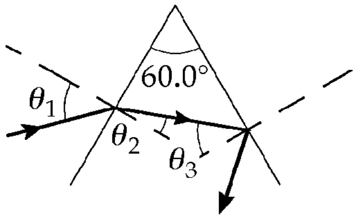
Department of Physics
National Dong Hwa University, 1, Sec. 2,
Da Hsueh Rd., Shou-Feng, Hualien, 974, Taiwan

General Physics II, Final 2
PHYS10400, Class year 99
06-23-2011

1.

At the first refraction, $1.00\sin\theta_1 = n\sin\theta_2$.

The critical angle at the second surface is given by $n\sin\theta_3 = 1.00$:



or $\quad \theta_3 = \sin^{-1}\left(\dfrac{1.00}{1.50}\right) = 41.8°$.

But, $\theta_2 = 60.0° - \theta_3$.

Thus, to avoid total internal reflection at the second surface (i.e., have $\theta_3 < 41.8°$), it is necessary that $\theta_2 > 18.2°$.

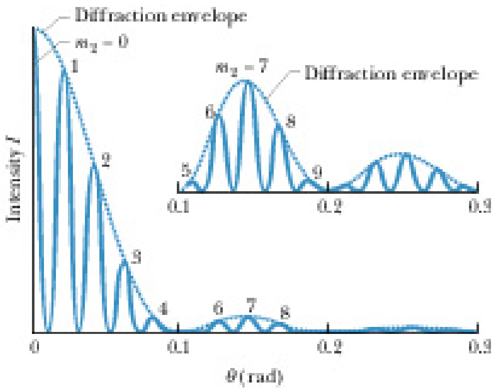
Since $\sin\theta_1 = n\sin\theta_2$, this becomes $\sin\theta_1 > 1.50\sin 18.2° = 0.468$

or $\quad \theta_1 > \boxed{27.9°}$.

2.

(a) For single slit diffraction, $a\sin\theta = \lambda$, *for m_1=1* center bright

For double slit (Yang's), $d\sin\theta = m_2\lambda$, *for m_2=0, 1, 2, ..*



Therefore, $\quad m_2 = \dfrac{d}{a} = \dfrac{19.44\mu m}{4.050\mu m} = 4.8$

For the center bright, there are **9** interference fringes

(b) At the second diffraction minimum, $\quad a\sin\theta = 2\lambda$

$$m_2 = \frac{2d}{a} = \frac{(2)(19.44\mu m)}{4.050\mu m} = 9.6$$

As shown in the right figure, there are only **4** bright interference fringes in either side band. There are total **8** bright fringes on the first side bands on both sides.

3. Let d is the diameter of the aperture, then $d\sin\theta = \lambda$ is the first minimum of the central bright diffraction pattern. θ=1°, sinθ ≅ θ = 1° = π/180

So, $\quad d = \dfrac{420\times10^{-9}m}{\sin(\frac{\pi}{180})} = \dfrac{420\times10^{-9}}{3.14/180} = 24\mu m$

4.

Since $\Delta V = \Delta V_{max}\sin\omega t$

$i_R = \dfrac{\Delta V}{R} = \dfrac{\Delta V_{max}}{R}\sin\omega t$

The power gives up by the resistor is $P = I_{rms}^2 R$

$$I_{rms} = \sqrt{\bar{i^2}} = \left[\frac{1}{T}\int\left(\frac{\Delta V_{max}}{R}\right)^2 \sin^2\omega t\, dt\right]^{\frac{1}{2}}$$

$$= \frac{\Delta V_{max}}{R}\left[\frac{1}{T}\int \underbrace{\sin^2\omega t\, dt}_{=\frac{1}{2}}\right]^{\frac{1}{2}}$$

$$= \frac{1}{\sqrt{2}}\frac{\Delta V_{max}}{R}$$

$$\therefore P = I_{rms}^2 R = \frac{1}{2}\frac{\Delta V_{max}^2}{R^2} R = \frac{1}{2}\Delta V_{max}^2 \frac{1}{R}$$

5.

Let N_1 N_2 be the number of waves in each media

$$N_1 = \frac{L}{\lambda_{n_1}} = \frac{L}{\lambda/n_1}$$

$$N_2 = \frac{L}{n_2} = \frac{L}{\lambda/n_2}$$

$$N_1 - N_2 = \frac{L}{\lambda}(n_1 - n_2)$$

① $\varphi = 2\pi\left[\left(\frac{L}{\lambda}(n_1-n_2)\right) - \text{Integer}\left(\frac{L}{\lambda}(n_1-n_2)\right)\right]$

② plug in numbers. $n_2 = 1.5$. $n_1 = 1$. $L = 10\lambda$

$$\phi = 2\pi\left[\frac{10\lambda}{\lambda}(1.5-1) - \underbrace{\text{Int}\left(\frac{10\lambda}{\lambda}\,0.5\right)}_{=0}\right]$$

$$= 2\pi\ 10\cdot(0.5)$$

$$= 2\pi \cdot 5.$$ i.e. no phase shift in this case

6. The magnitude of the poynting vector S_{av} is

$$S_{av} = \frac{P_{av}}{A} = \frac{P_{av}}{\pi r^2} = \frac{3.0\times10^{-3}W}{\pi(\frac{2.0\times10^{-3}m}{2})^2} = 955\,W/m^2\ ,\quad P_{av} = 2\frac{S_{av}}{c} = \frac{2\times955\,W/m^2}{3\times10^8\,m/s} = 6.36\times10^{-6}\,N/m^2$$