Name: _________________________________________________

Discussion Instructor (CIRCLE ONE): Abbott Galler Giddings
Discussion Section # ______ Leaver Saffer Stone

All numbers to 3 significant figures!

(a) Find the critical angle for total internal reflection for an oil-air interface if \( n_{oil} = 1.25 \).

(b) Find the thickness of a quarter wave plate for yellow light (\( \lambda = 589 \text{ nm} \)), if \( n_s = 1.5673 \) and \( n_f = 1.5123 \) for the material of the plate.

(c) A sugar solution has \( n_R = 1.34500 \) and \( n_L = 1.34400 \). Find the angle through which the plane of polarization is rotated, if plane polarized light of wavelength \( \lambda = 589 \text{ nm} \) passes 10.0 cm through this solution.

(d) Find the focal length for the lens shown. The lens is in air. (\( n = 1.55 \))

\[ |r| = 10.0 \text{ cm} \quad \rightarrow \quad |r| = 15.0 \text{ cm} \]

(e) The third interference maximum from the center is found at 6.75 cm from the center of the screen in a two-slit interference pattern. If the light is green (\( \lambda = 500 \text{ nm} \)) and the distance to the screen is 3.75 m, find the slit separation.
(a) \[ \theta = \frac{2\pi \times 4800}{6.6} \approx 53.1^\circ \approx 0.927 \text{ rad} \]

(b) \[(n_k - n_p) \Delta l = (4k \pm 1) \frac{\lambda}{4} \]

\[
\Delta l = \frac{(4k \pm 1) \times 589 \text{ (nm)}}{4 \times (1.5678 - 1.5125)} \approx (4k \pm 1) \times 2.65 \text{ (nm)}
\]

\[\approx (10.6k \pm 2.65) \mu m\]

- \(k = 0: \quad \Delta l = 2.65 \mu m\)
- \(k = 1: \quad \Delta l = 13.2 \mu m, \quad 7.95 \mu m\)

(c) \[\delta = \frac{(n_k - n_p) \Delta l}{\lambda} \approx \frac{(1.345 - 1.344) \times 0.1}{589 \times 10^{-9}} \mu m\]

\[\approx 533 \text{ rad} \approx (3.06 \times 10^4) \text{ }^\circ \approx 84.9 \text{ (rad)}, \text{ or, observable: } 320^\circ\]

(d) \[\frac{1}{f} = (n - 1) \left( \frac{1}{r_1} - \frac{1}{r_2} \right) = 0.55 \left( \frac{1}{10} - \frac{1}{15} \right) = -\frac{0.55 \times 2.5}{150} \]

\[f = -10.4 \text{ (cm)}\]

(2 points off for wrong sign)

(e) \[d = \frac{n_k \lambda l}{\Delta}\]

\[= \frac{3 \times 500 \times 3.75}{0.675} \text{ (nm)}\]

\[\approx 83.3 \text{ (um)}\]