**Frequency vs Wavelength**

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| **Grade/ Grade Band**: 9-12 | **Topic:** Properties of Waves  | **Lesson #** \_\_1\_\_\_ **in a series of** \_1\_\_\_\_ **lessons** |
| **Brief Lesson Description**: In this experiment, students will use two different wireless technologies, one at 2.4 GHz (WiFi) and one at 400 MHz (Walkie Talkie) so as to understand the relationship between the used frequency and the wireless signal strength. The first part will be an interactive lesson (demo), the teacher will control the transmitter, students will control the receiver. As the teacher change from 2.4 GHz frequency to 400 MHz, students should be able to see on the receiver that wavelength becomes larger and they are able to move further away and still receive the signal. For the second part, students will be separated into 4 groups. Two groups will control the transmitter, the other two groups will be the receiver.

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| Group #  | Experiment  | Description  |
| Group #1 &2  | Receiver  |  They will stay at the end of the hallway and read the signal strength as the transmitter group use walkie-talkie tell them to do so.  |
| Group #3 & 4 | Transmitter  | They will communicate with the receiver group every 5 meters that they moved through walkie-talkie.  |

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| **Specific Learning Outcomes:** * As frequency increases, wavelength decreases
* A higher frequency will transmit the signal to a smaller area (application, think about wifi signal strength at home)
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| **Narrative / Background Information**  |
| **Prior Student Knowledge Required:** * Perform calculation with equation v= fλ
* identify the type of wave from the electromagnetic spectrum based on the given frequency or wavelength
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| **Problem Solving Practices (Ex: Standards for Mathematical Practice):** Common Core Literacy Standard * CCSS.ELA-Literacy.RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.
* Plot graph of time vs temperature and find the best fit line.

[CCSS.Math.Content.6.SP.B.5](http://www.corestandards.org/Math/Content/6/SP/B/5/)Summarize numerical data sets in relation to their context, such as by:[CCSS.Math.Content.6.SP.B.5.a](http://www.corestandards.org/Math/Content/6/SP/B/5/a/)Reporting the number of observations.[CCSS.Math.Content.6.SP.B.5.b](http://www.corestandards.org/Math/Content/6/SP/B/5/b/)Describing the nature of the attribute under investigation, including how it was measured and its units of measurement. | **Main Content Ideas:** Physical Setting/ Physics Core CurriculumPhysical Setting/ Physics Core Curriculum4.3c The model of a wave incorporates the characteristics of amplitude, wavelength,\* frequency\*, period\*, wave speed\*, and phase. v= fλ | **Possible Multidisciplinary Concepts:**  |
| **Possible Preconceptions/Misconceptions:** The electromagnetic spectrum is a very abstract idea for high school students. They can not see what electromagnetic waves look like and how they behave. Hopefully, this lesson can help students visualize electromagnetic spectrum.  |
| **LESSON PLAN – 5-E Model**  |
| [**ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions:**](http://www.youtube.com/watch?v=PUB1GU_tvpI&safe=active) How can we describe the relationship between wavelength and frequency through modeling Wifi signal? Do now: We use 5 GHz and 2.4 GHz frequency for our Wifi service. Based on the equation v= fλ, what is the wavelength for 5 GHz? What is the wavelength for 2.4 GHz? Based on the electromagnetic spectrum diagram, what kind of waves are they? (Be careful with the unit!GHz=gigaHertz MHz=megaHertz) |
| **EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions:** In this experiment, students will use 2.4 GHz and 400MHz to model the wifi strength. (At home the typical frequencies of wifi are 5 GHz vs 2.4 GHz; however, since we don’t have the 5 GHz antenna, we will use 400 MHz instead. This will not affect the understanding of the concept of wave properties) The first part will be an interactive lesson (demo) where the teacher will control the transmitter and the students will control the receiver. As the teacher changes the frequency from 5 GHz to 400 MHz, the students will observe that the wavelength becomes larger, and that the students are still able to receive a signal after moving away from the transmitter.For the second part, students will be separated into 5 groups: One group will control the transmitter, and the other four groups will hold the walkie talkies and test the signal strength.  |
| **EXPLAIN: Concepts Explained and Vocabulary Defined:** **Key Vocabulary:** Signal strength: In telecommunications, particularly in radio frequency, signal strength (also referred to as field strength) refers to the transmitter power output as received by a reference antenna at a distance from the transmitting antenna.Covering range: maximum area your wifi service able to cover  |
| **ELABORATE: Applications and Extensions:** Let students think about why higher frequency able to cover a smaller area. What are some pros and cons for the high-frequency wifi?  |
| **EVALUATE:** **Formative Monitoring (Questioning / Discussion):** How students communicate with their group members to complete the activity. **Summative Assessment (Quiz / Project / Report):** **Post-activity questions:** 1. What do you notice from the data? How can you explain the relationship between distance and signal strength?
2. How can you explain the relationship between frequency and wavelength?
3. How do you think wavelength affects the covering range?
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| **Elaborate Further / Reflect: Enrichment:** Based on what you learned today, think about your wifi service at home, how can you implement what you learned today when you decide where to put your modem at home?  |