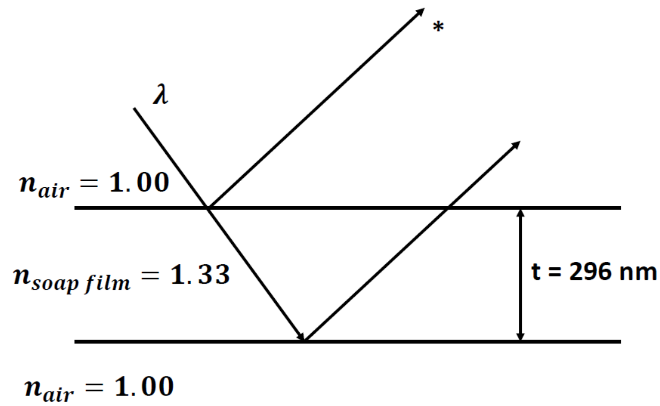
7. When monochromatic light shines perpendicularly on a soap film (n = 1.33) with air on each side, the second smallest nonzero film thickness for which destructive interference of reflected light is observed is 296 nm. What is the vacuum wavelength of the light in nm?



$$Total\ Phase\ Diff = Optical\ Path\ Diff + Phase\ Shifts = \left(m + \frac{1}{2}\right)\lambda$$

This is for destructive interference which is what a non-reflecting coating would need.

Since only the top ray is phase shifted due to going from lower n reflecting from higher n, we pick up one half of a wavelength. So the phase difference is the optical path difference and the one half wavelength.

$$2n_{soap}t + \frac{\lambda}{2} = \left(m + \frac{1}{2}\right)\lambda$$

So the condition for destructive interference is

$$2n_{soap}t = m\lambda$$

Solve for λ

$$\lambda = \frac{2n_{soap}t}{m}$$

For second smallest non-zero thickness we make m = 2

$$\lambda = \frac{2n_{soap}t}{m} = \frac{2(1.33)(296\ nm)}{2} = 393.7\ nm$$

$$\boxed{\lambda = 394\ nm}$$

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