IMHOTEP'S LEGACY ACADEMY

9.3 The Physics of Music

Grade 9 Activity Plan

Reviews and Updates

9.3 Waves and Sound

Objectives:

1. To understand the law of conservation of energy—with regard to how other forms of energy are converted sound energy.
2. To have a basic understanding of what longitudinal and transverse waves are.
3. To understand how different properties of waves determine sound.
4. To know why sound cannot travel through a vacuum but through solids, liquids and gases.

Key words/concepts: sound, disturbance, music, wavelength, frequency, pitch, amplitude, noise, transverse waves, longitudinal waves, crest, troughs, compression, rarefaction.

Take-home product: slinky

Segment	Details
African Proverb and Cultural Relevance *(5mins)*	A chattering bird builds no nest. **Cameroon**
Pre-test (10mins)	Ask probing questions on students' knowledge of music (could include exciting questions like their favorite artists) Build a beat and encourage all students to participate.
Background (10mins)	Introduce the scientific concepts associated with music.
Activity 1 (15mins)	Describe the key features of waves by creating a human wave, using a speaker and a slinky.
Activity 2 (15mins)	Introduce the concepts of frequency using plastic ruler, PVC pipes and tuning fork.
Activity 3 (15mins)	Using the music boxes provided, describe energy conservation as it relates to sound.
Post-test *(20mins)*	Game and Worksheet

Suggested interpretation of proverb: if one talks a lot, one will not get any work done. Always endeavor to pay attention and concentrate in order to get work done.

Information on some key concepts is available at: http://cnx.org/content/m10943/latest/

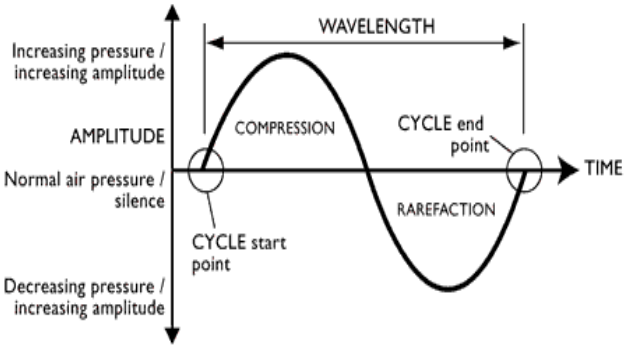
Background Information

The **law of conservation of** energy states that the total amount of energy does not changes in a closed system. Energy can be converted into different forms and it can be transferred by particles or by waves.

Types of Waves

- **Transverse** – causes the particles to vibrate perpendicular to the direction of the wave
- **Longitudinal** – cases the particles to move parallel to the direction of the wave

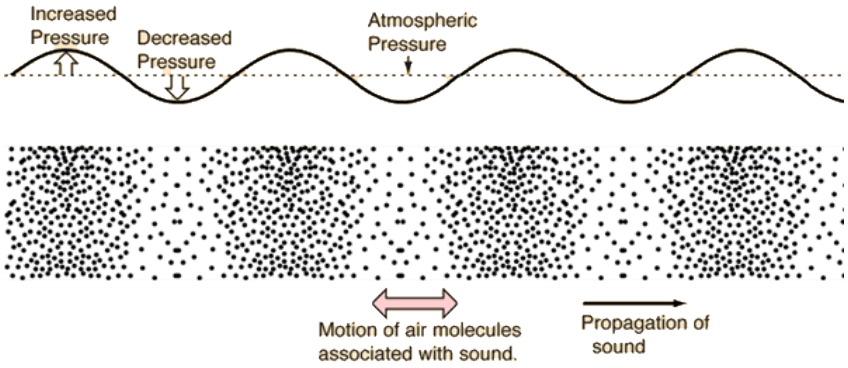
Properties of Waves



- **Amplitude** – the height of the wave (from the resting point to the place of largest displacement
- **Crest** – the highest point on the wave
- **Trough** – the lowest point on the wave
- **Wavelength** – the length of a single wave (the length from one crest to the next)
- **Frequency** – the number of waves within a certain period of time
- The **compression** section of the wave is the high pressure section and the **rarefaction** section of the wave is the low pressure section

Sound and Waves

Sound is produced when objects vibrate, which moves energy through the substance in the form of a **longitudinal wave**. Sound is a type of mechanical wave which means it must travel through a medium. A **vacuum** is a space without matter so sound cannot travel in a vacuum. This is why there is no sound in outer space.



The **loudness** of a sound is determined by the **amplitude** of the sound wave.
The **pitch** of a sound is determined by the **frequency** of the sound wave.

Activity 1a: Creating a Human Wave

Purpose: to be able to describe the various features of a wave such as amplitude, crest, trough, etc.

Procedure:

1. Make students form a line standing side to side.
2. Push and pull the person at the end to form a longitudinal wave.
3. While standing in a line, raise and drop hands consecutively to form a transverse wave.

Activity 1b: Amplitude and Slinky Demo

Suggested format: gather student and illustrate.

