Magnification Ratio Lab

Teacher's Guide

Topic:

Reflection and Mirrors

The following information is provided to the student:

Question:
What object locations (relative to the surface of a concave mirror and expressed in terms of focal lengths) would result in the formation of images with magnification values of -1, -2, and -0.5?

Purpose:
To determine the object distances (expressed in terms of f) which would be required to produce an image magnification of -1, -2 and -0.5 and to use the results to determine the focal length of the mirror.

A complete lab write-up includes a Title, a Purpose, a Data section, a Conclusion and a Discussion of Results. The Data section should include a table of M , d_o, d_i and f values and labeled work shown for at least one f calculation. The Conclusion should identify the object distances (in terms of focal lengths: 2f, 3f, 4f, etc.) required for the specified M values and should state the focal length. The Discussion section should discuss how the focal length was determined, how the object distances (in terms of focal lengths) were determined and should include a thorough error analysis for each of the three trials.

Materials Required:

Small concave mirror (focal length of 15 cm-20 cm; diameter of 4 to 6 cm); mirror holder; 7-Watt night light bulb; bulb base; large note card; meter stick.

Description of Procedure:

The meter stick is placed upon the lab table. The mirror and mirror holder are positioned at the 0.0-cm mark on the meter stick. The focal length of the mirror is determined by some form of measurement. Students then attempt to find the object position which results in an inverted image which is the same size as the object (a magnification of -1.0). (A magnification of -1.0 is also the position at which the object distance and the image distance are the same.) The bulb is moved to any position and the image is located using the note card. Students use their conceptual knowledge and their observations to adjust the object location so that the magnification is -1.0. The process is repeated for magnification values of -2.0 and -0.5.

Alternative Materials and Procedure:

Some schools may have access to sophisticated optics bench equipment which makes the task of data acquisition quicker and easier.

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.

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Suggestions, Precautions, Notes:

1. Night light bulbs can be purchased at home stores and department stores. A permanent marker can be used to draw a picture of a smiley face on the part of the bulb facing the mirror.
2. Some students will tend to place the note card in between the mirror and the light bulb, blocking the light from reaching the mirror. It may be necessary to slightly adjust the mirror so that it reflects light along a different line than the line from Smiley to the mirror.
3. Ideally, students should construct a data table with column headings for magnification, d_{object} (cm), d_{image} (cm), and d_{object}/f.
4. The best means of determining the focal length of the concave mirror is to find the center of curvature location. The radius of curvature can be determined, The focal length is one-half the value of the radius of curvature. This method of finding f also satisfies one of the three data trials - to find the object distance which results in the magnification of -1.0. Another useful method of determining the focal length involves collecting a d_{object} and d_{image} value and calculating the f value using the mirror equation. To insure accuracy, measurements could be made for a couple of other d_{object} and d_{image} values.
5. After a thorough explanation of the Purpose and the general procedure, it is best to not interfere with student efforts to accomplish the Purpose. Highly profitable discussions occur between lab partners as they talk through how they can find the object location which produces the three different magnifications. Most of the learning which is going to occur in this lab is going to occur during the conducting of the procedure.
6. Use the same mirror in this lab as was used in the Finding Smiley Lab. If the Finding Smiley has been done, then it would be useful to make the connection between the two labs. If a line with a slope of 1.0 is constructed on the d_{image} vs. d_{object} curve, then it will intersect the curve at a d_{object} coordinate value which corresponds to the magnification of -1.0; this is the center of curvature position of the mirror. If a line with a slope of 2.0 is constructed on the d_{image} vs. d_{object} curve, then it will intersect the curve at a d_{object} coordinate value which corresponds to the magnification of -2.0; this coordinate should correspond to the d_{object} value which was found in this lab.

Auxiliary Materials:

None

Scoring Rubric:

RM10. Magnification Ratio Lab	**Score**
____ Included, labeled and organized all parts of the lab report. ____ Data section included a complete table with the <u>measured</u> data for determining the magnification and the focal length (d_{object} and d_{image}). At least one focal length calculation is shown. The table is organized, clear, and includes the stated unit. Data appear accurate. Calculations are organized and accurate. Demonstrated a clear understanding of how to investigate the question. ____ Conclusion states the object distances (expressed in terms of f) required for each of the three magnification values. The average focal length is stated. ____ Discussion of Results section describes how the focal length was determined; an error analysis is performed (perhaps even a percent error for each trial using the average f value as the theoretical value). The manner in which the object distances - expressed as a multiple of focal length - was determined is discussed. Provided the logical link between experimental data and conclusion statements.	____/____

Connections to The Physics Classroom Tutorial:

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The following reading is a suitable accompaniment to this lab:

http://www.physicsclassroom.com/Class/refln/u13l3f.cfm

http://www.physicsclassroom.com/Class/refln/u13l4d.cfm

Connections to Minds on Physics Internet Modules:

Sublevels 7 and 10 of the Reflection and Mirrors module are suitable accompaniments to this lab:

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