

**Phys 375 – Prof. Hall**  
**Homework #2, due September 15&16, 2008**

- 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  $\alpha$ . Let the angle of refraction be called  $\beta$ .

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

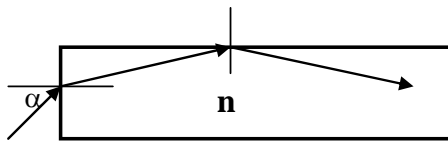
$$|d| = \frac{t \sin(\alpha - \beta)}{\cos \beta}$$

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  $\alpha$ , 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  $43.5 \pm 1.0$  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?