To Think About... The longest organ pipes are about 11 m long. A flute, about 0.5 m long, makes musical sound in the same way. How do a flute and organ pipes produce sound?

For You To Do:

1. Carefully cut a drinking straw in half. Cut one of the halves into two quarters. Cut one of those quarters into two eighths. Pass one part of the straw out to one member of your group.

2. Gently blow into the top of the piece of straw.
   a. Describe what you hear.
   b. Listen as the members of your group blow into their pieces of straw one at a time. Describe what you hear.
   c. Write a general statement about how changing the length of the straw changes the pitch you hear.

3. Now cover the bottom of your straw piece and blow into it again. Uncover the bottom and blow again.
   a. Compare the sound the straw makes when the bottom is covered and then uncovered. Write a general statement about how changing one end of a given length straw from covered to uncovered affects the pitch you hear.
   b. Listen to the members of your group blow into their straw pieces with the bottoms covered and then uncovered. Write a general statement about how changing the length of the straw changes the pitch you hear when one end is covered.

4. Obtain a set of four test tubes. Leave one empty. Fill the next halfway with water. Fill the next three-quarters of the way. Fill the last one seven-eighths of the way.

5. Give each test tube to one member of your group. Blow across your test tube.
   a. Describe what you hear.
   b. Listen as members of your group blow, one at a time, across their test tubes. Record what you hear.
   c. What pattern do you find in your observations?
   d. Compare the results of blowing across the straws with blowing across the test tubes. How are the results consistent?
Reflecting on the Activity and the Challenge

In this activity you have observed the sounds produced by different kinds of pipes. If the pipe is cut to a shorter length, the pitch of the sound increases. Also, when the pipe is open at both ends, the pitch is much higher than if the pipe were open at only one end. You have seen how simple drawings of standing waves in these tubes help you find the wavelength of the sound. If the tube is closed at one end, the air has zero displacement at that end. If the tube is open at one end, the air has maximum displacement there.

For your sound show, you may decide to create some “wind” instruments using test tubes or straws, or other materials approved by your teacher. When it comes time to explain how these work, you can refer to this activity to get the physics right.

Physics To Go

1. a) You can produce a sound by plucking a string or by blowing into a pipe. How are these two ways of producing sound similar?  
   b) How are these two ways different?

2. a) For each piece of straw your group used, make a full-sized drawing to show the standing wave inside. Show both the straw closed at one end and open at both ends.  
   b) Next to each drawing of the standing waves, make a drawing, at the same scale, of one full wavelength. You may need to tape together several pieces of paper for this drawing.  
   c) Frequency times the wavelength is the wave speed. The speed is the same for all frequencies. From your answer to Part (b), what can you predict about the frequencies of the standing waves in the straw pieces?  
   d) How well do your predictions from Part (c) agree with your observations in this activity?
3. a) What is the length, in meters, of the longest organ pipe? 
b) Assume this pipe is closed at one end. Draw the standing 
wave pattern. 
c) For this pipe, how long is the wavelength of this standing 
wave? 
d) Why does a long wavelength indicate that the frequency 
will be low? Give a reason for your answer.

4. a) Suppose you are listening to the sound of an organ pipe 
that is closed at one end. The pipe is 3 m long. What is 
the wavelength of the sound in the pipe? 
b) The speed of sound in air is about 340 m/s. What is the 
frequency of the sound wave? 
c) Now suppose you are listening to the sound of an organ 
pipe that is open at both ends. As before, the pipe is 3 m 
long. What is the wavelength of the sound in the pipe? 
d) What is the frequency of the sound wave?

5. Suppose you listen to the sound of an organ pipe that is 
closed at one end. This pipe is only 1 m long. How does its 
frequency compare with the frequency you found in 
Question 4, Part (b)?

6. Waves can spread into a region behind an obstruction. 
a) What is this wave phenomenon called? 
b) Draw a diagram to illustrate this phenomenon.