ELECTROMAGNETIC WAVES AND CLIMATE

(MODIFIED FOR ADEED)

INSTRUCTIONS

Science Teacher Education Program

Science Concept:

Different frequencies of electromagnetic radiation behave differently in the atmosphere.

Objectives:

The student will:

- explain interactions between different frequencies of light and atmospheric features;
- make predictions about how electromagnetic energy from the sun interacts with the atmosphere and affects Earth's temperature; and
- write an illustrated, informative essay with at least three paragraphs describing the process by which atmospheric features can affect the temperature of Earth.

GLEs Addressed:

Science

[9] SB3.3 The student demonstrates an understanding of the interactions between matter and energy and the effects of these interactions on systems by recognizing that atoms emit and absorb electromagnetic radiation.

[10] SB3.3 The student demonstrates an understanding of the interactions between matter and energy and the effects of these interactions on systems by comparing the relative wavelengths and applications of different forms of electromagnetic radiation (i.e., x-ray, visible, infrared, microwaves, radio).

[10] SA1.1 The student demonstrates an understanding of the processes of science by asking questions, predicting, observing, describing, measuring, classifying, making generalizations, analyzing data, developing models, inferring, and communicating.

Writing

[10] W4.2.2 The student writes for a variety of purposes and audiences by writing in a variety of nonfiction forms (e.g., letter, report, biography, autobiography, and/or essay) to inform, describe or persuade

Vocabulary:

electromagnetic wave – a wave produced by the acceleration of an electric charge and propagated by the periodic variation of intensities of, usually, perpendicular electric and magnetic fields*

frequency – the number of cycles or completed alternations per unit time of a wave or oscillation*

light – also called luminous energy, radiant energy; electromagnetic radiation to which the organs of sight react, ranging in wavelength from about 400 (blue) to 700 (red) nanometers and propagated at a speed of 186,282 miles per second (299,972 kilometers per second), considered variously as a wave, corpuscular, or quantum phenomenon; a similar form of radiant energy that does not affect the retina, as ultraviolet or infrared rays*

scattering – the process in which a wave or beam of particles is diffused or deflected by collisions with particles of the medium that it traverses

temperature – a measure of the warmth or coldness of an object or substance with reference to some standard value

wavelength – the distance, measured in the direction of propagation of a wave, between two successive points in the wave that are characterized by the same phase of oscillation*

**see Teacher Information Sheet: "Wavelength and the Visible Spectrum of Light"*

Materials:

- Intense light sources at two or three different narrow frequencies; lasers, collimated LED sources, or filtered white light (two or three options per group)
- Safety goggles (one per student)
- Clear plastic container, at least one-liter size (one per group)

- Water source
- Milk or powdered milk (one half-pint per group)
- Kool-Aid® packets in a variety of colors (two or three per group)
- Salt (3 tablespoons per group)
- Sugar, individual packets (three packets per group)
- Spenda®, individual packets (three packets per group)
- Science journal (one per student)
- Measuring spoons, cups, etc. (enough for class to share)
- Paper, blank white (one piece per group)
- TEACHER INFORMATION SHEET: "Wavelength and the Visible Spectrum of Light"

Activity Preparation:

Write directions for the Explore activity (see below) on chart paper or on board. At a central location, preferably a table with a sink, provide water, light sources, solutes (sugar, Splenda®, salt, Kool-Aid®, milk), and safety equipment. Lower the lights in the room.

Activity Procedure:

Please refer to the assessment task and scoring rubric located at the end of these instructions. Discuss the assessment descriptors with the class before teaching this lesson.

Gear Up

Process Skills: predicting, observing, describing, making generalizations, and inferring

1. Show students the sky, whether by going outside, looking through a window, or showing a picture. Ask the students to describe the various mechanisms through which the sun is heating Earth. Facilitate discussion with the following questions:
   a. What is light?
   b. Is sunlight made up of just one color?
   c. Why is the sky blue?
   d. Are the clouds scattering or absorbing the sunlight?
   e. Are the clouds blocking all of the sunlight?
   f. Is the surface of Earth absorbing, reflecting, or emitting electromagnetic energy?
   g. Does this affect temperature?

List responses on the board with the students' initials by each response. If necessary, explain sunlight is made up of all colors and that color is related to frequency and energy. Also, define the vocabulary and explain that Earth is absorbing, reflecting, and transmitting electromagnetic energy.

Explore

Process Skills: predicting, observing, describing, making generalizations, developing models, and inferring

2. Divide students into groups of two or three and have students develop a simple model of sunlight in the atmosphere using the following directions:
   - Put on safety goggles.
   - Pour a measured amount of room temperature water into a clear container.
   - Dissolve a measured amount of the solute of your choice (salt, sugar, Splenda®, Kool-Aid®, milk) into the water. Note the amount water and solute in science journal.
   - Predict what will happen to the beam for each frequency of light entering the container. Record prediction in science journal.
   - Shine each available frequency of light into the container, one at a time. Make sure the light is directed through the solution onto a white surface. Use a blank white piece of paper if necessary. Record observations in science journal.

- Repeat the process using a different solute until four different materials have been explored.
- Record observations for each solute in science journal.

Generalize

Process Skills: predicting, observing, describing, making generalizations, and inferring

3. As a class discuss the following:
   a. Did some materials scatter light more than others? How?
   b. Was light scattering affected by particle size? How could you tell?
   c. How did the amount of material dissolved in the water affect the beam scattering?
   d. Was one frequency of light generally scattered more than the other?
   e. Did some materials absorb the light? How could you tell?
   f. Was light absorption affected by frequency? If so, describe the effect.
   g. What happens to the energy in the light when it is absorbed? How would this impact temperature?

