

Virtual Laboratory

Topic 08 – Waves and Sound

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Name	Section #	Date	Topic #

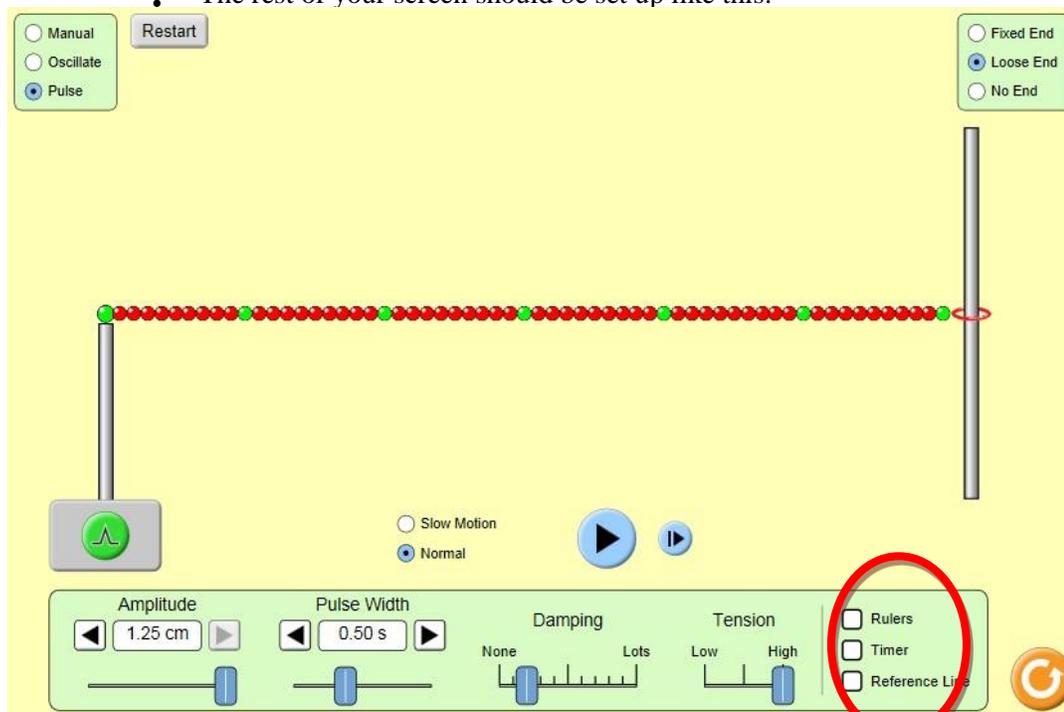
Google **PHET Waves on a String**. (These instructions are for the html5 version.)

Learning Goals:

- Be able to describe the fundamental properties of waves.
- Be able to explain how amplitude, frequency and wavelength are related.

Play with the simulation to gain familiarity with the controls.

- Set your controls to Pulse Loose End
- The rest of your screen should be set up like this:



(You can change the position of the rulers by dragging them with the cursor.)

Change the amplitude slider settings and observe the resulting waves. (Click on the button to make the wave move along the string.)

1. What amplitude setting makes the tallest waves? _____
2. What amplitude setting makes the shortest waves? _____
3. Explain what amplitude means in your own words. _____

- Set your controls to Oscillate and Loose End

Notice the pause play buttons. Change the amplitude slider setting to 50 and change the frequency setting. Observe the resulting waves. (Click on the PLAY button to make the wave move along the string.)

