1-Exploring Sound as a Mechanical Wave (Teacher Pages)

Activity Overview	The goal of this activity is to investigate sound as a mechanical wave. Sound waves are mechanical waves that require a medium to be conducted. We typically hear because air molecules vibrate, collide with one another, and, in this way, conduct the sound waves to our ears.
Materials	Tuning forks Mallets Plastic cup covered with plastic wrap Water in a plastic cup Sugar (or salt) or rice grains
Guiding Question	How can you make sound visible using tuning forks and other materials like sugar crystals or rice grains on a plastic wrap or water in a plastic cup?

Exploring Sound Using a Physical Model
 	
How can you make sound using tuning forks?
 	
Do all tuning forks make the same sound when tapped on a rubber mallet?
 	
Do tuning forks vibrate when they make sound?
	Step 1: Tuning Forks
	 
	• Provide students two tuning forks with different frequencies. The tuning forks will vary in prong length.
	• Instruct students to hold the tuning fork near their ear.
	  ○ Questions:
	  ▪ Is the tuning fork making a sound?
	  ▪ Is the tuning fork vibrating?
	• Next, tell students to tap the tuning fork on the rubber mallet.
	• Again instruct students to hold the tuning fork near their ear.
	  ○ Questions:
	  ▪ Is the tuning fork making a sound?
	  ▪ Is the tuning fork vibrating?
	• There are several different tuning forks to choose from. Students should select a different tuning fork, tap the fork on the mallet and listen carefully to the sound produced.
	  ○ Questions:
	  ▪ Does the fork produce the same sound as the tuning fork tapped earlier? How are the tuning forks different from one another?
	
	Step 2: Using sugar crystals to explore sound vibrations
	 
	• Instruct students to use the cup covered in plastic wrap for step 2.
	• Place a pinch of sugar crystals on the surface of the plastic wrap.
	• Next, tap the tuning fork on the mallet and hold the vibrating fork as close to the surface of the plastic wrap and sugar crystals as possible.
	  ○ Questions:
	  ▪ What happened to the sugar when the vibrating tuning fork was held close to the plastic wrap?
	A physicist will tell you that sound waves are mechanical waves. Can you identify any evidence from this investigation to support that claim?

Can sound propagate in water?
 	
The ripples which appear in the water when the vibrating tuning fork is held close are water waves that illustrate energy transfer by sound.
	Step 3: Exploring Sound with Water
	 
	• Students should select a tuning fork, mallet, and a cup of water.
	• Instruct students to tap the tuning fork on the mallet and hold the fork near their ear. Listen to the sound created.
	• ~~Can you make sound visible?~~ Instruct students to move the tuning fork so that it is near the surface of the water. **It is important to note that when you strike a tuning fork on a mallet, the prongs of the tuning forks are moving back and forth rapidly. This vibration causes the air around the prongs of the tuning fork to vibrate as well. Vibrations of particles in the air are not visible, we cannot see sound. However, we can see the effects of the vibrating tuning fork when the fork is held close to water and ripples form on the surface of the water.**
	  ○ Question:
	  ▪ Can you see ripples in the water when the tuning fork is held close to the surface? Why do you think ripples form on the surface of the water?
	• Next, tap the tuning fork on the mallet and touch the tuning fork to the surface of the water.
	  ○ Questions:
	  ▪ What happens when you touch the vibrating tuning fork to the surface of the water?
	  ▪ How can you tell if the tuning fork is vibrating?

Something to think about	• Statement: Sound is a mechanical wave.
	  ○ Ask students if they can find evidence from their observations and experiences with the activities described to support that statement.
	  ▪ Ask students to think about the three sound related activities completed during this investigation and draw conclusions from it.

Linking to the Standards	Next Generation Science Standards: **4-PS4-1.** Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move. <u>Disciplinary Core Ideas:</u> • Waves, which are regular patterns of motion, can be made in water by disturbing the surface. When waves move across the surface of deep water, the water goes up and down in place; there is no net motion in the direction of the wave except when the water meets a beach. <u>Science and Engineering Practices:</u> • Develop a model using an analogy, example, or abstract representation to describe a scientific principle. <u>Crosscutting Concepts:</u> • Similarities and differences in patterns can be used to sort, classify, and analyze simple rates of change for natural phenomena.

Assessment	Formative assessment is suggested: • Use the questions suggested at each step as a means to assess students' understanding. ○ Challenge students collaborating in teams to analyze their observations and interpret their data to develop supporting evidence to describe sound as a mechanical wave. • The questions listed on the student pages can also be used as a means of assessment

Sound Science: **Exploring Sound as a Mechanical Wave** [Teacher page: Answer sheet]

Name: _____

Step 1: Testing Tuning Forks

1. Do all tuning forks make the same sound? ___No_____ Explain your answer in the space below:

A tuning fork is an acoustic resonator which will vibrate at a specific pitch when tapped on a hard surface [rubber mallet]. The tuning forks are different in several ways (a) the prongs of the forks are different lengths and (b) the tuning forks produce different frequencies (pitch) when tapped making high or a low pitched sound. The tuning forks could also be different in colors and may weigh differently. This may be an indication that the tuning forks could be made up of different metals (alloys).

2. How do you think the tuning fork make a sound when you tapped it on a mallet?

The prongs of the tuning fork were vibrating after being tapped on the mallet. The vibration is responsible for the sound the tuning fork makes when tapped.

3. Could you stop the sound made by the tuning fork? __Yes_____ How did you do that?

If the student holds the prongs of the vibrating tuning fork, the vibrations will stop.

Step 2: Making Sound Visible

1. What happens to the grains of sugar crystals students placed on the plastic wrap covering the mouth of the cup?

The sugar crystals also vibrate. Once again, the energy in the vibrating prongs is transferred to the plastic wrap. As the plastic wrap vibrates, the sugar crystals appear to jump. This is additional evidence that sound is a mechanical wave which can actually cause other objects or materials to vibrate. Students were able to observe this phenomenon in Steps 2 and 3.

Step 3: Making Sound Visible

1. How does the water change when the vibrating tuning fork is held close to the surface of the water?

It is important to remember that the tuning fork produce vibrations after being tapped on the mallet. The vibrating prongs cause vibrations in the air and these vibrations are transferred through air molecules which we are able to hear. When the vibrating fork is held close to the surface of water, the water's surface also vibrates and ripples appear. If the student touches the vibrating prongs to the water, the water splashes out of the cup. The energy is transferred from the vibrating prongs to the water in the cup.

Sound Science: **Exploring Sound as a Mechanical Wave**

Name: _____

Step 1: Testing Tuning Forks

1. Do all tuning forks make the same sound? ___ _____ Explain your answer in the space below:

2. How do you think the tuning fork make a sound when you tapped it on a mallet?

3. Could you stop the sound made by the tuning fork? _____ How did you do that?

Step 2: Exploring Sound with Sugar Crystals

4. What happens to the grains of sugar placed on the plastic wrap covering the mouth of the cup?

Step 3: Exploring Sound with Water

1. How does the water change when the vibrating tuning fork is held close to the surface of the water?