Radio and Aurora

Overview:

When solar activity interacts with Earth's ionosphere, it can affect technology, including satellites and radio waves. Students complete a concept map to gain an understanding of the science behind radio waves and the influence the aurora has on radio communications.

Objectives:

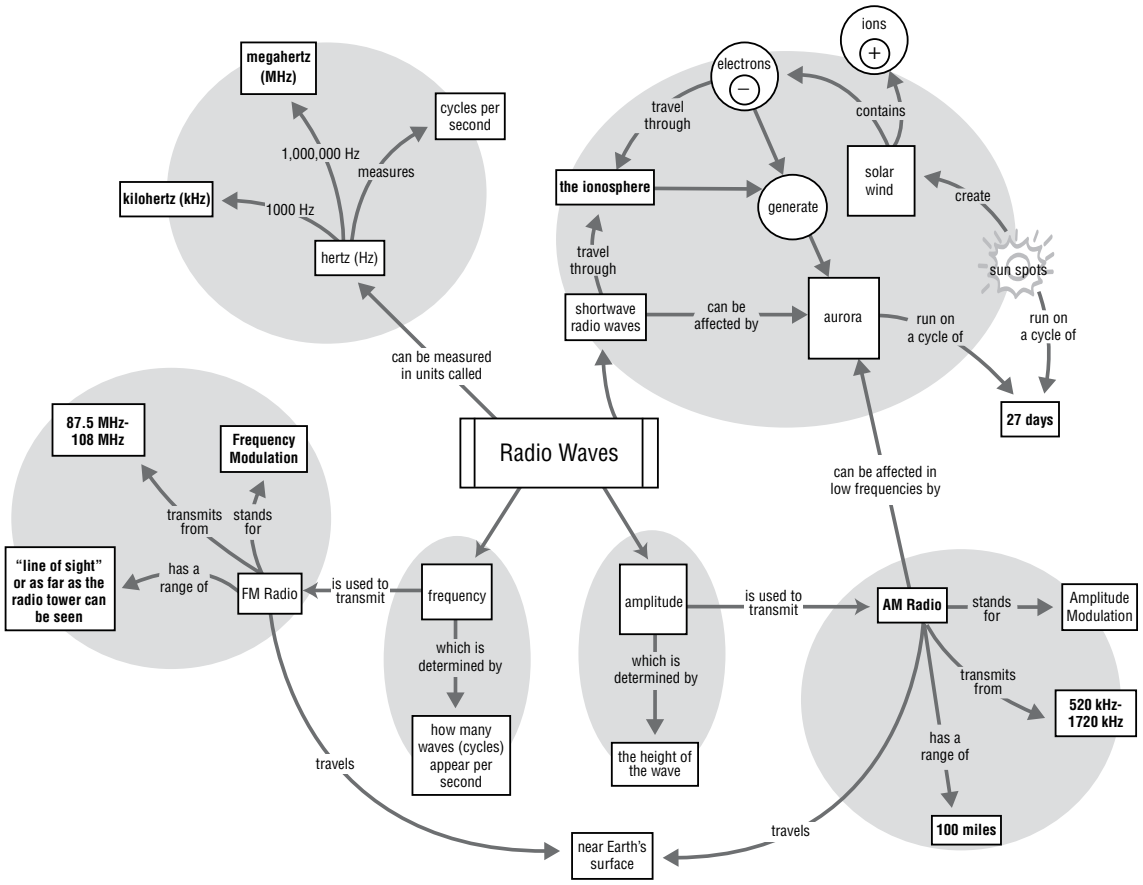
The student will:

- differentiate between AM, FM, and shortwave radio;
- understand the relationship between increased solar activity and radio wave transmissions; and
- complete a concept map showing the relationships between solar activity and radio wave transmissions.

Materials:

- 5-10 foot length of rope; and
- STUDENT WORKSHEET: "Radio Signals and the Aurora's 27-Day Cycle."

Answers to Student Worksheet:



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Activity Procedure:

1. Remind students that solar activity (solar flares and solar wind) affect Earth's magnetic field and the visible result of this is the aurora. Ask students to think of other things that solar activity might affect. Explain that radio waves are one such example.
2. Create a visual and kinesthetic representation of wave dynamics by asking two students to come to the front of the room. Have the students each hold one section of rope and stand apart so that the rope is slack between them. Have one of them gently move the rope up and down. Explain that radio waves move just the like waves of the rope. Have the students move the rope again, but with more force this time. Ask them to identify what is different about the wave. Explain that the more energy that goes into a wave, the higher up and down it goes. The height of the wave is called the amplitude.
3. Ask for two more volunteers. Again, have the students each hold one section of the rope and stand apart so that the rope is slack between them. Have one of them move the rope so that he or she is creating slow waves. Then have that student create fast waves. Explain that this is called frequency. The frequency of a wave is how many waves (or cycles) appear per second.
4. What does this have to do with radio? What does this have to do with the aurora and the sun? These questions will be addressed in the worksheet. Distribute STUDENT WORKSHEET: "Radio Signals and the Aurora's 27-Day Cycle." The students are to read the information to complete the concept map. Encourage students to use features of the text, like headings, sub-headings, and diagrams, to locate information.

