Sound Off!

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Date Created: August 3rd, 2010
Subject: Physics (Regents/Conceptual)
Level: High School – Grades 10-12
Standards: *New York State - High School Science*
(http://www.emsc.nysed.gov/ciai/mst/pub/phycoresci.pdf)
STANDARD 1—Analysis, Inquiry, and Design
STANDARD 2 – Information Systems
STANDARD 4.3 Energy exists in many forms, and when these forms change energy is conserved.
STANDARD 7—Interdisciplinary Problem Solving
Schedule: One or two 45-minute class periods

Objectives:

Give students the experience of determining which type of material is best suited for reducing sound by comparing amplitude levels.

Students will:

- Measure how much sound is absorbed by a given material by comparing amplitude levels.
- Learn physics vocabulary terms related to sound.
- Plot and graph data using Microsoft Excel
- Compare results of different materials
- Analysis of data and class comparison

Vocabulary:

Sound
Amplitude
Intensity
Waves
Frequency
Longitudinal Wave
Compressional Wave
Mechanical Wave

Materials:

For Each Group of Four:

- One box
- One computer (with Audacity software and Microsoft Excel, Pure tone sample A-G
- One microphone
- One pair of external speakers
- One sample – types will vary depending on Teacher.
  Examples of samples include: Tile, Styrofoam sponges, pinewood, plywood, fiberglass
- Tape
- Safety Scissors

Safety:

No food or drinks should be allowed near computers.

Science Content for the Teacher:

Sound can travel through many mediums such as air, liquid and gas states. Each medium represents a different manner in which sound is translated through that medium or between mediums. The way in which the sound travels through those mediums and between the mediums is important as it affects the way in which the sound deadening materials are used.

Sound in a non-technical or laymen's point of view is the amount of vibration(noise generation) through a medium that is dependent on both frequency (range of sound) and amplitude (amount or degree of loudness). Frequency is the pitch or what we hear from a tone, and amplitude is the degree or loudness of the tone. Deadening sound can be done through various means, but the two major ways of sound decreasing components are *Absorption* and Damping (*Dampening)*. To understand how to decrease sound a thorough understanding of each is needed.

Sound Absorption

Sound absorption is the manner in which sounds traveling through air are reduced by means of absorbing the sound waves (both amplitude and frequency). Imagine a room with a hard tile floor, large ceilings, no furniture, and no fabric or carpet. This room is a great chamber for sound to propagate as each wall, floor, and ceiling efficiently reflects the sound waves during its travel in and around the room. As the sound is generated the air borne vibration travels through the air with little deflection and bounces on the wall, and immediately off the wall with little loss. The walls within the room become an effective reflector thereby shooting the sound wave back into the air and the process continues. This reflective rate decreases slowly due to the hard reflective type surfaces and eventually dies out, but keeps the room noisy for a long period after the noise generation is stopped. Now let's look at the same room with carpet, drapery, pictures, furniture, etc. Imagine the same sound being produced again, but this time the loss is substantial. The reason is due to the "Sound Absorbing" type materials such as carpet, draperies, couches, paintings, etc that swallows up or does not efficiently reflect the sound waves as they travel around the room and back through the air. This absorption shows how sound can be trapped and effectively quiet the room. Sound absorbing materials are an important deterrent for air borne noise generated into and through air movement. These materials include lightweight fabrics, cloths, and special sound absorbing materials (sometimes even with irregular type materials and surfaces) to varying degrees. However they only take care of the sound that is generated through the air. They do not dampen sound through solid type surfaces.

Sound Damping (Dampening)

Now let's examine the same room again. This time instead of the noise being generated from the inside of the room, the noise is generated through the walls. Let's imagine that the walls are made of steel and that the noise is being generated from a piece of equipment which is bolted to the wall creating vibrational noise. Since the steel walls translate the noise quite efficiently, the

noise is propagated to the next medium of the air. Once the noise starts, it is difficult to reduce the noise without using materials to either help absorb or most importantly getting to the root of the noise and dampening it. Normally dampening type materials are heavy and bulky as the materials use their weight and density to stop or kill the vibration before it is propagated. As the noise is generated, the damping material takes the sound wave energy from the surface thereby effectively retarding its vibrational translation. This reduction in vibration leads to less sound being produced by the surface or structure and therefore into the air. This loss is effectively called sound damping and an important function to decreasing sound within the environment. Dampening materials come in many forms such as lead liners, heavy-dense insulation, and most recently in sound dampening coatings. Usually, the heavier the material, the better for the reduction of sound.

Taken from: *www.mascoat.com/pdf/**Sound**Transmission.pdf*

Preparation:

1. Prepare and photocopy activity sheet.
2. Photocopy challenge question sheet.
3. Distribute materials evenly to each group.

