SUGGESTED ACTIVITIES

(*Sound*)

From *Invitations to Science Inquiry 2nd Edition* by Tik L. Liem:

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From *Harcourt Science* Teacher's Ed. Unit E: (For ALL grade levels)

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THE COAT HANGER CHURCH BELL

A. Question: *Does sound travel faster through air?*

B. Materials Needed:

1. A pencil with eraser end.
2. A short piece of string.
3. A metal wire coat hanger.

C: Procedure:

1. Tie the string tightly to the pencil (opposite eraser end) and to the hook of the coat hanger.
2. Place the eraser end of the pencil in the ear and while holding it there, swing the coat hanger and let it hit a solid object (or hit the hanging coat hanger with another pencil).

D: Anticipated Results:

Students should be able to hear the sound and acknowledge the fact that sound travels faster through solid than through air.

E: Thought Questions for Class Discussion:

1. What do you hear with the ear in which the pencil is placed?
2. Why didn't you hear the coat hanger vibrations through the air?
3. What was the source of sound?
4. Describe how the vibrations reached the ear from the source.
5. What other objects could we hang from the string for a source of sound?
6. What would you do to hear someone's heartbeat?
7. What other applications of this principle do you encounter in daily life?

F: Explanation:

The coat hanger hitting a solid object would vibrate and act as the source of the sound. The vibrations travel through the string and the pencil to the ear drum. As the string and pencil are solids, it is much easier for the sound waves to travel through them than through the air. It is the vibrations of the pencil that are immediately transferred to the ear drum, that make the sound so audible.

Similarly, we place our ear against someone's chest, in order to hear his/her heartbeat. By placing our ear against the railroad tracks, we can hear a train approaching long before we can hear the train sounds through the air.

THE SODA CAN TELEPHONE

A. Question: *Through where is it easier for sound to travel, gases or solids?*

B. Materials Needed:

1. Two empty soda pop cans.
2. A string (same length as the classroom).
3. Nail and hammer.
4. Can opener.

C: Procedure:

1. Cut one end of the two soda cans completely with the can opener.
2. Punch a hole in the center of the other end with the nail and hammer.
3. Thread the string though the holes, such that the closed ends face each other and tie a large knot at the end of the string, so that it will not slip out of the hole.
4. Let two students stand at the far ends of the classroom, hold the cans keeping the string tight, and alternately speak softly and listen in the can.

D: Anticipated Results:

Students should be able to listen to each other when talking through the 'telephone'.

E: Thought Questions for Class Discussion:

1. How did the sound travel to the student's ear?
2. What did speaking in the can do to the bottom of the can?
3. Why did the string have to be held tightly?
4. Would this set-up work if we had a solid pipe or bar instead of the string between the two cans?
5. Could a whisper be heard from one end of the classroom to the other end, through the 'telephone'? Through the air?

F: Explanation:

By talking into the can, the vibrations from the vocal chords make the air in the can vibrate. Theses vibrations are transferred to the bottom of the can, which in turn vibrate. The same vibrations are traveling along the string in longitudinal waves, making the bottom of the other can vibrate. The air in the receiving can is thus reproducing the exact vibrations of the first can, resulting in the same voice of the original sender. A whisper could not be heard through air compared to a whisper through the 'telephone'. The waves travel through the solid string in the latter case, and it is much more facilitated. **Sound travels faster and easier through solids than through gases.**

WHICH AMPLIFIER WORKS BEST?

A. Question: *How can we amplify sound?*

B. Materials Needed:

1. A cheap polystyrene comb for each student.

C: Procedure:

1. Hold a comb in the air and pluck the teeth with your fingernail.
2. Ask students: “How can I amplify the sound?”
3. Hold the end of the comb against the table top and pluck again.
4. Distribute different combs to each of the students and let them try to hold against different material in the class and listen which of them gives the best amplification.
5. Point out to the students that the different lengths of the teeth give different pitches (simple tunes might be plucked by the teacher).

D: Anticipated Results:

Students should observe different amplifications when placing the comb against different materials.

E: Thought Questions for Class Discussion:

1. How did the sound get amplified?
2. Why do we hear the sound when the comb is held against other materials?
3. Which factors are influencing the loudness of a sound?
4. What material is the best amplifier for the comb?
5. What made the different pitches in the plucking of the teeth?

F: Explanation:

In holding the comb against the table top while plucking the comb’s teeth, it was not only the teeth and the comb that were vibrating but the whole table top vibrated with it. This means an increased surface of the vibrating object, which is the main reason for an increasing loudness or an amplification. The factors that are affecting the loudness of sound are: 1.distance from sound source; 2. the amplitude of the wave, i.e., how hard the teeth are plucked; 3. the surface area of the vibrating object.

Un general, wood sheets and wooden boxes are the best materials for quality in sound amplification. This is why sound boards (for the piano), guitar and violin bodies, and speaker boxes are all made out of wood.

