Why it Matters

Radio and TV Broadcasts

"You are listening to 97.7 WKID, student-run radio from Central High School." What does the radio announcer mean by this greeting? Where do those numbers and letters come from? The numbers mean that the radio station is broadcasting a frequency modulated (FM) radio signal of 97.7 megahertz (MHz). In other words, the electric and magnetic fields of the radio wave are changing back and forth between their minimum and maximum values 97,700,000 times per second. That's a lot of oscillations in a three-minute long song!

The Federal Communications Commission (FCC) assigns the call letters, such as WKID, and the frequencies that the various stations will use. All FM radio stations are located in the band of frequencies that range from 88 to 108 MHz. Similarly, amplitude modulated (AM) radio stations are all in the 535 to 1,700 kHz band. A kilohertz (kHz) is 1,000 cycles per second, so the AM band is broadcast at lower frequencies than the FM band is. The television channels 2 to 6 broadcast between 54 MHz and 88 MHz. Channels 7 to 13 are in the 174 MHz to 220 MHz band, and the remaining channels occupy even higher frequency bands in the spectrum.

How are these radio waves transmitted? To create a simple radio transmitter, you need to create a rapidly changing electric current in a wire. The easiest form of a changing current is a sine wave. A sine wave can be created with a few simple circuit components, such as a capacitor and an inductor. The wave is amplified, sent to an antenna, and transmitted into space.

If you have a sine wave generator and a transmitter, you have a radio station. The only problem is that a sine wave contains very little information! To turn sound waves or pictures into information that your radio or television set can interpret, you need to change, or *modulate,* the signal. This modulation is done by slightly changing the frequency based on the information that you want to send. FM radio stations and the sound part of your TV signal convey information using this method.

High-energy electromagnetic waves behave like particles

Sometimes, an electromagnetic wave's frequency (or wavelength) makes the wave behave more like a particle. This notion is called the *wave-particle duality* of light. It is important to understand that there is no difference in what light *is* at different frequencies. The difference lies in how light *behaves.*

When thinking about electromagnetic waves as a stream of particles, it is useful to define a **photon.** A photon is a particle that carries energy but has zero mass. You will learn more about photons in the chapter on atomic physics. The relationship between frequency and photon energy is simple: $E = hf$, in which h, Plank's constant, is a fixed number and f is the frequency of the wave.

photon

a unit or quantum of light; a particle of electromagnetic radiation that has zero mass and carries a quantum of energy

Low-energy photons tend to behave more like waves, and higher energy photons behave more like particles. This distinction helps scientist design detectors and telescopes to distinguish different frequencies of radiation.