Electromagnetic waves vary depending on frequency and wavelength

In classical electromagnetic wave theory, light is considered to be a wave composed of oscillating electric and magnetic fields. These fields are perpendicular to the direction in which the wave moves, as shown in **Figure 2.** Therefore, electromagnetic waves are transverse waves. The electric and magnetic fields are also at right angles to each other.

Electromagnetic waves are distinguished by their different frequencies and wavelengths. In visible light, these differences in frequency and wavelength account for different colors. The difference in frequencies and wavelengths also distinguishes visible light from invisible electromagnetic radiation, such as X rays.

Types of electromagnetic waves are listed in **Table 1.** Note the wide range of wavelengths and frequencies. Although specific ranges are indicated in the table, the electromagnetic spectrum is, in reality, continuous. There is no sharp division between one kind of wave and the next. Some types of waves even have overlapping ranges.

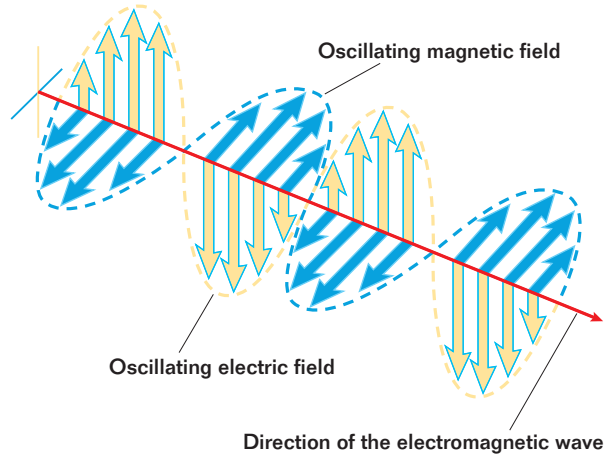

Figure 2
An electromagnetic wave consists of electric and magnetic field waves at right angles to each other.

Table 1 The Electromagnetic Spectrum

Classification	Range	Applications
radio waves	$\lambda > 30$ cm $f < 1.0 \times 10^9$ Hz	AM and FM radio; television
microwaves	30 cm $> \lambda >$ 1 mm 1.0×10^9 Hz $< f < 3.0 \times 10^{11}$ Hz	radar; atomic and molecular research; aircraft navigation; microwave ovens
infrared (IR) waves	1 mm $> \lambda >$ 700 nm 3.0×10^{11} Hz $< f < 4.3 \times 10^{14}$ Hz	molecular vibrational spectra; infrared photography; physical therapy
visible light	700 nm (red) $> \lambda >$ 400 nm (violet) 4.3×10^{14} Hz $< f < 7.5 \times 10^{14}$ Hz	visible-light photography; optical microscopy; optical astronomy
ultraviolet (UV) light	400 nm $> \lambda >$ 60 nm 7.5×10^{14} Hz $< f < 5.0 \times 10^{15}$ Hz	sterilization of medical instruments; identification of fluorescent minerals
X rays	60 nm $> \lambda > 10^{-4}$ nm 5.0×10^{15} Hz $< f < 3.0 \times 10^{21}$ Hz	medical examination of bones, teeth, and vital organs; treatment for types of cancer
gamma rays	0.1 nm $> \lambda > 10^{-5}$ nm 3.0×10^{18} Hz $< f < 3.0 \times 10^{22}$ Hz	examination of thick materials for structural flaws; treatment of types of cancer; food irradiation