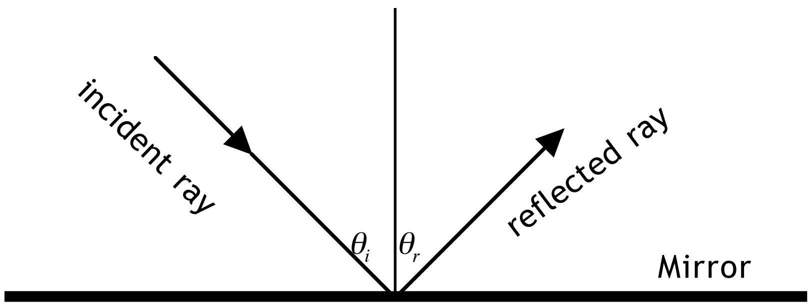
Chapter 8

Reflection & Refraction

Theory

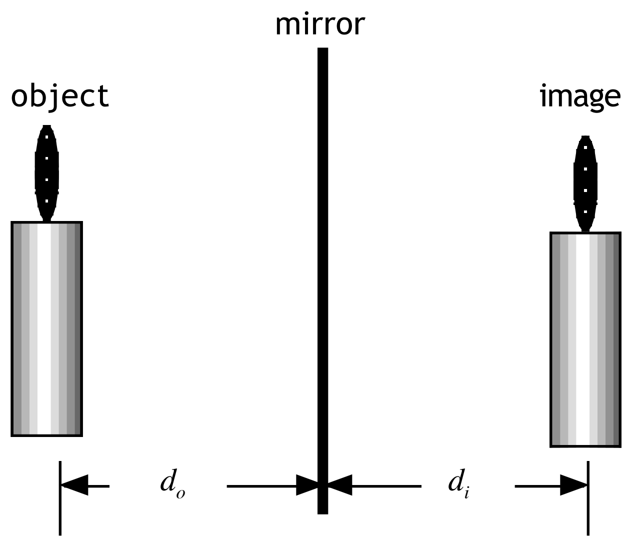
The Law of Reflection

When light strikes a plane surface, some of its rays are reflected. This reflection is described by the *Law of Reflection*. It states that *the angle of incidence is equal to the angle of reflection*. That is $\theta_i = \theta_r$, where θ_i is the angle of incidence and θ_r is the angle of reflection.



Law of Reflection : $\theta_i = \theta_r$

A corollary of the law of reflection is when an object is placed in front of a plane mirror, its image appears to form at a distance behind the surface of the mirror. This distance is called the *image distance* d_i and it is equal to the distance between the object and the mirror, the *object distance* d_o. That is $d_o = d_i$, as the figure below shows.



Alternate version for the Law of Reflection:
$d_o = d_i$

The Law of Refraction

If you place a pencil inside a clear glass filled with water, you will notice that the pencil appears to be broken or bent. When light passes from one medium to another different medium, its direction of motion changes. This is due to the different speeds of light in different media. The denser the material, the slower light is. For example, light moves slower in water than in air and even slower in glass than in water. Light is fastest in a vacuum, since the density of a vacuum is zero. The speed of light in a vacuum has been measured to be $c = 3.00 \times 10^8\ m/\text{sec}$.

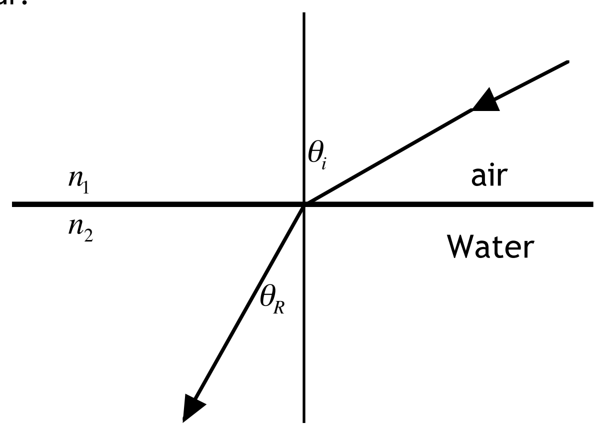
We define the ratio of the speed of light in a vacuum to the speed of light in a medium as the *index of refraction*:

$$n = \frac{\text{speed of light in vacuum}}{\text{speed of light in a medium}}$$

Symbolically,

$$n = \frac{c}{v}$$

So how does refraction occur?



From the figure above, as light passes from a less-dense medium to a more-dense medium (e.g., air to water) its speed decreases and thus its angle of incidence θ_i decreases to a new value θ_R, the angle of refraction. The relationship between the two angles is given by Snell's Law,

$$n_1 \sin\theta_1 = n_2 \sin\theta_2$$

where n_1 and n_2 are the indices of refraction for each medium. Please see the table in Appendix C for index of refraction for different materials.

Experimental Procedure

Experiment #1

Reflection: Measuring the image distance

Place a regular (8.5" by 11") sheet of paper on the table and position a glass plate at its center, as shown in the figure below. With a pencil, draw a line along the edge of the glass plate on the paper to mark its position. Place a small object, such as a candle or a pushpin, at the edge of the sheet. Measure its distance from the glass plate. This is the object distance d_o. Move your eye to the right and to the left of the object while viewing the image in the glass plate (while keeping one eye closed). Hold a pencil vertically, point down, behind the glass plate and move it around until it coincides with the image. Press the pencil to the paper and mark its location with a dot. Remove the glass plate and measure the distance between the dot and the line that you had drawn along the glass plate. This is your image distance d_i. Repeat the experiment several times for different object distances and enter all your data in the data table below.