Lesson: Science Grades 4-6
Sound Energy

Did You Hear That?

Sometimes it seems that it takes a long time to receive verbal messages from one location to another. Imagine what it would be like to wait for Rapunzel's response to your statement: "Rapunzel, Rapunzel, let your hair down."

Introduction

Objective:

Student will work in a cooperative group to investigate the amount of time necessary for sound to travel from the site of transmission to a receiver.

Academic Content Standards:

- National Science Education Standards: Physical Science
  - *Understand the interactions of energy and matter.*
- National Science Education Standards: Science as Inquiry (Scientific Ways of Knowing)
  - *Abilities necessary to do scientific inquiry.*
  - *Identify questions and concepts that guide scientific investigations.*
  - *Design and conduct scientific investigations.*
  - *Use technology and mathematics to improve investigations and communication.*
  - *Communicate and defend a scientific argument.*
  - *Understanding about scientific inquiry.*
- Ohio Academic Content Standards for Science: Physical Sciences
  - *Students demonstrate an understanding of the composition of physical systems and the concepts and principles that describe and predict physical interactions and events in the natural world…It includes understanding the nature, transfer and conservation of energy, as well as motion and the forces, the nature of waves and interaction of matter and energy.*
    - *Benchmarks: No direct benchmark correlation for 4th and 6th grades. Emphasis is at 5th Grade)*
    - *Benchmarks: E and F (5th Grade)*
- Ohio Academic Content Standards for Science: Science inquiry
  - *Students develop scientific habits of mind as they use the processes of scientific inquiry to ask valid questions and to gather and analyze information.*
  - *Students learn how to develop hypotheses and make predictions.*
  - *Students reflect on scientific practices as they develop plans of action to create and evaluate a variety of conclusions.*
  - *Students demonstrate the ability to communicate their findings to others.*
    - *Benchmarks: A, B and C (4th and 5th Grades)*
    - *Benchmarks: A and B (6th Grade)*
- Ohio Academic Content Standards for Science: Scientific Ways of Knowing
  - *Students realize that the current body of scientific knowledge must be based on evidence, be predictive, logical, subject to modification and limited to the natural world. This includes demonstrating an understanding that scientific knowledge grows and advances as new evidence is discovered to support or modify existing theories, as well as to encourage the development of new theories.*
  - *Students are able to reflect on ethical scientific practices and demonstrate an understanding of how the current body of scientific knowledge reflects the historical and cultural contributions of women and men who provide us with a more reliable and comprehensive understanding of the natural world.*
    - *Benchmark: A, B and C(4th, 5th and 6th Grades)*

Getting Started

Materials:

- For individual student groups: a stopwatch with the ability to time to tenths and hundredths of a second, 2, two by-four's (each about 45 cm long), metric trundle wheel, decibel meter, group instruction sheet, 1 flag or fabric

to wave as a flag (clapper and meter reader may need earplugs)
- For each student: a clipboard and data collection chart, graph paper, writing paper and colored pencils
- For the class: data collection chart enlarged, group instruction sheet, and processing questions

Vocabulary:
- Sender
- Receiver
- Transmission/transmitted
- Decibel
- Distance
- Energy transfer

Technology:
Use a video camera to tape each one of the science investigations. Replay them later to compare the results as shown on the tape to those actually recorded "in the field" at the time of the investigation.

Lesson (Note: This could become an inquiry based lesson by adding checkpoints, and including processing questions at those check points.)

Orientation Activity:
One student will clap his or her hands together while standing at least 50 meters away from the other students that have their backs to the clapper. When the students hear the sound, they will raise their hands. The student will continue the clapping while moving backward 10 meters at a time. Continue this activity until there is an extended delay between the clap and the students' signal that the sound was heard. (This range is used to determine the distances the groups will measure once the activity begins.)

The teacher will demonstrate the safe handling and clapping of the two- by-four boards. It is important that fingers are not injured when the boards make contact with each other. Mounted straps across the boards can assist students in their clapping. Students slide their hands between the straps when they clap the boards. Cymbals or trashcan lids may be used as alternatives to the boards if they seem more appropriate for a group of students.

The teacher will demonstrate how to use a stopwatch. Students will practice clicking on and off at your command. The teacher will also demonstrate how to record sound with the decibel meter.

Learning Activity:
The teacher will distribute to each student a data collection chart and a clipboard in preparation for the activity. Students will record measurements taken during the activity and complete their individual charts to add to the class data collection chart. Each group will gather the listed materials (see above), and those on the instruction sheet. Teacher will assign distances to each group.

The teacher will take the class outside to an area that is large enough for the student groups to work while not disturbing each other or other classrooms. If this space is limited, one group can do the activity while others observe.