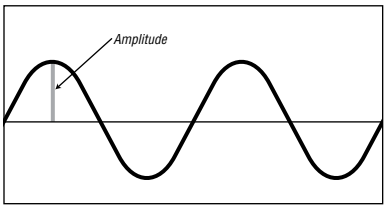
Extension Idea: Have students write a summary using the concept map as a guide.

Radio Signals and the Aurora's 27-day Cycle

Directions: Use the following information to complete the concept map worksheet.

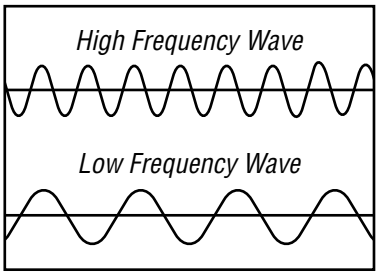
Radio Waves: Radio waves are invisible, but they surround our everyday life. Radio waves are electromagnetic signals that are used in AM and FM radio broadcasts, cell phones, televisions, radio-controlled toys, cordless phones, satellite communications, and more. These electromagnetic signals are sent using waves. These waves can be affected by solar activity and the aurora.

Wave Features:

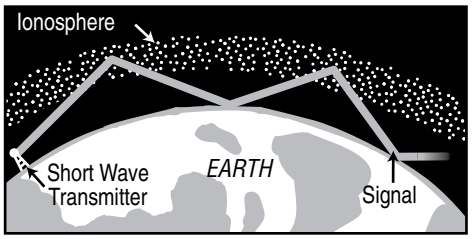


Amplitude: Radio waves have amplitude. Amplitude is the height of the wave. This wave feature is used to send signals through AM radio. The abbreviation AM stands for amplitude modulation. Modulation means change. So, in AM radio the amplitude of the wave is changed to send a different signal. These AM radio waves travel near Earth's surface and have a range of 100 miles. In low frequencies, AM radio can be affected by the aurora. Sometimes the ionosphere reflects AM radio waves.

Frequency: The frequency of a wave is determined by how many waves (cycles) appear per second. This wave feature is used to transmit, or send, FM radio signals. The abbreviation FM stands for frequency modulation. So, changes in frequency are used to send different signals. Like AM radio, FM radio signals travel near Earth's surface. However, unlike AM radio, the range of FM radios is "line of sight," or as far as the radio tower can be seen. This means that many things can block the signal, like mountains, buildings, and weather. If FM radio waves are aimed at the ionosphere, they will transmit through it into space.



Units of Measure: Radio waves are measured in units called hertz (Hz). Hertz measures cycles per second. 1,000 Hz is a kilohertz (kHz) and 1,000,000 Hz is a megahertz (MHz). AM radio transmits from a frequency of 520 kHz to 1,720 kHz. FM radio transmits from a frequency of 87.5 MHz to 108 MHz.



Shortwave Radio Waves: In addition to AM and FM radio waves, there are shortwave radio waves. However, shortwave radios work differently. AM and FM radio waves travel near the surface of Earth and rarely go beyond the horizon so the receiver can pick up the signal. Shortwave radio waves, in comparison, travel up into the ionosphere and are reflected back to Earth. In this way, they can travel great distances. Shortwave radio transmits between the frequencies of 2,310 kHz and 30 MHz (30,000 kHz).

Effects of the Sun: The activity on the sun is so powerful that it can affect Earth in many ways. Solar activity includes sunspots and solar flares. Since sunspots mostly stay in one spot on the sun and the sun rotates, or spins, around in a 27-day cycle, these holes are facing Earth every 27-days. Eventually, sunspots will shift or die down and new ones will appear starting a new 27-day cycle.

These sunspots produce solar flares, which send solar winds containing electrons and ions toward Earth. When energized electrons hit the ionosphere they react with gases to create the aurora. This activity is located in the same part of the atmosphere that shortwave radio waves use. So the aurora and the sun can interfere with shortwave radio transmissions. Knowing about the 27-day cycle and knowing the space weather conditions can be useful for shortwave radio operators.

Name: _____ **Student Worksheet (2 of 2)**