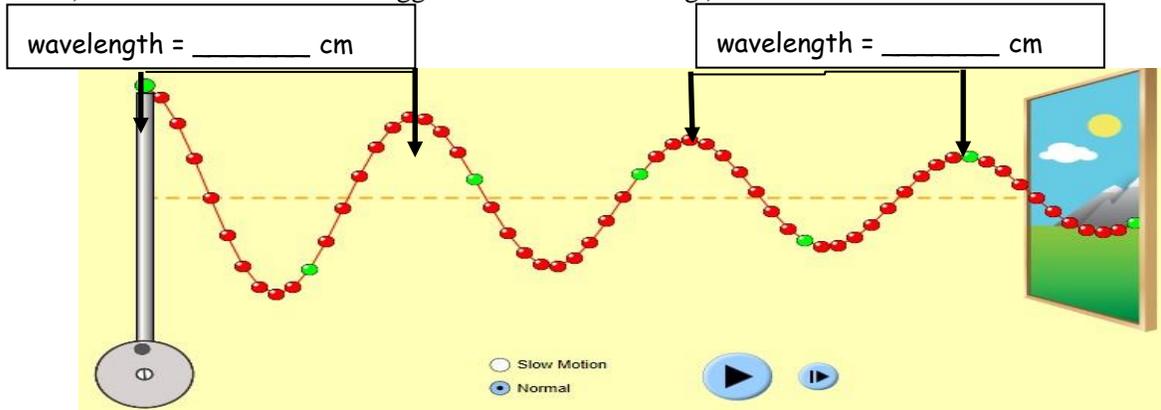
4. What do you observe at the lowest frequency setting (that works)? _____
5. What do you observe at the highest frequency setting (that works)? _____
6. Explain what frequency means in your own words. _____

Change your settings to observe wavelength and frequency:

- Set your controls to **Oscillate** and **Fixed End**
- Set amplitude at 1.25 cm and frequency at 3 HZ.
- Use the pause button to stop the wave for easier measurement.

7. Use the ruler to measure the wavelength at the two points on the diagram below and record your results in

the space provided. (Hint: Use the  button after you hit pause to line up the large green ball (on the left side moving up and down on the stick) to its maximum height so that your wave looks like the one below.) Note: The ruler can be dragged for easier measuring.)



What did you discover about the 2 wavelengths? _____

Does this match your expectations? _____

Why or why not? _____

8. Make a prediction about what you think will happen to the wavelength if you increase the frequency setting.

Change the frequency settings several times and observe the effect this has on the wavelength. Do you see a pattern? Describe your observations:

9. a. Now record some data as you change the frequency settings. (Remember to keep all the other settings constant! Frequency is found in the box above the frequency setting. and you use the ruler to measure the wavelength. Press pause to take your measurements.)

FREQUENCY	WAVELENGTH

9. b. Based on your data. write a statement about the relationship between frequency and wavelength.

Sound Waves

Sound Waves Learning Objectives:

- Explore and draw conclusions about the nature, properties and behaviors of sound waves.
- Use the simulation to develop your own definition of frequency and amplitude.
- Describe how frequency and amplitude affect the sounds we hear.
- Given a description of a sound like “high pitched and loud”. describe the amplitude and frequency.
- Calculate the speed of sound, and sound waves.

Go to the website <http://phet.colorado.edu/en/simulation/sound> . and click on the play button.

10. Discuss examples of things that make the different types of sounds listed in the table below. **Write your examples in the table below.**

Use the **Listen to a Single Source** tab. Turn on the **Audio Enabled** so you can hear the sound. Adjust the Frequency and Amplitude using the control panel provided.

Create the sounds in the table below.

Sound	Example of something that makes this sound	Explain how you used the simulation to make the right noise
Case A: Loud. High-pitched		
Case B: Soft. High-pitched		
Case C: Loud. Low-pitched		
Case D: Soft. Low-pitched		

11. Which cases above:
- Have a high frequency? _____
 - Have a large amplitude? _____
- Explain what controls pitch, and what controls loudness.

