Acoustical Society of America

Wave Basics

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Students explore the PhET Interactive Simulation "Wave on a String" focusing on amplitude and frequency as well as wave travel.

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ASA Activity Kit Committee

This lesson was designed as homework but would also make a nice in class activity if computers are available for students. I used this as a HW to prepare students for the *Anatomy of a Wave* in class lesson.

Science Topics	Process Skills	Grade Level
Sound Waves	Scientific Inquiry Observing Inferring Comparing	6-12

Time Required

Advanced Preparation	Set-Up	Activity	Clean-Up
HW- None In class – verify sim on computers	none	30 minutes	none

Learning Goals

Students will be able to

- model and describe amplitude and frequency.
- explain the difference between the direction of the wave travel and the string motion as a wave travels on it.
- describe how/if amplitude, frequency, damping and tension effect how fast a wave travels.

Materials

- Worksheet (page 4) – 1 per student
- If done in class: 1 computer for every 1 to 3 students
  - "Wave on a String" from PhET Interactive Simulations

Advanced Preparations

Please forward any questions or comments to:
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- In class: Make sure the simulations run on the computers

Set Up

- Prepare packet to give to students
- In class: Go to the computer lab or set up computers in the classroom

Introducing the Activity

No introduction needed. This simulation has been tested with students from grade school to college and the interface has been intuitive for all students tested. We have observed that too much instruction on the simulation creates a barrier between the students and the simulation. If they explore on their own, it becomes "their" simulation.

Doing the Activity

Heading 1

Students use the simulation to answer questions 1-5 on their worksheet.

For question 6 they will make a chart to show how the speed varies with several different factors. *Possible chart:*

Factor	How Speed Varies
Amplitude	
Frequency	
Damping	
Tension	

Explanation

In-depth background information for teachers and interested students

Wave on a String demonstrates transverse waves. The wave travels to the right in the simulation while the string moves up and down. This idea can be related to the class doing "the wave".

When investigating the speed that the wave travels, students will see that the amplitude, frequency and damping do not affect the speed that the wave travels but that tension does. The speed of sound for example is dependent on the medium it travels through (air, water, on a string). The amplitude affects loudness, the frequency affects the pitch and damping affects how quickly the sound dissipates. The loudness, pitch or damping do not affect how fast sound travels. Tension, on the other hand, does since it is related to the medium the sound travels

through so it does affect the speed of the wave. Another example is earthquake waves. The density and elasticity of the rock affects wave speed not amplitude, frequency or damping.

Key Terms:

In our experience students create their own informal definition of these terms while playing with the sim. Then they are ready to learn a formal definition from the teacher *after* they've played.

- Amplitude – For transverse waves it is the maximum height of the wave. Larger amplitudes create louder sounds.
- Frequency – wiggles per second (moves back and forth)
- Damping – Dissipation of energy with time or distance.
- Tension – how tightly the string is stretched.

Optional Extensions /Modifications

Modifications:

- The PhET website can be viewed in many languages, and learners can experience the simulations in their native tongue to help them fully understand the material being presented.

Optional Extensions:

- I use the Anatomy of Wave lesson after this homework to continue working on the basic properties of transverse and longitudinal waves including resonance.
- Create a wave on a string in the classroom by using a long string/slinky or rope.
    - It should be possible to change amplitude, frequency and tension while oscillating the string/slinky/rope. It is difficult to change damping, however.
- Subject extensions:
    - Sound – investigate the sound sim so that students understand that amplitude relates to how loud sound is and frequency relates to the pitch that we hear. Then discuss how the speed of sound cannot vary with amplitude and pitch or else if you listen to music from far way, it should be a mess!! You would not hear the flutes the same time as the bass cello etc… If it depended on loudness, it would be even stranger.
    - Earthquakes – after this lesson students are more ready to learn about S and P waves and how they travel through the earth. The idea that depending on the part so the earth the wave travels through, it may arrive at a location at a different time.
    - Light – Teach students the relationship between the color of light and the frequency. Also brightness with amplitude. After learning about these ideas, talk about how objects would appear if frequency changed the speed of light. Far away moving objects would be a sort of smeared rainbow.

Wave Basics

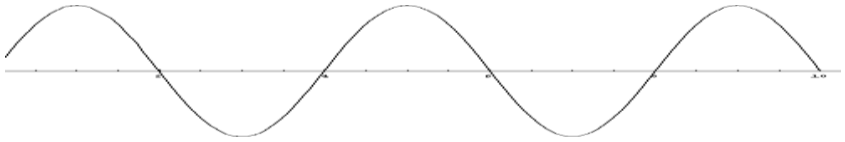
Name: _____

Use the PhET sim "Wave on a String" for the following questions. http://PhET.colorado.edu

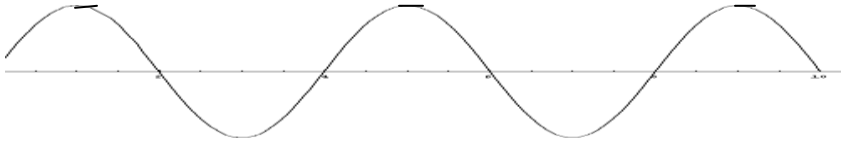
Play around and get familiar with the sim first. Be sure to try out all the buttons.

1. Are you familiar with longitudinal and transverse waves? Which type of wave is being shown by this sim?

2. Use arrows, or draw on the wave, to show what will happen when the **amplitude** is increased:



3. Use arrows, or draw on the wave, to show what will happen when the **frequency** is increased:



4. What direction does each individual part of the string move when a wave travels along it?

5. What direction does the actual wave move (hint, try pulse)?

6. The speed of the wave is how fast it travels from the oscillator/wrench to the clamp/window/loose end. Does the speed vary depending on Amplitude, Frequency, damping or tension? Make a table showing how/if it changes with each.