

Ruben's Tube Operating Instructions



Safety

Since this demonstration deals with open flames, safety should be a primary concern. Always have a fire extinguisher within close proximity while operating the Ruben's Tube. Keep flammable objects away from the tube when it is in operation. If a smell of gas is detected at any time while the flames are lit the gas line should be turned off immediately. There is most likely a leak somewhere on the tube that will need to be sealed. Any observers should be at least six feet from the tube at all times.

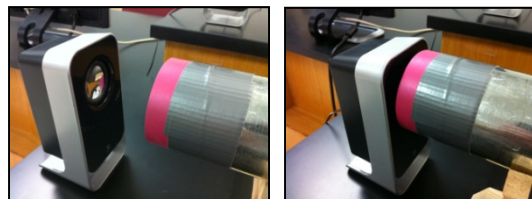
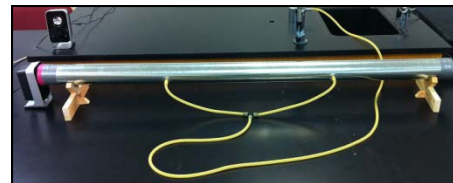
Required Software

In order to produce waves, a tone generator program will be needed. "Visual Analyzer 2011" is a good program that will produce a single tone of any given frequency. The program is free-ware and can be downloaded from <http://www.sillanumsoft.org/download.htm>



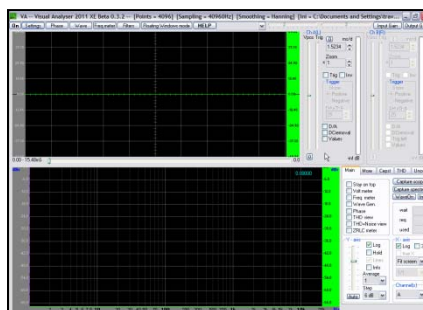
Equipment Setup

1. Setup the Ruben's Tube apparatus on an open table away from any flammable objects. If possible the demonstration should be performed in a room that can be darkened and is well ventilated.
2. The hose connecting to the tube should be attached to the gas source, such as a propane tank or natural gas hookup in a science classroom. Be sure that the hose is connected securely so that there will not be any leaks.
3. Place one of the computer speakers directly in front of the diaphragm. The speaker should be centered as much as possible in the center of the diaphragm. If necessary, use a book to ensure that the speaker is at the right height. Make sure that the speaker is as close to the diaphragm as possible without being in direct contact.
4. Plug the speakers into a power source and connect the audio cable to the headphone jack on the computer or laptop that will be used for the demonstration.
5. To light the tube, turn on the gas and immediately place an open flame above the holes in the top of the tube. They will light after a few seconds. Wait two or three minutes for the gas to build up in the tube. The flames should reach a height of about three inches.

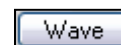


Producing Standing Waves

1. A Ruben's Tube that is 5 feet in length can produce standing waves with as many as six or seven antinodes. Typically lower frequencies (less than 1,000 Hz) will produce taller waves.
2. Open the Visual Analyzer 2011 Program by double clicking on the "VisualAnalyzer2011.exe" file.



3. Click the "Wave" button in the top menu to open the waveform generator. This is the feature that will produce tones of various frequencies.

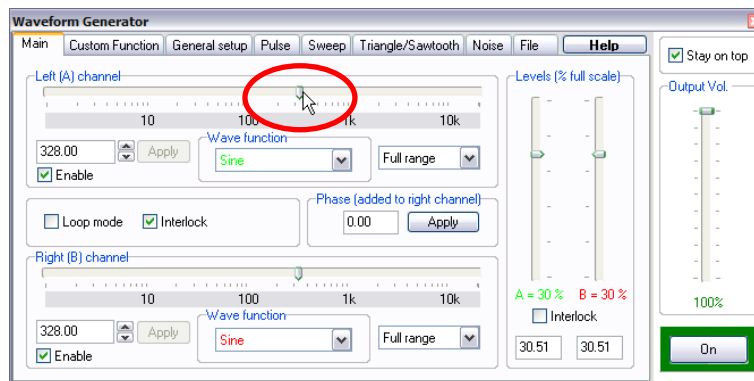


4. Check the "Interlock" box so that both speakers will play with the same frequency.



5. Click the "On" button to begin generating a tone. The flames in the tube should react in some way. Adjust the volume on the speakers so that it is not so loud that it damages them.

6. Move the slider to the left or right to change the frequency of the sound (see below).



7. The flames will produce standing waves at certain frequencies. More waves are produced as the frequency increases, and as a result the wavelength of each wave decreases. Taller flames indicate that the gas is compressed at that position, while shorter flames indicate that the gas is rarefied at that position.



8. When finished, turn off the gas but allow the flames to keep burning so that all of the gas in the tube will be consumed.