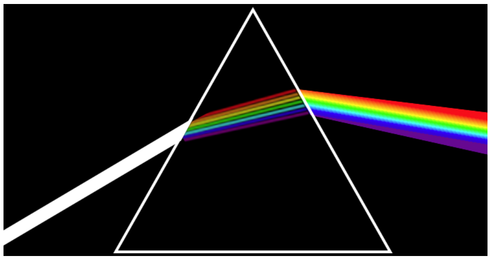
10.5: Dispersion

Dispersion

What determines the index of refraction for a medium is a very complicated problem in E&M, but there is one easily-observable fact: The amount that a ray bends as it enters a new medium is dependent upon the light's frequency. Specifically, the higher the frequency of the light, the more it bends – it essentially experiences a higher index of refraction when its frequency is higher. This phenomenon is most evident when white light is shone through a refracting object. The most iconic example of this is white light through a prism.

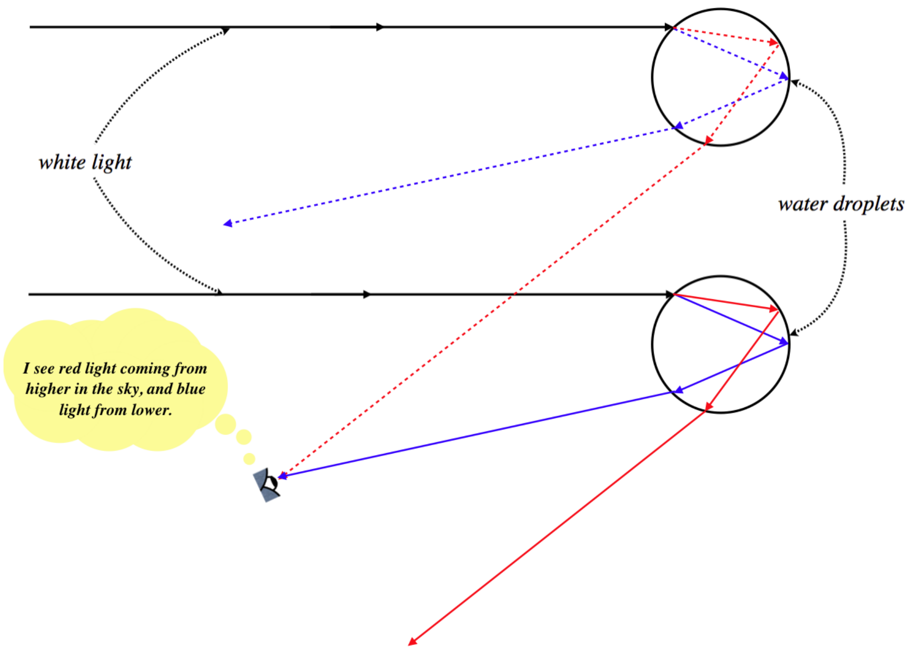
Figure 10.5.1: Dispersion Through a Prism



The emergence of the fully-separated spectrum of colors from a prism is reminiscent of a rainbow, and in fact rainbows are also a result of dispersion. Unlike the prism depicted above, however, internal reflection is an integral part of the rainbow effect (and in fact prisms can also feature internal reflection).

A droplet of water suspended in the atmosphere is a refracting sphere. White light that enters near the top of the droplet gets dispersed inside the droplet, reflects, and then gets dispersed as it exits the droplet, sending rays of different-colored light in different directions. The diagram below shows this effect for rays of red and blue light for two droplets.

Figure 10.5.2: Rainbows



A few things to note here:

- Notice that the sun always needs to be behind the observer in order to witness a rainbow. That's why it seems to move as you move, and why reaching the "end of the rainbow" is impossible (unless you can catch a leprechaun).
- The reason it is shaped like a bow is that the sun is nearly a point source, so the geometry is symmetric around the line joining the sun and the observer. If you create a "human-made rainbow" with a light and some mist, you can get close to an entire circle

(minus whatever light your body blocks out).

- The secondary rainbow above the primary one comes from the light that enters the *bottom* of the droplets, and has *two* internal reflections. This reversed direction of the light bouncing around inside the droplets results in the colors being reversed (the violet is at the top and the red at the bottom).
