Level	How Radio Waves Changed the World?
High School	
Time Required	**Lesson Summary**
4 – 50 min. class periods (200 min.)	Students will gain knowledge about radio waves through group research on an application that uses radio waves.

Standards

NGSS

HS-PS4-3 Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other.

HS-PS4-4 Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.

HS-PS4-5 Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.

Vocabulary	Objectives
Radio Waves Frequency Reflection SONAR RFID (radio frequency identification) RADAR Credible Non-Credible	• Students will be able to distinguish between a credible and non-credible source. • Students will use logic and evidence to construct arguments about how their application of radio waves would be the most beneficial for society. • Lastly, students will create the most engaging and persuasive argument about the applications of radio waves through a digital platform and oral presentation.

Materials

Electronic Device
Pencil/Pen/Markers
Printed Student Worksheet or use the digital version provided
Post it Notes
Random Number Generator
Use Classroom Screen (optional and free)

Pre-Requisites

Students need to understand the basic properties of waves and how to draw one properly. In addition, students need to have an understanding of electromagnetic waves and the properties of those waves.

Safety Considerations

There are no safety considerations here. Students will be researching electronic devices and creating a digital presentation to share.

Pacing Notes

Day 1- Presentation on radio frequencies and credible and non-credible sources.

Day 2- Group research

Day 3- research and create presentations

Day 4 - Presentations

Before the Lesson

The teacher should look over the whole lesson and see if there needs to be any revisions to fit their classroom needs. In addition, they need to decide if they would like to complete the project all during class or to assign some work for students to complete as homework.

Assessments	Classroom Instructions
Pre-Activity Assessments	**Introduction**
As students are	While you are taking care of administrative tasks project the third page of the presentation for students. Hand out the student notes

answering questions, you can finish taking attendance. Walk around the classroom to observe and possibly comment on what students are writing on their paper.	page and have them respond, in writing, to this prompt. ➔ *What do you think the quotes mean? Refer to the pictures on the slide.* Have students think-pair-share their work with their shoulder partners. Use equity cards to randomly choose a few students to share their answers to the class.
Activity Embedded Assessments	**Activities**
While students are working walk around and listen to their conversations. Redirect them if they stray from a portion of the EM spectrum. Stop a moment after the video and go over the answers to the questions so all students have the needed information. Watch students as they fill in the diagram. Are	1. Using the electromagnetic spectrum scenario. a. Page four of the presentation contains a survival scenario which requires the students to use the EM spectrum. Give the students a minute or two to read the page before advancing to the next page which contains a diagram of the EM spectrum. b. Have students work in pairs to come up with a solution to the problem. c. After the students have completed the task spend a few minutes allowing students to share their responses with the class. d. **Say**: This was an exercise to help you understand the importance of the electromagnetic spectrum. During this lesson you will be investigating one of the ways we depend on the radio frequency portion of the spectrum. 2. Next play a short video on the radio frequency portion of the EM spectrum. The link is included in the presentation but also below for your convenience. There are questions associated with the video on the student sheet. http://www.youtube.com/watch?v=al7sFP4C2TY 3. Radio waves have the same components as mechanical waves. Take a moment to review these with your students. On the next page of the presentation there is a diagram of a wave with blanks indicating important features. This diagram is also included on the student page. Give them a minute to

students moving with surety or do they seem hesitant? This may reflect students background knowledge. Be prepared to stop and reteach if students don't know these things.	fill in the diagram on their own. Then have students volunteer answers before moving on to the next page of the presentation. 4. Brief explanation of how radio waves transmit information. On the next page of the presentation there is a short explanation for you to share with your students. If you wish you can then project the Phet simulation "Radio Waves and Magnetic Fields on the board (https://phet.colorado.edu/sims/cheerpj/radio-waves/latest/radio-waves.html?simulation=radio-waves). This simulation can be used to explain that radio waves are electromagnetic waves which have both an electric and magnetic component. Those two fields interact in such a way that the wave continues to move away from the starting point for miles without losing energy. This is one of the reasons these waves are used for long-distance wireless communication. 5. Credible vs. Non-Credible Students are going to be doing a research project for the remainder of the lesson. It is important that students understand how to locate and cite reliable sources. As you continue through the next few pages of the presentation there are several points for students to reflect on their page. a. The first page goes through the meaning of credibility. b. On the next page there is a link for a short video on identifying credible sources. Students should summarize what they learned on their paper after the video c. Next there is a page that talks about non-credible sources. d. Small group discussion. The next page of the presentation has five discussion points. Break your class into small groups and have them discuss each of the points. After you feel enough time has gone by bring the class back together and discuss these points as a large group. e. Videos to investigate credibility Next, there are three videos which allow students to

Collect and grade the paper.	practice identifying credible sources. There are spaces on the student page for students to write about their view of each video. You may also hold a class discussion if you wish. f. MLA citation 6. Conclusions day 1 - Exit ticket The prompt is both in the presentation and on the student sheet. **Day 2** 1. Introduction a. Hand out the project sheet to students as they enter the room. They should read through it as you complete the administrative duties.
As students are researching walk around and ask some of the following questions. What are you looking up? Is that source credible? Why or why not? What are you doing next? What are your group mates working on? How are you working together to accomplish your task?	2. Research Project a. Go over the page with students. b. Either assign groups or allow students to select their own group. c. Research
	Day 3 1. Introduction Hand out the rubric for the project and go over it with students.
Use the same questions	2. Research complete

as above. As you walk around remind students of the rubric and encourage them to include all required elements. Grade presentations according to the rubric.	Give students a short amount of time to complete their research. 3. Presentations created Students should work as a group to create a presentation on their topic. **Day 3** 1. Introduction Students should have all their presentations completed and uploaded to a school platform that teachers can access. 2. Presentations Volunteers will be asked to start the presentation process and each team will have a maximum of 5 minutes of fame to share about their amazing radio wave application.
Post Activity Assessments	**Closure**
	Students will have the last 5 minutes of class to vote for the radio wave application that they think was the most informative, engaging, and persuasive. The teacher will pass out a post it note to each student so that they can write down their first choice which cannot be their own project to make it more fair. In addition, students will write down 2 things that they learned from all the presentations in class.

	The teacher will tally up the votes and see who had the most votes. That team will be acknowledged as the winner and receive their own special certificate (optional) to make it special or you can provide them extra credit or an extra bathroom pass to celebrate.

Culturally Inclusive/Responsive Components

Students will have the chance to collaborate and work in teams together so that all their voices are heard fairly and equally.

In addition, students will have the chance to spotlight a minority or female scientist that has contributed to changing and improving society. Students will create one slide in their presentation dedicated to showcasing who this special scientist is and what they contributed to the scientific community.

*If possible students can even print out their slide on their honorary scientist. This can be used as a flier to post around your school's hallway to showcase women or minorities in STEM fields.

Educator Resources

Female Scientists

- https://www.energy.gov/articles/five-fast-facts-about-actress-and-inventor-hedy-lamarr
- https://obamawhitehouse.archives.gov/women-in-stem
- https://youtu.be/nbZnrseHihI
- https://youtu.be/wfpHkJX5MOY
- https://www.popularmechanics.com/science/a26998723/womens-history-month-stem-inventions/
- https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=9117256

Credible or Non-Credible Resource

- https://www.commonsense.org/education/lesson-plans/evaluating-legitimate-sources

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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