Students will conduct the investigation as outlined on the group instruction sheet. Each student is responsible for recording all data gathered from individual group members. Once all groups have completed the assignment, the students will return to the classroom for processing the data.

Each group will add their group data to the class chart posted on the board. Each student adds each group's data to their individual data collection chart so that they have easy access to the data during the next step of processing.

Students will review questions to aid processing. The teacher will write the questions on the board, chart paper, or a handout. As the students process the observations and make inferences from them, they will refer to the data collected as evidence to support their responses. The teacher will use chart paper on the board and the format of a "T-chart" to record observations and inferences. Students will also take notes and write down the observations and inferences made by others. (See *Processing Question Suggestion* sheet.)

Evaluation and Follow-Up

Assessment Tools and Methods:

Each student will create a line graph to record the data collected from the trials by the class and information collected during data processing. The graph is labeled and titled appropriately and will include a description of the pattern that the data exemplifies. A written explanation that defines the problem and explains the task used to solve the problem is included. This description will have evidence to support observations and inferences. The class will create a scoring rubric to score individual elements of the assignment, or create a combined rubric that focuses on the monitored at the time of the activity.

Interdisciplinary Connections:

Math: Extend the activity by having students measure other distances and/or predicting what the results would likely be based upon the data already collected.

Language Arts: Students create questions based upon the data they collected for use in the assessment. The questions are identified as fact or opinion with emphasis on the evidence needed for consideration of the information as factual.

Did you get the message?

Your task today takes you outside. Use these steps to help you complete the tasks. Once your group is finished, think about the observations you made and write down some inferences that you can make based upon this data (your evidence). You will need these items during the investigation for data processing.

Step 1: Collect the following for your group. 1 stopwatch, 2 boards, 1 flag, 1 decibel meter. Each one of you should have a clipboard, data collection sheet, and a pencil.

Step 2: Assign jobs. (You will keep the same job through all 4 trials.) Your group will need 1 clapper, 1 timekeeper, 1 flagger, and 1 meter reader. Each person should become familiar with the operation and/or organization related to his or her specific job. Ask questions now!

Clapper will smack the boards together as hard as possible being careful not to catch fingers between them. Ouch!☹

Timekeeper will start the stopwatch at the exact moment the clapper brings the boards together, yes use your eyesight! Stand so that you can easily see the clapper and the flagger. And, click the stopwatch again at the moment that the flagger raises the flag. Share this information with your group to record on their data collection chart.

Flagger will listen carefully for the sound being transmitted by the clapper. At the moment the sound is first heard, raise the flag high into the air. Oh yes, turn your back to the clapper!

Meter Reader will record the readings on the meter at the time that the clapper smacks the boards together. Share this information with your group to be recorded on the data collection chart.

Step 3: "Hear" we go! Use the trundle wheel to measure the distance assigned to your group. The clapper stands at the beginning and the flagger at the other end. The meter reader should stand next to the clapper and the timekeeper next to the flagger.

Step 4: When each person is in their place and ready to go, begin the first trial.

Use this as a trial run to be sure that everyone knows exactly what to do. DO NOT RECORD THE DATA! Now, for the real thing! Conduct the trial 4 times, recording the data after each trial.

Step 5: Each group member averages the seconds/decibels of the 4 trials to find the group average for this investigation. Add all of the data that your group collected to the class chart.

Step 6: Look over the questions that will be used during processing of the investigation. Discuss how your group's data will be shared and what inferences you might make based upon the data.

Did you get the message? Data Collection Chart

Group	A		B		C		D		E	
	Sec	Dec	Sec	Dec	Sec	Dec	Sec	Dec	Sec	Dec
Distance (meters)										
Trial 1										
Trial 2										
Trial 3										
Trail 4										
Total										
Divide by 4										
Average										

Suggested processing questions for use in any combination or order as deemed necessary for a particular group of students. Put these on the board, chart, overhead, or give each student a copy of the questions that best fit the situation.

1. Using the data collected by the class, what likenesses and/or differences can you find between the groups? What might account for any differences that occur within the groups? What should we do to have more accurate data?

2. If the data in one trial is way off from the others, what do you think happened? Should this information be included in the group data? Why or why not?

3. What conclusions could we draw from the observations and inferences that have been made about this data? What kind of relationship exists between the distance the sound travels and the time it takes to get from the sender to the receiver?

4. What did the decibel meter readings tell you about the sound that was produced by the clapper? When could this type of information be helpful to humans?

5. What were the variables in this investigation? How did they affect the data that was collected? Would it be important in this type of investigation to keep the variables the same? Why or why not?

6. What everyday situations might be able to use this type of data or conduct this type of investigation to solve a problem?

7. How is the sound energy transferred during this investigation? What is transferring the sound?

8. Why do you think we conducted this investigation? What information did you gain related to energy and sound? How might this information be helpful to you in your life?