

NAVAL HISTORY STEM-H LESSON PLAN

TEACHER HELP GUIDE

LESSON PLAN: Making Waves: The US Navy and Electromagnetic Waves

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INSTRUCTIONAL GOAL: In this lesson students will research and discuss the various ways electromagnetic waves are used in the US Navy, other branches of the military and civilian life. Each student will research to find various ways electromagnetic waves are used, identify the wavelength by name, discuss the behavior of the waves used (reflection, refraction, transmission, or absorption) and identify the different devices that utilize those waves. The different examples should demonstrate how the waves are used for combat purposes, or non-combat purposes. The students should include uses of the various wave in medicine, business, law enforcement, recreation and other areas that affect their lives.

BACKGROUND: Electromagnetic waves are waves of energy formed when an electric field couples with a magnetic field. These waves were first studied by James Clerk Maxwell and Heinrich Hertz. These waves of energy are different from mechanical waves because they can transfer energy without any medium. Electromagnetic waves are separated and identified by their wavelength, energy and frequency.

Wavelength is the distance from one wave crest to the next wave crest, or one wave trough to the next wave trough.

Frequency is defined as the number of waves that pass a given point in a specific amount of time (one second). The different waves of the electromagnetic spectrum (continuum), from the lowest frequency to the highest frequency are: radio waves, infrared waves, optical or visible light, ultraviolet waves, x-rays, and gamma waves.

Many of the various wavelengths have been further subdivided for more accurate identification (radio waves are subdivided into (VLF) very low frequency, (LF) low frequency, radio frequency, (HF) high frequency, (VHF) very high frequency, and microwaves).

All electromagnetic waves travel at the "speed of light" which is 299,792,458 meters per second, or 182,282 miles per second. Electromagnetic waves behave in four specific ways when they strike an object, they reflect off the object, they are refracted by the object, they are absorbed by the object or they transmit the particular waves. Electromagnetic waves, of all frequencies, are used by the US Navy for guidance systems, medical purposes, nuclear propulsion, communication, detection, targeting, and much more.

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RESOURCES:

*resources listed are not all inclusive but represent a small selection of videos, websites, and documents available for use by students with access to the internet. Resources can also be used as tools for instruction.

http://missionscience.nasa.gov/ems/02_anatomy.html (NASA's "Anatomy of an Electromagnetic Wave, a basic explanation of "light waves".

<http://www.ndep.us/Amazing-Aegis-BMD> (From the files of the National Defense Education Program, a description of the Navy's AEGIS-Ballistic Missile Defense system and how it uses waves, one from a compilation of dozens of videos from the past two years of Webisodes . The short 4-5 minute videos show the amazing Army, Navy, and Air Force research, which is everyday work at the military research labs.)

<http://www.ndep.us/Bounce-Back> (From the files of the NDEP, a description of RADAR (radio detection and ranging) and how electromagnetic waves are used, one from a compilation of dozens of videos from the past two years of Webisodes . The short 4-5 minute videos show the amazing Army, Navy, and Air Force research, which is everyday work at the military research labs.)

<http://www.ndep.us/Light-Antennas> (From the files of the NDEP, a description making the connection between light and electricity using Luna Moth infrared wave abilities, one from a compilation of dozens of videos from the past two years of Webisodes . The short 4-5 minute videos show the amazing Army, Navy, and Air Force research, which is everyday work at the military research labs.)

<http://www.ndep.us/Light-Stage> (From the files of the NDEP, amazing Avatars from light waves, using spherical stages enveloped with lights and cameras, scientists bathe a subject's face in light from 6000 LEDs controlled by 60 computers , one from a compilation of dozens of videos from the past two years of Webisodes . The short 4-5 minute videos show the amazing Army, Navy, and Air Force research, which is everyday work at the military research labs.)

