Unit 7: The Electromagnetic Spectrum

CONTENT AREA: General Physical Science	GRADES: 8	UNIT: 1 of 8
Pacing: Approx. 1 Month		
Using Mathematics and Computational Thinking • Use mathematical representations to describe and/or support scientific conclusions and design solutions. (MS-PS4-1) **Developing and Using Models** • Develop and use a model to describe phenomena. (MS-PS4-2) **Obtaining, Evaluating, and Communicating Information** • Integrate qualitative scientific and technical information in written text with that contained in media and visual displays to clarify claims and findings. (MS-PS4-3) - ***Connections to Nature of Science*** **Scientific Knowledge is Based on Empirical Evidence** • Science knowledge is based upon logical and conceptual connections between evidence and explanations. (MS-PS4-1)	**Disciplinary Core Ideas** PS4.A: Wave Properties • A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude. (MS-PS4-1) • A sound wave needs a medium through which it is transmitted. (MS-PS4-2) PS4.B: Electromagnetic Radiation • When light shines on an object, it is reflected, absorbed, or transmitted through the object, depending on the object's material and the frequency (color) of the light. (MS-PS4-2) • The path that light travels can be traced as straight lines, except at surfaces between different transparent materials (e.g., air and water, air and glass) where the light path bends. (MS-PS4-2) • A wave model of light is useful for explaining brightness, color, and the frequency-dependent bending of light at a surface between media. (MS-PS4-2) • However, because light can travel through space, it cannot be a matter wave, like sound or water waves. (MS-PS4-2) PS4.C: Information Technologies and Instrumentation • Digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information. (MS-PS4-3)	**Crosscutting Concepts** **Patterns** • Graphs and charts can be used to identify patterns in data. (MS-PS4-1) **Structure and Function** • Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used. (MS-PS4-2) • Structures can be designed to serve particular functions. (MS-PS4-3) - ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Science, Engineering, and Technology on Society and the Natural World** • Technologies extend the measurement, exploration, modeling, and computational capacity of scientific investigations. (MS-PS4-3) - ***Connections to Nature of Science*** **Science is a Human Endeavor** • Advances in technology influence the progress of science and science has influenced advances in technology. (MS-PS4-3)
Performance Expectations: MS-PS4-1, MS-PS4-2, and MS-PS4-3		
Evidence Statement(s): MS-PS4-1, MS-PS4-2, and MS-PS4-3		
Essential Question: How do cell phones work?		

21st Century Skills: 9.2.8.B.3, 9.2.8.B.4

Career Ready Practices: CRP4, CRP6, CRP7

Technology:HS-ETS1-1 HS-ETS1-3

Technical Terms (Suggested)	Core Instructional Materials	Assessment Statement
Wavelength Waves Amplitude Reflected Absorbed Transmitted Radiation Frequency Medium Electromagnetic Spectrum ** All terms should be taught in context rather than in isolation. These terms should be addressed after conceptual understanding.**	MS-PS4-1- Chromebook, internet access, smartboard, notebook, pen, pencil, whiteboard. MS-PS4-2- Computer, Internet access, smartboard, notebook, pen, pencil, whiteboard. MS-PS4-3- Computer, Internet access, smartboard, notebook, pen, pencil, whiteboard.	*Students who understand the concepts can:* ● Use mathematical representations to describe and/or support scientific conclusions about how the amplitude of a wave is related to the energy in a wave. ● Use mathematical representations to describe a simple model. *Students who understand the concepts can:* ● Develop and use models to describe the movement of waves in various materials. *Students who understand the concepts can:* • Integrate qualitative scientific and technical information in written text with that contained in media and visual displays to clarify claims that digitized signals are a more reliable way to encode and transmit information than analog signals are.

