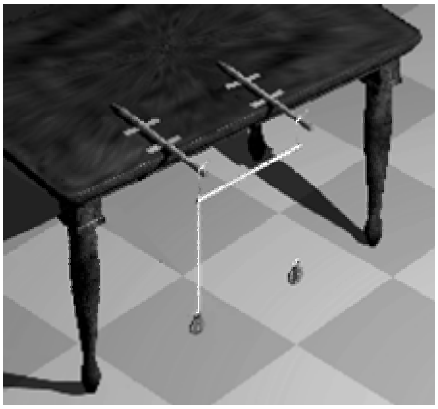

Coupled Resonant Pendulums

Take advantage of resonance

By taking advantage of resonance, you can cause two pendulums to swing in identical cycles.

materials

Tape
A drinking straw
Scissors
Four pennies
Two paper clips
String (thin)
Two pencils

assembly

Tape the two pencils to the edge of a table as shown in picture above. Cut two strings of equal length (20 to 30 centimeters works well) and tie a paper clip to each end. Tie the other end of each string to the end of a pencil and adjust the knots so that you have two pendulums of equal length. Attach two pennies to each paper clip. With the scissors, shorten the drinking straw to about 15 centimeters, cut small slits along the sides of the straw, and use the straw segment to link the two pendulums together (see the picture above).

to do and notice

Pull one pendulum toward you a short distance and let go. Notice that after a few swings, the second pendulum will begin to oscillate, or swing back and forth, with the same frequency as the first pendulum. With each swing, the second pendulum will increase its amplitude, or the height of its swing. Eventually, the pendulums will swing in unison - the second pendulum will swing in resonance with the first one.

what's going on?

Every pendulum has a natural vibration cycle that depends only on its length. For example, a weight tied to the end of a 25-centimeter-long string will complete one swing "to-and-fro" in about 1 second. The two pendulums in this activity have the same natural frequency because you made them equal in length.

When you start the first pendulum oscillating, it makes the attached drinking straw twist back and forth with the same frequency. Each time the first pendulum completes a swing cycle, the twisting straw gives the second pendulum a tiny shove - like a parent pushing a child on a swing. Because the straw is pushing with the same rhythm as the natural frequency of the second pendulum, the weight swings progressively higher and higher with each tiny push.

etcetera

I was stopped at a traffic light recently when a loose door panel on my car began to rattle loudly. What was making it vibrate so energetically even though the car was at a complete stop?

Like swinging weights on a pendulum, my door panel has a natural vibration frequency. The pistons, which were moving up and down in my idling engine, matched the resonant frequency of my door panel. Metal between the engine and the car door, like the drinking straw in the pendulum experiment, transmitted the pushes and pulls that eventually got the loose panel to shake violently. Each tiny motion of the car body made the loose door panel vibrate harder and harder - until finally the amplitude of the vibrations were large enough to get my attention.

This activity is related to the Making Waves at the Newton's Corner exhibit at the Mid-America Science Museum. This activity and more can be found online at
http://www.exploratorium.edu/snacks/coupledrespend/index.html