Resonating Rings

Introduction

Have you ever noticed a single object in your home vibrate vigorously due to the vibrations of loud music? Why is it that only certain objects vibrate and not all objects? This is due to a phenomenon known as resonance. Amaze your students with this simple demonstration.

Concepts

- Natural frequency
- Resonance
- Vibration

Background

All objects have a natural frequency or set of natural frequencies at which they vibrate. The natural frequency of an object is dependent upon its length and composition. If an object is forced to vibrate at its natural frequency, a vigorous vibration, known as resonance, will occur. An object can be forced to vibrate by a push, pull, pluck, strum, or even the vibrations of another object. When resonance occurs, it can be seen as a vibration or even heard as a humming sound.

In this demonstration, resonance is visibly shown using six paper rings mounted on a cardboard base. By physically moving the base back and forth, vibrations are created which cause the rings to vibrate. Resonance will occur in a ring when the frequency of the back and forth motion of the base matches the natural frequency of the ring. In this demonstration, a pair of matching rings will resonate at the same time. By altering the frequency of the back and forth motion of the base, different pairs of rings will resonate.

Materials

Cardboard, 1 piece, 12" × 18"
Construction paper, 1 piece, 12" × 18"
Pen or Pencil
Ruler
Scissors
Tape, clear or masking

Safety Precautions

This demonstration is considered nonhazardous. Please follow normal classroom or laboratory safety guidelines.

Procedure

1. Cut out six 1" × 18" strips from a piece of construction paper.
2. Take two of the paper strips and cut the length to 15 inches (38 cm).
3. Take another two paper strips and cut the length of each to 12 inches (30 cm). The last two strips should remain 18 inches (46 cm) long.
4. Form the strips into rings by taping the two ends together.
5. Tape the rings to the cardboard about 2 inches (5 cm) apart as shown in Figure 1.
6. Place the cardboard on a flat surface and push it back and forth as shown in Figure 2. Start with a very low frequency and gradually increase the frequency until a pair of rings starts vibrating vigor-

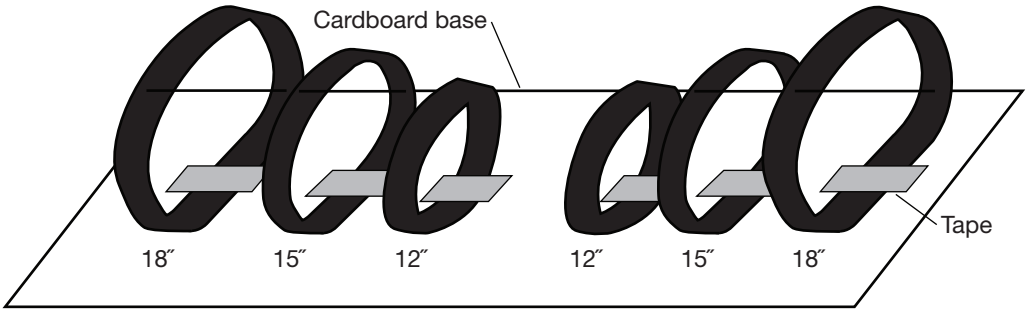

Figure 1.

Figure 2.

ously and achieves resonance. When this occurs, keep the frequency of the base constant for a short time and allow the students to observe the resonance of the rings. Discuss any pattern in terms of which rings resonate at the same frequency.

7. Gradually increase the frequency of the back and forth motion of the cardboard base until another pair of rings achieves resonance. When this occurs, keep the frequency of the base constant, and allow the students to observe. Note any pattern or trend in the resonance of the rings.
8. Increase the frequency of the back and forth motion of the base until the last pair of rings achieves resonance. When this occurs, keep the frequency of the base constant and allow the students to observe. Discuss the relationship between the back-and-forth motion of the base and the resonance of different size rings.

Disposal

Materials should be saved for future demonstrations.

Tips

- A ring will only resonate when the frequency of the back-and-forth motion of the cardboard base matches the natural frequency of the ring. Proper timing is therefore very important. Practice this activity before demonstrating to the class in order to find the proper timing.
- During the demonstration, all of the rings will bounce around a bit due to the vibration of the base, but only two rings will achieve resonance at a given frequency of the back-and-forth motion of the base.
- When the cardboard base is vibrated back and forth at a low frequency, the larger rings will resonate. A higher frequency will cause the smaller rings to resonate.

NGSS Alignment

This laboratory activity relates to the following Next Generation Science Standards (2013):

Disciplinary Core Ideas: Middle School
MS-PS2 Motion and Stability: Forces and Interactions
PS2.B: Types of Interactions
MS-PS4 Waves and Their Applications in Technologies for information transfer
PS4.A: Wave Properties

Science and Engineering Practices
Developing and using models
Analyzing and interpreting data

Crosscutting Concepts
Cause and effect
Energy and matter
Stability and change

Reference

"Resonant Rings". Exploratorium Snacks. www.exploratorium.edu/snacks/resonant_rings (accessed December 2014).

Materials for *Resonating Rings* are available from Flinn Scientific, Inc.

Catalog No.	Description
AP4396	Scissors, Metal, Office-type
AP1734	Tape, Masking, 60 yds
AP6324	Ruler, Metric/English, Clear

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