Teacher's Note: It's important to point out that temperature is related to the amount of energy in the system.

Apply

Process Skills: predicting, describing, and making generalizations

4. Direct students to explain how materials dissolved or suspended in the air might affect the range of visibility in Denali National Park and Preserve or a nature park or landmark in your local area. Is there a way to test this hypothesis?

Source:

(2009). Fact Monster - Dictionary Page. Retrieved June 16, 2009, from Fact Monster website: http://dictionary.factmonster.com

ELECTROMAGNETIC WAVES AND CLIMATE

RUBRIC

Assessment Task:

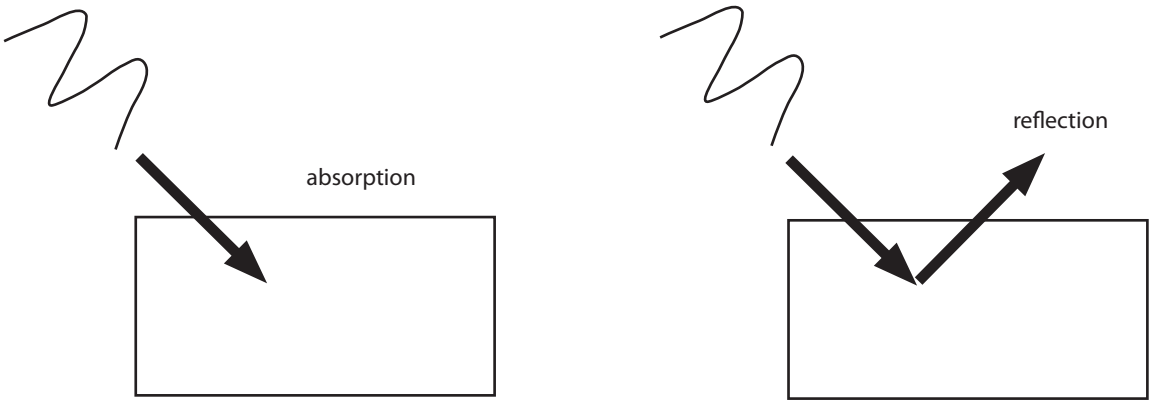
Using knowledge of the interaction of electromagnetic energy from the sun with atmospheric features, students are to write an essay with at least three paragraphs that explains at least one interaction between sunlight and Earth's atmosphere. The essay should include at least one prediction about the effect of the interaction of sunlight with atmospheric features on the temperature of Earth. Students should include an illustration of at least one frequency of light interacting with the atmosphere.

Rubric:

Objective	GLE	Below Proficient	Proficient	Above Proficient
The student explains interactions between different frequencies and atmospheric features.	[10] SB3.3	The student does not attempt to explain the interactions between frequencies and atmospheric features.	The student correctly explains the interactions of one frequency range with atmospheric features.	The student correctly explains the interactions of two or more frequency ranges with atmospheric features.
The student makes predictions about the effects of atmospheric features on the temperature of Earth.	[10]SA1.1	The student does not attempt to make a prediction about the effect of atmospheric features on the temperature of Earth.	The student makes a prediction about the effect of atmospheric features on the temperature of Earth.	The student makes two or more predictions about the effect of atmospheric features on the temperature of Earth.
The student writes an illustrated informative essay describing the process by which atmospheric features can affect the temperature of Earth.	[10] W4.2.2	The student does not attempt; creates an illustration only; creates an essay only; creates an essay with two or fewer paragraphs.	The student creates a three-paragraph essay with an accompanying illustration.	The student creates an essay with four or more paragraphs and includes an illustration.

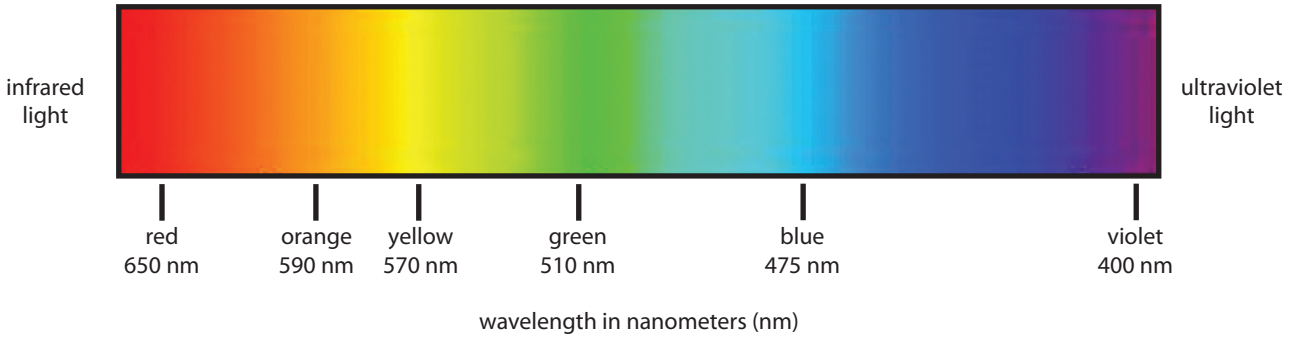
WAVELENGTH AND THE VISIBLE SPECTRUM OF LIGHT

Light travels as a wave: when it strikes an object, the energy is absorbed or reflected.



Visible light is just one type of wave. It is a small part of the electromagnetic spectrum.

The Visible Spectrum



Wavelengths are measured in nanometers. One nanometer is one billionth of a meter. Wavelength is measured from peak to peak or trough to trough.