Lesson plan for *Sound Waves* activity: **Sound Homework**
http://phet.colorado.edu/ Time for activity 30 minutes.
Learning Goals: Students will be able to

- **Explain how different sounds are modeled, described, and produced.**
- **Design ways to determine the speed, frequency, period and wavelength of a sound wave model.**

Background:
We will have been studying waves and have done the *Waves on a String* activity. I am going to do this after a lab that uses a microphone probe. I'll include the lab I do in the database. The Wave Interference simulation has been added since I wrote this lesson; it has many interesting features that would help tie sound to water and light waves.

Sound Waves Introduction:
I'll use a slinky and a rope to review longitudinal versus transverse waves. Then show how the sim is modeling the compression and rarefaction with dark and light colors. I'll use my overhead wave tank to demonstrate further that the simulation is only showing two dimensions like the wave tank shadow does. We'll have a class discussion to review how waves on a string are generated and how the energy moves through the string. Then we'll compare sound waves are generated and travel. We won't have covered an electricity or magnetism, so we can't really discuss how the speaker is made to vibrate yet.

Lesson: I assigned this to be done at home and several students could not get the sim to open at home. Several students came in during open lab time to do the activity or ask questions. I have added clicker questions to go with this simulation. Many are adaptations from CU 1240 class about Sound and Music for non-science majors.

Hints about the sim: The sim could be used to demonstrate a variety of things. I have listed them below sorted by tab. For this activity, I decided to focus on just a few things; see the goals. In our research, it seems that about 1/2 people think that black represents emptiness and light more intensity, and the other 1/2 the inverse. Our group decided that any lesson should require that the students determine what is being represented and then chose black for low density. If you investigate using the first tab, you'll see that when the speaker is going out, the sound wave looks light. I found this a little tricky to observe, but using low frequency helps. So when you go to the last tab and evacuate the chamber, it will make sense that the color goes black like space.

Listen to a Single source:

- Waves modeling: How frequency and amplitude effects the wave model qualitatively
- Wave generation: How the vibration of the speaker changes to make the amplitude and frequency vary. The higher the amplitude, the greater the distance that the speaker vibrates. The frequency changes are apparent by the rate at which the speaker moves.
- Frequency and amplitude relationship to what a listen perceives (pitch and volume). *The students without music background had a difficult time hearing the change in volume; many thought that the pitch was different.*
- Doppler effect (The quality of the computer effects whether or not this can really be used. In my classroom, the computers are not good enough)

Measure

- Waves modeling: How frequency effects the wave model quantitatively (f=#waves/sec)
- Calculate period (T=time/#waves) Or Frequency (# waves/time) Tip: hit reset, start then stop, count the waves. Relate frequency to period mathematically by using T=1/f
- Speed of sound = wavelength * frequency (I got about 340m/s easily. Smaller frequencies gave the best results because the wave front was more clear. Put the ruler on the speaker center, hit reset, start then stop, measure how far a wave front has gone/ time elapsed. The ruler will not be movable when pause is on.)

Two Source Interference

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- Waves modeling: Two wave interference.

Interference by a barrier

- Waves modeling: Reflection is best seen using the pulse feature. I think the interference is best seen in continuous mode.

Listening with Varying Air pressure

- Waves modeling: Shows how a mechanical wave is affected by the medium.