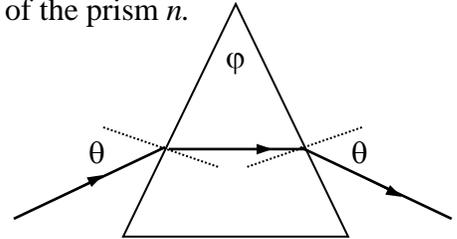


Refraction

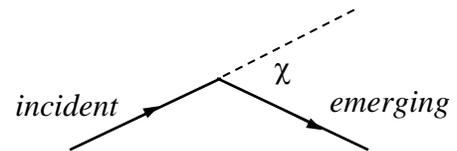
This laboratory considers the phenomenon of refraction in various instances.

1. Consider light symmetrically entering and exiting a prism with interior angle φ as shown in the figure.

a) Find a relationship between the angles θ , φ and the index of refraction of the prism n .



b) In the case above the “angle of minimum deviation” χ is defined as the angle by which the emerging ray deviates from the incident ray. Find a relationship between the angles given and the angle of deviation. How is the index of refraction related to χ and φ ?

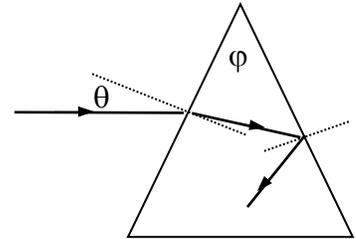


c) Assuming that glass is used with $n \approx 1.5$ would it be possible to use a right-angled prism $\varphi = 90^\circ$ for this experiment?

d) Obtain a prism, laser, and angle-disc from the front of the room. Determine the angle of deviation and hence the index of refraction of the prism. Record your results below.

e) For the index of refraction you found in part (d) what is the critical angle for light emerging from the prism to air?

f) Is it possible to have an incident ray such that total internal reflection occurs at the point where the refracted ray meets the second glass-air interface? Explain. Assuming $\theta > 0$ in the figure, what minimum value of ϕ would permit such a circumstance?



g) *Predict* the largest angle θ that will cause total internal reflection at the exit point of the ray in part (f).

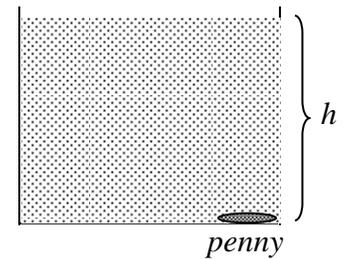
h) Using your prism and laser test your prediction to part (g).

2. Obtain a beaker, penny, and stir-stick from the front of the room. Fill the beaker to its top and submerge the penny next to one of its edges. Assume that the penny is submerged a depth h as shown in the figure.

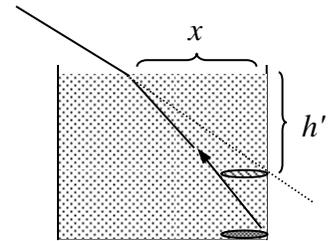
a) Sketch *several* rays that leave the penny and reach the eye in the figure. By continuing these rays determine the location of the apparent position of the object.



b) Suppose the penny is viewed near normal incidence. Find an expression for the apparent depth h' in terms of the actual depth h and index of refraction of water n .

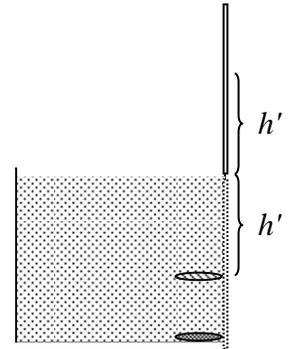


c) Attempt to measure the apparent depth of the penny by placing a stir-stick alongside the beaker at the same height that you perceive the image. Focus on a specific point of the penny – perhaps its back edge. Locate the point where the ray from the penny exits the surface and determine the distance x shown in the figure. Use the information you recorded and your ray sketch to determine the water index of refraction.

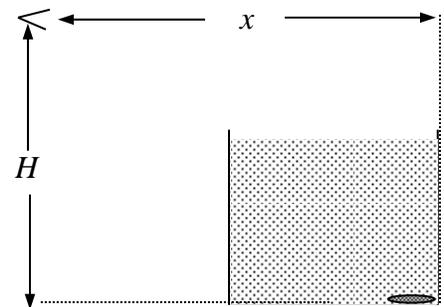


d) What result would you have obtained by assuming the rays leaving the water surface are very nearly normal to it so that the considerations of part (b) apply? (This assumption is often made when estimating apparent depths). In this limit does your result depend on x ?

e) Now measure the apparent depth by another method. Place a stick above the water and look at its reflection from the water surface. Find the point on the stick whose reflection coincides with the penny image and measure the height of this point on the stick from the water surface. On the figure below sketch the rays associated with this determination of the apparent depth. As in part (d) locate x and from you information determine n . Compare with your previous estimate.



f) Consider estimating n by determining the point where a specific point of the penny image is no longer visible when viewed from a height H . On the figure draw the ray from the back point of the penny reaching your eye when it just becomes visible. Relate H , and x to the refractive index n . Measure H , and x , for two separate heights H and use them to determine n .



g) Repeat part (f) while viewing the penny from the other side of the beaker.

