The Virginia Instructors of Physics

CONDUIT CHIMES

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Va. SOL:

PH.9 The student will investigate and understand how to use models of transverse and longitudinal waves to interpret wave phenomena. Key concepts include

a) wave characteristics (period, wavelength, frequency, amplitude, and phase);
b) fundamental wave processes (reflection, refraction, diffraction, interference, polarization, Doppler effect); and
c) light and sound in terms of wave models.

National Standards:

Waves, including sound and seismic waves, waves on water, and light waves, have energy and can transfer energy when they interact with matter.

Topic/Concept

This is a demonstration of how sound interference can be generated in open tube pipes to form notes and thereby play songs. The specific structure of the chimes can be used to help explain nodes and antinodes.

Materials

- 20 feet _ inch electrical conduit
- pipe cutter/hack saw
- Metal sandpaper/file to remove sharp edges
- 3/32 in metal drill bit/power drill
- Fishing Line
- PVC pipe, fittings and pipe cutter for stand
- Metal spoon(s)

Safety Considerations

When constructing the chimes, make sure to wear ear and eye protection due to the metal filings.

Presentation

I play a simple song on the chimes. I discuss how the interference in an open and closed end tube are formed. This demonstration is done along with a demonstration with a water column. Following this, I take apart the chimes and allow students to play songs on them. The chime song book is still under construction.

How the physics is demonstrated

In this demonstration, the chimes are specific lengths to generate a tone at a particular frequency, which is an actual note. The chimes are set up for the fundamental harmonic. The suspension point is at the first node to allow appropriate sound vibration in the tube. Euler's equation is used to calculate the actual pipe lengths.

Construction and Tips Regarding the Demonstration

All the materials can be purchased at any hardware store. The tubes are cut (a pipe cutter is recommended over a hacksaw due to the accuracy of a horizontal cut on the tube and drilled to the following lengths:

Note	Frequency	Tube Length	Suspension Point
6C	1047	13 5/8	3 1/16
6C#/Db	1109	13 1/4	2 15/16
6D	1175	12 7/8	2 7/8
6D#/Eb	1245	12 1/2	2 13/16
6E	1319	12 1/8	2 3/4
6F	1397	11 13/16	2 5/8
6F#/Gb	1480	11 1/2	2 9/16
6G	1568	11 1/8	2 1/2
6G#/Ab	1661	10 13/16	2 7/16
6A	1760	10 1/2	2 3/8
6A#/Bb	1865	10 3/16	2 5/16
6B	1976	9 15/16	2 1/4
7C	2093	9 5/8	2 3/16
7C#/Db	2217	9 3/8	2 1/8
7D	2349	9 1/8	2 1/16
7D#/Eb	2489	8 7/8	2
7E	2637	8 9/16	1 15/16
7F	2794	8 3/8	1 7/8
7F#/Gb	2960	8 1/8	1 13/16
7G	3136	7 7/8	1 3/4
7G#/Ab	3322	7 5/8	1 11/16
7A	3520	7 7/16	1 11/16
7A#/Bb	3729	7 1/4	1 5/8
7B	3951	7	1 9/16
8C	4186	6 13/16	1 1/2

When drilling, you have to use a powerful drill; a drill that runs on batteries may not have the power required to drill through the tubes. Make sure you file off any loose metal shavings or

rough edges where you cut and drilled the hole. Not doing this may lead to premature strings being broken and trips to the clinic with cut fingers.

Cut a 10 inch piece of fishing line and thread it through the hole and then tie the end of the fishing line.

I constructed a platform on which to hang the chimes. I used 1 inch PVC pipe with T and elbow fittings to connect the hanging bars.

You can make base chimes as well or change tube sizes(see references for details). "Chuck's Chimes" website contains a calculator that will allow you to determine the appropriate length for any size of tube.

Be as precise as you can measuring both tube length and the suspension point. As you can see from the table, a small difference in length can change to tone of the chime.

Sources & References

"Chuck's Chimes" – Retrieved November 21, 2004, from http://www1.iwvisp.com/cllsj/windchimes/

Jim Haworth. "Making Wind Chimes" Retrieved November 21, 2004, from http://www.geocities.com/teeley2/chimeart.html

Tom Hite. "An Engineering Approach to Wind Chimes" Retrieved November 21, 2004 from http://home.fuse.net/engineering/Chimes.htm