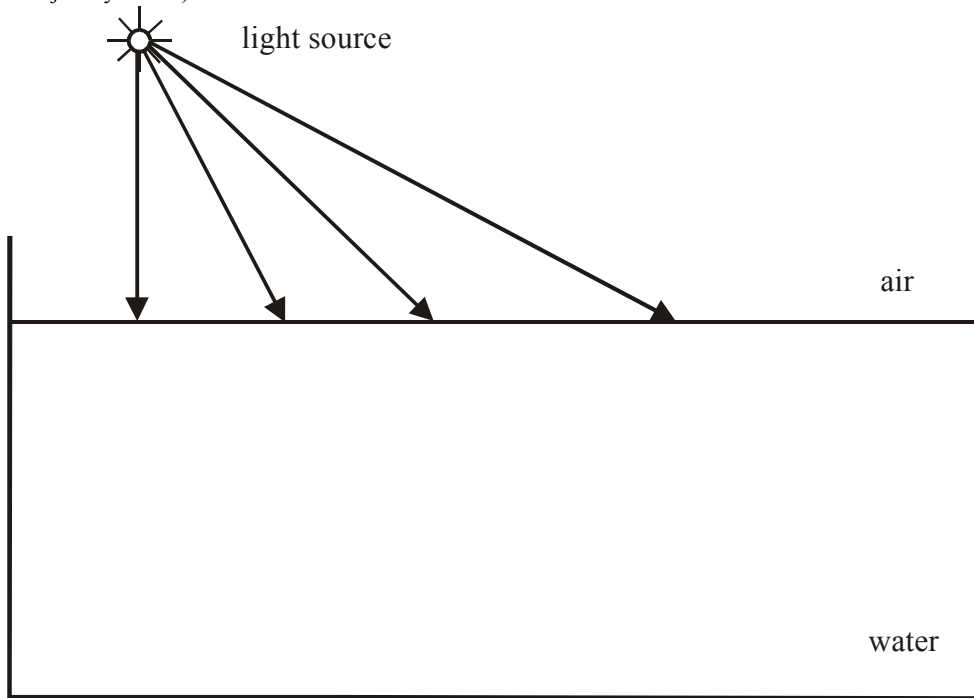
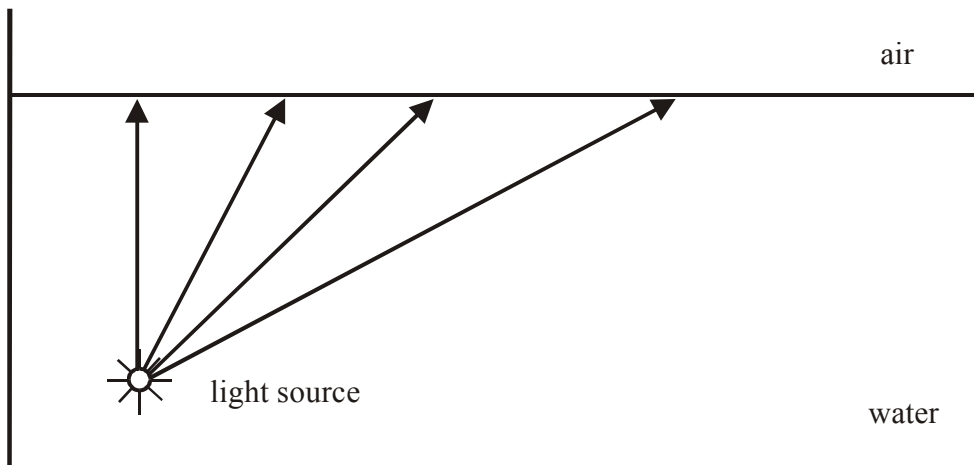