12. In the **Listen to a Single Source** tab click on listener and make sure audio enabled is still checked.
 - a. Explain what happens to the sound when you move the person towards and away from the speaker.
 - b. Increase and decrease the frequency and record what happens to the waves and the sound. Record your results.
 - c. Increase and decrease the amplitude and record what happens to the waves and the sound. Record your results.
 - d. What can you conclude about amplitude and frequency of sound waves?
13. Now go to the **Measure** tab. Notice the timer in the yellow box. Press start and then stop to measure the time of one of the waves exiting the speaker. Make sure the timer is starting from 0.0000 sec.
 - a. Measure how long it takes the sound waves to reach 5 meters. _____seconds. Calculate the speed of sound in m/s. _____
 - b. Increase and decrease the frequency and amplitude of the waves and see if they make a difference in the speed of the waves. Record your results. Do frequency and wavelength affect the speed of sound? _____. Explain how you arrived at this conclusion. _____
14. Go to **Two Source Interference** tab. Make sure audio enabled is checked.
 - a. Click on a speaker and drag further and closer to the other speaker. Describe what happens to the sound. Why does this happen?
 - b. What happens when you adjust the frequency and amplitude of the two sources?
15. Go to **Interference by Reflection** tab. Notice the waves reflecting off of the wall.
 - a. Change the wall's angle by sliding the bar in the control panel. What happens to the reflections when the slider is in the most up position as compared to when it is in the most down position?
 - b. Change the wall's position by changing the sliding bar in the control panel. What happens to the reflections as the wall gets further away from the source of sound?
 - c. When is the interference greatest; when the wall is closer or further away from the sound source?
16. Go to <http://faraday.physics.utoronto.ca/PVB/Harrison/Flash/ClassMechanics/Beats/Beats.html>
And review the six slides/pages provided about Beats. Skip the math page. Follow the instructions on each page. Listen carefully on the last page when you click the 1+2 button.

Describe what you heard when you clicked on the 1+2 button. Using your own words describe why you heard this phenomenon.

WAVES and S O U N D

		08
		08
		08
Name	Section #	Kit #
		Topic #

Part A – How to use the Model of Sound:

Section 1 – Applying the Model of Sound

1. The following drawings indicate a model of a sound. The frequency of each sound is the number of wavelengths occurring each second or $f = \# \text{ of wavelengths/s}$ For each sound count the number of waves. determine the time for those waves and calculate the frequency of each sound.