Modifications

English Language Learners	Special Education	At Risk	Gifted & Talented
Scaffolding	Word walls	Teacher tutoring	Curriculum compacting
Word walls	Visual aides	Peer tutoring	Challenge assignments
Sentence/paragraph frames	Graphic organizers	Study guides	Enrichment activities
Bilingual dictionaries/translation	Multimedia	Graphic organizers	Tiered activities
Think alouds	Leveled readers	Extended time	Independent research/inquiry
Read alouds	Assistive technology	Parent communication	Collaborative teamwork
Highlight key vocabulary	Notes/summaries	Modified assignments	Higher level questioning
Annotation guides	Extended time	Counseling	Critical/Analytical thinking tasks
Think-pair-share	Answer masking		Self-directed activities
Visual aides	Answer eliminator		
Modeling	Highlighter		
Cognates	Color contrast		

5E Model	
Performance Expectation: 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.	
Engage: Anticipatory Set	Use an example of "wall ball" and the bouncing of a ball. Predict where the ball will bounce given the angle of incidence. Relate this to the Law of Reflection and the angle of incidence and reflection. Discuss the difference between regular and diffused reflection. Watch the following BrianPop video to provide students with a general introduction to waves: https://www.brainpop.com/science/energy/waves/ Types of Waves: https://www.youtube.com/watch?v=w2s2fZr8sqQ
Exploration: Student Inquiry	Wave Behavior Labs Day 1: http://betterlesson.com/lesson/633386/wave-behavior-lab-rotation-day-1 Day 2 :http://betterlesson.com/lesson/633450/wave-behavior-lab-rotation-day-2
Explanation: Concepts & Practices	In these lessons: Teachers Should: Introduce formal labels, definitions, and explanations for concepts, practices, skills or abilities. Students Should: Verbalize conceptual understandings and demonstrate scientific and engineering practices. Topics to Be Discussed in Teacher Directed Lessons (Disciplinary Core Ideas): PS4.A: Wave Properties A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude. (MS-PS4-1)
Elaboration: Extension Activity	Have students review the graphs they created during the lab. Ask them to predict the change in the energy of the wave if any one of the parameters of the wave is changed. Wavelength: http://www.ck12.org/physical-science/Wavelength-in-Physical-Science/ Wave Frequency: http://www.ck12.org/physical-science/Wave-Frequency-in-Physical-Science/ Wave Amplitude:http://www.ck12.org/physical-science/Wave-Amplitude-in-Physical-Science/
Evaluation: Assessment	

5E Model	
Performance Expectation: MS-PS4-2. Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.	
Engage: Anticipatory Set	Provide an example of how light or sound can be reflected, absorbed or transmitted through a medium (between objects).

	Find one object within the classroom that will represent light being reflected, absorbed or transmitted and bring it back to your seat (examples of: translucent, opaque and transparent). The class will create a list on the Smartboard and discuss whether their "object" reflects, absorbs or transmits light and how/why they choose that "object." Introduction to Light Video: https://www.youtube.com/watch?v=yHJ_X_lXtB8 Indoor Rainbow: http://www.weatherwizkids.com/experiments-rainbow-indoor.htm http://www.bozemanscience.com/waves
Exploration: Student Inquiry	What is a medium? What types of materials can light and sound pass through? How will sound/light passing through solids, liquids or gasses affect the energy (waves) that are transmitted? What real-life situations/experiences can you use as examples to support your thinking? Are We On the Same Wavelength? Lab https://www.nsa.gov/academia/_files/collected_learning/middle_school/interdisciplinary/same_wavelength.pdf Light Activity: Exploring Light: Absorb, Reflect, Transmit or Refract? https://www.teachengineering.org/view_activity.php?url=collection/van_/activities/van_troll/van_troll_lesson02_activity1.xml Sound Activity: http://www.ehow.com/info_8119201_sound-wave-experiments-kids.html Water Activities: https://www.ck12.org/physical-science/Mechanical-Wave-in-Physical-Science/
Explanation: Concepts & Practices	In these lessons: Teachers Should: Introduce formal labels, definitions, and explanations for concepts, practices, skills or abilities. Students Should: Verbalize conceptual understandings and demonstrate scientific and engineering practices. Topics to Be Discussed in Teacher Directed Lessons (Disciplinary Core Ideas): PS4.A: Wave Properties A sound wave needs a medium through which it is transmitted. (MS-PS4-2) PS4.B: Electromagnetic Radiation When light shines on an object, it is reflected, absorbed, or transmitted through the object, depending on the object's material and the frequency (color) of the light. (MS-PS4-2) The path that light travels can be traced as straight lines, except at surfaces between different transparent materials (e.g., air and water, air and glass) where the light path bends. (MS-PS4-2) However, because light can travel through space, it cannot be a matter wave, like sound or water waves. (MS-PS4-2)
Elaboration: Extension Activity	Extension/Follow Up: These activities are designed for the teacher to use as homework or extra credit assignments. Activity A 1. Who was Heinrich Hertz and why is he important to what you are now exploring? Activity B 1. What is a medium? 2. Which medium would transport a wave the fastest: a solid, a liquid, or a gas? Explain your reasoning. Activity C 1. What is a tsunami? 2. How is a tsunami produced? 3. What is the medium for a tsunami? 4. Predict the amplitude of a tsunami. Explain your reasoning. Activity D 1. What is an echo? 2. How is an echo produced? 3. What is the medium for an echo? 4. What is the source of energy for an echo? Activity E 1. What

