Physics 135-3-01, Winter 2017 **Name** ________________________________

Quiz #3

1) (12 points) A glass lens with an index of refraction of $n_1 = 1.5$ has a very thin coating on it with an index of refraction of $n_2 = 1.35$, and above the coating there is air. I want the lens to *not* reflect any light that has $\lambda = 540$ nm in air. If the light on the lens is normally incident, calculate two different thicknesses of coating could I use.

Solution

The light reflecting from the coating, and then from the lens behind it, must interfere destructively in order to *not* reflect any light at 540 nm. They therefore must be a half-wavelength out of phase after one ray has passed through the coating. (The light reflecting from both surfaces will undergo a phase flip, so these cancel out and we do not need to worry about phase flips.)

In short, we have $\Delta\delta / 2\pi = \Delta x/\lambda$, where $\Delta\delta = \pi$, $\Delta x = 2L$ (where L is the thickness of the coating), and $\lambda = 540 \text{ nm} / 1.35 = 400$ nm, because we need to use the wavelength inside the coating.

$\pi/2\pi = 2L/400$ nm means $L = 100$ nm, at least. I could also put another full wavelength inside the coating (i.e., another 400 nm) and still achieve destructive interference. That means $L = 300$ nm is also possible (as is 500 nm, 700 nm, etc.)

2) (8 points) Suppose monochromatic light of 668 nm is incident on a single narrow slit. The angle between the first diffraction minimum on one side of the central maximum, and the first minimum on the other side, is 0.85°. What is the width of the slit?

Solution

The minima in a single-slit diffraction pattern are given by $\sin\theta = m\lambda/a$. In this case we have $\theta = 0.85/2 = 0.425°$, $m = 1$, and $\lambda = 668$ nm. $a = (668 \text{ nm}) / \sin(0.425°) = 90{,}000 \text{ nm} = 90$ μm.