



**Instructor:** D. Cretsinger (2003 Science Teacher Workshop participant)

**School District:** East Brunswick

**Lesson Title:** Electromagnetic Energy: The relationship between the wavelength, frequency and energy of waves

**Grades:** 10,11,12

**Subject:** Science

**Overall Objectives:**

- To introduce the students to the properties of energy and waves.
- Allow students to visually compare continuous and bright line spectra.

**Objectives: SWBAT:**

Part I:

1. Identify the wavelength and frequency of a wave
2. Determine the relationship between the wavelength and frequency of a wave
3. Relate the energy of a wave to its wavelength and frequency

Part II:

1. Relate the color of light to its energy
2. Compare a continuous spectrum to a bright line spectrum

**Target Audience:**

This activity can be modified to fit any age group. Part I can be used in any discussion of electromagnetic radiation. Part II is appropriate for students investigating atomic structure in more detail.

**Introduction:**

A class discussion of electromagnetic energy and radiation can be used to introduce the concept of energy traveling in the form of waves. Other terms are defined in the directions. The students will develop other concepts and definitions as they do the activity.

**Procedure:**

1. Divide students into groups of three: two to generate the waves with the slinky and one to record the answers to the questions.
2. You will need floor space! I generally take the kids into the hall.
3. Start by having the students stretch the slinky out on the floor and generate a wave. Only one student should move the slinky at once. The other end should stay fixed. This allows the relationship between energy, wavelength and frequency to be seen more easily.
4. Have them answer all questions as they do the activity.

**Student Worksheet:** Answer all questions in complete sentences on separate paper.

Part I:

1. Move the slinky slowly side to side. The wavelength of a wave is defined as the distance between the top (crest) of one wave and the next. Identify one wavelength on your wave. Draw a sketch of what you see and label the wavelength
2. The frequency of a wave is defined as the number of waves that pass a given point in a given period of time (generally per second). Count the number of waves that pass your shoe in ten seconds. Record the frequency.
3. Move the slinky faster. Determine the wavelength. Is it shorter or longer than the wave in step one?
4. Count the number of waves that pass your shoe in ten seconds. Is the frequency higher or lower than the frequency you determined in step 2?
5. What is the relationship between the length of the wave and the frequency of the wave?
6. Move the slinky faster. Does this take more or less energy to do?
7. What happens to the wavelength of your waves as you increase the energy?
8. What happens to the frequency of your waves as you increase the energy?
9. State the relationship between the energy of a wave and the wavelength and frequency of the wave.

#### Part II:

1. Find a picture of the electromagnetic spectrum and sketch it into your notebook. Be sure to label the wavelength, frequency and energy.
2. Notice the area labeled "visible light" in the spectrum. What colors are on the lower energy end of the spectrum? What colors are on the higher energy end of the spectrum? How would you predict the wavelength and frequency of red light would compare to that of blue light?
3. Use the spectrosopes to observe the spectra of sunlight, incandescent light and fluorescent light. **DO NOT POINT THE SPECTROSCOPES DIRECTLY AT THE SUN!** Just point them at any daylight outside the window.
4. Sketch what you see in your notebook.
5. Compare your sketches to the spectra shown in your book and label yours as continuous or bright line spectra. What is the difference between them?
6. Observe the glowing gas tubes in the front of the room through the spectroscopy. Do the gas tubes give off a continuous or a bright line spectrum? What does this tell you about the wavelengths and frequencies of energy being given off by the gases?
7. Write a paragraph summarizing the concepts learned in this activity.

Follow this activity with a thorough discussion of all questions and conclusions. A number of students will be able to formulate a hypothesis about the significance of the bright line spectrum. This leads directly into further study of electrons in atoms.

#### **Assessment:**

- Class discussion of activity and observations
- Answers to conclusion questions
- Conclusion paragraph