A Wiggle in Time Lab

Teacher's Guide

Topic:

Waves

The following information is provided to the student:

Question:
How would you describe (verbally, graphically and mathematically) the motion of a mass on the end of a spring?

Purpose:
To describe (verbally, graphically and mathematically) the motion of a mass on the end of a spring.

A complete lab write-up includes a Title, a Purpose, a Data section, and a Conclusion/Discussion . The Data section should include a plot of position versus time and a plot of velocity vs. time (use provided graphs). The Conclusion/Discussion should include a verbal description of the mass's motion, a description of the manner in which the position and the speed of the mass change with respect to time; this description should rely on the *language of mathematics*.

Materials Required:

Spring; 100-g hooked mass; lab poles and clamps; note card; masking tape; computer interfaced motion detector.

Description of Procedure:

A spring is mounted to a clamp and a lab pole so as to extend over the edge of the table. A 100-g mass is attached to the end of the spring. A motion detector rests on the floor below the mass. The motion detector is zeroed and prepared to collect data. The mass is pulled down below its equilibrium position and released. As the mass bobs up and down, the motion detector senses variations in its vertical position and its velocity with respect to time. Students sketch the basic shape of these plots in their notebook. Observations are recorded and measurements of period and amplitude are made.

Alternative Materials and Procedure:

If a computer interfaced motion detector is not available, then the graphical description could be skipped and the mathematical description could include a discussion of period and frequency based upon stopwatch measurements.

Safety Concern:

There is always a higher than usual level of risk associated with working in a science lab. Teachers should be aware of this and take the necessary precautions to insure that the working environment is as safe as possible. Student *horseplay* and off-task behaviors should not be tolerated.

Suggestions, Precautions, Notes:

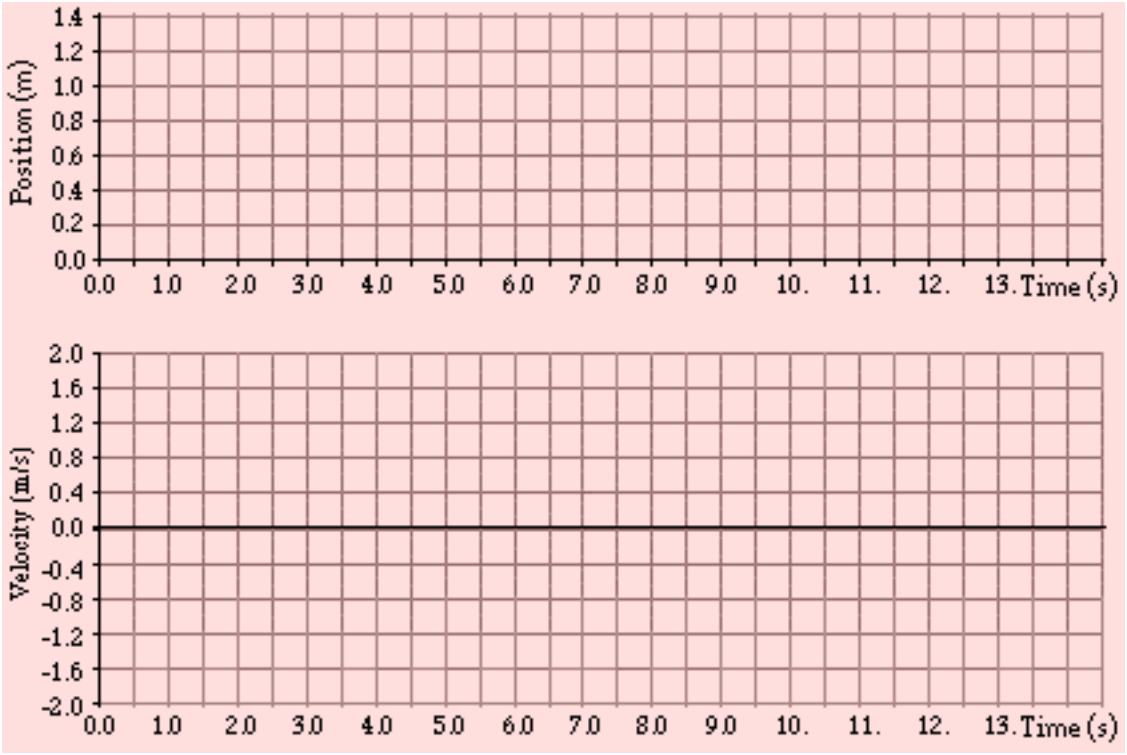
1. Taping a note card to the bottom of the 100-g mass makes the mass much more easily detectable.
2. The optimal amount of mass to suspend from the spring depends on the spring constant of the spring. Experiment with this in advance of the lab.

