

**Phys 375 – Tuesday section – Prof. Hall
Homework #2, due September 18, 2007**

- 1) (5 pts) Pedrotti, problem 2-4.
- 2) (5 pts) Show that the law of reflection follows from Fermat's principle of least time.
- 3) (12 pts) A ray of light is traveling along the x-axis. It meets a sheet of glass of thickness t which is tilted so that the ray's angle of incidence is α . Let the angle of refraction be called β .

a) Show using geometry and Snell's law that the ray emerges from the sheet of glass traveling parallel to the x-axis.

b) Show that the ray has been displaced in the y direction by an amount d with magnitude

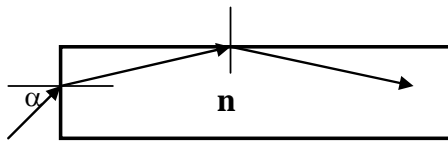
$$|d| = \frac{t \sin(\alpha - \beta)}{\cos \beta}$$

c) Re-write this expression as

$$\tan(\beta) = \tan(\alpha) - \frac{|d|}{t \cos(\alpha)}$$

d) If you measure $|d| = 28$ mm, $t = 72$ mm, and $\alpha = 50$ degrees, what is the index of refraction of the glass?

- 4) (6 pts) A ray of light in air (index of refraction = 1) enters a rectangular piece of plastic with index of refraction n at an angle of incidence α , and subsequently undergoes total internal reflection inside the plastic:



a) Show that $\sin \alpha < \sqrt{n^2 - 1}$.

b) How large should n be for all rays to undergo total internal reflection regardless of their angle of incidence?

- 5) (5 pts) You measure the critical angle in a piece of glass to be 43.5 ± 1.0 degrees. Use propagation of errors to show that the error on the index of refraction is 0.026. Hint: what units should you use for the angular error?