tutorial #10 [wave nature of light] .quiz

1) A beam of light is sent directly down onto a glass plate, $n_g = 1.5$, and a plastic plate, $n_p = 1.2$, that form a thin wedge of air as shown in fig. 1. An observer looking down through the glass plate sees the fringe pattern shown in the lower part of the drawing, with the dark fringes at the ends A and B. The wavelength of the light is 520 nm. Using the fringe pattern shown in the drawing, determine the thickness of the air wedge at B.

t : thickness of the air gap

So the lights 1 and 2 go through different paths and get phase shifted w/ respect to one another.

1 reflects from P, and 2 reflects from Q,

$n_g = 1.5 > n_{air} = 1$ so there is no phase shift reflecting from P → 0

$n_{air} = 1 < n_p = 1.3$ " " " π " " " " Q → $\pm \lambda/2$ (does not matter)

2 goes 2t through air more than 1 → $\Delta \ell = \ell_2 - \ell_1 = 2t + \lambda/2$ ($n_{air} = 1$)

At A $2t = 0$, so as expected we have dark fringe, $\Delta \ell_A = +\lambda/2$

next dark fringes happen at $2t = \lambda, 2\lambda, 3\lambda, 4\lambda, 5\lambda$

so $\Delta \ell_B = 5\lambda + \lambda/2$ or $t_B = \frac{5}{2}\lambda = 1.30\ \mu m$.

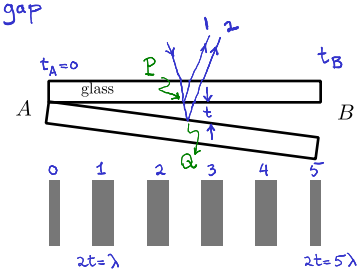
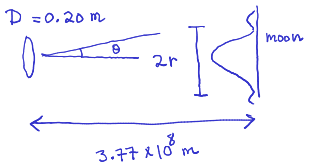


Figure 1: A wedge producing interference pattern.

2) A spotlight sends red light (wavelength 694.3 nm) to the moon. At the surface of the moon, which is 3.77×10^8 m away, the light strikes a reflector left there by astronauts. The reflected light returns to the earth, where it is detected. When it leaves the spotlight, the circular beam of light has a diameter of about 0.20 m, and diffraction causes the beam to spread as the light travels to the moon. In effect, the first circular dark fringe in the diffraction pattern defines the size of the central bright spot on the moon. Determine the diameter (not the radius) of the central bright spot on the moon.



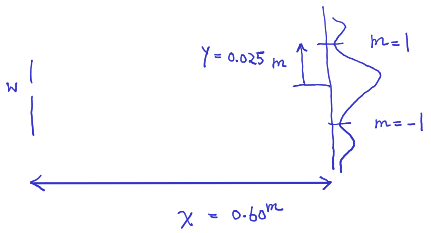
$\theta \approx 1.22 \frac{\lambda}{D} = 4.2 \times 10^{-6}$ rad : using circular diffraction formula

$r = 3.77 \times 10^8\ m \times \tan\theta = 1.6$ km

$2r = 3.2$ km.

3) A flat screen is located 0.60 m away from a single slit. Light with a wavelength of 510 nm (in vacuum) shines through the slit and produces a diffraction pattern. The width of the central bright fringe on the screen is 0.050 m. What is the width of the slit?

$\tan\theta = \frac{Y}{X} = \frac{0.025}{0.60} = .042$

$W \sin\theta = m\lambda$, $m = 1$

$\rightarrow W = \frac{\lambda}{\sin\theta} = \frac{510\ nm}{.042} = 12\ \mu m.$