

Steam Whistle

Category: Physics: Sound & Waves

Type: Make & Take

Rough Parts List:

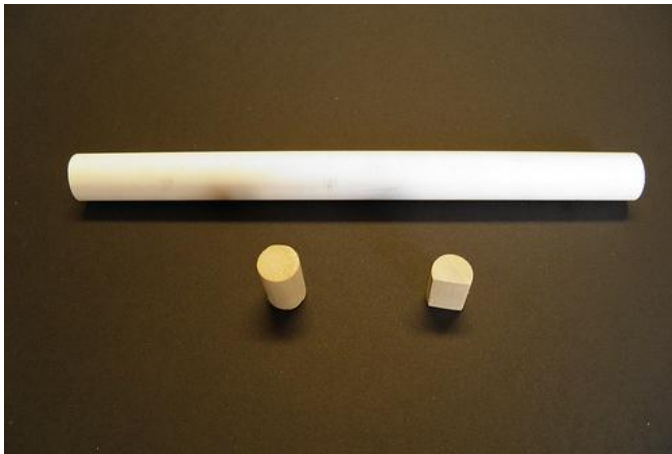
1	½" - 1" Diameter PVC pipe
1	½" - 1" Diameter Wood dowel

Tools List:

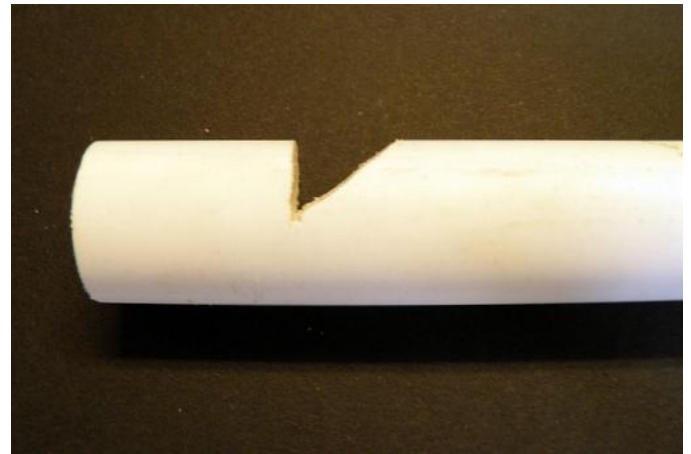
Fine toothed wood saw & miter box or scroll saw
Chisel



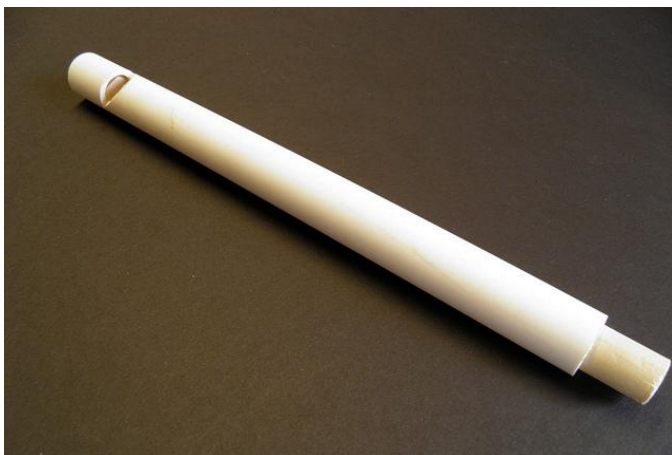
How To:



Cut a 1" piece of dowel. Cut another 1" piece of dowel, this time with 1/3 of the circle cut or chiselled off.



Cut a notch into the PVC pipe, 1" from the end to make the mouth of the whistle. Make sure the notch depth is less than half the width of the PVC.



Insert the 1" round dowel into the bottom of the whistle to create a plug.



Insert the other dowel into the top of the whistle, positioning it so the flat side is "up," facing the mouth. Blow!

