

19-1 What is the electromagnetic spectrum?

Objective

Identify the parts of the electromagnetic spectrum.

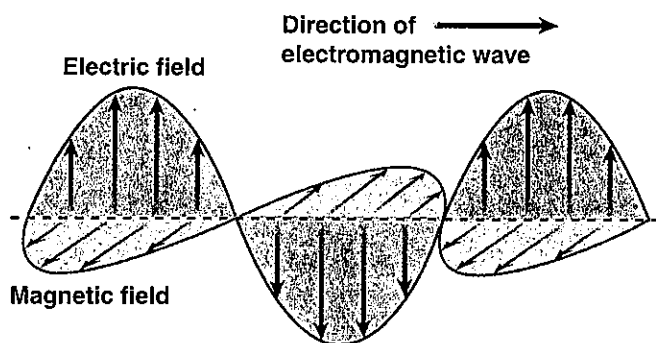
Key Terms

electromagnetic (ee-lehk-troh-mag-NEHT-ihk)

spectrum: range of electromagnetic waves

visible spectrum: seven colors that make up white light

Electromagnetic Waves Light is a form of energy. Sometimes light behaves as if it is made up of tiny particles of energy called photons. Unless disturbed, photons travel in straight lines. Other times, light behaves as an electromagnetic wave. Unlike mechanical waves, electromagnetic waves can travel through empty space.



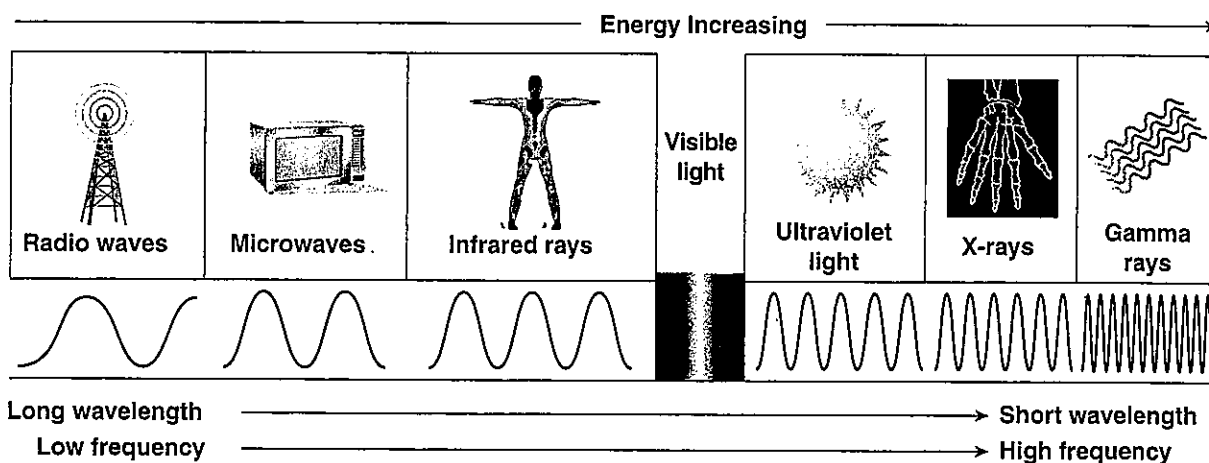
▲ Figure 19-2 Electromagnetic waves are made up of two transverse waves.

Electromagnetic waves have both electrical properties and magnetic properties. These waves are made up of two transverse waves that vibrate at right angles to each other.

▶ **COMPARE:** How are electromagnetic waves different from mechanical waves?

The Electromagnetic Spectrum Light that you can see is called visible light, or white light. Visible light waves make up a small part of a much larger band of waves called the **electromagnetic spectrum**. Figure 19-3 shows the different types of waves that make up the electromagnetic spectrum. As the figure shows, the energy of a wave is related to its wavelength and its frequency.

- **Radio waves** Radio waves have the longest wavelength and the lowest frequency. They are used for radio, television, and radar signals.
- **Microwaves** Microwaves are used for wireless communications and microwave ovens.
- **Infrared rays** All objects give off infrared rays. You cannot see infrared rays, but you can feel them as heat.
- **Visible spectrum** The only part of the electromagnetic spectrum that can be seen by the human eye is the **visible spectrum**. It is made up of the colors red, orange, yellow, green, blue, indigo, and violet.



▲ Figure 19-3 The electromagnetic spectrum is made up of different wavelengths and frequencies.

Ultraviolet rays Ultraviolet rays can cause sunburn. Ultraviolet light is used to kill bacteria.

X-rays X-rays have a very short wavelength and a high frequency. X-rays are used in medicine to form images of bones and internal organs.

Gamma rays Gamma rays have a shorter wavelength and a higher frequency than X-rays do. They are given off during nuclear reactions.

2 LIST: What are the electromagnetic waves that make up the electromagnetic spectrum?

✓ CHECKING CONCEPTS

1. Waves with the longest wavelength and the lowest frequency are _____.
2. Waves usually given off during nuclear reactions are _____.
3. Only those waves in the _____ can be seen by the human eye.

4. Waves with wavelengths slightly longer than visible light are _____.

5. Rays usually felt as heat are _____.



THINKING CRITICALLY

6. **HYPOTHESIZE:** Microwaves are high-frequency radio waves. Microwave ovens can be used to cook food quickly. The microwaves are absorbed by the food. Why do you think that food in a microwave oven gets hot, but a dish does not?

HEALTH AND SAFETY TIP

High-frequency electromagnetic waves are dangerous. Too much exposure to X-rays is harmful. Find out why X-ray technicians wear lead aprons or stand behind a lead screen when taking X-ray pictures. Why are pregnant women advised not to have X-rays taken?



Science and Technology

CELL PHONES

Cellular or cell phones have helped change the way we communicate. These phones are small radio transmitters and receivers. One of hundreds of antennae receives radio signals when you make a call. These radio signals are transmitted on a radio frequency to a local cell site. A mobile telephone switching office (MTSO) picks up the signals and sends them through regular wired phones. The MTSO tracks and transfers your calls as you move from area to area. It reverses when you get a call.

Two kinds of wireless phone networks are analog and digital. In analog, voices are carried on radio waves with limitations. This service is easy to steal, and busy signals and static are common. Conversations can be picked up on radio scanners.

Digital service is newer. Voices convert to computer language and then change back to voices on the receiving end. Busy signals and static are less common. Your conversation cannot be heard on a scanner. This service is hard to steal. The newest technology is PCS (personal communication service). Computer language is transmitted on a range of frequencies that are always changing. This technology allows you to access the Internet, and have paging and text messaging capabilities.



▲ Figure 19-4 Cell phones receive and transmit radio waves.

Thinking Critically How have cell phones changed the way we communicate?