



Ch. 22 – The Nature of Light

Section 2  
The Electromagnetic  
Spectrum

# Essential Questions

- How do electromagnetic waves differ?
- What are some of the uses for radio waves and microwaves?
- What are some examples of how infrared waves and visible light are important in your life?
- Why are ultraviolet light, X rays, and gamma rays both helpful and harmful?

# Characteristics of EM Waves

- The light that you can see is called *visible light*.
- Visible light and light that you cannot see are both electromagnetic (EM) waves.
  - Other kinds of EM waves include X rays, radio waves, and microwaves.
- All EM waves travel at 300,000 km/s in a vacuum.

# Characteristics of EM Waves 2

- The entire range of EM waves is called the **electromagnetic spectrum**.
- The electromagnetic spectrum is divided into regions according to the length of the waves.

# Radio Waves

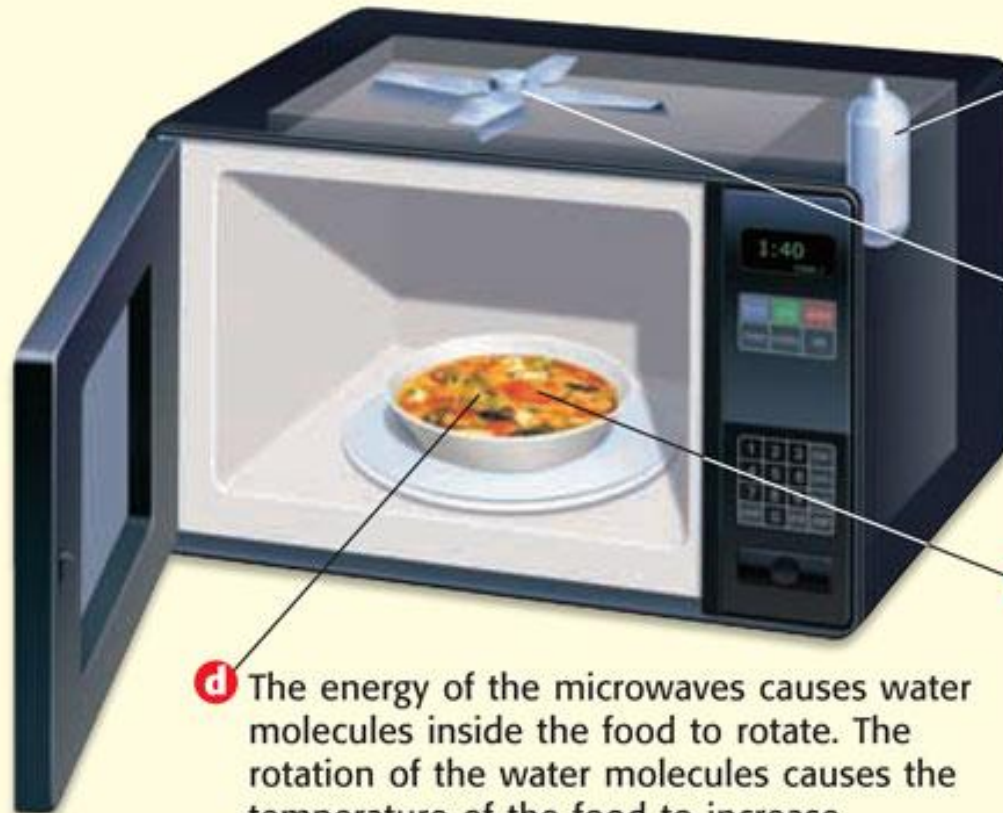
- *Radio waves* cover a wide range of waves in the EM spectrum.
  - Radio waves have some of the longest wavelengths and the lowest frequencies of all EM waves.
- Radio waves are any EM waves that have wavelengths longer than 30 cm.
  - Radio waves are used for broadcasting radio signals.

# Microwaves

- Microwaves have shorter wavelengths and higher frequencies than radio waves.
  - Microwaves have wavelengths between 1 mm and 30 cm.
  - Microwaves are used in radar.
- *Radar* (**radio detection and ranging**) is used to detect the speed and location of objects.
- Radar sends out microwaves that reflect off an object and return to the transmitter.
  - The reflected waves are used to calculate speed.

# Microwave Ovens

## How a Microwave Oven Works



**a** A device called a *magnetron* produces microwaves by accelerating charged particles.

**b** The microwaves reflect off a metal fan and are directed into the cooking chamber.

**c** Microwaves can penetrate several centimeters into the food.

**d** The energy of the microwaves causes water molecules inside the food to rotate. The rotation of the water molecules causes the temperature of the food to increase.