3. To promote a good verbal description of the motion of the bob, suggest to students that they consider how they would describe the motion to a friend who was in another room.
4. A great post-lab demonstration involves setting the mass in motion and tracing an up and down line on the board in sync with the up and down motion of the bob. Mention that the bob and your chalk (marker) are wiggling in time. Then, keeping the same synchronized up and down motion, begin walking across the room. The chalk (marker) will trace out the pattern of a wave. Define a wave as a wiggle in time that extends itself across space.
5. This is the first of several labs designed with the intent of conveying the nature of a wave. The labs titled A Wiggle in Time and Space Lab and Wave Motion Lab are excellent complements to this lab. The take-home ideas from the collection of three labs include the following:
    - A wave is a disturbance which is introduced into the medium at one end and travels through the medium by particle to particle interaction to the other end.
    - There is a distinction between wave motion and particle motion. Wave motion is the movement of a wave pattern across the medium from one end to the other end. The wave pattern might be the sinusoidal pattern of alternating crests and troughs or it might be the pattern of a series of compressions and rarefactions. Particle motion is the back and forth vibrational movement of the particles of the medium about a fixed position. The particles might vibrate parallel to the direction of wave motion or perpendicular to the direction of wave motion (or in a circle).
    - A wave is a wiggle in time which is extended across space. Particles of the medium wiggle up and down (or back and forth) over the course of time. Neighboring particles interact with one another so as to create a pattern which is spread through space - from one end of the medium to the other.
    - A wave propagates or travels through space by particle to particle interaction. The disturbance which is introduced to the first particle of the medium travels to the last particle of the medium because the particles interact. The frequency and the amplitude (ideally) of the disturbance is maintained as one particle *passes it on* to the neighboring particle.
    - A wave is an example of periodic motion; particles of the medium undergo continuous up and down (or back and forth) periodic motion.
    - A wave is an energy transport phenomenon and not a material transport phenomenon. Matter (particles, stuff, atoms, material) is not moved from the location of the original disturbance to the opposite end of the medium. The particles simple vibrate about a fixed position as the energy is passed from one end of the medium to the other.
    - There is always something *sinusoidal* about a wave. For instance, the particles vibrate in such a manner that their distance from the resting position varies as the sine of the time. Or the entire collection of particles occupy a position at a fixed moment in time which together creates the appearance of a sine wave.

Auxiliary Materials:

The following graphic is provided to the student for completion and inclusion in the Data section of their lab notebook.

The Laboratory



Scoring Rubric:

W1.	**A Wiggle in Time Lab**	**Score**
____	Included, labeled and organized all parts of the lab report.	
____	Data section includes plots of position-time and velocity-time. Plots are complete and reasonable representations of the motion.	____/____
____	Conclusion/Discussion provides a simple description of the mass's motion, a description of how the position and the velocity change with respect to the time; a *mathematical language* is used in the description.	

Connections to The Physics Classroom Tutorial:

The following readings are a suitable accompaniment to this lab:

http://www.physicsclassroom.com/Class/waves/u10l1a.cfm

http://www.physicsclassroom.com/Class/waves/u10l1b.cfm

Connections to Minds on Physics Internet Modules:

Sublevel 1 of the Waves module is a suitable accompaniment to this lab:

http://www.physicsclassroom.com/mop/module.cfm