

## Refraction Action Lab

### Teacher's Guide

**Topic:**

Refraction and Lenses

**The following information is provided to the student:**

**Question:**

When does light refract? Why does light refract? When does light not refract?

**Purpose:**

To describe when light refracts, why it refracts and when light does not refract?

A complete lab write-up includes a Title, a Purpose, a Data section, a Conclusion /Discussion section. The Data section should include an organized record of a collection of refraction observations and activities. The Conclusion/Discussion section should respond to the three parts of the purpose, providing an answer to each of the three *questions*. For each *answer*, evidence and/or examples from the Data section should be cited in support of the answer.

**Materials Required:**

Glass beaker (500 mL); water; pencil; meter sticks; masking tape.

**Description of Procedure:**

Students are given a beaker that is mostly filled with water in order to conduct *The Broken Pencil* activity. A pencil is placed in the water. The beaker is held at eye level and the pencil is moved toward the front, the back, and the sides of the beaker. Observations of the relative size of the pencil are made and recorded using diagrams and/or words in the Data section. Results are summarized as a class. The class then exits the room to a hallway or outdoor space in order to conduct *The Marching Soldiers* activity. Five student volunteers hold meter sticks and form a line. Each student (with the exception of the end students) hold two meter sticks - one in each hand - and then place their fists together in front of their bodies. The students represent a light wave. They direction they walk would represent the direction of the light ray. A masking tape boundary is constructed on the walking surface at an angle to the line of students. Students walk forward at a normal pace toward the *boundary*. When the first student crosses the boundary, he/she immediately slows down and walks with baby steps while the other students continue at a normal pace. Every student does the same slowing down from a normal pace to baby steps upon crossing the boundary. Once all students have crossed the boundary, they continue walking together in a new direction with baby steps. The demonstration is repeated a couple of times by the student volunteers until the observations of the change in speed and directions can be documented. The class returns to the room and the teacher guides the students through a diagram representing the demonstration. The incident ray, the boundary and the refracted ray are drawn and labeled on the boundary. The two *media* are labeled as fast and slow. The class uses the observations to discuss *the why?* and the *when not?* of refraction.

**Alternative Materials and Procedure:**

If the school administration discourages the use of hallway and/or outdoor space for labwork, consider rolling a Hot Wheels car from a smooth surface (fastest) across the boundary with a rougher (slowest)

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surface at an angle to the boundary. For instance roll a car from a tiled surface to surface made of outdoor carpeting or low-pile carpeting.

### 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. If using outdoor space for the *marching Soldiers* activity, students should be aware of any possible traffic that could present a hazard. Student *horseplay* and off-task behaviors should not be tolerated.

### Suggestions, Precautions, Notes:

1. This lab consists of two quick exploratory activities which introduce three basic ideas regarding refraction - *the when?*, *the why?*, and *the when not?* of refraction. Guiding the activities insures that students get off to a good start on their study of refraction. The first activity (*The Broken Pencil* activity) involves a simple and interesting set of observations. Emphasize that the alteration of the appearance of the pencil is due to the refraction or bending of the path of light and that it occurs when light crosses a boundary between two materials. The second activity (*The Marching Soldiers* activity) involves a student demonstration. Emphasize that the cause of a direction change is a change in speed occurring at a boundary. This change in direction only occurs when the students are heading at the boundary along an angle such that they change their speed at a different instant in time.
2. Before conducting the *Marching Soldiers* activity, select five student volunteers and give them a brief training regarding what they will be doing. Emphasize that they should walk together when on the same side of the masking tape and will be changing their walking speed only when they individually cross the boundary.
3. If using outdoor space, be sure to discuss in advance the necessity of maintaining good, safe behaviors and to be exercise extreme caution around any potential traffic.
4. The *Refraction Action Lab* and the *Direction of Bending Lab* can usually be performed in a single class period, providing students with several experiences which can be referred to during subsequent lessons.

### Auxiliary Materials:

None

### Scoring Rubric:

RL1. Refraction Action Lab	Score
___ Included, labeled and organized all parts of the lab report.	___/___
___ Data section includes an organized documentation of observations for both parts of the lab ( <i>The Broken Pencil</i> and the <i>Marching Soldiers</i> ). Observations are accurate.	
___ Conclusion/Discussion answers all three <i>questions</i> of the Purpose; <i>answers</i> are correct. Each <i>answer</i> includes a specific reference to an observation from the Data section as logical and empirical evidence for the statement. Conclusion/Discussion is understandable and well-written.	

### Connections to The Physics Classroom Tutorial:

The following readings are a suitable accompaniment to this lab:

<http://www.physicsclassroom.com/Class/refrn/u14l1a.cfm>

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<http://www.physicsclassroom.com/Class/refrn/u14l1b.cfm>

<http://www.physicsclassroom.com/Class/refrn/u14l1c.cfm>

<http://www.physicsclassroom.com/Class/refrn/u14l1d.cfm>

## **Connections to Minds on Physics Internet Modules:**

Sublevel 1 of the Refraction and Lenses module is a suitable accompaniment to this lab:

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