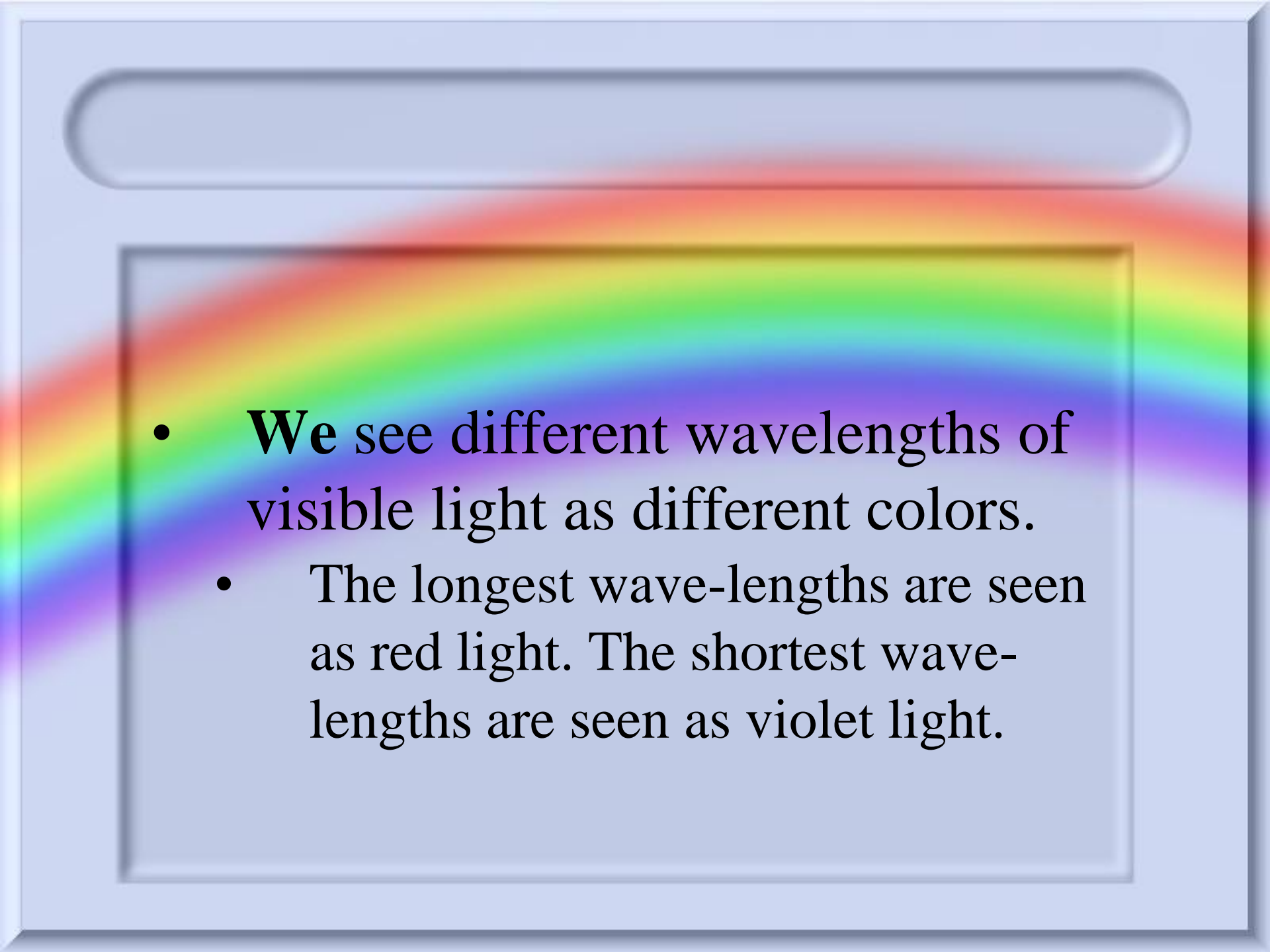
# Infrared Waves

- Infrared waves have shorter wavelengths and higher frequencies than microwaves.
  - b/w 700 nanometers (nm) and 1 mm.
- Almost everything gives off infrared waves
  - Ex: sun, buildings, trees, and your body.
- The infrared waves an object emits depend on the object's temperature.
  - Warmer objects give off more infrared waves than cooler objects.



