

1. The resonant frequency for lead glass is in the ultraviolet region fairly near the visible region, whereas the resonant frequency for fused silica is far into the ultraviolet region. Make a rough sketch of  $n[\lambda]$  for both cases for the visible region of the spectrum; label significant features of the graphs.
2. A narrow bundle of white light (a “pencil” of rays) is incident upon a plane-parallel plate of thickness  $\ell_0 = 10$  mm and with indices of refraction for red light and for blue light of  $n_{\text{red}} = 1.614$  and  $n_{\text{blue}} = 1.653$ . The angle of incidence is  $\frac{\pi}{4}$  radians. Determine the “sideways separation” of these two colors upon exiting the plate.
3. A plano-convex lens is made of borate flint glass for which the Abbé number is  $v = 55.2$ . The focal length of the lens for sodium light ( $\lambda_D = 589.59$  nm) is 762 mm. An image of the sun is formed by this lens; find the distance between the images for red light and for blue light (a differential equation might be helpful).
4. Calculate the reflection and refraction coefficients for both TE and TM polarizations for light incident from air onto glass with index  $n = 1.6$  at angle  $\theta_0 = \frac{\pi}{6}$ .
5. The critical angle for a certain oil is found to be  $\theta_c = 33^\circ 33'$  of arc. Find the Brewster angle for both external and internal reflections.
6. Unpolarized light is reflected from a plane surface of fused silica glass of index  $n = 1.458$ .
  - (a) Determine the critical and polarizing (Brewster) angles.
  - (b) Determine the reflectance and transmittance for the TE mode at normal incidence ( $\theta_0 = 0^\circ$ ) and at  $\theta_0 = 45^\circ$
  - (c) Repeat part (b) for TM light.
  - (d) Calculate and plot the phase difference between the TM and TE modes for internally reflected light at angles of incidence of  $\theta_0 = 0^\circ, 20^\circ, 40^\circ, 50^\circ, 70^\circ$ , and  $90^\circ$ . (extra credit given for a graph from  $\theta_0 = 0^\circ$  to  $\theta_0 = 90^\circ$ ).