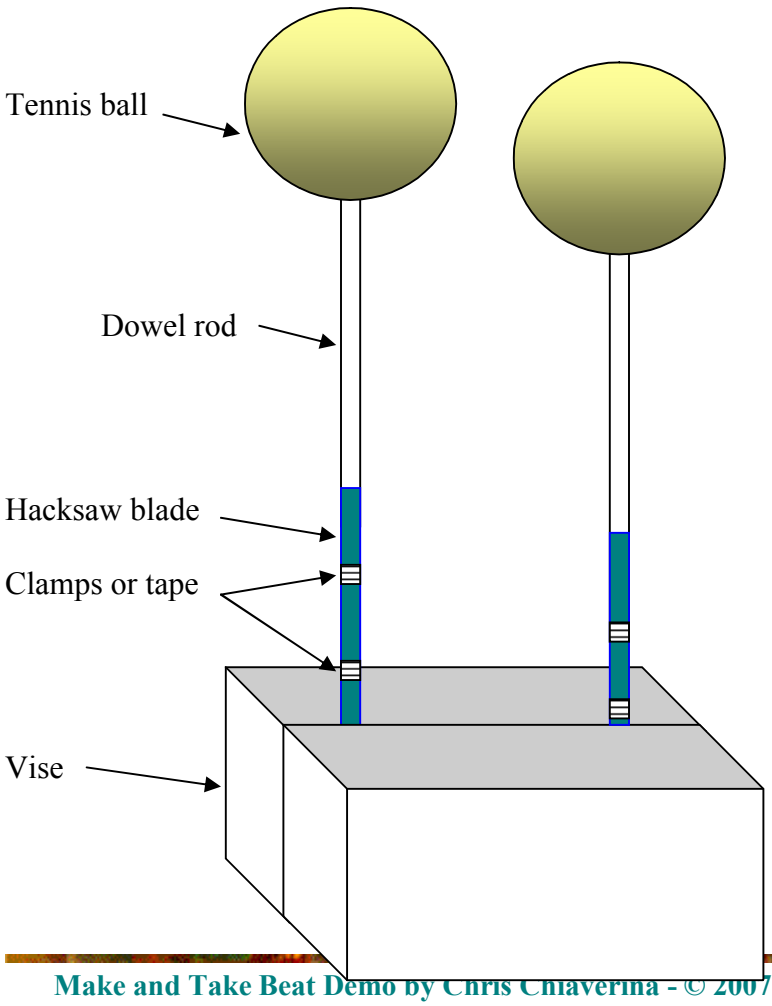
"And the Beat Goes On…."
A Quantitative Study of the Phenomenon of Beats

Description:

Two oscillators, fashioned from tennis balls, dowel rods, and hacksaw blades, are kept upright by a vice, or other clamp. When displaced and released, each oscillator swings back and forth with a frequency that is of the order of one hertz. Beats are observed as the two oscillators simultaneously swing back and forth. By measuring the period of each oscillator and the beat frequency of the pair, the relationship $f_{beat} = |f_1 - f_2|$ may be readily verified.

Materials:

2 – tennis balls
2 – ~ 0.5 m length of ¼ inch dowel rod
1 – vise
2 – hacksaw blades
4 – small hose clamps or tape
1– stopwatch



Construction:

Cut two pieces of ¼ inch dowel rod, each approximately 0.5 m long. Attach a hacksaw blade to one end of each dowel rod with the small hose clamps or tape. Allow between 6 and 8 cm of the blade to extend beyond the end of the dowel rod. Use a sharp-tipped object (a knife or scissors works well) to make a small hole in each tennis ball. Force the free ends of the dowel rods into these holes. Place the oscillators' hacksaw blades into the vice as is shown in the figure. Adjust the length of the clamped portion of the blades so that each oscillator possesses a unique frequency.

Using the Beat Demonstrator

I. Demonstrating beats

1. Displace the two oscillators from their equilibrium position. Release them simultaneously and observe their motion. You will see the oscillators move in and out of phase. This phenomenon is an example of mechanical beats. The number of times that the oscillators move out of phase, and back again, each second is called the *beat frequency*.

2. Observe the effect of changing the length of the clamped portion of <u>one</u> of the blades on the beat frequency. What must be done in order to increase the beat frequency?; decrease the beat frequency? What is the beat frequency when the oscillators have the same frequency?

II. Determining the Beat Frequency

1. Determine the frequency of the oscillators individually. To accomplish this, use your stopwatch to time ten swings, or cycles, of each oscillator. Due three trials for each oscillator and enter you data in the tables below.

Oscillator 1

Trial	Time for 10 cycles (s)	Frequency (Hz)
1		
2		
3		
Average		

Oscillator 2

Trial	Time for 10 cycles (s)	Frequency (Hz)
1		
2		
3		
average		

2. Calculate the difference between these two frequencies. That is, find $|f_1 - f_2|$.
   The use of absolute value bars insures that the result will always be positive.

   $|f_1 - f_2| =$ _____

3. Determine the beat frequency by timing ten beats. Remember, during one beat, the oscillators start out together, move out of phase, and then come back together. Due three trials and record your data in the table below.

Trial	Time for 10 beats (s)	Beat Frequency (Hz)
1		
2		
3		
average		

4. How does $|f_1 - f_2|$ from part 2 compare with the beat frequency obtained in part 3 ?

5. State a rule or equation for calculating the beat frequency from the frequencies of two oscillators.