THIRD MIDTERM

Name (print) ZHANG, TIAN

Discussion Instructor (circle): Condella Guilkey Leong Nott Paul Zhang

Discussion Section #

REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES!
Use the conversion constants and data given on the front page.

(a) What is the critical angle for total internal reflection for light from diamond \((n = 2.42)\) to water \((n = 1.33)\)?

\[
\theta_c = \sin^{-1} \left( \frac{n_2}{n_1} \right) = 0.582 \text{ rad} \left( 33.3^\circ \right)
\]

(b) Calculate the focal length of the lens shown. The lens is made of plastic with an index of \(n = 1.40\).

\[
f = \frac{n - 1}{(n - 1)\left( \frac{1}{R_1} - \frac{1}{R_2} \right)} = \frac{(1.40 - 1)}{(2.40 + 1.32)}
\]

\[= 7.33 \text{ cm}\]

(c) If the speed of red light is \(1.93 \times 10^8 \text{ m/s}\), and blue light is \(1.99 \times 10^8 \text{ m/s}\) in a sample of glass, calculate the angle between the two colors after they enter a glass plate at \(45^\circ\) to the normal.

\[
\theta_r - \theta_b = \sin^{-1} \left( \frac{\sin 45^\circ}{n_r} \right) - \sin^{-1} \left( \frac{\sin 45^\circ}{n_b} \right)
\]

\[= \sin^{-1} \left( \frac{\sin 45^\circ}{c/v_r} \right) - \sin^{-1} \left( \frac{\sin 45^\circ}{c/v_b} \right) = 0.605^\circ\]

(d) In a 2-slit pattern the position of maxima on a screen are at \(y = 0, \pm 2.00 \text{ cm}, \pm 4.00 \text{ cm}, \text{ etc.}\) If the intensity is \(I_o\) at \(y = 0\), what is the intensity at \(y = 1.67 \text{ cm}\)?

\[
dY = \lambda \frac{\Delta l}{d} = 1.2 \text{ cm} \quad I = I_o \cos^2 \left( \frac{\pi d Y}{\lambda} \right) = I_o \cos^2 \left( \frac{\pi \times 1 \times 1.67}{\lambda} \right) = 0.75 \%
\]

(e) A soap film \((n = 1.33)\) is 800 nm thick and surrounded by air. Calculate the longest wavelength of light for which there will be constructive interference in reflection at normal incidence.

\[
zn = (m + \frac{1}{2}) \lambda \quad m = 0 \quad \lambda = 4nz = 4.26 \times 10^{-6} \text{ m} = 426 \mu \text{m}
\]