Sound Pipe

Introduction

A sound pipe, which many think is just an annoying toy for young children, can actually help you teach some very basic and more complex scientific principles.

Concepts

- Doppler effect
- Quantum theory
- Wave theory

Materials

Sound pipe

Safety Precautions

Be sure the area directly above and around the demonstrator is clear.

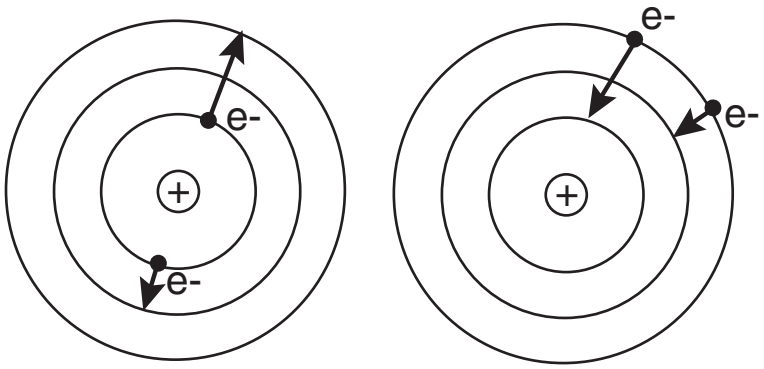
Procedure

1. Spin the sound pipe slowly above your head to produce a low resonant tone.
2. Now spin the sound pipe slightly faster to show that the tone is the same.
3. Then spin it slightly faster until it jumps to the next resonant frequency.
4. Spin the sound pipe at a variety of different speeds to produce all five resonant tones.

Discussion

The Doppler effect is the change in the observed frequency of sound waves due to the relative motion between the wave source and the observer. The pitch (frequency) of the sound emitted by a moving object seems to increase as the object approaches and to decrease as it recedes. The rotating sound pipe demonstrates the Doppler effect as it alternately moves towards and away from the observers.

When a sound pipe is swung in a circular motion, air passes over the open end and causes an air disturbance there. The air inside the tube then resonates and a standing wave is established. When enough energy has been added by swinging the tube faster, the sound pipe jumps spontaneously to the next highest resonance frequency. This behavior can be used as an analogy to describe how electrons move about in an atom.



Absorption of Energy Emission of Light

Figure 1. The Bohr Atom. When energy is added to the atom, the electrons absorb energy and jump to higher energy levels. When the electrons fall back to the lower energy levels, light (photons) is given off.

Niels Bohr developed the planetary model of the atom. In this model, he used Max Planck's quantum theory. Quantum theory states that energy from an atom is given off in packets called photons (instead of being given off continuously).

The Bohr atom assumes that electrons exist in an atom at specific energy levels. When energy is added to the atom, the electrons gain energy and move to higher energy levels. When the electrons fall to lower energy levels, the energy is given off in the form of photons. In the atom, any amount of energy can be added, but the electrons can only accept or release the energy in specific amounts, or quanta. Many students have difficulty understanding that the electrons do not exist *between* energy levels at any point in time. The sound pipe demonstrates this same characteristic; it only produces sounds at five specific frequencies. When the sound changes, it does so spontaneously; that is, it jumps or falls to the next frequency without existing at any frequencies in between.

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References

Lafferty, P. and Rowe, J., Eds. The Dictionary of Science; Simon and Schuster: New York, 1993.

Becker, B. Twenty Demonstrations Guaranteed to Knock Your Socks Off—Volume II; Flinn Scientific: Batavia, IL, 1997.

The *Sound Pipe* is available from Flinn Scientific, Inc.

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AP9241	Sound Pipe

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.