Phys 375 – Homework #2

1) (5 pts) Determine the minimum height of a wall mirror that will permit a 6-foot person to view his/her entire height. Sketch rays from the top and bottom of the person, and determine the proper placement of the mirror such that the full image is seen, regardless of the person's distance from the mirror.

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

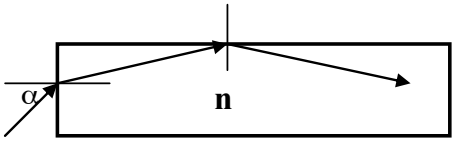
$$|d| = \frac{t\sin(\alpha-\beta)}{\cos\beta}$$

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 α = 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?