Refraction

BACKGROUND: The bending of light rays in passing from one medium to another is called refraction. In Fig. 10.1. light is traveling in media 1 with index of refraction n_1, and is incident on medium 2 which has an index of refraction of n_2. The light ray in medium 1 is referred to as the incident ray, and that in medium 2 is referred to as the refracted ray. The angle of incidence is defined as the angle that the incident ray makes with the normal to the surface. Similarly the angle of refraction is the angle that the refracted ray makes with the normal to the surface.

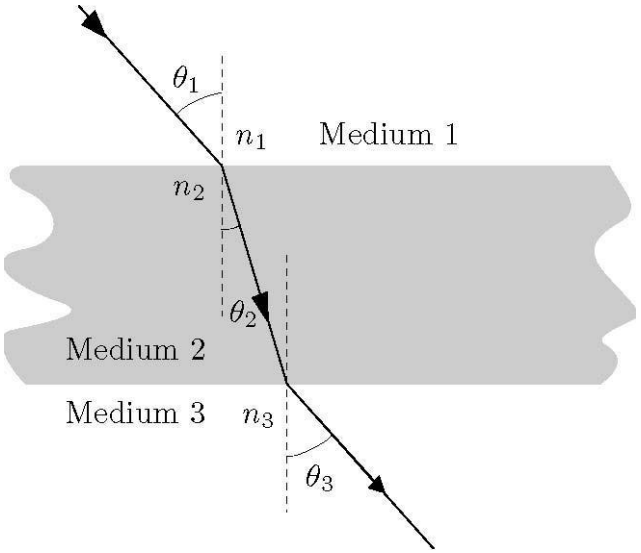

Figure 10.1: Double Refraction.

The angles of incidence and refraction are related to the indices of refraction of the two media through Snell's Law:

$$n_1 \sin(\theta_1) = n_2 \sin(\theta_2) \,, \tag{1}$$

or, more conveniently for us:

$$n_2 = n_1 \sin(\theta_1) \,/\, \sin(\theta_2) \,. \tag{2}$$

From Eq. (2), it can be seen that the index of refraction of the second medium, with index of refraction n_2, can easily be determined from measurements of the angles θ_1 and θ_2 if the index of refraction in thefirst medium, n_1, is known. For this laboratory exercise the first medium will be air, so that $n_1 \approx 1$.

OBJECT: To investigate Snell's Law and determine the index of refraction of liquid media.

APPARATUS: Reflection & Refraction Demonstrator

WARNING: Never look directly into a laser beam.

PROCEDURE:

1. Fill the demonstrator to the halfway point, so the water border is touching the horizontal (90 degrees line).
2. Loosen the wing nut in the back. Move the laser to the first quadrant (right upper corner) and se the angle of incident to approximately 10 degrees. Press the momentary button on the laser to check the angle and adjust the laser position accordingly, then tighten the wing nut. Record the angle of refraction.
3. Change the angle of incidence to 20, 30 and 40 degrees. Record the angle of refraction each time. Also observe the brightness of the refracted rays.
4. Use equation (1) or (2) to verify the law of refraction.
5. Explore the refraction at higher angles of incidence and observe how reflection also occurs.
6. Repeat the experiment using salt water.

QUESTIONS:

1. Why does light bend when it travels from one medium to another?
2. For what incidence angle would light not bend when passing from water to glass?
3. Explain the differences in the values that you obtained for the index of refraction for water and for the water-salt mixture. Where there significant differences in the two answers? What would you guess the difference in these two values to be? Explain.

Data to determine the index of refraction of water.					
Trial	θ_1	$\sin(\theta_1)$	θ_2	$\sin(\theta_2)$	n_2
1					
2					
3					
4					
5					
Average					
% of error					
Data to determine the index of refraction of water-salt mixture.					
Trial	θ_1	$\sin(\theta_1)$	θ_2	$\sin(\theta_2)$	n_2
1					
2					
3					
4					
5					
Average					