Standing Wave Generator

Introduction

Teachers can demonstrate a standing wave by using a centrifuge device with a simple attachment. The discussion of wavelength and amplitude will become much more concrete as students see these principles for themselves!

Concepts

- Properties of waves
- Wavelength
- Nodes
- Antinodes
- Frequency
- Amplitude

Materials

Battery, D size
Bracken's Demonstration Spinner
Candle or burner
Cotton cord
Paper clip or dissection needle
PVC elbow
PVC pipe, long
PVC pipe, short, with cup hook
Ring stand
Soda bottle cap
Strobe light (optional)
Swivel, hole and latch
Swivel, two holes

Safety Precautions

Make sure hooks are firmly connected before operating the centrifuge. Do not touch the motor axle while rotor is spinning. Remove the battery from Bracken's Demonstration Spinner when not in use and during storage.

Procedure

1. Thread one end of the cotton cord through the 2-hole swivel and tie.
2. Melt a hole in the center of the flat surface of the cap (see Figure 1) using a heated straightened paper clip or dissection needle. (A candle or burner may be used to heat the paper clip.) The motor axle of the centrifuge device should fit snugly through this hole.
3. Melt a second hole on the side of the bottle cap.
4. Place the cap, flat side down, on the axle of Bracken's Demonstration Spinner through the center hole.
5. Tie the loose end of the cord through the hole of the swivel with the hole and latch. Clip the latch of the swivel to the hole on the side of the bottle cap.
6. Attach the PVC elbow to the two PVC pieces as shown in Figure 2.
7. Place the 2-hole swivel onto the cup hook (see Figure 2).
8. Slide the long PVC piece over the rod of the ring stand.
9. Turn on the motor and observe the wave pattern in the cotton cord.
10. Vary the number of nodes by changing the tension on the rope. This is easily done by holding and raising the PVC pipe assembly to tighten the rope.

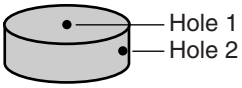

Figure 1. Cap

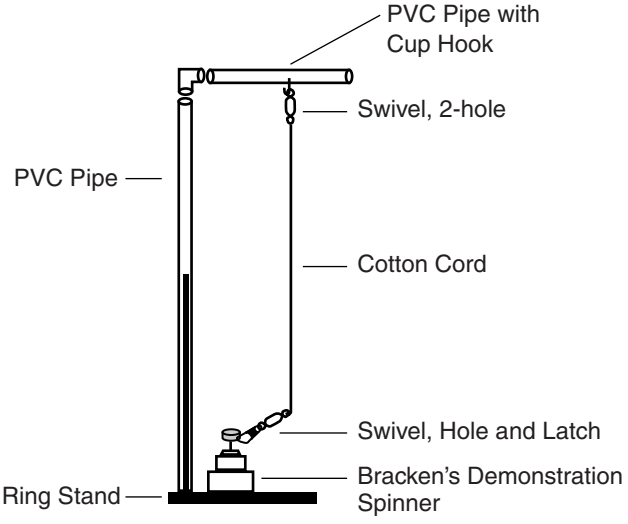

Figure 2. Setup

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Tips

- Bracken's Demonstration Spinner, Flinn Catalog No. AP6202, is required and sold separately.
- Properties like frequency, wavelength, nodes, and antinodes can be discussed using this wave generator.
- A strobe light can be used with this demonstration to "fool" our eyes. If the strobe light is properly adjusted, the spinning rope will appear motionless! This should be done in a dark room. Be advised that the use of strobe lights can trigger epileptic seizures in some people—take all necessary precautions.
- A video presentation of the *Standing Wave Generator* activity is available through the Flinn Scientific Web site (www.flinnsci.com) in *Electron Configuration*, part of the Flinn Scientific—Teaching Chemistry™ eLearning Video Series.

Discussion

All traveling waves follow the *principle of superposition*. That is, when two or more waves meet at the same location the waves overlap with each other and add together to instantaneously create a new wave form. However, the original wave patterns are not lost. Instead, they travel through each other, interact with superposition, and then emerge with the same original shape.

The superposition of two or more waves creates two types of interference—constructive interference and destructive interference. *Constructive interference* occurs when two or more waves combine at the same location and instantaneously produce a wave form with a larger amplitude than any of the original waves. *Destructive interference* occurs when two or more waves combine at a given location to instantaneously produce a wave with a lower amplitude than any of the original waves. When two continuous waves traveling in opposite directions with the same frequency interact with each other, an interesting wave form can be created. If the waves are the correct frequency, a *standing wave* is produced. A standing wave form is the result of constructive and destructive interference of waves that interact in such a way to make the peaks (antinodes) and valleys (nodes) of the wave remain fixed in space.

Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

Unifying Concepts and Processes: Grades K–12
Systems, order, and organization
Evidence, models, and explanation
Content Standards: Grades 5–8
Content Standard B: Physical Science, understanding of motions and forces
Content Standards: Grades 9–12
Content Standard B: Physical Science, motions and forces

Acknowledgment

Flinn Scientific would like to thank Jeff Bracken, chemistry teacher at Westerville North High School in Westerville, Ohio for sharing this original idea. Jeff would like to thank his student lab assistant, Ben Swanger, for his valuable assistance in creating this demonstration.

Reference

Tipler, Paul A. *Physics for Scientists and Engineers*, 3rd Ed., Vol. 1; Worth Publishers: New York, 1990; pp 414–424.

The *Standing Wave Generator* is available as a demonstration kit from Flinn Scientific, Inc.

Catalog No.	Description
AP6161	Standing Wave Generator
AP6202	Bracken's Demonstration Spinner
AP1425	Battery, Replacement, D size
AP5720	Stroboscope

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