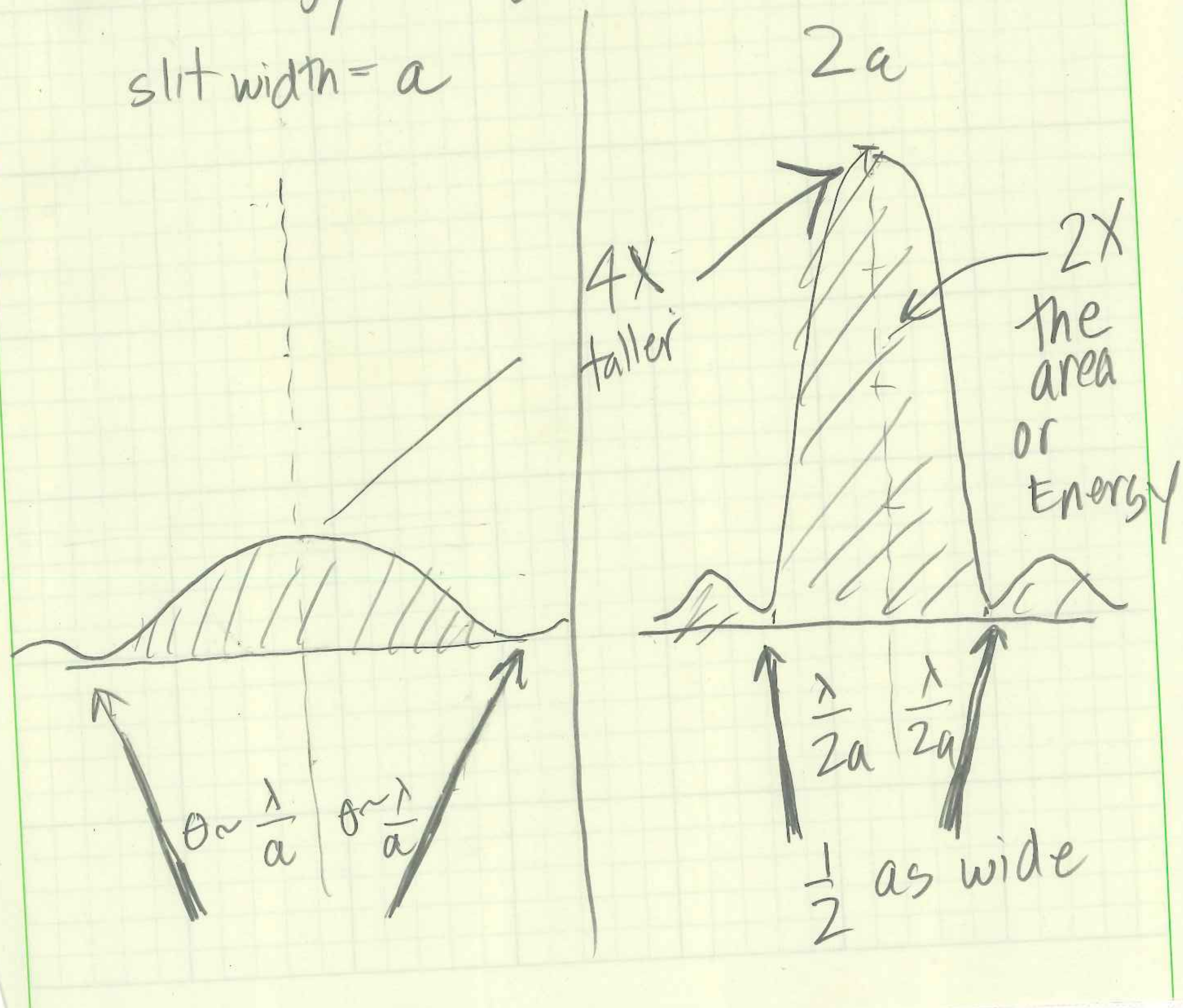
so, $\theta_m = \frac{\lambda m \cancel{\pi}}{\cancel{\pi} a} = m\frac{\lambda}{a}$

$d_2 = f\theta_2 = f \cdot 2 \times \frac{\lambda}{a} = (71.4\text{ cm}) \cdot 2 \times \frac{593 \cdot 10^{-9}}{420 \cdot 10^{-6}}$

$\boxed{d_2 = 0{,}20\text{ cm} = 2{,}02\text{ mm}}$

$\boxed{46.12}$ The <u>width</u> of the central peak is $\propto$ slit width.

So, if you double the slit width, the peak grows by a factor 4, but the width declines by a factor of 2, so, the <u>area</u> goes up by a factor of 2, which is the factor by which the energy through the slit increases.



