What's Your Frequency…?

Objectives

Students Will:

- Generate a simple radio wave
- Use an FM radio to detect meteor showers
- Record and display data for the meteor showers

Suggested Grade Levels

3rd – 8th

Subject Areas

Science, Engineering, Technology, Mathematics

Timeline

60 – 75 minutes

Standards

NGSS Standards:

- 3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
- MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
- MS-PS4.1. Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave.
- MS-PS4.2. Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.

21st Century Essential Skills

- Critical thinking, problem-solving, creativity & innovation, creativity & imagination, technology literacy

Background Information

Do you enjoy listening to the radio? Have you ever wondered how the music travels from the radio station to your radio? Electromagnetic waves are the answer. Electromagnetic

waves consist of vibrating electric and magnetic fields and transfer energy across space (and also through matter). Radio waves are one type of electromagnetic wave and have the longest wavelengths and lowest frequencies. They have wavelengths longer than a football field, but with low frequencies, they have the least energy of all electromagnetic waves! Many items that we use daily utilize radio frequencies: cell phones, TV broadcasts, AM/FM radio, for example.

The electromagnetic spectrum represents the range of all types of electromagnetic radiation. Radio waves are just one type of electromagnetic radiation; other types include microwaves, infrared light, visible light, ultraviolet light, x-rays, and gamma rays.

Sound travels from the radio station to your radio through signals being encoded in radio waves, then the waves are transmitted through the atmosphere from a radio tower, and finally, the radio receiver detects the waves and changes them back to sounds. FM (frequency modulation) radio sound signals are encoded by changing the frequency of radio waves and encode more information than amplitude modulation (AM), which is why FM broadcasts generally produce clearer sound.

Vocabulary

Electromagnetic spectrum, waves, wavelength, frequency, period, amplitude, radiant

Materials

- 9-volt battery
- A coin (nickel, dime, quarter)
- AM/FM radio
- Antennae
- Sound recorder/level meter to record data (optional)

Lesson

1. Explain the electromagnetic spectrum and radio waves to students (as described in the background information section above).
2. The first activity is to make a simple radio wave. Tune the radio to an AM radio station that is all static.
3. Near the antennae, touch the coin to both 9-volt battery terminals (release the connection quickly).
4. You will hear a short crackle (a transmitted radio wave) on the radio. The radio wave will be brief, but if you listen closely you will hear it.

5. The next activity is detecting a meteor shower using an FM radio station.
6. Find a meteor shower that is occurring in your area. The American Meteor Society provides a calendar of meteor showers.
7. Find a frequency on the FM radio where no nearby FM radio station is broadcasting (best chances are below 91.1 MHz). The FM Atlas lists all FM stations in North America and includes frequency-by-frequency maps.
8. Normally, you would hear a hiss of noise on the empty radio station, but as meteors pass through the atmosphere, the station will abruptly "boom, crack, or whistle" for anywhere from a fraction of a second to several seconds.
    a) The best time to listen for the meteor shower is when the radiant (the spot from where the meteor shower appears to originate) is 45 degrees above the horizon.
    b) Tuning into a station that is located in a direction that is perpendicular to the radiant will also help produce the best sound (for example, if the meteor shower is west of you, tune into a station that is north or south).

Extensions

- Record the sounds of the meteor shower on a recording app (for example, GarageBand) to visually represent the frequency waves.
- Graph radio waves and determine wavelength, period, amplitude, and frequency
- Use this mathematical model to show how the amplitude of the wave is related to the energy in the radio waves

Resources

- 18.5 Radio Waves. (n.d.). Retrieved May 12, 2020, from https://flexbooks.ck12.org/cbook/ck-12-middle-school-physical-science-flexbook-2.0/section/18.5/primary/lesson/radio-waves-ms-ps
- Electromagnetic Spectrum - Introduction. (n.d.). Retrieved May 14, 2020, from https://imagine.gsfc.nasa.gov/science/toolbox/emspectrum1.html
- Elving, B. F. (2010). FM Atlas. Retrieved May 14, 2020, from http://www.americanradiohistory.com/Archive-FM-Atlas/FM-Atlas-21-2010.pdf
- Meteor Shower Calendar. (n.d.). Retrieved May 14, 2020, from https://www.amsmeteors.org/meteor-showers/meteor-shower-calendar/
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