Level	Understanding FM Radio
Middle School	

Time Required	Lesson Summary
3 50-minute class periods (150 min.)	Students and adults alike listen to the radio with little thought as to what the FM and AM band numbers actually mean. This introductory activity will offer students some local context to radio frequency and extend their thinking to where those signals come from and how else they are used. Students will have a chance to tune a radio receiver and explore radio waves.

Standards

NGSS

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 how waves are reflected, absorbed, or transmitted through various materials.

MS-PS4-3.Integrate qualitative scientific and technical information to support the claim that digitized signals are a more reliable way to encode and transmit information than analog signals.

Vocabulary	Objectives
FM: frequency modulation AM: amplitude modulation	• Students will be able to explain the transmission of radio waves from a radio station • Students will be able to describe the basic concepts of how radio transmissions work, including what the number of a radio station represents.

Materials

- An iPad, Chromebook, or any other device with internet access (this lesson works best in a 1-1 device classroom, but could also work with partners)
- Headphones if students are working independently; listening space if working in small groups

Pre-Requisites
Students should have an introductory understanding of mechanical waves and the electromagnetic spectrum. Radio waves will be explored in greater detail.
Safety Considerations
Students may possibly be exposed to foul language when listening to radio stations.
Pacing Notes
Day 1 – introduction, instructions, start the hyper doc Day 2- Continued work on the document Day 3 - complete hyper doc, slide creation
Before the Lesson
This lesson would ideally fit within a unit of study on the electromagnetic spectrum where students have already been exposed to waves and the spectrum. If not, the PhET simulation and suggested activities at https://phet.colorado.edu/sims/html/waves-intro/latest/waves-intro_en.html would be a helpful introduction.

Assessments	Classroom Instructions
Pre-Activity Assessments	**Introduction**
This should not be graded but rather used as a way to determine what they learned at the end of the activity.	1. Student handout – Section A a. Students will start with a pre-assessment asking what they know about radio waves and for some basic information about their favorite radio station. b. After students have time to complete Part A, discuss the questions they generated as a class. Some possible questions that may arise (or in case you need to give examples): What is the range of a radio station transmission? Why do I lose a station as I drive out of state? Who picks the numbers the station gets? What do those numbers (106.1, 93.3, 103.9) mean? How does a radio wave look different for two different radio stations?

	How does satellite radio work?
Activity Embedded Assessments	**Activities**
All assessments are embedded in the hyperdoc Walk around while students are working and ask some of the following questions. What did you just read? Can you tell me more about what you wrote? Do you have any questions? What are you going to do next? What else do you need to know about that topic? Give me a summary of what you have done so far.	1. The activity in this lesson is student-led. Hand out the document (or make it available on your LMS) and allow students to work at their own pace until the end of the third day when you should collect the page. The page contains the following sections. **a.** Section A: Pre-assessment, Question Generating, and Discussion. **b.** Section B: Radio Station Virtual Tours. These tours are either 5-minute YouTube videos or Google Street View tours. Students will either need headphones or listening space to view them. c. Section C: Technical Details. Students will examine video and text to explain how FM radio works. d. Section D: Explore Some More. This section includes some more technical details to running a radio station like costs and includes a software-defined radio (SDR) receiver and a how-to guide to listening (question 23). You can give students a time limit for this part if time is limited, but this section will enable students to explore multiple radio bands using a receiver and look at the waterfall of radio waves. Students could spend a long time experimenting with this if interested. e. Section E: Answering Research Questions. Students will take time to answer either their initial questions from Section A or new questions they've developed along the way. This section should take approximately 20 minutes. f. Section F: The Final Project: Google Slide. Students create a one-pager (Google Slide) to share what they've learned with their classmates. You could have students share these Slides or copy and paste their single slides into one long slideshow to share with the class. g. Extension Activities. There are extension activities listed at the end for students who are interested in learning more and/or have extra time.
Post Activity Assessments	**Closure**
Collect and grade the document	Discuss the research students did to answer their own questions to close the lesson. In a class discussion, ask at least 3 students to share their questions and their answers. Other students may have had

	similar questions and connecting their findings would be valuable for all learners.

Culturally Inclusive/Responsive Components

1. One exploration of cultural elements would be finding and listening to multicultural radio stations. Some examples are: Native Radio, Chinese American Radio, and Radio Centro. You could also try using this online receiver to try to tune in to some of these stations.

2. Other ideas include examining how radio can build representation and increase communication such as by:
    a. Examining low-power radio stations (such as PhillyCAM in Philadelphia) to increase the reach of various community movements and activist resources like this one
    b. Exploring racism in radio (see this article from New England) or its use to advance movements such as Black Lives Matter as in this article

All web pages last accessed (4/12/23)

Educator Resources

The how-to guide for using WebSDR can be found at https://tinyurl.com/twentesdr (Last accessed 4/12/23)

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Below is a list of the lesson titles included in the series. All lessons can be accessed from this web page, https://superknova.org/educational-resources/.

Middle School

Introduction to Satellites
Weather Predicting
Introduction to Radio Wave Communication
The Importance of Radio Astronomy
Cubesat Model Building
Understanding FM Radio
Radio Frequency Technology

Who Decides if You Get 5G?

High School

The Uses of Radio Waves and Frequency Allocation
Is Radio Technology Safe?
Diffraction of Radio Waves
Measuring Sea Surface Temperatures with Satellites
Marine Animal Tracking and Bathymetry
How to Design Your Own Crystal Radio
How Radio Waves Changed the World
Simple Wireless Communication
Seeing and Hearing the Invisible
Local Wireless Radio Frequency Communication
Investigating the Internet Connection
The Geometry of Radio Astronomy

Informal

Modeling Radio Astronomy