THE REVERSING PITCH

A. Question: *Does mass affect pitch of sound?*

B. Materials Needed:

1. Three identical empty bottles.
2. A wooden stick or ruler.

C: Procedure:

1. Fill the three identical bottles with different amounts of water, and ask the students: "Which will give the highest tone when I hit it on the side with the ruler?"
2. Lift the bottle with 2 fingers at the neck and hit the side of each bottle with the ruler and listen to the pitch of the tone.
3. Now ask the students: "Will bottle C always give the highest pitch?"
4. Blow over the bottle mouth, by placing your lower lip on the bottle rim and blowing a narrow stream of air almost horizontally over the mouth. Listen to the tone/pitch.

D: Anticipated Results:

Students should observe a lower pitch when they hit or blow over the bottle with the greatest mass of water.

E: Thought Questions for Class Discussion:

1. What was vibrating when the bottles were hit on the sides?
2. What produced the tone when the bottles were blown into?
3. What is generally affecting the pitch of a tone?
4. Would different liquids of the same height in the bottles affect the pitch of the tone? When hitting the bottle? When blowing over the bottle opening?

F: Explanation:

When the bottles were hit on the side with the wooden ruler, the bottle and the water vibrated to produce the sound pitch. The more water there was in the bottles, the lower the pitch. When blowing over the bottle mouth, the air above the water in the bottle vibrated to produce the tone. The larger the column of air in the bottle, the lower the pitch. If we generalize over theses two events we can say that **the more the mass of the material that vibrates, the lower the pitch it produces.** This is why the lower and deeper tones on the guitar or piano are coming from the larger and longer strings. By shortening the strings (by placing the finger on a fret), the higher the pitch obtained.

By using different liquids in the bottles, but filling them to the same height, the pitch would probably be different when hit on the side (because of the different masses of the liquids), but stay the same when blown over the mouth (because the air column stays the same).

THE STRAW OBOE

A. Question: *Does the pitch of sound get affected by length of vibrating air?*

B. Materials Needed:

1. Two plastic drinking straws.
2. A pair of scissors.

C: Procedure:

1. Cut small holes on one side of a straw, about 1 to 1.5cm apart from each other.
2. Flatten one end of both straws and cut triangle pieces out.
3. Place the end of the straw with holes in the mouth holding your lips just where the cut ends are, and blow until an oboe sound is produced. (Shifting the straw somewhat in or out of the mouth might help obtaining the sound.)
4. Place three fingers of the left hand on the farthest three holes and three fingers of the right hand on the nearest three holes of the straw; and open or close holes for the different pitches.
5. Now blow the straw with no holes. Make the oboe sound, take the pair of scissors and cut small pieces off the straw while blowing.

D: Anticipated Results:

Students should observe different pitches when closing or opening a hole on the straw.

E: Thought Questions for Class Discussion:

1. What was actually producing sound?
2. What pitch did we get when all holes were closed, compared to when all holes were open?
3. What does opening or closing a hole in the straw really mean in terms of vibrating an air column?
4. Which musical instruments are based on this principle?

F: Explanation:

This demonstration especially shows that the pitch of a note is determined by the length of vibrating air. By cutting the end of the straw we are actually making two reed-like protrusions, which when air is blown through them, will vibrate and produce the oboe sound. The air column in the straw is vibrating with it and produces the pitch. With the holes in the straw we are able to make the vibrating air column longer or shorter, by either closing or opening a hole or several holes at a time.

This principle is applied in the flute, clarinet, oboe, saxophone, and their varieties soprano, alto, tenor and bass instructions.

PLUCK A RUBBER BAND

A. Question: *What are the factors affecting pitch?*

B. Materials Needed:

1. A small medium thick rubber band.

C: Procedure:

1. Place the rubber band between thumb and forefinger, and stretch it a little.
2. Hold it close to your ear and pluck it with the other hand.
3. Stretch the rubber band by widening the gap between thumb and forefinger and pluck again. What pitch do you hear now?

D: Anticipated Results:

Students should observe that after widening the gap between the fingers by stretching the rubber band, the pitch stayed about the same.

E: Thought Questions for Class Discussion:

1. Did the pitch of the sound change after widening the gap?
2. Which properties of the rubber band changed while being stretched?
3. What property changes when a guitar string is tightened?
4. Which properties do not change when a guitar string is tightened?
5. How do these properties compare to those of the rubber band?
6. In what ways can we change the pitch of a guitar string?
7. How could we change the pitch of the rubber band?

F: Explanation:

When the rubber band stretched and was plucked again, the pitch of the sound was staying about the same, if not getting a little lower. This is definitely contrary to what one would expect, which is a higher pitch for the stretched rubber band.

When a guitar string is tightened, the pitch becomes higher, because the tension is higher, thus the string vibrates with higher frequency; the length and the density of this string, however, is staying constant.

With the stretching of the rubber band, all three properties: tension, length, and density change. The higher tension tends to increase the pitch, but this is compensated by the increase of the length, which tends to lower the pitch.

When the length of the rubber band is held constant, the pitch changes similarly like a regular guitar string. This can be done by stretching the rubber band over an empty open box.