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| **Title**  | Innovations in Healthcare: It all starts with the EMS! |
| **Introduction**  | This lesson introduces students to the Electromagnetic Spectrum. The lesson begins with a comical narrative chain which leads in to a simple jump roping activity that will simulate an electromagnetic wave. The teacher will then prompt the students with discussion prompts related to jump rope as it acts as a metaphor for the Electromagnetic Spectrum. Students then label the EMS using the narrative chain as a reference. Finally, the class then discusses uses of each type of wave and possibilities for the future. |
| **Curriculum Alignment**  | 6th Grade NC Science Essential Standards: 6.P.1.2- Explain the relationship among visible light, the electromagnetic spectrum, and sight.H.B.6b Electromagnetic waves result when a charged object is accelerated or decelerated. Electromagnetic waves include radio waves (the longest wavelength), microwaves, infrared radiation (radiant heat), visible light, ultraviolet radiation, x-rays, and gamma rays. The energy of electromagnetic waves is carried in packets whose magnitude is inversely proportional to the wavelength. |
| **Learning Outcomes**  | Students will be able to understand that the electromagnetic spectrum is a range of energy waves that are distinguished by their frequencies.Students will be able to identify the different types of waves and identify applications in the real world using each type of wave. |
| **Time Required and Location**  | This lesson should take one 60-minute class period. |
| **Materials Needed**  | * EMS handout
* Two large jump ropes

**Technology resources**Internet access (website) <http://missionscience.nasa.gov/nasascience/ems_full_video.html> |
| **Safety**  | Follow typical lab safety procedures. |
| **Participant Prior Knowledge**  | Students should have an understanding of the properties of transverse, longitudinal, and surface waves. |
| **Facilitator Preparations**  | Sheet Copies of EMS handoutCopies of Hospital Coloring |
| **Activities**  | **Exploration Activity**: Begin this unit with the dream you had last night. Attached is the dream. Be sure to use the call backs and body motions to help kids remember the key types of waves in the electromagnetic spectrum. It is also important to keep the lesson content a mystery to the students as this is just a fun enrolling activity that will be labeled later in the lesson. After this dream, continue directly to the Model System activity.**Model System:** Clear an area in the room and have another student help you turn the two jump ropes in Double Dutch form. If your ceiling isn’t tall enough you may consider going outside. You may want to give each of your students an opportunity to jump the ropes just for fun! This is where the model begins and we start asking questions. Your question set could include the questions below or you may choose to ask more or less questions to guide students to the conclusion of higher frequencies = higher energy.Does it take energy to turn the ropes? yesWould it take more energy to turn the ropes faster? yesWould it create more waves? YesAfter students have had the opportunity to jump rope, begin slowly turning the rope. Then turn the rope really fast! Ask the students to discuss the similarities and differences between the 2 with the students around them. After about 30 seconds of discussion, write student observations on the board. Next, you may want to only use one rope to make the counting easier Turn the rope really slowly for 10 seconds. Count the number of high points (crests) in 10 seconds. Then, turn the rope really fast for 10 seconds and record the crests of that demo. Lead the students (by questioning) to the fact that there were more turns per second in the second model vs. the first. Then, ask the students which of the two waves had the most energy in them. They should pick the second one. Have them come to the conclusion that the more waves per second the more energy. Label the word frequency as wavelengths per second. Higher frequencies carry higher amounts of energy.A discussion series may include the following:* Which jump rope speed, slow or fast, would more likely cause a bruise? fast
* Which jump rope speed, slow or fast, is more likely to damage a cell in the body? fast
* What cells in the body might need to be destroyed? Cancer cells
* If you had a cell phone that goes next to your ear, which types of waves would you want the cell phone to send off? Low frequency, radio waves

After the students understand that a higher level of energy correlates to a higher frequency wave, pass out the EMS label sheet. With the EMS label sheet, have students label the EMS using the clues from the dream. Give the students an opportunity to review the EMS in order from lowest energy level to highest energy level. This is the time that you will share the types of waves in the EMS and correlate it to the dream you had at the beginning. When labeling each of your waves refer back to the story. Encourage them to say the word and do the body motion associated with that part of the story. This will help your students remember the waves from lowest frequencies to highest.**Content Wrap-Up:** Now that students have a label for the individual waves show the NASA video. <http://missionscience.nasa.gov/nasascience/ems_full_video.html> Have students jot down intriguing facts and applications of each type of wave on the EMS worksheet.After the video have students share with their neighbors the information found in the video about each wave type. As a whole class review the different types of waves in order using the narrative chain motions from the story at the beginning.**Guided Practice** Have students rotate around the room reading a description of each type of wave and its uses. Students should continue to add facts and details to their EMS label sheet about the different types of waves and their applications. Once students have completed the rotations have them review their findings with a partner. |
| **Assessment**  |  Pass out the hospital picture and have students identify by coloring the different parts of the hospital according to the wave types used in that department. Then have students give a brief explanation of 1 use of each wave on the back of the picture. |
| **Critical Vocabulary**  | **Prior to this lesson:**Transverse waves: waves that cause the medium to move perpendicular to the direction of the waveWavelength: the distance between the crests (or troughs) of a waveFrequency: the number of wavelengths per secondCrest: The highest point of a waveTrough: The lowest point of wave**Vocabulary obtained during this lesson**:Electromagnetic wave: A wave of energy consisting of electric and magnetic fields, moving at right angles to each other.Types of Electromagnetic waves: (Defined on info cards in lesson) Radio, Micro, Infrared, Visible Light, Ultraviolet, X, and Gamma*.*  |
| **Modifications**  | The physical jump roping activity may be challenging for some students. If this is the case, the actual double dutch activity can be shown as a demo rather than a full class participation activity. The Electromagnetic waves sheet can be printed off for students that need copies of notes or students that have difficulty transcribing and taking notes. |
| **Supplemental Information**  | NASA Electromagnetic Wave Video: <http://missionscience.nasa.gov/nasascience/ems_full_video.html>Background Information for teachers on Electromagnetic Waves <http://imagine.gsfc.nasa.gov/docs/science/know_l1/emspectrum.html> |
| **Author Info**  | Marty Creech teaches sixth grade Science at North Davie Middle School in Mocksville, NC. He has been teaching middle school science for 8 years. Mr. Creech is a National Board Certified teacher in Early Adolescence Science and holds a Master’s of Instructional Media from Appalachian State University. Marty created this lesson as a Kenan Fellow at Wake Forest University Baptist Medical Center. He studied the Electromagnetic Spectrum because he found it a difficult concept for students to visualize and understand. In his externship with Dr. Jonathan Burdette, M.D. Radiology, he found that many of the hospital patients and a lot of the research all begins with the electromagnetic spectrum in the form of X-rays, CT scans and MRIs. |