Fine Points:

- Before you start, you can try to blow across the top of your PVC tube while covering the bottom of it with the palm of your hand. See if the sound you hear is the same as the one you get once you've made your whistle. Bottles can also be blown like this.
- To accommodate the dowels inserted at both ends of the pipe, cut the PVC pipe 2" longer than the desired length of the whistle.
- PVC pipes and dowels are not consistent in diameter so you might need to add some masking tape to the dowel plugs to keep them from falling out.
- You can also connect some kind of stopper to a long stick so it can slide up and down in the tube to see if there is any difference in sound. See the activity called "PVC Slide Whistle."
- Playing this whistle should be easy, but if it doesn't work the first time, there are several variables to adjust:
 - Size and angle of the cut in the PVC
 - Fraction of dowel cut off from the full round
 - Smoothness of the cut in the PVC

Concepts Involved:

- Flutes and whistles make sound because the air trapped inside them can resonate. As you blow, the pressure inside the tube increases then decreases as the stream of air alternatively travels into the tube and out of the whistle mouth causing the air to vibrate.
- The frequency of the vibration is determined by the length and diameter of the whistle tube. The diameter of the tube affects the whistle's playing characteristics.

Focus Questions:

1. How could you change the pitch of this whistle?
2. How could you change the volume?
3. What happens if you cover the mouth of the whistle with your finger while you blow?

Elaboration:

The specific pitch, or frequency, of the whistle is determined by the interior length of the tube-- from the top to the bottom plug. While the whistle's length determines the natural frequency it will play, blowing extra hard (overblowing) on the whistle can cause the pitch to shift upwards to a quieter, breathy sounding overtone. A simple approximation for pitch is $F = V/4L$, where the frequency (F) will equal the speed of sound (V) over 4 times the length of your whistle tube (L), as closed tubes tend to resonate with a quarter wave length and multiples of this (3/4, 5/4, etc.).

For more information, see [the Wikipedia article](#) on "acoustic resonance." Try building whistles of different lengths and diameters. What happens if you make a short, wide whistle? What about a long, skinny whistle? Some combinations of width and length will not make a sound – if it's too short and too wide, or too long and too skinny. You may hear different sounds arising, including breathy overtones which may be at a higher frequency and require you to blow harder.

Links to k-12 CA Content Standards:

Grades k-8 Standard Set Investigation and Experimentation

Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other strands, students should develop their own questions and perform investigations.

Grade 2 Standard Set 1: Physical Sciences

1.g. Students know sound is made by vibrating objects and can be described by its pitch and volume.

Grade 3 Standard Set 1: Physical Sciences

1.d. Students know energy can be carried from one place to another by waves, such as water waves and sound waves, by electric current, and by moving objects.

Grade 9-12 Standard Set 4: Waves

4.a Students know waves carry energy from one place to another.

4.d. Students know sound is a longitudinal wave whose speed depends on the properties of the medium in which it propagates.

Grades k-12 Mathematical Reasoning:

1.0 Students make decisions about how to approach problems:

1.1 Analyze problems by identifying relationships, distinguishing relevant from irrelevant information, sequencing and prioritizing information, and observing patterns.

1.2 Determine when and how to break a problem into simpler parts.

2.0 Students use strategies, skills, and concepts in finding solutions:

2.1 Use estimation to verify the reasonableness of calculated results.

2.2 Apply strategies and results from simpler problems to more complex problems.

2.3 Use a variety of methods, such as words, numbers, symbols, charts, graphs, tables, diagrams, and models, to explain mathematical reasoning.

2.5 Indicate the relative advantages of exact and approximate solutions to problems and give answers to a specified degree of accuracy.

3.0 Students move beyond a particular problem by generalizing to other situations:

3.1 Evaluate the reasonableness of the solution in the context of the original situation.

3.2 Note the method of deriving the solution and demonstrate a conceptual understanding of the derivation by solving similar problems.

3.3 Develop generalizations of the results obtained and apply them in other circumstances.