Classroom Procedure:

Engage (Time: 5-7 minutes)

- The teacher should have discussed the characteristics of sound in the previous lesson.
- Circulate the materials around the classroom and have students observe and write down a couple of physical characteristics of each sample.
- Have students predict and explain which material will be most resistant to sound traveling through it.
- Ask the class to share their predictions of which sample would be most resistant to sound.
- Document their answers on the board.

Explore (Time: 25 minutes)

- Have one person from each group collect the materials and instruction sheet for their group.
- The Audacity software and musical notes should be installed, open and ready to collect data on each computer prior to box assembly.
- Provide each group with one sample to collect data from. Note: All samples used should be of uniform, shape and size and able to fit into a small box. Do not use shoe boxes as the lid will not allow for the complete closure of the box with speaker and microphone cords.
- One of the speakers should lie horizontally at one end of the box.
- Center the sample at the bottom of the box using the tape provided. Note: The sample should not lie flat but stand in the box.
- Place one microphone at the other end of the box lying horizontally or as centered as possible in front of the sample.
- Close the flaps to the box and secure enough with tape that it will not open during experiment but light enough to open when needed. Placing the cords at the corners of the box will allow for the box flaps to close easily.
- Have students click on project tag within the Audacity software and press “New Audio Track”.
- Press record and then have the pre-recorded notes (A-G) played. This should take approximately one minute.
- Once the recording is complete hit analyze at the top and press “Plot Spectrum”.
- A graphical view of recording will be displayed. However, it can only be saved as a text document.
- Each group should then export data from the text file to Microsoft Excel in order to use data to graph the results. Make sure save the files to the computer.

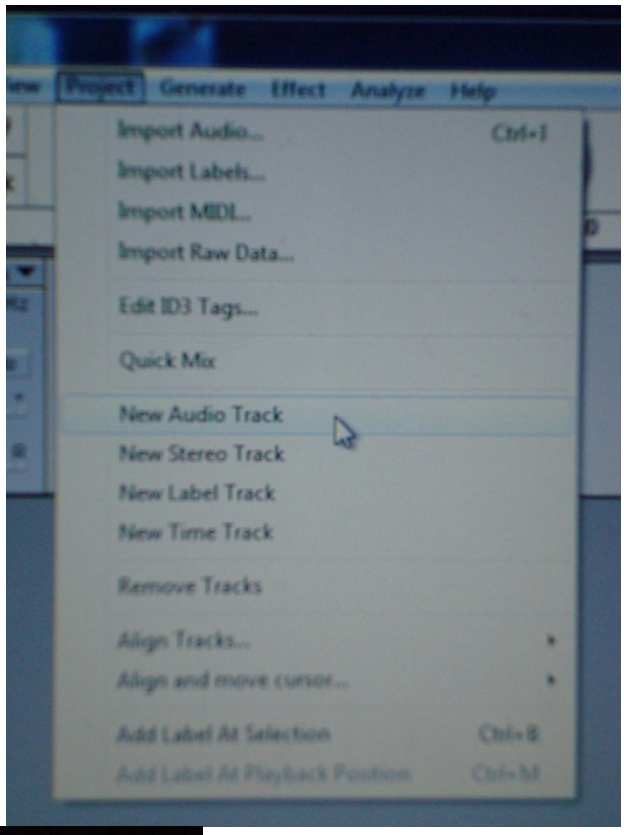
Explain (Time: 15 minutes)

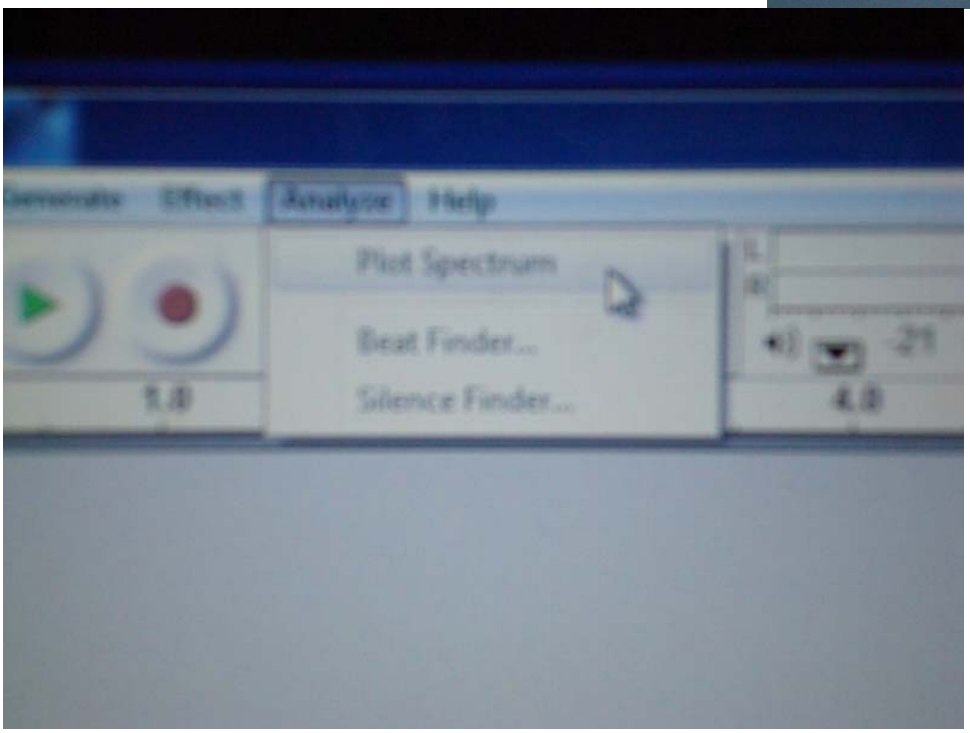
- Students should then analyze and interpret the data as a group.
- Each group will then present their results to the class and collectively determine which material is most resistant to sound.

