Chapter 5 – Wave Motion and Sound

As usual, read the chapter carefully. It is about waves which are really important to many areas of physics.

Waves are tremendously important in physics. There are water waves, sound waves, and light waves that people generally experience, but radio signals, heat radiation, X-rays, and even electrons and atoms are also waves.

Normally, we speak of simple **traveling waves**. They undulate up and down in both space and time, usually spreading out from a vibrating source. The time variation of a traveling wave at a particular point in space is shown in the text in Figure 5.4. The spatial variation of a traveling wave at a particular instant in time is shown in the text in Figure 5.9.

Simple waves are described by an **amplitude** *A*, **frequency** *f*, and **speed** *v*. From these parameters, one can calculate related parameters: **period** $T = 1/f$ and **wavelength** $\lambda = v/f$. Theses have the following units:
period: seconds (s) frequency: hertz (1/s = Hz) speed: meters/second (m/s) wavelength: meter (m)
The amplitude of a wave has a unit that depends on the type wave. Water waves have amplitudes units in meters, sound waves have units in pressure, and electromagnetic waves have units of electric field strength.

Standing waves are formed by a traveling wave echoing back and forth in such a manner that it appears to not be moving forward or backward. Figure 5.22 shows standing waves in a stretched string. Musical instruments generate standing waves at specific frequencies and broadcast the sound out as traveling waves.

Waves can be **compression waves** or **transverse waves**. These are shown in the text in Figure 5.6.

Waves of different frequencies can add together to form nearly any shape, even ones that do not have repeating shapes. Ocean waves near the shore become distorted as the upper part of the wave moves faster than the lower part forming breakers much to the delight of surfers. The breakers can be thought of as being made up of many simple waves of different frequencies and amplitudes.

The Perfect Storm story is based on waves converging from three separate ocean storms onto one location to produce 30-m high waves that led to an boater and rescuer tragedy.

Shock waves are produced by one-time events such as an explosion. They are a pulse of distortion that does not repeat.

Earthquakes produce **seismic waves** in the earth, but can also displace large regions of the ocean causing a **tsunami**.

Radio, television, infra-red radiation, light, ultra-violet rays, X-rays, and gamma rays are all **electromagnetic waves**.

In quantum mechanics, photons are packets of electromagnetic waves, but are more accurately packets of **probability waves** describing the likelihood of the photon energy being detected.

Electrons and other elementary particles as well as whole atoms are also packets of probability waves with a wavelength dependent on their momentum and a frequency dependent on their energy.