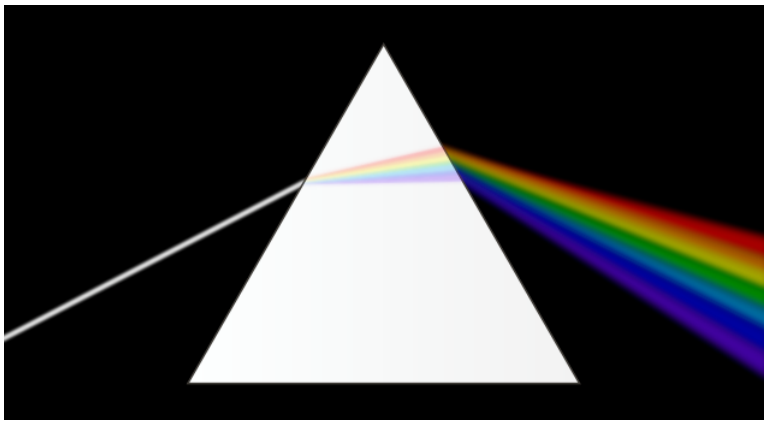
15.4: Electromagnetic Waves and Materials

When electromagnetic waves reach objects, the waves can either reflect from the object, pass through the object, or be absorbed by the object. These behaviors are part of the language we use when describing objects. 'Shiny' means that the surface is reflecting much of the energy that reaches it. 'Dull' means that it reflects less. When objects absorb most of the energy that reaches them, we call it 'opaque', but if most of the energy passes through it, it is 'transparent'. When we speak of a 'bright light', we mean the intensity is large. When the light is 'dim', the intensity is small and very little wave energy reaches out eyes..

The same object does not produce the same results for all wave frequencies. An object can be opaque to visible light but transparent to x-rays, for example. It might refect a wave of one frequency and absorb a wave with a different frequency. What we call the color of an object depends on which wavelengths are reflected from the object's surface and which ones are absorbed. Part of what influences the way a wave interacts with an object is the frequency of the source and the molecular properties of the object.

The behavior of the waves generally depends on the wave speed in the different materials. Imagine materials 1 and 2. Where they meet is called a boundary. Any changes in wave behavior happens at the boundary. A wave starts in material 1 and moves towards material 2. If the wave speed in material 2 is less than the wave speed in material 1, then part of the wave will be reflected from the boundary. The greater the difference in wave speeds, the greater the amount that is reflected. Waves will also change the direction they are traveling when they cross a boundary. If the wave slows down as it crosses the boundary, it will bend in one direction. If the wave speeds up, it will bend in the opposite direction as it crosses the boundary. These topics will be explored more completely in the chapter on optics.

Earlier, it was mentioned that the speed of an electromagnetic wave varies according to the frequency of the oscillation. That means that light that contains a mixture of different frequencies will show a difference in the way that the light interacts with it. A prism is a prime example of the effect of materials on the electromagnetic waves passing through them.



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A mix of all colors enters the prism at the left edge. Due to the difference in wave speeds for each different color (source frequency), the path traveled through the prism is also different. Red light travels the fastest through the prism and is deflected the least, Blue light travels the slowest and is affected more by passing through the prism.

In general, waves with low frequencies tend to be affected least by passing through materials, and waves with high frequencies tend to be affected the most. This difference in behavior helps explain why the sky is blue during the day, but becomes reddish at sunset. These topics will be explored further in the chapter on reflection and refraction.