

PHYS-1200 PHYSICS II
HOMEWORK #17 SOLUTIONS

8. (a) The time t_2 it takes for pulse 2 to travel through the plastic is

$$t_2 = \frac{L}{c/1.55} + \frac{L}{c/1.70} + \frac{L}{c/1.60} + \frac{L}{c/1.45} = \frac{6.30L}{c}.$$

Similarly for pulse 1:

$$t_1 = \frac{2L}{c/1.59} + \frac{L}{c/1.65} + \frac{L}{c/1.50} = \frac{6.33L}{c}.$$

Thus, pulse 2 travels through the plastic in less time.

(b) The time difference (as a multiple of L/c) is

$$\Delta t = t_2 - t_1 = \frac{6.33L}{c} - \frac{6.30L}{c} = \frac{0.03L}{c}.$$

Thus, the multiple is 0.03.

13. (a) We choose a horizontal x axis with its origin at the left edge of the plastic. Between $x = 0$ and $x = L_2$ the phase difference is that given by Eq. 35-11 (with L in that equation replaced with L_2). Between $x = L_2$ and $x = L_1$ the phase difference is given by an expression similar to Eq. 35-11 but with L replaced with $L_1 - L_2$ and n_2 replaced with 1 (since the top ray in Fig. 35-36 is now traveling through air, which has index of refraction approximately equal to 1). Thus, combining these phase differences and letting all lengths be in μm (so $\lambda = 0.600$), we have

$$\frac{L_2}{\lambda}(n_2 - n_1) + \frac{L_1 - L_2}{\lambda}(1 - n_1) = \frac{3.50}{0.600}(1.60 - 1.40) + \frac{4.00 - 3.50}{0.600}(1 - 1.40) = 0.833.$$

(b) Since the answer in part (a) is closer to an integer than to a half-integer, the interference is more nearly constructive than destructive.

18. In Sample Problem 35-2, an experimentally useful relation is derived: $\Delta y = \lambda D/d$. Dividing both sides by D , this becomes $\Delta\theta = \lambda/d$ with θ in radians. In the steps that follow, however, we will end up with an expression where degrees may be directly used. Thus, in the present case,

$$\Delta\theta_n = \frac{\lambda_n}{d} = \frac{\lambda}{nd} = \frac{\Delta\theta}{n} = \frac{0.20^\circ}{1.33} = 0.15^\circ.$$

25. The maxima of a two-slit interference pattern are at angles θ given by $d \sin \theta = m\lambda$, where d is the slit separation, λ is the wavelength, and m is an integer. If θ is small, $\sin \theta$ may be replaced by θ in radians. Then, $d\theta = m\lambda$. The angular separation of two maxima associated with different wavelengths but the same value of m is $\Delta\theta = (m/d)(\lambda_2 - \lambda_1)$, and their separation on a screen a distance D away is

$$\begin{aligned} \Delta y &= D \tan \Delta\theta \approx D \Delta\theta = \left[\frac{mD}{d} \right] (\lambda_2 - \lambda_1) \\ &= \left[\frac{3(1.0 \text{ m})}{5.0 \times 10^{-3} \text{ m}} \right] (600 \times 10^{-9} \text{ m} - 480 \times 10^{-9} \text{ m}) = 7.2 \times 10^{-5} \text{ m}. \end{aligned}$$

The small angle approximation $\tan \Delta\theta \approx \Delta\theta$ (in radians) is made.

Q36.04)

- contract (wavelength is decreased)
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- $m=5$ minimum
- (approximately) maximum between $m=4$ and $m=5$ minima