

Unit 9: Waves

Content Outline: Electromagnetic Spectrum : Long Waves (9.4)

I. Electromagnetic Spectrum

- A. These are the energy waves *produced* by stars, such as our sun.
- B. Electromagnetic waves are associated with *vibrating* charged particles called electrons.
 1. The *vibrating* of the electron creates an electric force “field” surrounding the electron.
 - a. The vibrating electric force creates a *vibrating* magnetic field with poles (positive and negative)
 - b. When the two forces are combined, we get an **electromagnetic force “field”**.
- C. Electromagnetic waves are transverse waves traveling at 300,000,000 m/sec. (3×10^8 m/sec)
 1. This distance is called the **speed of light (c)**.

You have probably heard of Albert Einstein and then his equation $E = mc^2$. C is the speed of light.
- D. There are several different wavelengths within the *Electromagnetic Spectrum*.
 1. *Longest* waves have the *least* energy within them.
 2. *Shortest* waves have the *most* energy within them.

II. The *longest* waves:

A. **Radio Waves**

1. **Radio waves** are the broad range of electromagnetic waves with the *longest wavelengths* and lowest frequencies. [Wavelengths of radio waves may be longer than a soccer field.](#)
2. With their *low frequencies*, radio waves have the *least energy* of electromagnetic waves, but they still are extremely useful.
 - a. They are used for radio and television broadcasts, microwave ovens, cell phone transmissions, and radar.

3. **AM and FM Radio**

- a. In radio broadcasts, sounds are encoded in radio waves that are sent out through the atmosphere from a radio tower.
- b. A receiver detects the radio waves and changes them back to sounds.

[You’ve probably listened to both AM and FM radio stations. How sounds are encoded in radio waves differs between AM and FM broadcasts.](#)
- c. **AM** stands for **amplitude modulation**.
 - i. In AM broadcasts, sound signals are encoded by changing the *amplitude* of radio waves.
 - ii. AM broadcasts use *longer-wavelength* radio waves than FM broadcasts.
 - iii. Their longer wavelengths, AM radio waves reflect off a layer of the upper atmosphere called the ionosphere. This allows AM radio waves to reach radio receivers that are very far away from the radio tower.
- d. **FM** stands for **frequency modulation**.
 - i. In FM broadcasts, sound signals are encoded by changing the *frequency* of radio waves.
 - ii. Frequency modulation allows FM waves to encode *more information* than does amplitude modulation, so FM broadcasts usually sound clearer than AM broadcasts.
 - iii. Their shorter wavelengths than AM, FM waves do not reflect off the ionosphere. Instead, they pass right through it and out into space. As a result, FM waves cannot reach very distant receivers.

4. **Television**

- a. Television broadcasts also use radio waves.
- b. Sounds are encoded with *frequency modulation*, and pictures are encoded with *amplitude modulation*.
- c. The encoded radio waves are broadcast from a TV tower.
- d. When the waves are received by television sets, they are decoded and changed back to sounds and pictures.

5. Microwaves

- a. The *shortest wavelength, highest frequency radio waves* are called **microwaves** .
- b. Microwaves have *more energy* than other radio waves.
That's why they are useful for heating food in microwave ovens.
- c. Microwaves have other important uses as well, including cell phone transmissions and **radar**.
 - i. **Radar** - is a device for determining the *presence and location* of an object by measuring the time for the echo(reflection) of a radio wave to return from it and the direction from which it returns.