# PHY431, Homework 1 DUE: Thursday Jan 19 2017

Key ideas: ray tracing, Snell's law, refraction, index of refraction, total internal reflection, trigonometry practice

1. (3 pts) A ray of light makes an angle of incidence of $45°$ at the center of the top surface of a transparent cube of index n=1.414, and its plane of incidence is parallel to one face of the cube. Trace the ray through the cube, and find the angle deviation (exit from cube). Check for where total internal reflection occurs, and where it does not. (Trace the complete path of the ray.) The figure below gives the idea (incident light at top, details of later reflections may or may not be drawn accurately.)
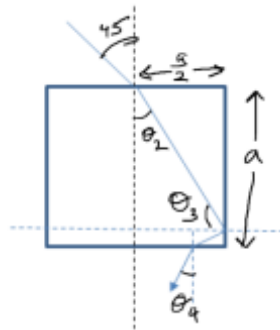
2. (3 pts) A ray of light penetrates a rectangular plate.

   (a) Find an expression for the lateral displacement d of the ray, as a function of the angle of incidence Θ_1, the angle of refraction Θ_2, and the thickness of the plate t.

   (b) Calculate the lateral displacement d for a plate thickness t=6 cm, refractive index n=1.5, and angle of incidence Θ_1=60°.
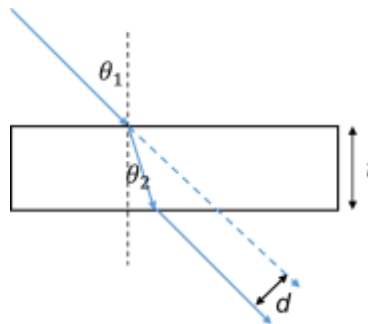
3. (2 pts) A glass rod of rectangular cross-section is bent into the shape shown in the figure below. A parallel beam of light falls perpendicularly on the flat surface A. Determine the minimum value of the ratio R/d for which all the light entering the glass through the surface A will emerge from the glass through surface B. The index of refraction of the glass is $n=1.5$ (air on the outside). Hint: consider for which ray entering the opening A will the initial TIR condition be the worst. (Practically: This is related to how much you can bend a fiber optic cable before it stops working, i.e., the light leaks out.)
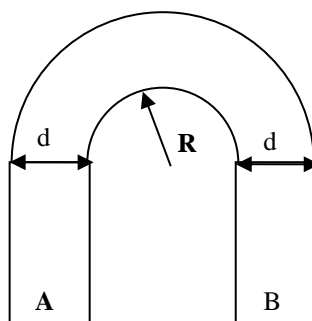
4. (2 pt) Refer to the figure below: on the left is a circular curved piece of glass (2 cm radius), on the right is air. A small bubble is located within the glass, 1 cm from the surface. If you are in the air and looking to the left, where would the air bubble appear to be? Is this a real or virtual image? Hint: be very careful with signs!