General Physics 204, Section . . . — Monday, Apr 6, 2015

Quiz #8 — The Wave Nature of Light

Name:

1) CLASS(2)

A thin sheet of glass with $n = 1.5$ and thickness t is covering one of the slits in the double slit experiment. Using a green laser with $\lambda = 550$ nm, we see that the bright spot in the middle became a dark spot. Find the possible values for t. See fig. 1. $c_{air} \approx c$.

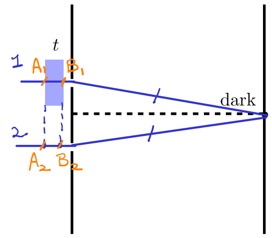

Figure 1: Double slit experiment with a thin sheet of glass.

– 1 travels A_1B_1 through glass $\rightarrow$ $\frac{t}{\lambda_g}$ = number of wave lengths 1 travels from A_1 to B_1 $\left(\lambda_g = \frac{\lambda}{n}\right)$

2 travels A_2B_2 through air $\rightarrow$ $\frac{t}{\lambda}$ = number of wave lengths 2 travels from A_2 to B_2

– The rest of the paths are the same, $B_1O = B_2O$.

So in order to have dark point at O $\quad \frac{t}{\lambda_g} - \frac{t}{\lambda} = \left(m + \frac{1}{2}\right)$ (Destructive)

$$\rightarrow \boxed{t = \frac{m + 1/2}{n - 1}\lambda} = \frac{m + 1/2}{0.5} 550\,\text{nm} = \left(m + \frac{1}{2}\right) 1.1\,\mu\text{m}$$

2) CLASS(2)

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. 2. 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.

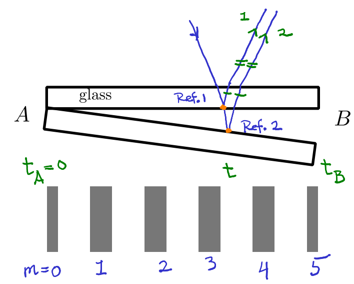

Figure 2: A wedge producing interference pattern.

The difference between the paths 1 and 2 is $2t$ through air ($\lambda_{air} \approx \lambda = 520$ nm).

Ref 1. glass / air — no phase shift

Ref 2. air / plastic — π phase shift

$\downarrow$

Difference : $\boxed{\pi \text{ phase shift}}$

textbook notation :

$$2t + \left\{\begin{matrix}\text{take care of the} \\ \text{reflections} \\ \text{either } 0 \text{ or } \boxed{\frac{\lambda}{2}}\end{matrix}\right\} = \begin{cases} m\lambda & \text{Costructive} \\ (m + \frac{1}{2})\lambda & \text{Destructive}\end{cases}$$

Lecture notation :

$$2t = \begin{cases} m\lambda & \text{Costructive ? / } \boxed{\text{Destructive}} \\ (m + \frac{1}{2})\lambda & \text{Destructive ? / } \boxed{\text{Costructive}}\end{cases}$$

at A, $t_A = 0$

$0 + \frac{\lambda}{2} = (m + \frac{1}{2})\lambda$ or $0 = m\lambda$

$m = 0$ at A in the relation

B is $m = 5$

$\rightarrow 2t_B = 5\lambda \rightarrow t_B = \frac{5}{2}\lambda = 1.3\,\mu\text{m}$.