

**\* Chapter 17**  
**The Electromagnetic**  
**Spectrum**

**Notes on 17.4**

**Wireless Communication**



Radio waves are produced by charged particles moving back and forth inside transmission antennas.

Transmission antennas send out, or broadcast, radio waves in all directions.

Radio waves carry information from the antenna of a broadcasting station to the receiving antenna of your radio or television.

There are two methods of transmitting the signals:

- ❖ amplitude modulation (AM)
- ❖ frequency modulation (FM)

Radio stations broadcast using either method.

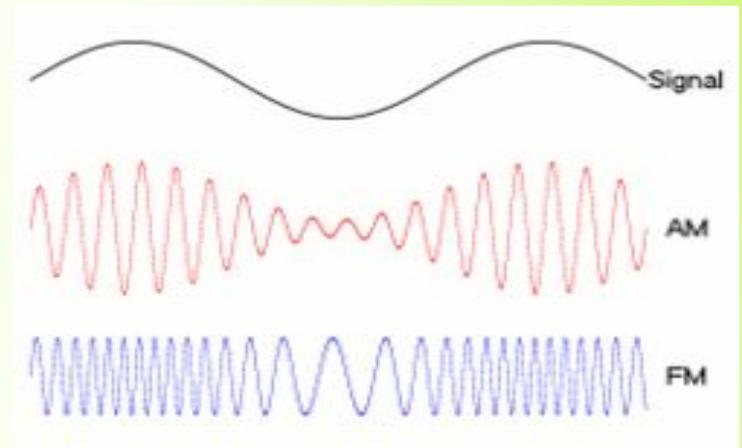
Television stations use both: amplitude modulation for pictures  
frequency modulation for sound.

# Amplitude Modulation

## AM

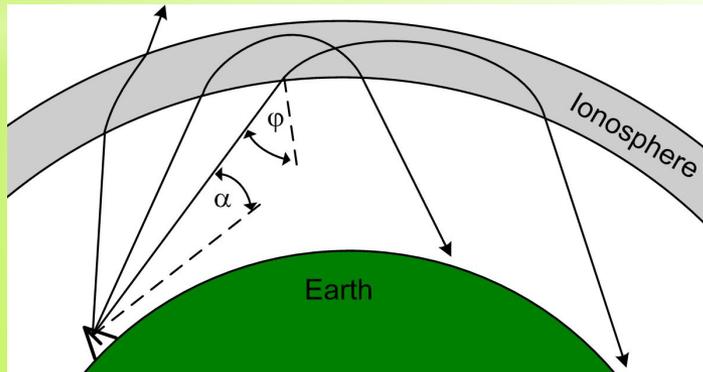
Changing the amplitude of a wave.

The frequency remains constant.



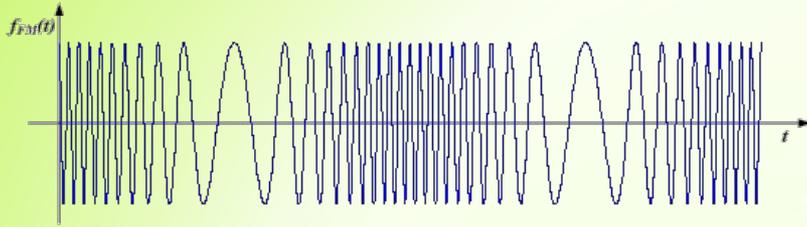
The information will become sound (speech and music) and is coded in changes, or modulations, of a wave's amplitude.

At a radio broadcasting station, the sound is converted into electronic signals. These are then converted into a pattern of changes in the amplitude of a radio wave. Your radio receives the wave and converts it back into sound.



AM radio waves have relatively long wavelengths and are easily reflected by Earth's ionosphere - a region of charged particles high in the atmosphere.

This is why AM radio stations can broadcast over long distances.



## Frequency modulation

### FM

Method of transmitting signals by changing the frequency of a wave.

FM signals travel as changes, or modulations, in the frequency of the wave. The amplitude remains constant.

FM waves have higher frequencies and more energy than AM waves. They can pass through the ionosphere instead of being reflected back to Earth.

This is why FM waves do not travel as far as AM waves.

FM waves produce better sound quality and are received clearly, but if you are traveling a distance, you may lose your FM station.



