Objectives

- **Compare** and **contrast** the different forms of radiation in the electromagnetic spectrum.
- **Discuss** how satellites and sonar are used to map Earth's surface and its oceans.
- **Describe** the Global Positioning System.

Vocabulary

- remote sensing
- electromagnetic spectrum
- frequency
- Landsat satellite
- *Topex/Poseidon* satellite
- Global Positioning System
- sonar

Remote Sensing

- Until recently, mapmakers had to go on-site to collect the data needed to make maps.
- Today, advanced technology has changed the way maps are made.
- **Remote sensing** is the process of collecting data about Earth from far above Earth's surface.

The Electromagnetic Spectrum

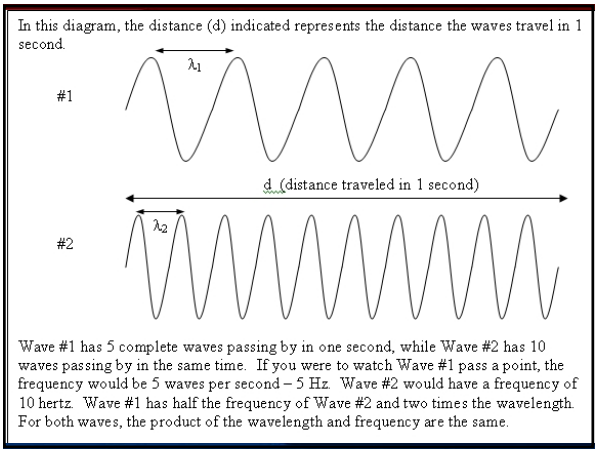
- Satellites detect different wavelengths of energy reflected or emitted from Earth's surface.
- This energy has both electric and magnetic properties and is referred to as electromagnetic radiation.
- Electromagnetic radiation includes visible light, gamma rays, X rays, ultraviolet waves, infrared waves, radio waves, and microwaves.

The Electromagnetic Spectrum

Wave Characteristics

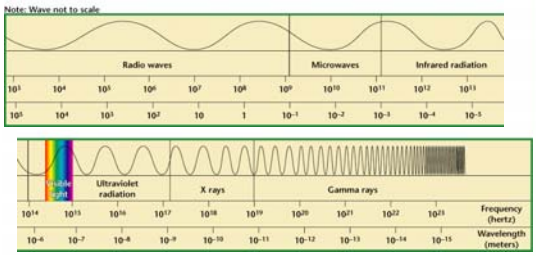
- All electromagnetic waves travel at the speed of 300 000 km/s in a vacuum, a value commonly referred to as the speed of light.
- Electromagnetic waves have distinct wavelengths and frequencies.
- The **electromagnetic spectrum** is the arrangement of electromagnetic radiation according to wavelengths.
- **Frequency** is the number of waves that pass a particular point each second.
- These unique characteristics help determine how the energy is used by different satellites to map Earth.

- **$\lambda = c/f$**
- Or
- **C= λf …where**
- Lambda (λ) = wavelength in any unit of length (generally meter)
- C = velocity of light = (m/s) 300,000km/s or $3x10^8$ m/s
- f = frequency in Hz (cycles per second)



The Electromagnetic Spectrum

Wave Characteristics

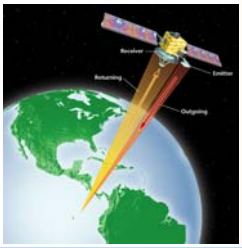


Landsat Satellites

- A **Landsat satellite** receives reflected wavelengths of energy emitted by Earth's surface, including some wavelengths of visible light and infrared radiation.
- Since the features on Earth's surface radiate warmth at slightly different frequencies, they show up as different colors in images

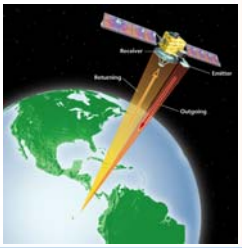
Topex/Poseidon Satellite

- The ***Topex/Poseidon* satellite** uses radar to map features on the ocean floor.
- Radar uses high-frequency signals that are transmitted from the satellite to the surface of the ocean.
- A receiving device then picks up the returning echo as it is reflected off the water.



Topex/Poseidon Satellite

- The distance to the water's surface is calculated using the known speed of light and the time it takes for the signal to be reflected.
- Variations in time indicate the presence of certain features on the ocean floor.



The Global Positioning System

- The **Global Positioning System,** or **GPS,** is a radio-navigation system of at least 24 satellites that allows its users to determine their exact position on Earth.
- Each satellite orbits Earth and transmits high-frequency microwaves that contain information about the satellite's position and the time of transmission.
- A GPS receiver calculates the user's precise latitude and longitude by processing the signals emitted by multiple satellites.

Sea Beam

- Sea Beam technology is similar to the *Topex/ Poseidon* satellite in that it is used to map the ocean floor.
- Sea Beam is located on a ship and relies on sonar to map ocean-floor features.
- **Sonar** is the use of sound waves to detect and measure objects underwater.

Sea Beam

- First, a sound wave is sent from a ship toward the ocean floor.
- A receiving device then picks up the returning echo when it bounces off the seafloor.
- Computers on the ship can then calculate the distance to the ocean bottom based on the time it takes the signal to be reflected.