Radio Waves

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CONCEPT 1 Radio Waves

- Give an overview of the electromagnetic spectrum.
- Describe radio waves and identify their uses.
- Explain how radio waves are used for radio and television broadcasts.

Raymond can't help singing along when his favorite song starts playing on the radio. Do you like to listen to the radio? Did you ever wonder how music travels from a radio station to a radio receiver? How do the sounds travel through air and buildings and everything else in between you and the station? The answer is by electromagnetic waves.

A Spectrum of Waves

Electromagnetic waves consist of vibrating electric and magnetic fields. They transfer energy across space as well as through matter. Electromagnetic waves vary in their wavelengths and frequencies, and higher-frequency waves have more energy. The full range of wavelengths of electromagnetic waves is called the electromagnetic spectrum. It is outlined in the following **Figure** 1.1.

Introducing Radio Waves

Electromagnetic waves on the left side of the diagram above are called radio waves. **Radio waves** are electromagnetic waves with the longest wavelengths. They may have wavelengths longer than a soccer field. They are also the electromagnetic waves with the lowest frequencies. With their low frequencies, they have the least energy of all electromagnetic waves. Nonetheless, radio waves are very useful. They are used for radio and television broadcasts and many other purposes. You can learn more about radio waves, including how they were discovered, at this URL: http://www.youtube.com/watch?v=al7sFP4C2TY

Q: Based on the electromagnetic spectrum diagram above, what is the range of frequencies of radio waves?

A: The range of frequencies of radio waves is between 105 and 1012 Hz, or waves per second.

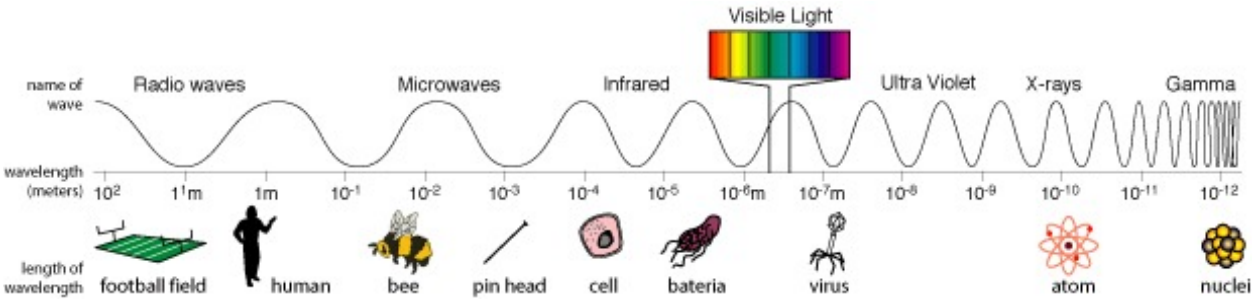

FIGURE 1.1

AM and FM Radio

In radio broadcasts, sounds are encoded in radio waves, and then the waves are sent out through the atmosphere from a radio tower. A radio receiver detects the waves and changes them back to sounds. You may have listened to both AM and FM radio stations. How sounds are encoded in radio waves differs between AM and FM broadcasts.

- AM stands for amplitude modulation. In AM broadcasts, sound signals are encoded by changing the amplitude, or maximum height, of radio waves. AM broadcasts use longer wavelength radio waves than FM broadcasts. Because of their longer wavelengths, AM waves reflect off a layer of the upper atmosphere called the ionosphere. You can see how this happens in the **Figure** 1.2. Because the waves are reflected, they can reach radio receivers that are very far away from the radio tower.
- FM stands for frequency modulation. In FM broadcasts, sound signals are encoded by changing the frequency of radio waves. Frequency modulation allows FM waves to encode more information than does amplitude modulation, so FM broadcasts usually produce clearer sounds than AM broadcasts. However, the relatively short wavelengths of FM waves means that they don't reflect off the ionosphere as AM waves do. Instead, FM waves pass through the ionosphere and out into space. This is also shown in the **Figure** 1.2 below. As a result, FM waves cannot reach very distant receivers.

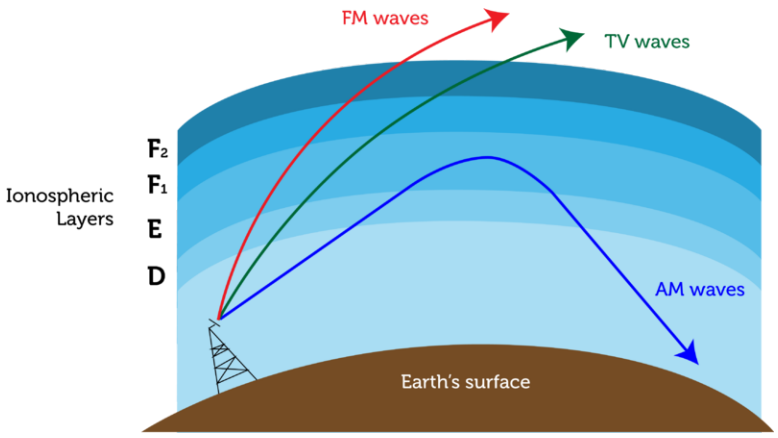

FIGURE 1.2

Q: The composition of the ionosphere changes somewhat from day to night. The changes make the nighttime ionosphere even better at reflecting AM radio waves. How do you think this might affect the distance AM radio waves travel at night?

A: With greater reflection off the ionosphere, AM waves can travel even farther at night than they can during the day. Radio receivers can often pick up radio broadcasts at night from cities that are hundreds of miles away.

Television

Television broadcasts also use radio waves (see diagram above). For TV broadcasts, sounds are encoded with frequency modulation, and pictures are encoded with amplitude modulation. The encoded waves are broadcast from a TV tower. When the waves are received by television sets, they are decoded and changed back to sounds and pictures.

Summary

- Electromagnetic waves vary in their wavelengths, frequencies, and energy levels. The full range of electromagnetic waves makes up the electromagnetic spectrum.
- Radio waves are electromagnetic waves with the longest wavelengths, lowest frequencies, and least amount of energy. They are used for radio and television broadcasts and many other purposes.
- In radio broadcasts, sounds are encoded in radio waves by changing either the amplitude (AM) or frequency (FM) of the waves. The encoded waves are broadcast from a tower and changed back to sounds by radio receivers.
- In television broadcasts, sounds and pictures are encoded in radio waves, broadcast from a tower, and changed back to sounds and pictures by television sets.

Vocabulary

- **radio wave**: Any wave in the electromagnetic spectrum that has a wavelength longer than infrared light.

Practice

Observe the three radio waves in the animation at the following URL. Then write a short paragraph comparing and contrasting the three waves. http://en.wikipedia.org/wiki/File:Amfm3-en-de.gif

Review

1. What are radio waves?
2. Compare and contrast AM and FM radio broadcasts.
3. Explain how radio waves are used to encode sounds and pictures in television broadcasts.