Laboratory Investigation | Name ______________________

Physics@Frisch: Form L7.2A | Date ____________ Period ____

Why Things Oscillate

PROBLEM

What kinds of systems oscillate?

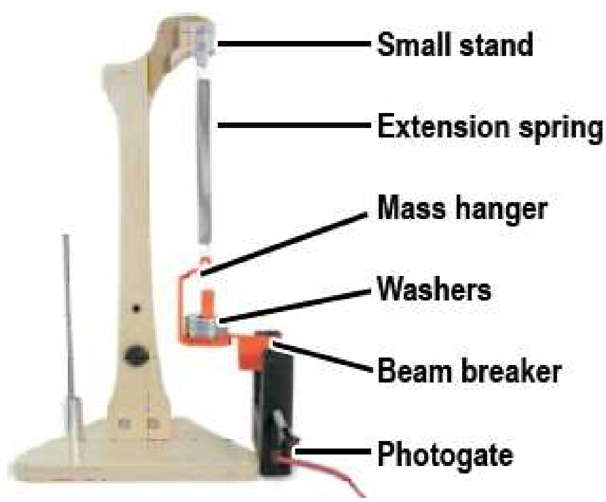
INTRODUCTION

Motion results when we disturb a system in equilibrium. For example, consider a cart balanced on top of a hill. If you push the cart even a little, it quickly rolls downhill and does not return. When balanced at the top of the hill, the cart is in unstable equilibrium. A cart in a valley is in stable equilibrium. If you move the cart partly up the hill and release it, harmonic motion results as the cart rolls back and forth in the bottom of the valley. An object in harmonic motion is an oscillator. In this investigation, you will: build a mechanical oscillator; find the oscillator's period and natural frequency; and change the oscillator's natural frequency. To make a mechanical oscillator, you need to provide some kind of restoring force connected to a mass that provides inertia.

MATERIALS *(per group)*

Beam breaker; Data Collector; Extension springs (blue tab and white tab springs); Mass hanger; Photogate; Small stand; Washers.

PROCEDURE



1. Set up a spring system that oscillates up and down (see photo at right). Use the extension spring that has the blue tab. Pull the mass hanger down a very small amount and gently let go to create smooth oscillations.

2. Place six washers on the mass hanger, and place the photogate on or near the small stand as shown in the photo at the right.

3. Plug the photogate into the A input on the Data Collector. Select timer mode, then the period (p) function. (For slow oscillators like this spring/mass system, rather than measure frequency, it is more accurate to measure period and then calculate the natural frequency.)

4. Gently pull down on the spring (you should be using the one with the blue tab) to begin a controlled, smooth oscillation. The period in seconds will vary at the last three decimal places. Practice measuring the period several times, and choose a period with two significant digits. Avoid creating any swinging motion with the oscillator. Practice until you can get smooth up and down oscillations with very little movement in any other direction

5. The natural frequency is a balance between the strength of the restoring force and the mass providing the inertia. To change the natural frequency, change the balance between force and inertia. You have another spring to try (it has a white tab) to vary the restoring force, and you can vary the number of washers to change the inertia.
   a. Determine the period of your oscillator using the spring with the blue tab using 3, 6, and 9 washers. Record your results in the data table on the next page.
   b. Repeat these observations using the spring with the white tab.

CALCULATIONS

Calculate the natural frequency for each of your observations by dividing 1 by the period in each case. Record your result in the data table on the next page.

OBSERVATIONS

Extension Spring	Number of washers	Period	Natural frequency
Blue tab			
White tab			

CONCLUSIONS

1. Describe an example of a stable system in one or two sentences. What happens when you push it a little away from equilibrium? ______________________________

2. Describe an example of an unstable system in one or two sentences. What happens when you push the unstable system a little away from equilibrium? ______________________________

3. Explain why the changes you made to the oscillating system affected the natural frequency. Refer to evidence from your data table to support your explanation. ______________________________

4. Explain why a guitar string's frequency increases when the tension increases, in terms of how the balance between force and inertia is changed. ______________________________

5. If you look closely at an ordinary guitar, you will see that some strings are thicker than others. They have a lower pitch than the smaller strings. Explain why this is so in terms of changing the balance between force and inertia. ______________________________