

Microwaves

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CONCEPT 1

Microwaves

- Outline the electromagnetic spectrum.
- Describe microwaves and list their uses.
- Explain how microwaves are used in cell phone transmissions.
- Define radar and explain how it works.



This police officer is pointing a gun at oncoming traffic. But it's not the type of gun that can be used as a weapon. It's a radar gun, and it's used to detect the speed of moving vehicles. Do you know how a radar gun works? Instead of shooting bullets, it "shoots" electromagnetic waves.

Defining Electromagnetic Waves

Electromagnetic waves carry energy through matter or space as vibrating electric and magnetic fields. Electromagnetic waves have a wide range of wavelengths and frequencies. The complete range is called the electromagnetic spectrum. The **Figure 1.1** shows all the waves of the spectrum. The waves used in radar guns are microwaves.

Defining Microwaves

Find the microwave in the diagram above. A **microwave** is an electromagnetic wave with a relatively long wavelength and low frequency. Microwaves are often classified as radio waves, but they have higher frequencies than other radio waves. With higher frequencies, they also have more energy. That's why microwaves are useful for heating food in microwave ovens. Microwaves have other important uses as well, including cell phone transmissions and radar. These uses are described below. You can learn more about microwaves and their uses in the video at this URL: <http://www.youtube.com/watch?v=YgQQb1BVnu8>

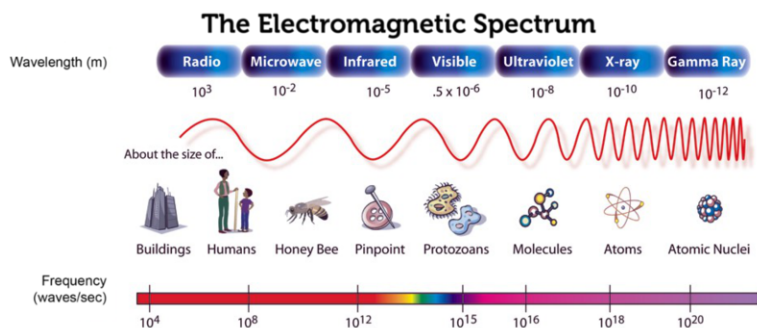


FIGURE 1.1

Cell Phones

Cell phone signals are carried through the air as microwaves. You can see how this works in the **Figure 1.2**. A cell phone encodes the sounds of the caller's voice in microwaves by changing the frequency of the waves. This is called frequency modulation. The encoded microwaves are then sent from the phone through the air to a cell tower. From the cell tower, the waves travel to a switching center. From there they go to another cell tower and from the tower to the receiver of the person being called. The receiver changes the encoded microwaves back to sounds.

Cell Phones

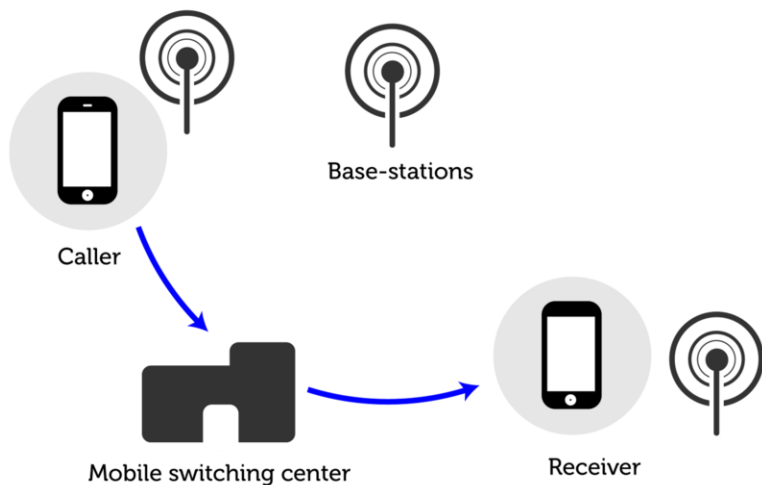


FIGURE 1.2

Q: Cell towers reach high above the ground. Why do you think such tall towers are used?

A: Microwaves can be interrupted by buildings and other obstructions, so cell towers must be placed high above the ground to prevent the interruption of cell phone signals.

Radar

Radar stands for radio detection and ranging. In police radar, a radar gun sends out short bursts of microwaves. The microwaves reflect back from oncoming vehicles and are detected by a receiver in the radar gun. The frequency of the reflected waves is used to compute the speed of the vehicles. Radar is also used for tracking storms, detecting air traffic, and other purposes.

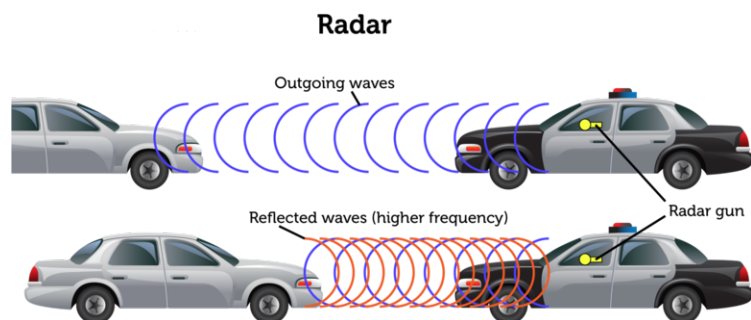


FIGURE 1.3

Q: How are reflected microwaves used to determine the speed of oncoming cars? (See **Figure 1.3**)

A: As the car approaches the radar gun, the reflected microwaves get bunched up in front of the car. Therefore, the waves the receiver detects have a higher frequency than they would if they were being reflected from a stationary object. The faster the car is moving, the greater the increase in the frequency of the waves. This is an example of the Doppler effect, which can also occur with sound waves.

Summary

- Electromagnetic waves vary in their wavelength, frequency, and energy. The full range of electromagnetic waves makes up the electromagnetic spectrum.
- Microwaves are electromagnetic waves with relatively long wavelengths and low frequencies. They are used for microwave ovens, cell phones, and radar.
- A cell phone encodes the sounds of the caller's voice in microwaves by changing the frequency of the waves. The encoded microwaves then travel through the air to a cell tower and eventually to the receiver of the person being called. The receiver decodes the microwaves and changes them back to sounds.
- Radar stands for radio detection and ranging. It is the use of reflected microwaves to determine vehicle speeds, track storms, or detect air traffic.

Vocabulary

- **microwave:** Wave in the electromagnetic spectrum that falls at the upper range of radio waves.
- **radar:** Radio detection and ranging; use of reflected radio waves to track the position of objects.

Practice

At the following URL, run the microwave simulation. Simulate heating a cup of coffee in the microwave oven and view the waves as a curve. Observe what happens to the molecules of coffee and its temperature as you change power levels, starting at 25% and working up to 100%. Then answer the questions below. <http://phet.colorado.edu/en/simulation/microwaves>

1. Describe how the microwaves change as you increase the power of the microwave oven.
2. What happens to the molecules and the temperature of the coffee as you increase the power?
3. Relate the change in microwaves to the change in molecules and temperature.

Review

1. What are microwaves?
2. Identify uses of microwaves.
3. How does a cell phone use microwaves to encode and transmit sounds?
4. What does radar stand for? How does radar work?