46.15

(a) $I_\theta = I_m\left(\dfrac{\sin\alpha}{\alpha}\right)^2$

$$\frac{dI_\theta}{d\alpha} = 2I_m\left[\underbrace{\left(\frac{\sin\alpha}{\alpha}\right)}_{=0}\underbrace{\left(\frac{\cos\alpha}{\alpha} - \frac{\sin\alpha}{\alpha^2}\right)}_{=0}\right] = 0$$

$=0$

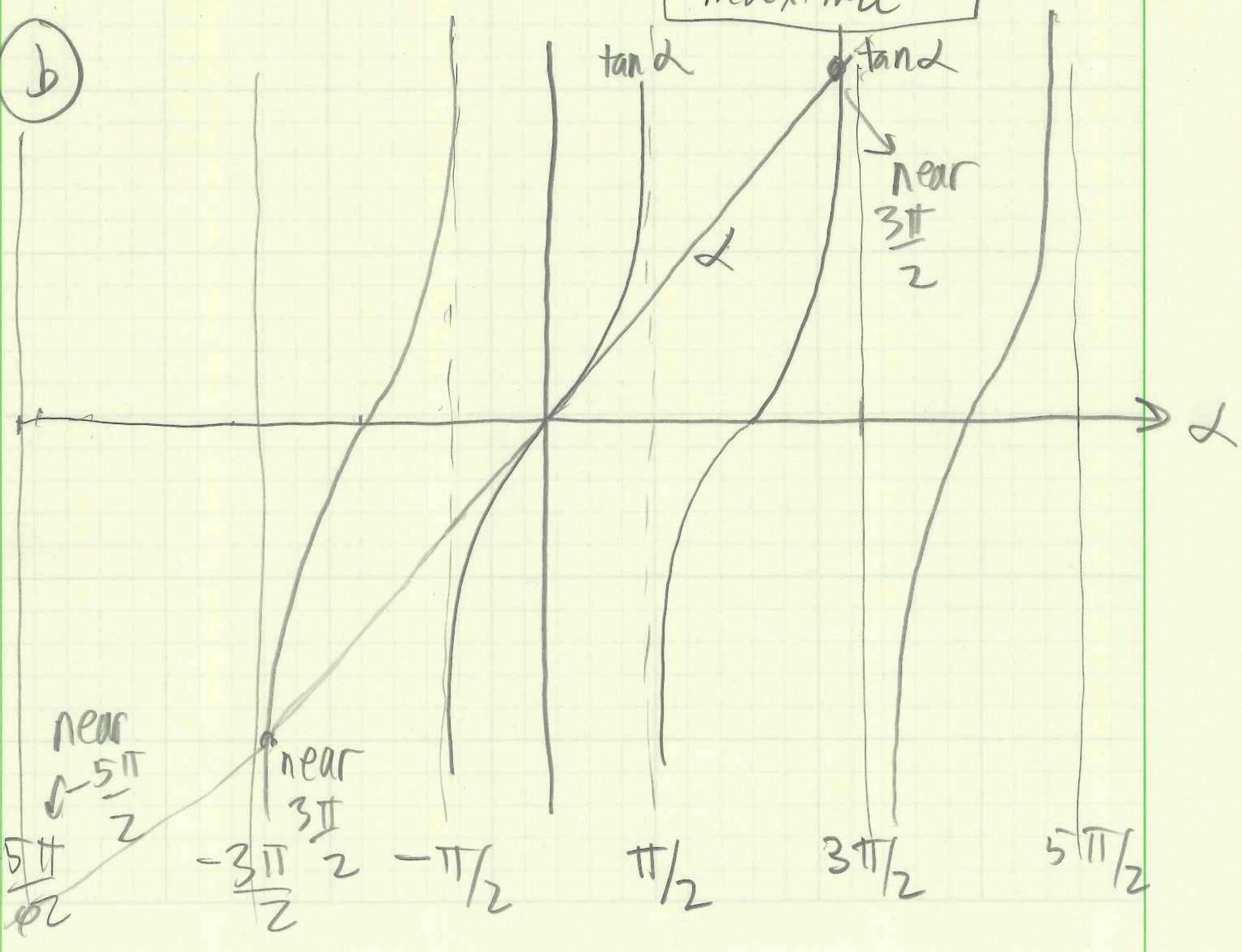
minima

$$\underbrace{\frac{\cos\alpha}{\alpha} = \frac{\sin\alpha}{\alpha^2}}$$

$$\boxed{\begin{array}{c}\alpha = \tan\alpha \\ \text{maxima}\end{array}}$$

near $\frac{5\pi}{2}$

(b)



Wolfram Alpha says

$$\left(\frac{\sin\alpha}{\alpha^2} - \frac{\cos\alpha}{\alpha} = j_1(\alpha) = 0\right)$$

spherical Bessel 1st kind

near	exact	m_{max} $\left[\left(m_{max} + \frac{1}{2}\right)\pi \text{ of actual}\right]$
0	0	
$\pm\frac{3\pi}{2} = \pm 4.7124$	± 4.49341	0.9303
$\pm\frac{5\pi}{2} = \pm 7.8540$	± 7.72525	1.9590
$\pm\frac{7\pi}{2} = \pm 10.99557$	± 10.90412	2.9709
$\pm 9\pi/2 = \pm$	± 14.06619	3.9774

average
1.9506