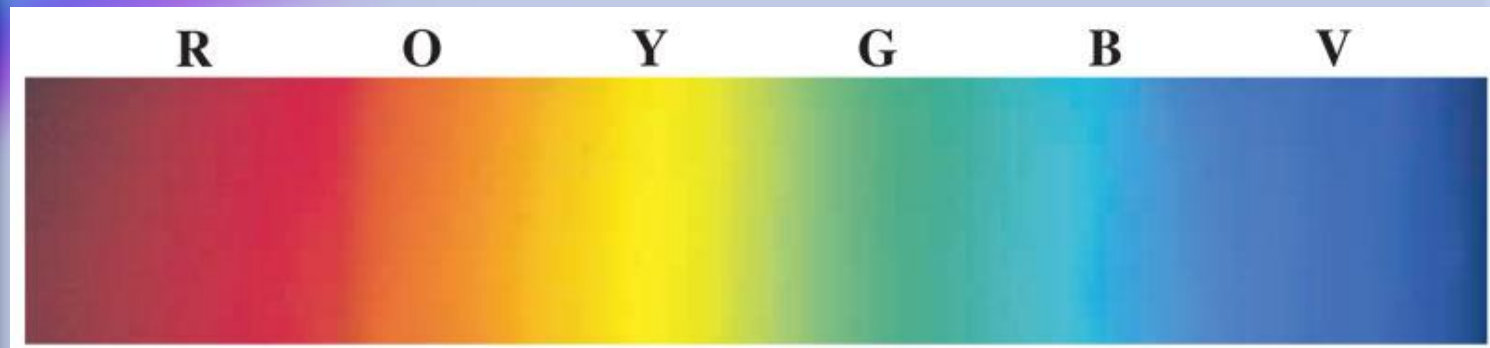
# Visible Light

- Visible light is the narrow range of wavelengths and frequencies in the EM spectrum that people can see.
  - Visible light waves have wavelengths between 400 nm and 700 nm.
- The visible light from the sun is white light.
  - *White light* is visible light of all wavelengths combined.

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- **We** see different wavelengths of visible light as different colors.
  - The longest wave-lengths are seen as red light. The shortest wave-lengths are seen as violet light.

# Visible Light 3

- The range of colors is called the *visible spectrum*.



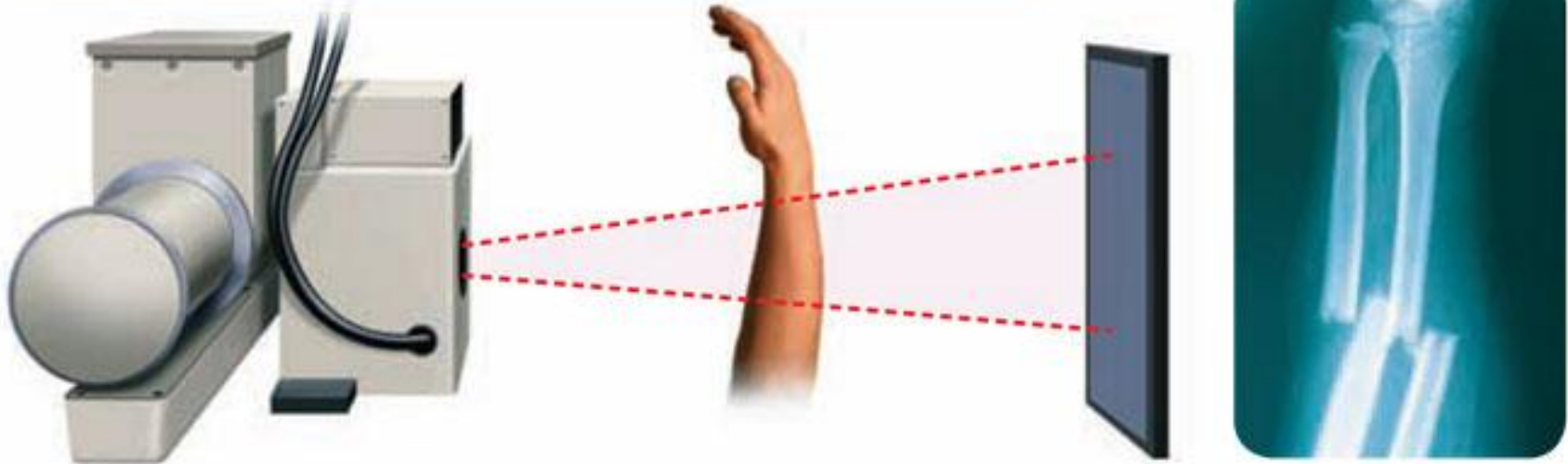
# Ultraviolet Light

- *Ultraviolet light* (UV light) is another type of EM wave produced by the sun.
- Ultraviolet waves have shorter wavelengths and higher frequencies than visible light.
  - b/w 60 nm and 400 nm

# X Rays and Gamma Rays

- **X Rays** have wavelengths between 0.001 nm and 60 nm.
- X rays can pass through many materials, making them useful in the medical field.
  - Too much exposure to X rays can damage or kill living cells.

## How a Bone Is X Rayed



**1** X rays travel easily through skin and muscle but are absorbed by bones.

**2** The X rays that are not absorbed strike the film.

**3** Bright areas appear on the film where X rays are absorbed by the bones.

- **Gamma Rays** have wavelengths shorter than 0.1 nm.
  - They can penetrate most materials easily.
- Gamma rays are used to treat some forms of cancer.
  - Doctors focus the rays on tumors inside the body to kill the cancer cells.
- Gamma rays are also used to kill harmful bacteria in foods, such as meat and fresh fruits.