# The Radio Spectrum

Radio waves are used for many types of communication other than radios and televisions: taxi drivers, firefighters, and police officers use radio waves to do their jobs.

The Federal Communications Commission (FCC) assigns different radio frequencies for different uses. This way they travel without interfering.

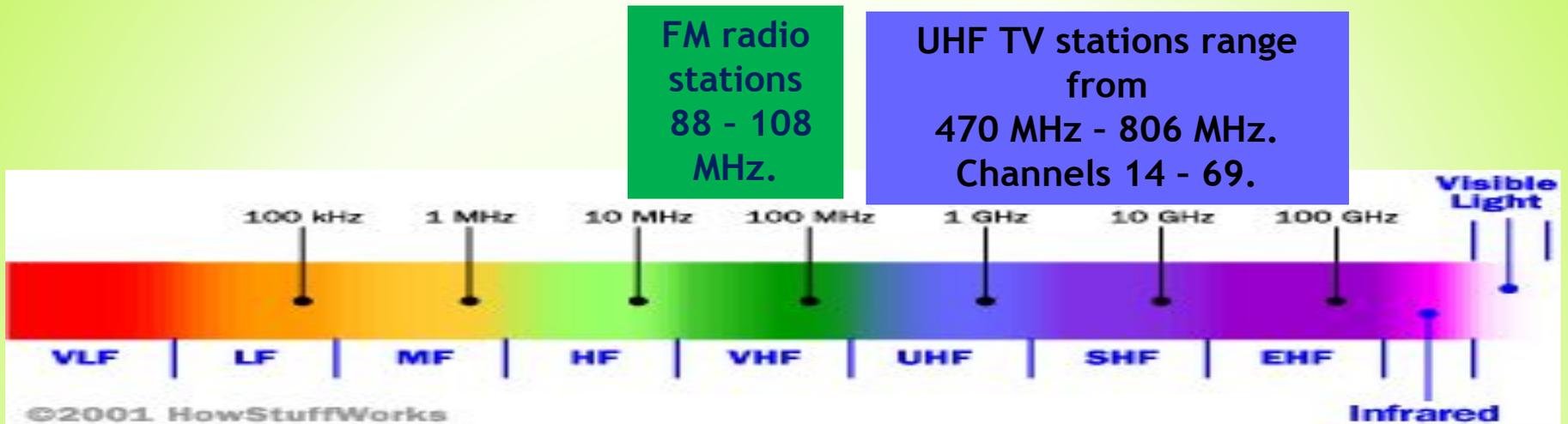
AM stations use kHz (kilohertz).

A hertz is one cycle per second.

If something vibrates 1,000 times a second, it has a frequency of 1,000 Hz, or 1 kilohertz (kHz). “kilo” means 1,000.

FM stations use frequencies measured in MHz (megahertz)

If something vibrates 1,000,000 times a second, it has a frequency of 1,000,000 Hz, or 1 megahertz (MHz). (“mega” means 1 million)



**AM radio**  
535 kHz to 1,605 kHz.

**VHF TV**  
54 MHz - 216 MHz.  
Channels 2-13.

What does VHF stand for?  
Very High Frequency

What does UHF stand for?  
Ultra High Frequency

What does the term *kilohertz* stand for?  
1,000 hertz

Which type of broadcast uses the highest frequency radio waves? **UHF**

What does the term megahertz stand for?

Which one uses the lowest? **AM radio**

1,000,000 hertz

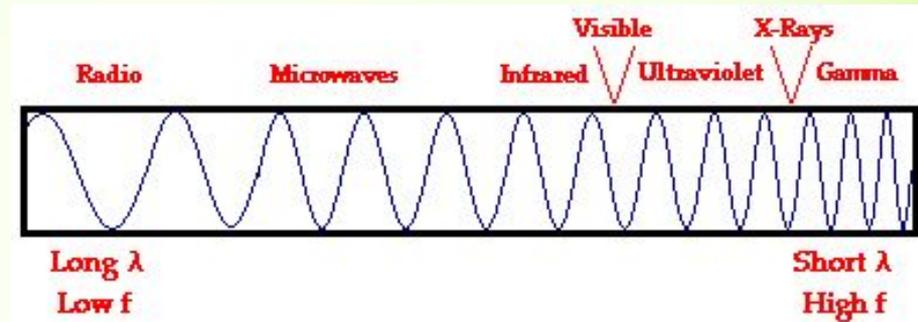
## Cellular Phones

The cellular system works by dividing regions into many small cells, or geographical areas.

