Making Use of the EM Spectrum

NASA SUMMER OF INNOVATION

UNIT
Physical Science—Waves and Optics

GRADE LEVELS
4 – 6

CONNECTION TO CURRICULUM
Science, Mathematics, and Technology

TEACHER PREPARATION TIME
1 hour

LESSON TIME NEEDED
2.5 hours *Complexity: Basic*

DESCRIPTION

This lesson guide integrates a pair of activities designed to demonstrate methods of using the Electromagnetic Spectrum to learn about our universe.

OBJECTIVES

Students will:

- Demonstrate methods of collecting electromagnetic energy
- Compare levels of detail shown by utilizing different wavelengths of electromagnetic radiation

NATIONAL STANDARDS

National Science Education Standards (NSTA)

Science as Inquiry
• Skills necessary to become independent inquirers about the natural world
• An appreciation of "how we know" what we know in science

Physical Science
• Light, heat, electricity, and magnetism
• Transfer of energy

History and Nature of Science
• Science as a human endeavor

MANAGEMENT

This set of activities is fairly basic. Preparing the ice trays for investigating ice worlds will require a freezer large enough to hold the six trays flat and time for them to freeze solidly. Overnight freezing is highly recommended. You will also need a very dark room for the Investigating Ice Worlds activity.

CONTENT RESEARCH

As the wavelength of electromagnetic radiation decreases, finer detail in the overall structure of illuminated objects may be observed. Decreases in wavelength also translate to increased energy present in the wave and therefore greater detection potential over larger distances. Using different colors of the visible spectrum also allows for emphasis or de-emphasis of specific details when using passive detection.

Key Terms:

- **Reflection:** the bouncing of a wave from a surface
- **Refraction:** the bending of a wave's path as it travels across the boundary between media
- **Diffraction:** the spreading of a wave as it passes through an opening in a wave barrier
- **Spectrum:** the range of frequencies of the electromagnetic waves
- **Medium:** material through which a wave passes
- **Passive detection:** collection of energy that is radiated or reflected off of the surface of an object without actively directing energy to that object.

Misconceptions:
Students often think that we gain most of our knowledge about the universe from white light observations and that most satellite sensors send some sort of beam down to analyze surfaces. In reality, there is much more information available to us in nonvisible parts of the spectrum, and the use of passive sensors is less expensive and can be more revealing than active sensors.

MATERIALS
- Sheet of 8.5- by 11-in. photosensitive paper
- Transparent tape
- Pencils
- Scissors
- Three 4- by 5-in. sheets of black poster board
- 12 flashlights
- Two UV lights
- One sheet each of red, blue, and green colored gel
- 4- to 6-in.- wide and 2-in.- deep or larger containers to hold water
- One box of food coloring
- Ice cube tray
- Small spoon
- Bottle of tonic water or two sheets of white paper
- Water
- Marker

LESSON ACTIVITIES
The suggested sequence is to start with simple detection of light through passive sensing and then demonstrate the differences in knowledge gained by using different light sources.

Amazing Rays
Students explore light and heat as different components of the Sun's energy using photo reactive paper as a passive sensor
http://www.lpi.usra.edu/education/skytellers/sun/activities/rays.shtml

Investigating Ice Worlds
Students use various light sources to examine ice and understand how NASA studies planets and moons from space
http://www.lpi.usra.edu/education/explore/ice/activities/ice_solar_sys/reflections/

ADDITIONAL RESOURCES
The Sun Earth Viewer allows students to view the Sun in different wavelengths to compare the structures visible in each.
http://ds9.ssl.berkeley.edu/viewer/flash/flash.html

DISCUSSION QUESTIONS
Each activity includes questions for discussion.
Additional questions:
- Why does NASA use passive sensing? *Passive sensors use less energy and cause no damage to the object being observed.*
- How could we see finer detail on an observed object? *Use smaller wavelengths to observe it.*
- How does the ability to split electromagnetic waves into a spectrum help us learn about distant objects? *Different parts of the spectrum tell us different things about an object.*

ASSESSMENT ACTIVITIES
Each activity has a series of questions in the student pages.
Pretest/Posttest questions:
- Give two types of energy provided by the Sun**.** *Light, heat*
- What do we call sensors that collect reflected or emitted energy? *Passive sensors*
- Why do we observe objects in multiple parts of the spectrum? *We learn different things from different parts of the spectrum*

ENRICHMENT
- Students may want to explore passive detection of the Earth.
- Have students design a passive sensor mission to study the Moon and describe what parts of the spectrum they chose to observe and why.

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