Purpose: to know the relationship between amplitude and loudness of sound.

Items	**Quantity**
Speakers	1pair
Salt	a pinch
Music player (ipod)	1
Slinky	11

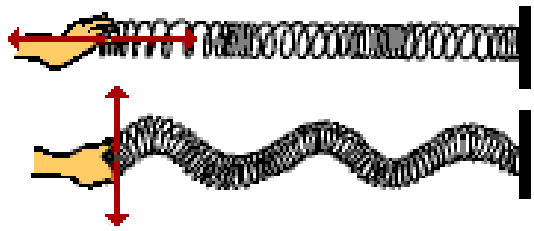
Procedure:

<u>Amplitude demo</u>

1. Connect a music player to a speaker.
2. Place a pinch of salt on the speaker.
3. Ask students to observe what happens to the height of the vibrating salt crystals when the volume is adjusted. The higher the volume, the higher the amplitude and the higher the salt crystals jump.

<u>Slinky demo</u>

1. Hold one end of the slinky, and get a student to hold the other end.
2. Place the slinky on the floor (still holding the ends), maintain a distance of about 2-3.5m from the student, depending on the length of the slinky, one may need to move closer or further apart.

3. 

Slinky waves can be made by vibrating the first coil back and forth in either a horizontal or a vertical direction.

http://physicsed.buffalostate.edu/Wiley/CJ6e/links16.html

Activity 2: Understanding Sounds and Vibrations

Suggested format: gather student and illustrate.

Purpose: To understand the relationship between the length of a musical instrument and frequency/pitch of sound produced from it; and show that sound is produced via vibrations.

Items	**Quantity (for mentor and 10 students)**
Plastic rulers	11
PVC pipes	6pipes of varying lengths
Tuning fork	1
Hammer (something to hit the fork)	1

Procedure:

1. Put a plastic ruler overhanging the edge of a table; hit the ruler and watch it vibrate.
2. Hit the end of PVC pipes of various lengths (but the same material and diameter) with your palm and allow students to observe the nature of the sound produced.
3. Hit tuning fork with hammer (or any other available material). Allow students to listen and observe how the sound fades away as the fork stops vibrating. Also, allow a student stop the vibration by holding the tuning fork
   This should stop the sound too, there by demonstrating that the sound is generated due to the vibration of the tuning fork.

Activity 3: Music Box

Suggested format: makes students form groups of two.

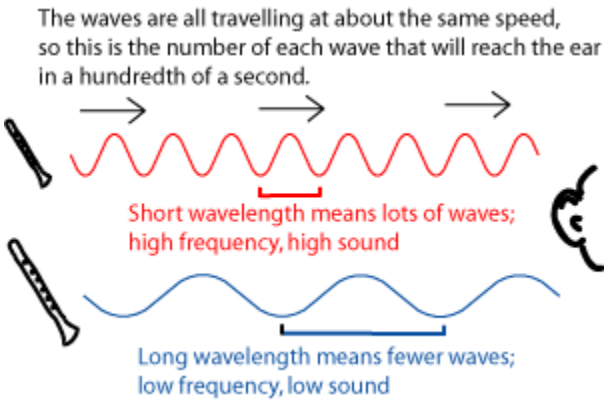
Purpose: To know the energy conversion that occurs in order to produce sound.

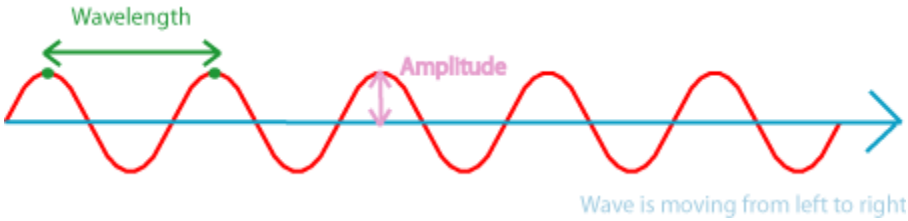
Items	**Quantity (for 10 students)**
Music box	5

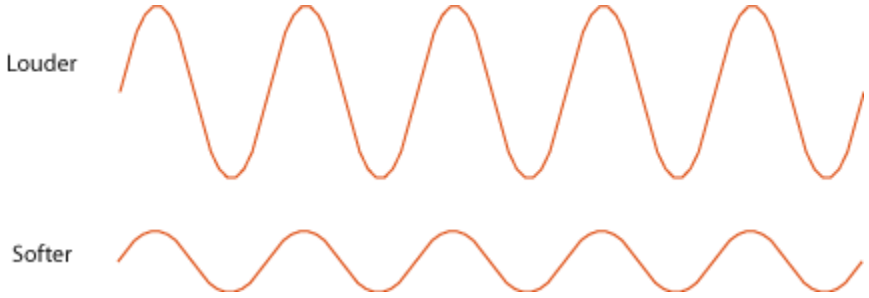
Procedure:

1. Screw-open the music box and turn the knob.
2. Allow students to observe and come up with ideas on how the sound is produced and why the music box plays pleasant notes.

