Laboratory Investigation | Name ____________

Physics@Frisch: Form L7.4A | Date ____________ Period ______

Natural Frequency and Resonance

Problem

How do we make and control waves?

Introduction

A vibrating string is perfect for investigating waves because the waves are large enough to see easily. The frequency, *f*, is the rate at which the string shakes back and forth, or oscillates. As the string oscillates at its natural frequency, nodes will form. A node is a point where the string does not move. An antinode is a point where the amplitude is greatest. You can measure the wavelength as the distance separating three consecutive nodes. What you will see and learn applies to guitars, pianos, drums—to almost all musical instruments. In this investigation, you will: explore the relationship between the frequency of a wave and its wavelength.

Materials *(per group)*

Data Collector; Physics Stand; Ruler; Sound and Waves kit.

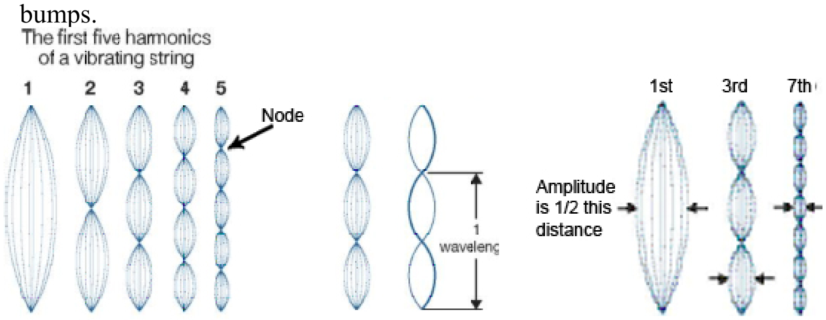
Procedure

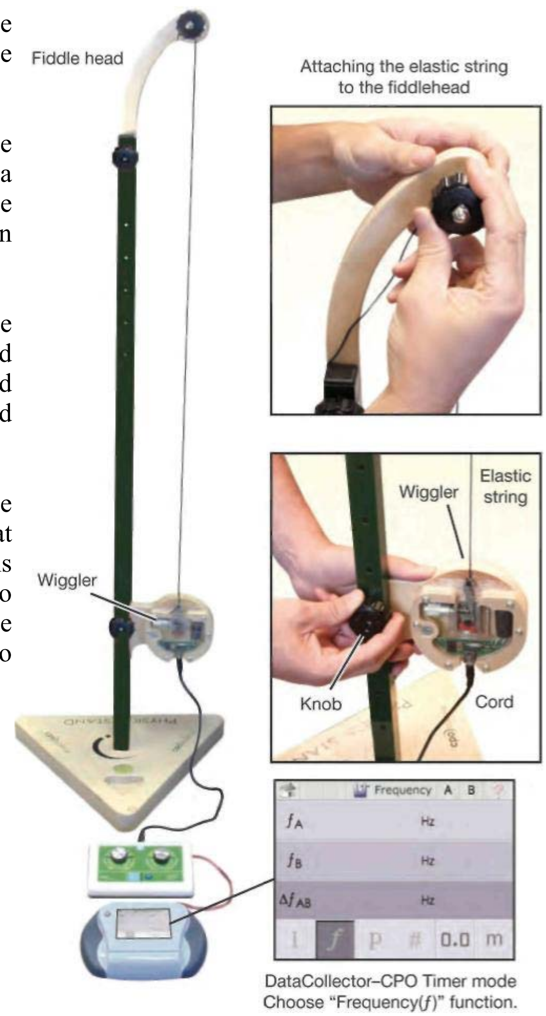
1. Connect the Data Collector to the sound and waves generator as shown in the diagram. The telephone cord connects the Data Collector and wave generator. The black wire goes between the wave generator and the wiggler.

2. Attach the fiddle head to the top of the stand as high as it will go. Attach the wiggler to the bottom of the stand as low as it will go. Stretch the elastic string a little (5 to 10 centimeters) and attach the free end to the fiddle head. Loosen the knob until you can slide the string between any two of the washers. Gently tighten the knob just enough to hold the string.

3. Turn on the Data Collector and be sure to plug in the AC adapter. Set the wave generator to waves using the button. The wiggler should start to wiggle back and forth, shaking the string. Set the Data Collector to measure frequency. You should get a reading of about 10 Hz, which means the wiggler is oscillating back and forth 10 times per second.

4. Try adjusting the frequency of the wiggler with the frequency control on the wave generator. If you watch the string, you will find that interesting patterns form at certain frequencies. At certain frequencies, a vibrating string forms wave patterns called harmonics. The first harmonic has one bump, the second harmonic has two bumps, and so on. The wavelength is the length of one complete wave. One complete wave is two "bumps." Therefore, wavelength is the length of two bumps.





5. Adjust the frequency to obtain the first 6 harmonics of the string and record the frequency and wavelength for each one in the table below. Fine-tune the frequency to obtain the largest amplitude before recording the data for each harmonic. Look for harmonics two to six before looking for the first one. The first harmonic, also called the fundamental, is hard to find with exactness. Once you have the frequencies for the others, they provide a clue for finding the frequency of the first harmonic The string is 1 meter long. If you have a pattern of three bumps, the wavelength is two-thirds of a meter since three bumps equal 1 meter and a wave is two bumps.

6. Using a ruler, measure the amplitude for each harmonic. The amplitude is one-half the width of the wave at its widest point. Record your measurements in the table below. Measure at least five different harmonics, including the sixth or higher.

CALCULATIONS

7. For each frequency, calculate the wavelength by dividing the length of the string (1 *m*) by the number of bumps and multiplying by 2. Record the results in the data table below.

8. Calculate the product of the frquency (f) and the wavelength (λ), and record the result in the table below.

OBSERVATIONS

Harmonic #	Frequency (f)	Wavelength (λ)	Product ($f \times \lambda$)	Amplitude (A)

CONCLUSIONS

1. Describe how the frequencies of the different harmonic patterns are related to each other. ______________________________

2. Why is the word fundamental chosen as another name for the first harmonic? ______________________________

3. Propose a meaning for the number you get by multiplying frequency and wavelength. (*HINT*: Think of the units.) ______________

4. For a wave of a given speed, if the frequency increases by a factor of two, what happens to the wavelength? ______________

5. Give an equation relating frequency (f) and wavelength (λ) that best describes your observations. ______________