Electromagnetic Waves

SECTION 4

SECTION OBJECTIVES

- **Describe what electromagnetic waves are and how they are produced.**
- **Recognize that electricity and magnetism are two aspects of a single electromagnetic force.**
- **Explain how electromagnetic waves transfer energy.**
- **Describe various applications of electromagnetic waves.**

PROPAGATION OF ELECTROMAGNETIC WAVES

Light is a phenomenon known as an *electromagnetic wave*. As the name implies, oscillating electric and magnetic fields create electromagnetic waves. In this section, you will learn more about the nature and the discovery of electromagnetic waves.

The wavelength and frequency of electromagnetic waves vary widely, from radio waves with very long wavelengths to gamma rays with extremely short wavelengths. The visible light that our eyes can detect occupies an intermediate range of wavelengths. Familiar objects "look" quite different at different wavelengths. **Figure 19** shows how a person might appear to us if we could see beyond the red end of the visible spectrum.

In this chapter, you have learned that a changing magnetic field can induce a current in a circuit (Faraday's law of induction). From Coulomb's law, which describes the electrostatic force between two charges, you know that electric field lines start on positive charges and end at negative charges. On the other hand, magnetic field lines always form closed loops and have no beginning or end. Finally, you learned in the chapter on magnetism that a magnetic field is created around a current-carrying wire, as stated by Ampere's law.

Electromagnetic waves consist of changing electric and magnetic fields

In the mid-1800s, Scottish physicist James Clerk Maxwell created a simple but sophisticated set of equations to describe the relationship between electric and magnetic fields. Maxwell's equations summarized the known phenomena of his time: the observations that were described by Coulomb, Faraday, Ampere, and other scientists of his era. Maxwell believed that nature is symmetric, and he hypothesized that a changing electric field should produce a magnetic field in a manner analogous to Faraday's law of induction.

Maxwell's equations described many of the phenomena, such as magnetic induction, that had already been observed. However, other phenomena that had not been observed could be derived from the equations. For example, Maxwell's equations predicted that a changing magnetic field would create a changing electric field, which would, in turn, create a changing magnetic field, and so on. The predicted result of those changing fields is a wave that moves through space at the speed of light.

Figure 19
At normal body temperature, humans radiate most strongly in the infrared, at a wavelength of about 10 microns (10^{-5} m). The wavelength of the infrared radiation can be correlated to temperature.