Explanation: when the ratchet lever is twisted, the spring stores up potential energy which is converted to kinetic energy by the spinning barrel and the protrusions on the barrel plucks the bristles of the comb causing them to vibrate and produce sound hence converting kinetic energy to sound energy.


The waves are all travelling at about the same speed, so this is the number of each wave that will reach the ear in a hundredth of a second.
Short wavelength means lots of waves; high frequency, high sound
Long wavelength means fewer waves; low frequency, low sound

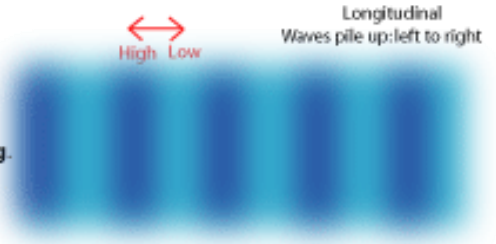

Wavelength
Amplitude
Wave is moving from left to right


Louder
Softer

Sound Waves

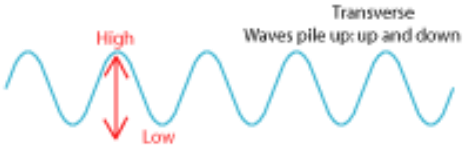
Longitudinal and Transverse Waves

In longitudinal waves, the
waves "pile up" in the same direction that they are moving.
Sound waves are longitudinal waves,
but they are often pictured as if they were transverse,
because its easier to picture.



All waves are moving from left to right

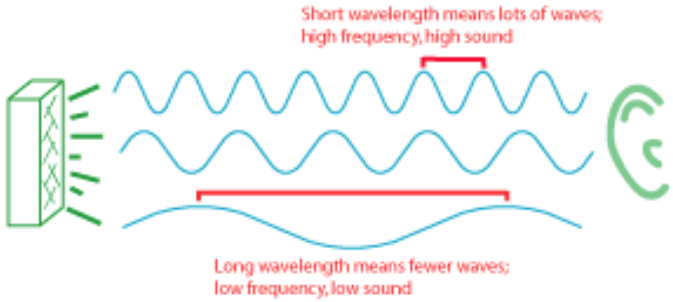
In transverse waves, the
waves "pile up" in a different direction
from the direction that they are moving.
Light waves and water waves are transverse waves.



Frequency

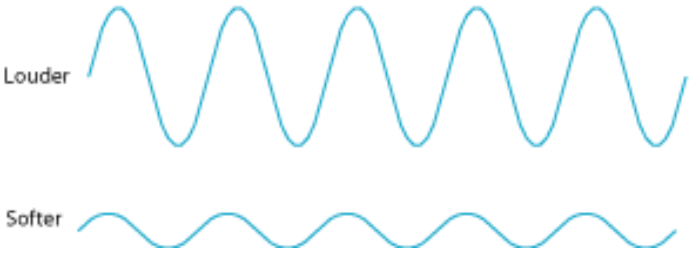
The **longer the wavelength**,
the lower the frequency,
and the **lower the sound**.

The waves are all travelling at about the same speed,
so this is the number of each wave that will reach the ear
in a hundredth of a second.



Amplitude

The **bigger the difference**
in the highs and lows of the waves,
the **louder the sound**.



Post-game: Musical Chairs

This game is played like a normal game of musical chairs but the person who is not able to get a chair is given the opportunity to kick somebody else out of their chair if they ask another student a question that they are unable to answer.

What part of your body is most like a musical instrument and why?

Match each statement with its corresponding term by placing the letter in the blanks provided. Then use these letters to figure crack the code below and solve the riddle. The first one is done for you.

1. _S_ Waves in air caused by vibrations
2. _I_ The distance between the crests of two waves that are next to each other
3. _B_ How high the crests are
4. _O_ Waves that move in a direction perpendicular to the direction it is produced
5. _T_ Waves that travel in the same direction that the wave was produced
6. _C_ How often a single wave goes by
7. _D_ A sound that is a mixture of all wavelengths
8. _E_ A sound organized by people
9. _K_ The ability to do work
10. _A_ Amplitude determines _____
11. _Y_ Low amplitude = _____ sound
12. _W_ High amplitude = _____ sound
13. _N_ Invisible waves moving through the air around us
14. _U_ The higher the volume, the _____ the amplitude
15. _P_ many short waves have _____ frequency
16. _L_ very few long waves have _____ frequency

A. loudness
B. amplitude
C. frequency
D. white noise
E. music
I. wavelength
K. energy
L. low
N. sound
O. transverse
P. high
S. sound waves
T. longitudinal
U. higher
W. louder
Y. softer

N	O	S	E		B	E	C	A	U	S	E	
13.	4.	1.	8.		3.	8.	6.	10.	14.	1.	8.	

Y	O	U		C	A	N		P	I	C	K		A	N	D
11.	4.	14.		6.	10.	13.		15.	2.	6.	9.		10.	13.	7.

B	L	O	W		I	T
3.	16.	4.	12.		2.	5.