Expand (Time: Varies) Homework Assignment – See Challenge Questions on the next page.

Audacity Software View – Note this software can be downloaded for free from:

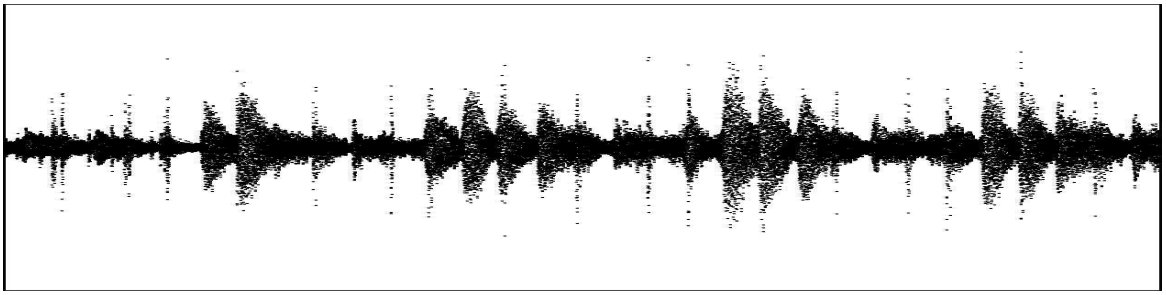
http://audacity.sourceforge.net/





Sound Off Challenge Questions

Name:_____Period:___ Date:_____



1. How would your results differ if the sample were thinner/thicker? Justify your answer.

2. Describe how dampening the samples may affect sound transmission.

3. Does the temperature of the material have an effect on the transmission? Why or why not?

4. Why is the study of sound useful to society?

5. How does the study of sound apply to building residential or commercial structures? Be sure to provide at least two examples.

6. Describe the purpose of an amplifier.

7. Since loudness depends primarily on the amplitude of the sound wave, how is it possible for two different individuals to hear at different levels of loudness at the same amplitude?

Assessment:

The following rubric can be used to assess students during each part of the activity. The term "expectations" here refers to the content, process and attitudinal goals for this activity. Evidence for understanding may be in the form of oral as well as written communication, both with the teacher as well as observed communication with other students. Specifics are listed in the table below.

1= exceeds expectations
2= meets expectations consistently
3= meets expectations occasionally
4= not meeting expectations

	Engage	Explore	Explain
1	Shows leadership in the discussion and offers creative ideas reflecting a good understanding of the physics behind sound.	Completes work accurately while providing an explanation for what is observed. Works very well with group members.	Provides an in-depth explanation of findings, making good use of vocabulary terms. Fills out worksheet clearly.
2	Participates in the brainstorm and shows and understanding of the physics related to sound.	Completes work accurately and works cooperatively with group members.	Provides clear explanation of findings. Fills out worksheet clearly.
3	Contributes to the brainstorm, but shows little understanding of the physics behind sound.	Works cooperatively with group members, but makes some mistakes with the procedure.	Provides a limited explanation of findings. Fills out some of the worksheet.
4	Does not participate in brainstorm. Shows no understanding of the physics behind sound.	Has difficulty working with group members. Does little to complete procedure.	Is not clear in explanation of findings. Does not fill out worksheet.

Extension Activities:

- Challenge students to adjust the thickness of the sample to determine how the data might change.
- Encourage students to dampen or coat material and identify any changes.

Safety: No food or drinks should be allowed near computer equipment.

Acknowledgments:

- Cornell Center for Materials Research
- CCMR Facility Managers
- Nev Singhota
- Kevin Dilley
- Daniel Blakeley