



NSF Research Experiences for Teachers
 Northeastern University, 2007
 Carrie-Anne Sherwood

Lesson Title	Invisible Universe Expedition: EM Waves Introduction
RET Project Connection	<p>The work that I've done in Dr. Hashemi's lab this summer is in the area of mechanical engineering. In particular we studied aluminum metal matrix composites (Al-MMCs). Metal matrix composites are a type of composite with a reinforcing fiber material into a matrix material (usually a metal). Due to their superior mechanical properties MMCs are used for the Space Shuttle, commercial airliners, electronic substrates, bicycles, automobiles, golf clubs, and a variety of other applications. We studied the effect of heat exposure on the mechanical properties of Al-MMCs. To do this we used a couple of non-destructive evaluation techniques (NDE) as well as tensile tests. NDE techniques are used to predict the failure loads of damaged materials without performing traditional experiments that could destroy the structure or create more damage. The output of NDE experiments are used to characterize the damage of structures and predict the safe and reliable use of engineering structures.</p> <p>In my lesson I hope to incorporate the idea that some phenomena cannot be "seen" in the literal sense, but must be indirectly observed—similar to our attempts this summer to indirectly observe internal damage to specimens through NDE methods. Students will use indirect observation to "see" different regions of the EM Spectrum.</p>
RET Teacher	Carrie-Anne Sherwood
School	Codman Academy Charter Public School
Town/District	Dorchester, MA
Subject(s) Taught	10th Grade Physics
Subjects covered in lesson	Electromagnetic spectrum, waves
Grades Appropriate	10th
Lesson Duration	1 class period (1 hour)
Goals/Objectives of lesson	<ol style="list-style-type: none"> 1. Students begin to understand the different waves/regions that make up the EM spectrum 2. students will begin to see patterns in the characteristics (energy, harmfulness, etc.) of different regions of the spectrum by observing what waves are able to pass through what materials 3. students will understand something about detectors and sources of light (all EM radiation)—our eyes are only detectors for one kind of light, and there is an entire "invisible universe" accessible to us only through the use of other detectors.
Background Information	measurement and data collection techniques, waves, kinds of (EM & mechanical) description of travel (transverse & longitudinal), characteristics of waves (amplitude, period, frequency, wavelength), periodic motion & relationship to waves

Essential Questions

What are sources of light?
What are detectors of light? Why do we need detectors?
What regions of the EM spectrum appear to have more energy and why (based on the activity)?
The overlying theme of this expedition is the Gamma Ray Burst mystery. How do you think gamma rays (which we cannot experiment with in the lab) would fit into your ideas about the energy of waves?

Links to Frameworks and Standards:

* National

Science as Inquiry

CONTENT STANDARD A: As a result of activities in grades 9-12, all students should develop: abilities necessary to do scientific inquiry and understandings about scientific inquiry

Physical Science

CONTENT STANDARD B: As a result of their activities in grades 9-12, all students should develop: an understanding of interactions of energy and matter.

Science and Technology

CONTENT STANDARD E: As a result of activities in grades 9-12, all students should develop: abilities of technological design, and understandings about science and technology

* State

Scientific Inquiry Skills Standards

SIS1. Make observations, raise questions, and formulate hypotheses.

SIS2. Design and conduct scientific investigations.

SIS3. Analyze and interpret results of scientific investigations.

SIS4. Communicate and apply the results of scientific investigations.

Introductory Physics High School Content Standards

4. Waves

4.2 Distinguish between mechanical and electromagnetic waves

6. Electromagnetic Radiation

6.2 Describe the electromagnetic spectrum in terms of frequency and wavelength, and identify the locations of radio waves, microwaves, infrared radiation, visible light (red, orange, yellow, green, blue, indigo, and violet), ultraviolet rays, x-rays, and gamma rays on the spectrum.

Materials Required

Flashlight, laser pointer, heat lamp, remote control, radio, black light, white paper, black paper, digital camera, tonic water, x-ray pictures, cloth, foil, plastic wrap, transparency, wax paper, cell phone, station worksheets.

Lesson Development

Gather Background Knowledge: Question students to review: waves, how waves travel, overall theme of expedition (gamma ray burst mystery). Then see what students know about other waves in the EM Spectrum (students might say things about x-rays, "heat waves," microwaves, etc.) Ask questions related to the activity—can you see these waves? How? If so, describe them, where have you seen them? If you have not seen them how do you know they exist? What do you need to determine they are present in your life? Etc.

Immersion into the investigation: students watch a short video clip about "invisible waves" and how certain detectors are needed to "see" most parts of our world/universe.

The investigation: stations are set up around the room and students work in groups to investigate sources of light from different parts of the EM spectrum. They use various materials to see if the light will pass through (transmission) or be blocked (shielded) on their way to the detector of that kind of light. For example: A cell phone is a source of microwaves. It can also be a detector of microwaves (if the cell phone tower is considered the source). One cell phone is used to call another, as the cell phone is wrapped in different "test shields." Students then keep track of the data they collect for use in analysis after the completion of all stations.

Assessment

Students complete worksheet accompanying activity, keeping track of all of their data. They will then use this data to begin to formulate some ideas about the different regions of the EM spectrum—which regions appear to be more energetic than others (based on how many “test shields” they are able to pass through), what relative order do you think the regions would go in, based upon their ideas. Students have not yet been introduced to the organization of the EM spectrum, so all logical, well-thought-out ideas, based upon the activity, will be accepted.

References

National Science Education Standards, National Research Council

Massachusetts State Science Standards:

<http://www.doe.mass.edu/frameworks/scitech/0106standards.doc>

Invisible Universe LHS GEMS curriculum

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Feel free to contact me with any questions.

Contact Information