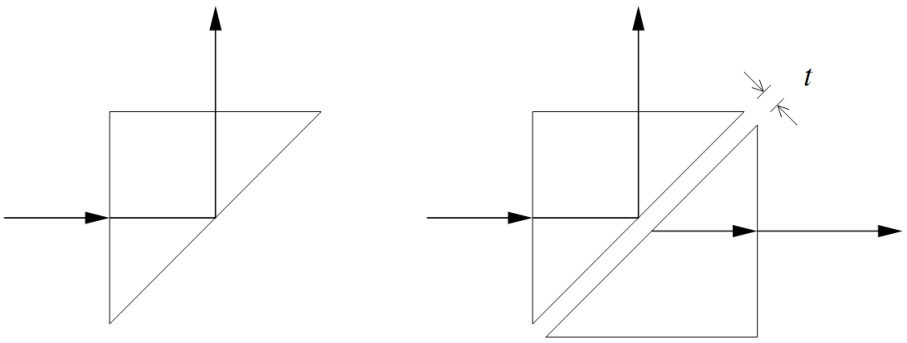
Homework 7

Reflection and Refraction

Ex. 3.1: Frustrated total internal reflection

a) A light ray undergoes total internal reflection in a prism at an angle of incidence of $\pi/4$, see the left panel of the figure below. What is the minimal value of the index of refraction n of the material the prism is made of for this to happen?



b) A second prism is held at a distance t from the prism of part (a), see the right panel of the figure above. The space between the prisms is filled with air. (Air has unit index of refraction.) What are the amplitudes of the reflected and transmitted waves in this case? Take the light to be polarized perpendicular to the plane of incidence.

c) What are the reflection and transmission coefficients $R_\perp$ and $T_\perp$ in this case? Explain the behavior of your answers in the limits $t \to 0$ and $t \to \infty$.

Ex. 7.2: Secondary Rainbow

Under suitable atmospheric conditions you can see two rainbows in the sky. The secondary rainbow is from light that reflects twice inside a single drop of rain. At what angle (compared to the direction of the sun) does the secondary rainbow appear? In what order do the colors appear in the secondary rainbow? Please explain your answers! (The index of refraction for water is $n_{\text{water}} \approx 1.333$. It has a weak frequency dependence, $dn_{\text{water}}/d\omega > 0$.)

Ex. 7.3: Brewster angle twice

Heald & Marion, Ex 6-9.

Suggested Heald & Marion problems for further study:

6-2 (Matching Impedances), 6-6 (Optical Length), 6-8 (Fresnel Formulas for magnetic media), 6-10 (Brewster angle and total internal reflection), 6-12 (Poynting vector for conditions of total internal reflection), 6-13 (Reflection off a conductor)