The Unknown n Lab

Teacher's Guide

Topic:

Refraction and Lenses

The following information is provided to the student:

Question:
What is the index of refraction for the materials which comprise a variety of prisms?

Purpose:
To determine the index of refraction of the unknown materials which comprise a variety of prisms.

A complete lab write-up includes a Title, a Purpose, a Data section and a Conclusion. The Data section should include an outline of at least two of the provided prisms; the path of the laser light into, through and out of the prism should be indicated by light rays. Proper constructions and measured angles should be included on each diagram in an effort to determine the index of refraction of the material of the prism. Measurements and calculations should be made (and clearly shown) for the entry and the exit boundary; an average **n** value for each prism should be reported. The Conclusion should respond to the question raised in the Purpose of the lab (as always).

Materials Required:

Laser; transparent Lucite block; transparent glass square; transparent glass triangle; protractor.

Description of Procedure:

A refraction block (Lucite block, glass square, or glass triangle) is placed on a sheet of paper and outlined using a pencil or pen. A leveling laser is set to LINE setting and placed with its flattest edge on the sheet of paper such that the light path is projected onto the paper. The laser line is directed such that it passes into one side of the refraction block at an angle to the normal line and out the other side. The path of the laser is traced on the paper; arrowheads are placed on the path to indicate the direction of the rays. The process is repeated for a second block. Students analyze the diagrams by drawing normal lines for each boundary (two per diagram), measuring and labeling the angles of incidence and refraction and calculating the index of refraction values based on the analysis at both boundaries. Average values of **n** are computed for each block and students then answer the question posed in the Purpose of the lab.

Alternative Materials and Procedure:

If lasers are not available, a cardboard platform and four pins can be used as a replacement. A sheet of paper is placed upon the cardboard. The prism or block is placed upon the paper; a trace of the prism or block is made using a pencil. Two pins are pushed through the paper into the cardboard on one side of the block so that they are upright. Students look through the prism or block from the opposite side at the pins. With one eye closed, they change their sighting location until the pins are aligned one behind the other. Holding their line of sight steady at this location, the students place two more pins along the same line of sight such that all four pins are optically aligned along the same line. The two sets of two pins represent an incident ray entering the prism or block and a refracted ray exiting the prism or block. The entire path of light can be traced. Students analyze the diagrams by drawing normal lines for each boundary (two per diagram), measuring and labeling the angles of incidence and refraction and

calculating the index of refraction values based on the analysis at both boundaries. Average values of **n** are computed for each block and students then answer the question posed in the Purpose of the lab.

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. Light from lasers should never be pointed into a person's eye. Caution should be taken to avoid such mishaps. Student *horseplay* and off-task behaviors should not be tolerated.

Suggestions, Precautions, Notes:

1. Inexpensive leveling lasers can be purchased at a home store. They often go on sale for $5 during the Christmas season. They possess the capability of projecting the laser as a line or a beam. If the price is right, consider picking up a class set for use in both reflection and refraction activities.
2. Refraction blocks and prisms can be purchased from most science supply houses.
3. Emphasize to students that there are two boundaries - one for laser light entering and one for light exiting the block. They should perform a Snell's law analysis at each boundary in order to calculate the value of **n** two times; the two **n** values will be averaged.
4. Warn students in advance of the lab of the need to never direct laser light at another person's eye. Students who do not heed your warning should immediately be dismissed from the lab.
5. The procedure for this lab is very similar to the Direction of Bending Lab with the exception that actual measurements are made of the angles of incidence and refraction. In that sense, this lab is the quantitative version of the Direction of Bending Lab.

Auxiliary Materials:

None

Scoring Rubric:

RL5.	**The Unknown n Lab**	**Score**
____	Included, labeled and organized all parts of the lab report.	
____	Data section includes outline of at least two prisms. The path of laser light through the prism is shown; arrowheads are included on the light rays. An appropriate entry angle is selected - one which provides significant refraction at both boundaries. Normal lines are drawn at the entry and exit boundary and properly measured angles are indicated on the diagram. Work for the calculation of the index of refraction is clearly shown for each of the two boundaries for each prism; calculations are accurate. An average n value based on both boundaries is calculated. Work is accurate and complete.	____/____
____	Conclusion states the index of refraction value for each of the two materials; stated value is reasonably accurate.	

Connections to The Physics Classroom Tutorial:

The following reading is a suitable accompaniment to this lab:

http://www.physicsclassroom.com/Class/refrn/u14l2c.cfm

http://www.physicsclassroom.com/Class/refrn/u14l2d.cfm

Connections to Minds on Physics Internet Modules:

The Laboratory

Sublevel 4 of the Refraction and Lenses module is a suitable accompaniment to this lab:

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