Physics 135-3-02, 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 $n_2 = 1.65$, and above the coating there is air. I want the lens to brightly reflect light that has $\lambda = 600$ 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 constructively for maximum reflection. They therefore must be in phase (a full wavelength apart) after one ray has passed through the coating.

However, the light reflecting from the front surface will phase-flip, whereas the light reflecting from the second surface will not phase-flip. Thus, the second ray is already half a wavelength out of phase with the first, so it only needs to gain another half wavelength going through the glass.

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 $\lambda = 600$ nm / 1.65 = 364 nm, because we need to use the wavelength inside the coating.

$\pi/2\pi = 2L/364$ nm means $L = 91$ nm, at least. I could also put another full wavelength inside the coating (i.e., another 364 nm) and still achieve destructive interference. That means $L = 273$ nm is also possible (as is 455 nm, 637 nm, etc.)

2) (8 points) Suppose monochromatic light of 624 nm is incident on two very narrow slits that are 40 μm apart. At what angle (in degrees) would you find the second bright fringe away from the central one?

Solution

The maxima in a double-slit interference pattern are given by $d \sin\theta = m\lambda$. In this case we have $(40 \times 10^{-6}) \sin\theta = 2(624 \times 10^{-9})$, or $\theta = 1.8°$