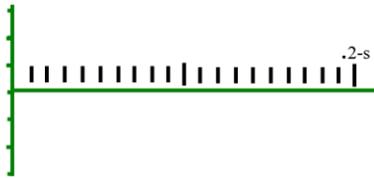


Figure A

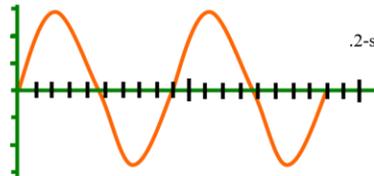


Figure B

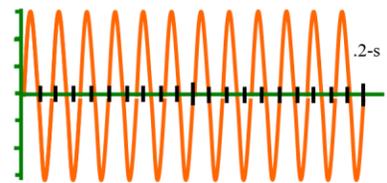


Figure C

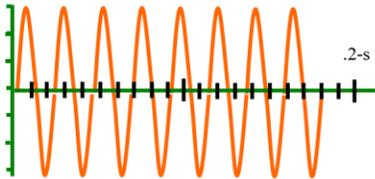


Figure D

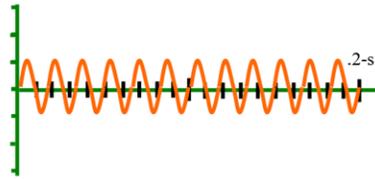


Figure E

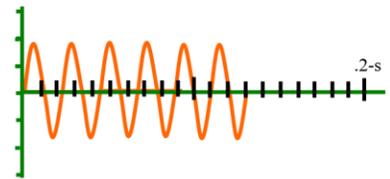


Figure F

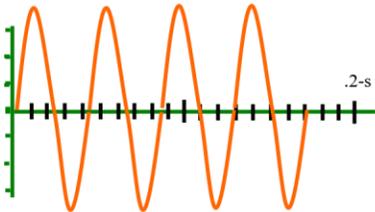


Figure G

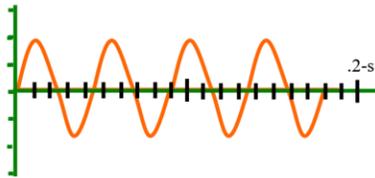


Figure H

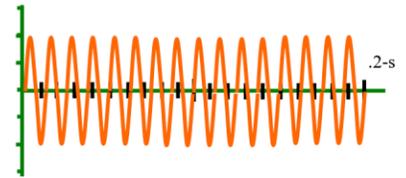


Figure I

Sound Model									
	A	B	C	D	E	F	G	H	I
Number of Waves	0								
Time	-								
Frequency (# of waves / time)	-								

2. According to the model which sound is the loudest? _____
3. Which sound is the softest? _____
4. Which sounds have the same frequency but different loudness? _____ And _____
5. Which sound is the highest frequency? _____
6. Which sound is the lowest frequency? _____

Section 2 – Applying the Model to a Musical Instrument (the straw)

1. If figure B represents the model of sound made by the full straw length which figures could represent the one-half straw lengths ___ and one-quarter straw lengths ___?

Part B – Resonance and the Velocity of sound

Pre-lab prep: What is the research question for this portion of the lab? _____

Pre-lab prep: Develop your hypothesis (don't forget the prediction): _____

5 cm Resonance Tube	480 Hertz Tuning Fork	512 Hertz Tuning Fork
Air Temperature (°C)	°C	°C

Velocity of sound in the air (Theoretical) $V_T = 331.3 \text{ m/s} + (0.6 \text{ m/s } ^\circ\text{C} \times T)$	m/s	m/s
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Measured Length of air column for Resonance (L)	meters	meters
Wavelength $\lambda = 4 \times L$	meters	meters
Experimental Velocity of sound $V_E = f \times \lambda$ (the frequency is indicated on the tuning fork)	m/s	m/s

Error = $ V_E - V_T $ (notice absolute value bars)	m/s	m/s
% Error = $100 \times \text{Error} / V_T$	%	%

- Which tuning fork has a higher pitch? _____
- Do your best to strike each tuning fork with an equal force so that they vibrate with equal amplitudes. Is one louder than the other one? _____
Explain your results. _____
 Are these the results you expect? **Explain.** _____
- What effect did changing the tuning forks (frequency) have on the length of the air column?

Part C – Measuring the frequency of sound

Determine the frequency of _____ (as indicated by your instructor)

Label On the Sound Source (if there is one) _____

Time for ten waves _____ seconds

Time for one wave _____ seconds

Experimental Frequency _____ Hertz (waves/ sec)

Theoretical Frequency _____ Hertz (waves/ sec)

Error ($f_{exp} - f_{theo}$) _____ Hertz (vib/sec)

% Error = $(Error \div f_{theo}) \times 100$ _____ Hertz (vib/sec)

1. Explain why your results might be different from the theoretical frequency. Provide an explanation that includes your numerical results and compares them to the theoretical results. In other words, if your results are greater than expected, what could cause this to occur? If your results are less than expected, what could cause this? Provide explanations.

2. The wave pattern you see on the computer is a graphical representation of the sound. What is plotted on the vertical axis? _____

What is plotted on the horizontal axis? _____

Typically, we say the vertical axis is the dependent variable and the horizontal axis is the independent variable. Is this true in this case? Explain your answer. _____

Part D Measuring Loudness

Set the decibel meter to MAX HOLD. When the loudest sound level is reached the number will be held until something louder comes along. To re-set the meter for the next item turn the MAX HOLD off and then back on. **Decibel Meter Settings:** Auto. A weighting. Slow Response. Fill in the number of decibels for the following situations:

Source	dB from decibel meter	Similar dB to which object from list on page 164
Whisper at 5 feet		
Quiet Classroom		
Noisy classroom		
Toilet Flushing		
Outside		