<http://www.ndep.us/Laser-Dazzlers> (From the files of the NDEP, a new light tool called "driver defeat" will slow approaching cars to determine friend or foe, one from a compilation of dozens of videos from the past two years of Webisodes . The short 4-5 minute videos show the amazing Army, Navy, and Air Force research, which is everyday work at the military research labs.)

http://missionscience.nasa.gov/ems/03_behaviors.html (NASA's description of light reflection, absorption, diffraction, scattering, and refraction.)

http://missionscience.nasa.gov/ems/04_energytoimage.html (NASA's description of how scientist's visualize light we cannot see.)

http://missionscience.nasa.gov/ems/05_radiowaves.html (NASA's description of radio waves and radio telescopes.)

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<http://www.dtic.mil/cgi-bin/GetTRDoc?Location=U2&doc=GetTRDoc.pdf&AD=ADA390349> (From Defense Technical Info Center, how guided missiles use light to track and attack targets).

<http://www.archives.gov/st-louis/civilian-personnel/x-rays.html> (From the National Archives, how to find an x-ray from within the archived x-ray files.)

<http://www.defense.gov/news/newsarticle.aspx?id=40581> (From the Defense Department, how we have digitized x-rays to improve health care and save lives.)

<http://www.nehc.med.navy.mil/downloads/ih/UVDOC.pdf> (The most important document to you in this list, learn from the Navy Environmental Health Center how ultraviolet waves can affect you, and how to protect yourself.)

<http://aec.army.mil/usaec/p2/p209.html> (From the US Army Environmental Command, how UV waves can be used to reduce hazardous substances in use.)

<http://science.nasa.gov/astrophysics/big-questions/How-do-matter-energy-space-and-time-behave-under-the-extraordinarily-diverse-conditions-of-the-cosmos> (NASA describes the study of microwaves in this complex topic.)

<http://www.publichealth.va.gov/exposures/radiation/military-exposure.asp> (Department of Veteran's Affairs description of military exposure to radiation and facts about radiation, including dangerous gamma rays).

http://www.centennialofflight.gov/essay/Evolution_of_Technology/radar/Tech39.htm (Basics on the history of radio detection and ranging, RADAR, from NASA)

STANDARDS:

South Carolina Science

SC 8- 1 Recall that waves transmit energy but not matter.

SC 8-6.3 Summarize factors that influence the basic properties of waves (includes frequency, amplitude, wavelength, and speed)

SC 8-6.4 Summarize the behavior of waves (includes reflection, refraction, transmission, and absorption)

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Common Core Standards – Literacy in History, Social Studies, Science and Technical Subjects , Grade 6-12

1. The student will write arguments focused on discipline-specific content.
 - a. Introduce claim(s) about a topic or issue, acknowledge and distinguish the claim(s) from alternate or opposing claims, and organize the reasons and evidence logically.
 - b. Support claim(s) with logical reasoning and relevant, accurate data and evidence that demonstrate an understanding of the topic or text, using credible sources.
 - c. Use words, phrases, and clauses to create cohesion and clarify the relationships among claim(s), counterclaims, reasons and evidence.
 - d. Establish and maintain a formal style.
 - e. Provide a concluding statement or section that follows from and supports the argument presented.

INSTRUCTIONAL PROCEDURES FOR LESSON:

Activity 1 : The students will work in small groups to research and collaborate on specific electromagnetic wave “types” (radio, infrared, visible, ultraviolet, x-ray, and gamma), the history of the discovery and development, and their uses in the military/industrial/ commercial communities. Each group will devise a method of presentation for their group to present their findings at the designated time to all the other small groups in a whole class setting. Each group should discuss how their EM wave is used, how it affects their community, its impact on history and human development. The small group presentation can be oral, power point, graphic display, etc... Students will record various uses of electromagnetic waves in military and business communities.

Activity 2 : As an extended time research project: the teacher will assign each student all the EM waves in the EM spectrum and have the students research all the wave designations (radio, infrared, visual, ultraviolet, x-ray, and gamma). Each student will develop a graphic presentation of the EM waves to present to the class at the designated time. Student projects should include uses, impact on their community, impact on history, and human development. All students will record, in their science notebook, the various uses of the different frequencies of the electromagnetic spectrum.

INSTRUCTIONAL PROCEDURES FOR ACTIVITIES:

Each student will research, and use information, to write an expository paper or create a team presentation, about an assigned EM wave (or all the waves if assigned as an individual assignment).