	are seismic waves? 2. How are seismic waves produced? 3. What is he medium for seismic waves? 4. What kind of work is done by seismic waves? Sunscreen and Sunburn http://www.haspi.org/curriculum-library/PhysicalScience-core/11%20Sunburns%20&%20Sunscreen/11a%20sunburns%20&%20sunscreen%20-%20teacher%20sheet.pdf
Evaluation: Assessment	

5E Model	
Performance Expectation: 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.**	
Engage: Anticipatory Set	Analog vs. Digital Video: http://www.diffen.com/difference/Analog_vs_Digital Guiding Questions: Besides digital (computers, phones, etc.) what are other ways that you have heard/seen/read of transmitting information (mail, music, video, etc.) without the use of computers?
Exploration: Student Inquiry	http://educators.brainpop.com/bp-topic/analog-and-digital-recording/ Have students read the following article about analog vs. digital media and information http://www.diffen.com/difference/Analog_vs_Digital What are examples of analog vs. digital media? How has the real world transitioned from analog to digital in the last 10 years? Please provide examples from your life where you were able to see and record these changes. Day 2: Examples of Media to Explore: Music, Images, Phone/Communication, Maps/Satellites, Video Games (8 bit cartridges vs. now can download to console - no disc required!), shopping (go to mall vs. online shopping). Below is a list of items that students can be asked to research how it has changed/grown to be more digital as time has gone by. It is important for students to realize the resources and learning potential they NOW have available to them (that once did not exist due to technological constraints). Clocks, Medical Devices, Telephones, Cassettes/Radio vs. Pandora/Sirius, Paper Maps vs. Google Maps/Earth, Cars
	In these lessons:

Explanation: Concepts & Practices	Teachers Should: Introduce formal labels, definitions, and explanations for concepts, practices, skills or abilities. Students Should: Verbalize conceptual understandings and demonstrate scientific and engineering practices. Topics to Be Discussed in Teacher Directed Lessons (Disciplinary Core Ideas): PS4.C: Information Technologies and Instrumentation Digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information. (MS-PS4-3)
Elaboration: Extension Activity	http://faraday.theiet.org/resources/overview/analogue-digital.cfm Bluetooth and WiFi: How do they work? What is actually being transmitted? How have these technologies help to make every day "activities" easier? (Communication, Satellites, NASA Probe Missions - Pluto, Fiber Optic Cables vs. Dial-Up). What's a cloud?
Evaluation: Assessment	

How do cell phones work?

In this unit of study, students *develop and use models, use mathematical thinking,* and *obtain, evaluate, and communicate information* in order to describe and predict characteristic properties and behaviors of waves. Students also apply their understanding of waves as a means of sending digital information. The crosscutting concepts of *patterns* and *structure and function* are used as organizing concepts for these disciplinary core ideas. Students *develop and use models, use mathematical thinking,* and *obtain, evaluate, and communicate information.* Students are also expected to use these practices to demonstrate understanding of the core ideas.

This unit is based on MS-PS4-1, MS-PS4-2, and MS-PS4-3.

