Wave Behavior Demonstration Lab

Teacher's Guide

Topic:

Waves

The following information is provided to the student:

Question:
What are some classical wave behaviors and how can they be described both verbally and graphically?

Purpose:
To observe and describe (in some detail) the variety of wave behaviors - including interference, fixed- and free-end reflection, and the behavior of a pulse at the boundary with a second medium.

A complete lab write-up includes a Title, a Purpose, a Data section, and a Conclusion/Discussion. The Data section should be divided into several sections – a section for each of the behaviors which are demonstrated. Observations and diagrams should be included in each section. The Conclusion/Discussion should provide a clear and thorough description of each type of behavior. When the behavior occurs, what the behavior involves and how the behavior occurs should be addressed.

Materials Required:

Wave motion demonstrator; snakey; slinky; lab pole and clamp.

Description of Procedure:

A snakey is stretched out to about 5-6 meters; one end is held and the other end is hooked to a lab pole and clamped down with a clamp so that it is unable to move. A single upward displaced pulse is introduced at one end; it travels to the opposite end of the snakey and reflects back. The orientation of the reflected pulse is observed for this fixed end reflection; observations are documented using a diagram and words. The clamp is now raised so that the end of the snakey attached to the pole is free to move up and down when a pulse reaches the pole's end. A single upward displaced pulse is once more introduced at one end; it travels to the end of the snakey and reflects back. The orientation of the reflected pulse is observed for this free end reflection; observations are documented using a diagram and words.

A slinky is stretched out about 5-6 meters on the floor. Two pulses are simultaneously introduced into opposite ends of the slinky; the pulses are displaced in the same direction. They slowly travel towards each other and interfere in the middle of the slinky. The appearance of the medium at the moment of complete interference is observed and recorded using a diagram and words. The observations are repeated for the case of two pulses displaced in opposite directions.

A wave motion demonstrator with a section of short steel rods and a section of long steel rods is used to demonstrate the behavior of pulses at a boundary. A single pulse is introduced into each of the sections and the relative speed of the wave in the two individual sections is observed. Then the sections are connected to each other using the provided clamp. A single pulse is introduced at one end (e.g., the end of the section containing the long steel rods). The behavior of the pulse at the boundary between the two sections is observed and diagrammed. Special attention is given to the relative speed of the incident, transmitted and reflected pulses. Special attention is also given to the orientation of the reflected pulse compared to the orientation of the incident pulse. Finally, attention is also given to the wavelength of the pulses in the two medium; this is best demonstrated by introducing standing waves into one of the

media and observing the resulting standing wave in both medium. The boundary behavior of the pulses and waves are studied for situations in which they move from the section of short steel rods to the section of long steel rods and vice versa.

Alternative Materials and Procedure:

If a wave motion demonstrator is not available, then numerous web sites make a similar experience (though not nearly as captivating) possible through the manipulation and viewing of an animation. These online animations can easily be found through a Google search. One example includes the physlet found at:

http://www.surendranath.org/Applets/Waves/TwaveRefTran/TwaveRefTranApplet.html

Alternatively, much of the lab can be demonstrated using a slinky and or a snakey.

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. Stretched out snakeys snap back quite violently when accidentally let go of. Students (and teachers) should be aware of the potential dangers associated with this rapid snap back.

Suggestions, Precautions, Notes:

1. This lab makes use of a wave motion demonstrator such as those distributed by Bell Labs to many schools in the post-Sputnik era. These machines can be purchased from many science supply houses. For instance, Pasco Scientific offers a wave motion demonstrator with the model number SE-9600.
2. Wave motion demonstrators are both expensive and fragile. Posting a china shop notice ("Please look and don't touch.") reduces the amount of damage done by *the bulls*.
3. Given the cost of a torsional wave machine, this lab is best done as a teacher demonstration lab. Students can make observations from their seats and construct before and after diagrams as the teacher demonstrates all the phenomenon.
4. It is helpful to students to see the two sections of the torsional wave machine labeled with cards which read *greater inertia* and *lower inertia* or *most dense* and *least dense*.
5. Next day activity: If computer projection capabilities are available in your classroom, then the behavior of waves can be quickly reviewed on the following day using the many available online animations.

Auxiliary Materials:

None

Scoring Rubric:

W9.	**Wave Behavior Demonstration Lab**	**Score**
____	Included, labeled and organized all parts of the lab report.	
____	Data section includes several sections in which meaningful observations are recorded to describe the various behavior of waves. Labeled diagrams were included where appropriate; diagrams are clear and informative.	____/____
____	Conclusion/Discussion provides a thorough description of each behavior using well-written sentences and paragraphs. Details regarding when the behavior occurs, what the behavior involves and how the behavior occurs are addressed. Demonstrated a meaningful understanding of wave behavior.	

Connections to The Physics Classroom Tutorial:

The following reading is a suitable accompaniment to this lab:

http://www.physicsclassroom.com/Class/waves/u10l3a.cfm
http://www.physicsclassroom.com/Class/waves/u10l3b.cfm
http://www.physicsclassroom.com/Class/waves/u10l3c.cfm

Connections to Minds on Physics Internet Modules:

Sublevels 5 and 6 of the Waves module are suitable accompaniments to this lab:

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