Unit 2
Radio Phenomena
Lesson 2.2

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Lesson Title The Nature of Radio Waves

Curriculum Area(s) Science

Grades 6 – 8

Duration 1 to 2 class periods

Content Standard SC-3

Benchmarks SC-3.1
SC-3.2
SC-3.3

Goal

- Students will gain an understanding of the nature and characteristics of radio waves.

Objectives

- Identify the characteristics of an "ac" sine wave.
- Identify the properties of frequency and wavelength.

Resource Materials

Now You're Talking
10-foot flexible rope
Slinky

Instructional Content

Nature of Radio Waves
Sine Wave
Frequency
Wavelength

Suggested Activities

1. Activity Sheet 2.1
2. Activity Sheet 2.2

Activity Sheet #2.1
The Nature Of Radio Waves

Jerry Hill, KH6HU

Introduction:

Radio Waves seem very mysterious because we cannot see them in action. To help visualize a radio wave traveling through space, we can use some common items to demonstrate what is happening.

Problem:

How can you represent a radio wave traveling through space?

Materials:

10-foot flexible rope
Slinky
Pail of Water & marble
Cake pan & ruler

Procedure #1

- One student holds one end of the rope stationary on the floor (stand on it)
- Stretch the rope out and pull it tight.
- Holding the other end of the rope, start rapidly moving the rope back and forth on the floor, a distance of about one foot.
- Notice how the rope forms a wave pattern that moves along the floor.

Questions For Discussion:

- What causes the wave to travel down the rope?
- What happens when you speed up the hand movements?
- What happens when you slow the hand movements?
- This is an example of what type of wave?
- What is the unit of measurement for frequency?

Procedure #2

- Stretch a slinky out on the floor (or table) with a student holding each end.
- “Snap” the slinky with a flick of the wrist toward the other end.
- Notice how the slinky, like the rope, forms a pattern that moves down to the stationary end.

Questions For Discussion:

- Describe the movement of the wave observed in the slinky.
- This is an example of which type of wave?
- Describe the differences between the two wave patterns.

Procedure #3

- Drop a marble into a pail of water and observe how the ripples move to the edge of the pail.

Procedure #4

- Fill a cake pan half way with water. Place a ruler in the water, edge up, at one end of the pan. Move the ruler forward about one inch and stop. Observe the wave pattern set up by the movement of the ruler.

Questions For Discussion:

- Describe the movement of the waves as they travel through the pail or pan.
- This is an example of which type of wave?

Activity Sheet #2.2
Frequency and Wavelength

Jerry Hill, KH6HU

Introduction:

Some signals have low frequencies, like the 60-Hz ac electricity the power company supplies to your house. Other signals have higher frequencies; for example, radio signals can alternate at more than several million Hertz (times each second).

To help understand the relationship between frequency and wavelength, we should first look at *frequency*. The unit of measurement for frequency is the Hertz (Hz). This helps us describe the frequency of a signal. We can talk about 60-Hz power or a 3725-kHz radio signal (the letter k stands for 1,000).

Wavelength refers to the distance that the wave will travel through space in one single cycle. All such signals (sometimes called electromagnetic waves) travel through space at approximately the speed of light, 300,000,000 meters per second. We use the Greek letter lambda (λ) to represent wavelength.

The faster a signal alternates, the less distance the signal will be able to travel during one cycle. There is an equation that relates the frequency and wavelength of a signal to the speed of the wave…

$c = f/\lambda$

Where
C is the speed of light in meters per second m/s
F is the frequency of the wave in hertz
Λ is the wavelength of the wave in meters

We can solve this equation for either frequency or wavelength depending on which quantity we want to find.

$f = c / \lambda$

and

$\lambda = c / f$

From these equations you may realize that as the frequency increases, the wavelength gets shorter. As the frequency decreases, the wavelength gets longer. Suppose you are transmitting a radio signal on 225 MHz (M stands for 1,000,000). What is the wavelength of this signal? We can use the equation to find the answer.

$\lambda = c/f = 3.00 \times 10^8 \text{m/s} / 225 \times 10^6 \text{ Hz}$

$\lambda = 300{,}000{,}000 / 225{,}000{,}000 = 1.33$ meters

This frequency is in the band we often call the 1 ¼ meter band. When we refer to an amateur band by a wavelength, we normally use round numbers that are easier to remember, so this answer doesn't exactly match the common name for this band.

As another example, what is the wavelength of a signal that has a frequency of 144.25 MHz (144.25 MHz = 144.250,000 Hz)

$\lambda = c/f = 3.00 \times 10^8$ m/s / 144.25×10^6 Hz

$\lambda = 300{,}000{,}000$ m/s / 144,250,000 Hz = 2.08 meters

Notice that higher-frequency signals have shorter wavelength. Lower-frequency signals have longer wavelengths. As you increase a signal frequency the wavelength gets shorter. As a signal's wavelength increase, the frequency goes down.

Application Procedure:

Now that we know the relationship between frequency and wavelength, let's practice the process so we can become familiar with both frequency and wavelength.

Find the wavelength for this popular simplex frequency: 146.52 MHz

Process: $\lambda = c / f$

Find the wavelength for a signal at 223 MHz

Process: $\lambda = c / f$

Find the wavelength for a signal at 432 MHz

Process: $\lambda = c / f$