#	STUDENT LEARNING OBJECTIVES	CORRESPONDING PEs and DCIs
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.** *[Clarification Statement: Emphasis is on describing waves with both qualitative and quantitative thinking.] [Assessment Boundary: Assessment does not include electromagnetic waves and is limited to standard repeating waves.]* **(MS-PS4-1)**	**(MS-PS4-1)**

2	**Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.** *[Clarification Statement: Emphasis is on both light and mechanical waves. Examples of models could include drawings, simulations, and written descriptions.] [Assessment Boundary: Assessment is limited to qualitative applications pertaining to light and mechanical waves.]* **(MS-PS4-2)**	**(MS-PS4-2)**
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.** ***[Clarification Statement: Emphasis is on a basic understanding that waves can be used for communication purposes. Examples could include using fiber optic cable to transmit light pulses, radio wave pulses in wifi devices, and conversion of stored binary patterns to make sound or text on a computer screen.] [Assessment Boundary: Assessment does not include binary counting. Assessment does not include the specific mechanism of any given device.]*** **(MS-PS4-3)**	**(MS-PS4-3)**

The Student Learning Objectives above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:		
Evidence Statements: MS-PS4-1 **Using Mathematics and Computational Thinking** **Mathematical and computational thinking at the 6–8 level builds on K–5 and progresses to identifying patterns in large data sets and using mathematical concepts to support explanations and arguments.** **Use mathematical representations to describe and/or support scientific conclusions and design solutions.** **Connections to Nature of Science** **Scientific Knowledge is Based on Empirical Evidence** Science knowledge is based upon logical and conceptual connections between evidence and explanations. Evidence Statements: MS-PS4-2	**PS4.A: Wave Properties** **A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude.** **PS4.A: Wave Properties** **A sound wave needs a medium through which it is transmitted.** **PS4.B: Electromagnetic Radiation** **When light shines on an object, it is reflected, absorbed, or transmitted through the object, depending on the object's material and the frequency (color) of the light.** **The path that light travels can be traced as straight lines, except at surfaces between different transparent materials (e.g., air and water, air and glass) where the light path bends.**	**Crosscutting Concepts** **Patterns** Graphs and charts can be used to identify patterns in data. **Structure and Function** Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used. **Structure and Function** Structures can be designed to serve particular functions.

Developing and Using Models Modeling in 6–8 builds on K–5 and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. Develop and use a model to describe phenomena. Evidence Statements: MS-PS4-3 **Obtaining, Evaluating, and Communicating Information** Obtaining, evaluating, and communicating information in 6-8 builds on K-5 and progresses to evaluating the merit and validity of ideas and methods. Integrate qualitative scientific and technical information in written text with that contained in media and visual displays to clarify claims and findings.	**A wave model of light is useful for explaining brightness, color, and the frequency-dependent bending of light at a surface between media.** **However, because light can travel through space, it cannot be a matter wave, like sound or water waves.** **PS4.C: Information Technologies and Instrumentation** **Digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information.**	**Connections to Engineering, Technology, and Applications of Science** **Influence of Science, Engineering, and Technology on Society and the Natural World Technologies extend the measurement, exploration, modeling, and computational capacity of scientific investigations.** **Connections to Nature of Science** **Science is a Human Endeavor** **Advances in technology influence the progress of science and science has influenced advances in technology.**

Connections to other DCIs in this grade-band: MS.LS1.D
Articulation of DCIs across grade-bands: 4.PS3.A ; 4.PS3.B ; 4.PS4.A ; HS.PS4.A ; HS.PS4.B, 4.PS4.B ; HS.PS4.A ; HS.PS4.B ; HS.ESS1.A ; HS.ESS2.A ; HS.ESS2.C ; HS.ESS2.D
Common Core State Standards Connections: **CCSS- ELA: SL.8.5, RST.6-8.1, RST.6-8.2, RST.6-8.9, WHST.6-8.9** **CCSS- Math: MP.2, MP.4, 6.RP.A.1, 6.RP.A.3, 7.RP.A.2, 8.F.A.3**