# Refraction Worksheet

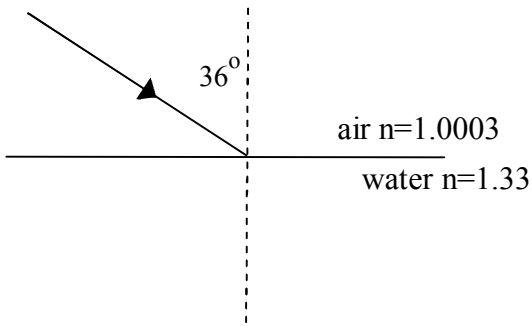
1. Sketch the path of the rays showing the refraction at the air/water boundary. Include the normal for each ray and a correct location of an observer's eye in the water that could see each ray. (no calculations, just eyeball it)



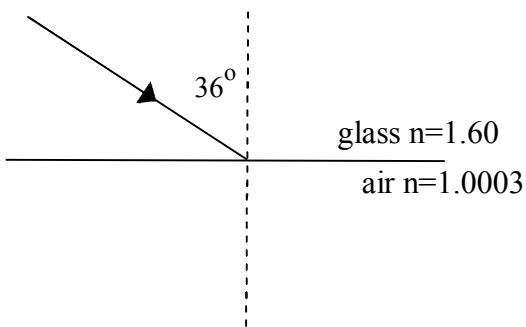
2. The light source is now under water. Sketch the path of the rays as they pass from the water into the air. Include the normal for each ray and a correct location of an observer's eye in the air that could see each ray. (no calculations, just eyeball it)



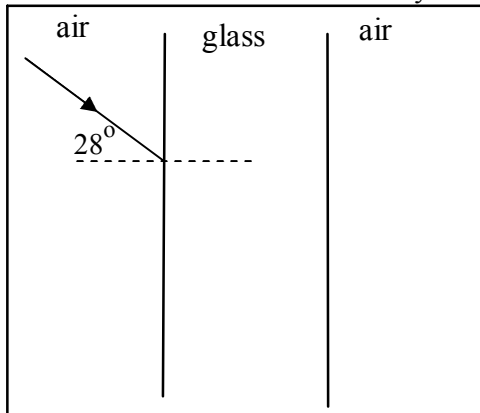
3. Use the Law of Refraction to determine the direction of the refracted ray. Sketch (eyeball) the refracted ray and label the angle.



4. Use the Law of Refraction to determine the direction of the refracted ray. Sketch (eyeball) the refracted ray and label the angle.



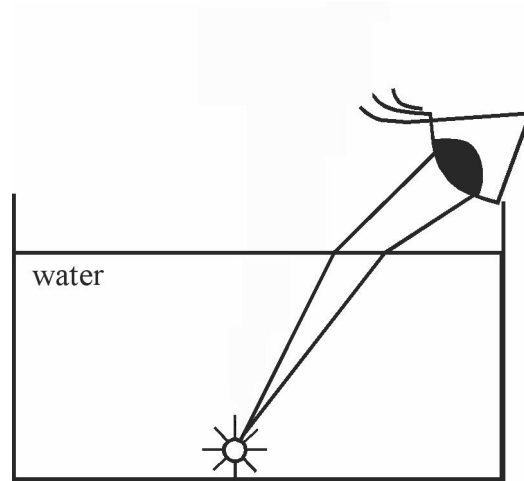
5. a) Use the Law of Refraction to determine the direction of the refracted ray through the 1<sup>st</sup> and the 2<sup>nd</sup> boundaries. Sketch the refracted rays and label the angles. Assume the boundaries are parallel.



b) Sketch (eyeball) the reflected rays above.

6. In a lab experiment where light passes from air into a plastic block, the incident angle is measured to be  $25^\circ$  and the refracted angle is  $21^\circ$ . Find the index of refraction for the block.

7. a) Locate the position of the image of the underwater light source as seen by the eye.



- b) If one of the light rays in the tank of water hits the surface at  $35^\circ$  as measured from the normal, at what angle will it enter the air? ( $n_{\text{water}} = 1.33$ )

- c) Now suppose the incident angle in the water is  $80^\circ$  as measured from the normal. What is the refracted angle? What problem arises?

- d) Find the critical angle for the water-air interface (this is the incident angle that corresponds to the largest possible refracted angle,  $90^\circ$ ).