Each cell has one or more towers that relay signals to a central hub.



Cellular phones transmit and receive signals using high frequency microwaves.



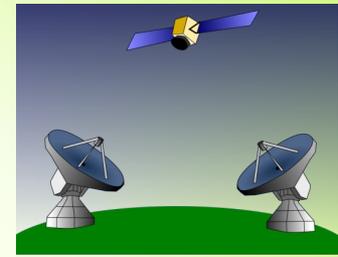
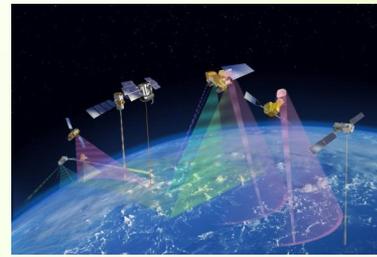
- When you place a call, the phone sends out microwaves which are tagged specifically to your phone number.
- A tower picks up the microwaves and transfers the signal to a hub.
- The hub then channels and transmits the signal to a receiver.

The receiver may be another tower or hub, depending on the distance between the two phones.

- That tower or hub will transmit the signal to the receiving cell phone.
- The receiving phone will ring when it picks up the microwave signal.

# Communication Satellites

Satellites that are orbiting the Earth are used to send information around the world.



Communication satellites receive radio, television, and telephone signals and relay the signals back to Earth.

Most satellites are 35,000 km above the Earth.  
The Earth's diameter is about 13,000 km.

**Satellite Phone Systems:** The radio waves are sent to a satellite which are then transmitted back to a receiving phone. With these phones, you can call anywhere in the world.

**Television Satellites:** The TV signals are changed into AM and FM waves which are sent to satellites. The signals are then relayed to local stations around the world.

Some people have their own antennas to receive signals for their TV. They are dish-shaped; thus the name satellite dishes. They are now able to be made smaller because the signals from satellites have become more powerful.

TV signals are often scrambled to keep people honest! Customers need a decoding box to unscramble the signals.

## Important Events

Heinrich Hertz's discoveries in the 1880s proved that radio waves exist and that they behave like light. This was the basis for all later developments in wireless communication, because wireless communication uses radio waves.

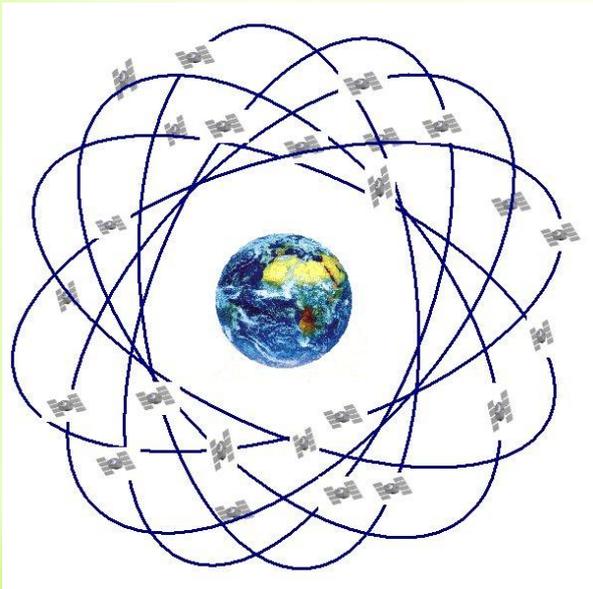
Guglielmo Marconi was the first person to successfully transmit a wireless signal using radio waves in 1895.

The launching of Sputnik I by the Soviets on October 4, 1957, was the first artificial satellite that was launched into orbit which enabled satellite communication and led to a new era in wireless communication.



# Global Positioning System

GPS consists of 24 orbiting satellites and several stations on the ground that monitor the satellites.



GPS was developed by the U.S. Department of Defense.

Beginning in the early 1970s, communication satellites were launched by rockets from Cape Canaveral into circular orbits about 20,000 km above Earth's surface. Each satellite circles the globe twice a day.

With information from four GPS satellites, you can locate where you are. The signals from three satellites tell you where you are on Earth's surface, and the fourth one tells you your altitude from the surface.

