

Read §5 in the notes on EM waves at interface between media. You might also find it useful to read corresponding chapters about the Fresnel equations in standard texts, e.g., §23 in Pedrotti or §4 in Hecht.

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. Use the dispersion equation to make a rough sketch of $n[\omega]$ (**AND** $n[\lambda]$) for the visible region of the spectrum.
2. Crystal quartz has refractive indices of $n = 1.557$ at $\lambda = 410.0$ nm and $n = 1.547$ at $\lambda = 550.0$ nm. Calculate the first two coefficients (only) in Cauchy's approximation for the refractive index:

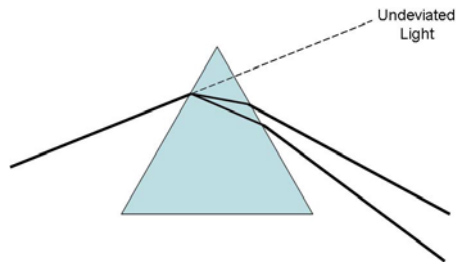
$$n = C_1 + \frac{C_2}{\lambda^2} + \frac{C_4}{\lambda^4} + \dots$$

to calculate C_1 and C_2 and estimate n at $\lambda = 610.0$ nm.

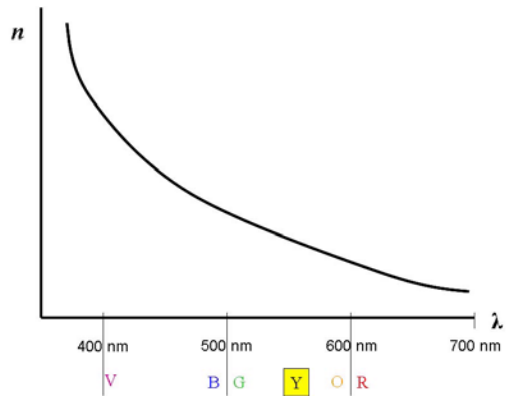
3. The critical angle for a certain oil is found to be $\theta_{\text{critical}} = 33^\circ 33'$ of arc. Find the Brewster angle for both external and internal reflections.
4. The refractive index of water is $n = 1.33$. Plot the reflectances of water for both TE and TM polarizations between $\theta_0 = 0^\circ$ and $\theta_0 = 90^\circ$
5. 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° . (extra credit given for a graph from $\theta_0 = 0^\circ$ to $\theta_0 = 90^\circ$).

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6. Light is dispersed by a glass prism to create the spectrum as shown:

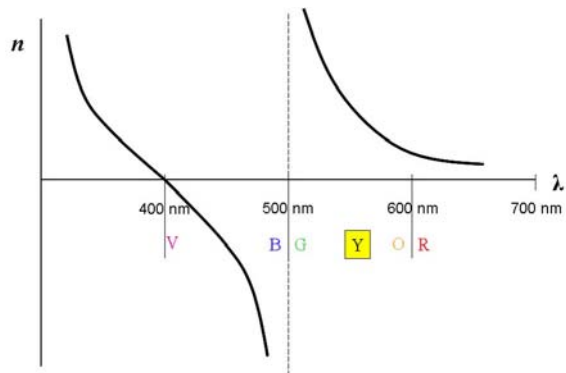


(a) One glass exhibits normal dispersion:



On a sketch of the prism, show the sequence of dispersed colors.

(b) Now consider a substance that exhibits anomalous dispersion centered at $\lambda = 500$ nm using the “undamped” model of the refractive index:



On a sketch of the prism, show the sequence of dispersed colors.