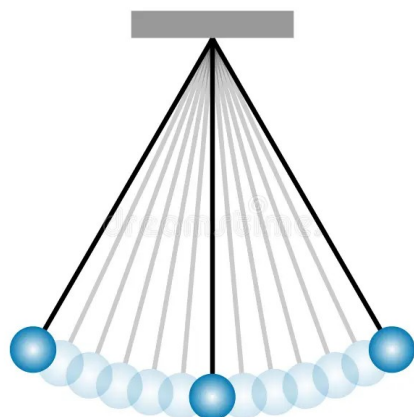


Oscillations and Resonance: Swinging Pendulums



- An **oscillation** is any repeating motion around some **equilibrium** position
- The **period** of an oscillation is how long it takes to make one back-and-forth movement
- A **pendulum** is a weight on a string (or stick) that hangs down and swings back and forth. Each pendulum has its own preferred period.

Discuss: what do you think can be done to a pendulum to make it have a longer period? A shorter period?

Pendulum Period and Length

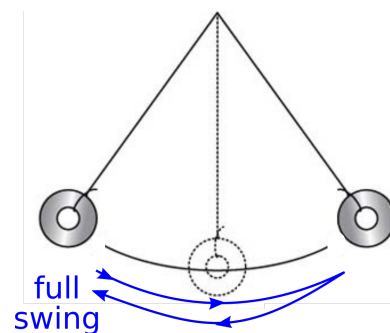
1. Tie a washer to the bottom of the hanger so that it hangs from a string about 12" long.

4. One partner: hold the top of the hanger firmly so it does not move. Pull up the washer a little and let it swing.

5. Other partner: use the timer to measure how long it takes the pendulum to make 10 full back-and-forth swings. Record the time in the table below. This is your control.

6. Do a second trial, make sure you get a consistent measurement.

7. Now tie a second washer onto the hanger so that it hangs from a string about 6" long. Leave the other washer on, but hold it out of the way.



Make a prediction: the period of the shorter string will be:

longer / shorter / about the same

8. Repeat your two trials and measure the time for 10 full swings.

Washer (small mass)	Time for 10 full swings	
	Trial 1	Trial 2
12" string		
6" string		

The shorter string had a period that was: longer / shorter?

Pendulum Period and Mass

1. Tie a fishing weight to the hanger so that the bottom of the weight is hanging at exactly the same height as the washer on the long string.

Make a prediction: Compared to the washer on the long string, the period of the heavier fishing weight will be: longer / shorter / about the same ?

2. Repeat your measurements with the fishing weight. (Hold the washers out of the way)



12" string	Time for 10 full swings	
	Trial 1	Trial 2
Washer, small mass	(copy over)	
Fishing weight, large mass		

The period of the fishing weight was: longer / shorter / about the same?

The leg of a walking animal can be thought of as a pendulum. Based on your experiment, who do you think swings their legs with the shortest period when walking? (circle one)

ants

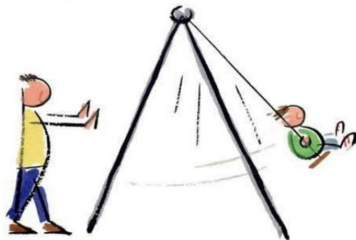
humans

elephants

Discuss: Why are grandfather clocks always about the same height? Why don't people make miniature ones?

Resonance of Pendulums

Resonance describes how pushing a swinging system at its natural, preferred period makes it swing very high. Resonance explains why you have to push with just the right rhythm to get a child swinging on a swing. Resonance can make entire structures (like a bridge!) collapse if they happen to be pushed with just the right period.



1. Release all 3 pendulums. Try swinging the top of the hanger very slightly.

Can you push it with just the right period to get the longer pendulums to swing high?

Can you push it with just the right period to get the shorter pendulum to swing high?

Is it possible to get all 3 swinging high for a long time at once? Why or why not?

Is it possible to make the fishing weight swing but not the long-string washer? Why or why not?