Improving Your Image Lab

Teacher's Guide

Topic:

Reflection and Mirrors

The following information is provided to the student:

> **Question:**
> What is the mathematical relationship between the number of images formed by a combination of two plane mirrors and the angle between the mirrors?
>
> **Purpose:**
> To determine the mathematical equation which relates the number of images (N) formed by a set of two plane mirrors to the angle (Θ) between the mirrors?
>
> A complete lab write-up includes a Title, a Purpose, a Data section, and a Conclusion. The Data section should include an organized table of labeled data (with unit), a graph of the number of images vs. the angle between mirror (with labeled axes) and some form of data analysis which leads to an appropriate conclusion. The data analysis could involve linear regression (with slope, y-intercept, regression constant and equation), power regression (with coefficients, power, regression constant and equation) or simply a trial and error process of equation fitting. Whatever method is used to link the data to an equation, the process should be fully documented.

Materials Required:

Two plane mirrors with a vertical mounts; protractor; pencil or pen.

Description of Procedure:

Two plane mirrors are used to create an adjustable angle mirror. The mirrors are placed in a upright position on the table with the meeting point of the two mirrors at the protractor's origin. The mirrors are arranged to make a 180° angle with each other. A pencil is placed in front of the mirrors and the number of images are counted. The process is repeated for a 90° angle, a 72° angle, 60° angle, etc. with a pencil placed between the mirrors and the number of images are counted. The process is continued for many more angles in order to determine the relationship between the number of images (N) and the angle (Θ) between the mirrors. Once the data is collected, an equation is developed.

Alternative Materials and Procedure:

Alternative materials and procedures are not recommended.

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:

The Laboratory

1. Square mirrors a foot along their edge can be purchased at home stores and department stores. Two mirrors can be taped together along their edge with duct tape to form an adjustable angle mirror.
2. Here are two methods for vertically mounting a plane mirror so that it stands upright on a sheet of paper. First, 1-inch thick strips of wood with the same dimensions as the mirrors can be cut and glued to the back of the mirrors. The wood must be perfectly flat along one of its edges. Second, large binder clips could be purchased and clipped to the bottom sides of your mirrors to provide a base of support.
3. Most inexpensive mirrors are coated with a reflective material on the back surface of a thin pane of glass. This does cause difficulties for many optics labs since the reflecting surface is actually behind the glass and not on the glass. A quick fix is to use a so-called two-way mirror which has its reflective coating on the front of the glass (actually, on both sides of the acrylic). An acrylic sheet can be purchased and cut into 3"x5" strips for a cost of approximately $2 per mirror. Avoid scratching the mirror during the cutting process.
4. This lab offers students a challenging exercise in equation fitting. Students generally find the data collection process fun; they are thrilled to see so many images (especially for the really small angles). An equation which fits the data can often be found by inspection and careful analysis; students will have to experiment. Having the correct measurements will help - consider the results for the following strategic angles: 180°; 1; 90°:3; 72°:4; 60°:5; 45°:7; 40°:8; 30°:11; and 20°:17. Graphing the data also yields results (the relationship is inverse), though the results tend to be less meaningful.

Auxiliary Materials:

None

Scoring Rubric:

RM6.	**Infinity Derivation**	**Score**
____	Included, labeled and organized all parts of the lab report.	
____	Data section includes diagram with two parallel mirrors, object and the several images to the left and to the right of the mirrors. Image distances are stated. The process used to determine the equation is documented and logical. A clear effort to derive an equation is documented; unsuccessful attempts may be shown and ruled ineffective. Logic and reasoning are evident; the final equation(s) is(are) consistent with distances stated in the diagram. Equation(s) is/are accurate and works; process of finding it is thoroughly documented.	____/____
____	Conclusion states the equation or equations which relate(s) the distance between the nth image and the rightmost mirror in terms of pertinent variables; definition of variables are clearly stated.	
____	Discussion of Results shows how the equation can predict the first five image distances to the right of the right-most mirror. Work is shown and labeled.	

Connections to The Physics Classroom Tutorial:

The following reading is a suitable accompaniment to this lab:

http://www.physicsclassroom.com/Class/refln/u13l2f.cfm

Connections to Minds on Physics Internet Modules:

There are no sublevels of Minds On Physics pertaining to the topic of multiple mirror systems.