

## Right Angle Mirror Lab

### Teacher's Guide

**Topic:**

Reflection and Mirrors

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

**Question:**

At what location is the secondary image for a right angle mirror formed? What theoretical rule or general strategy could be stated to predict its location if given the object location?

**Purpose:**

To describe the location of the secondary image formed by a right angle mirror and to state a theoretical rule which could be used in predicting its location.

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 the provided diagram with two sets of laser-guided incident and reflected rays showing the path of light from the object off both mirrors. The reflected rays (off the second mirror) should be extended by dashed lines behind the mirror; the image location should be marked and labeled. Class data should be included in the Data section and distinguished from individual data. A student might record and label some measurements. In addition to the usual treatment of the connection between the evidence and the conclusion, the Discussion of Results section should include an error analysis.

**Materials Required:**

Two plane mirrors with a vertical mounts; metric ruler; laser light; provided diagram (see Auxiliary Materials section).

**Description of Procedure:**

Students use a diagram which includes two mirror lines at right angles to one another and a dot which represents an object. (see Auxiliary Materials section). The reflecting surfaces of two plane mirrors are placed on the mirror lines so as to form a *right angle mirror*. A laser is set on LINE setting so that its path is projected on the sheet of paper. The laser line is directed from the object towards one of the mirrors at such an angle that it undergoes a double reflection - i.e., reflects off one mirror and then reflects off the second mirror. The path of the laser light is traced upon the diagram; arrowheads are placed upon the light rays. The laser line is then used to determine a second and a third double reflected path; each path is clearly drawn with arrowheads placed upon the rays. The laser is turned off and set aside; the mirrors are removed as well. For each of the three double reflected paths, the second reflected ray is traced backward beyond the mirror until it intersects at the middle image location. The location is labeled as image location. Measurements are made and students use their results and class data to ponder the answer to the question raised in the Purpose.

**Alternative Materials and Procedure:**

If lasers are not available, a line of sight method which makes use of three pins can be implemented. One pin serves as the object. The other two pins are placed along a sight line as the student sights with one eye at the middle image of the object. The image of the object pin and the two sighting pins should all be in a perfect line. A straight edge can be used to trace the extension of this sight line back beyond the

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mirror. A second and a third sight line is determined and extended backward behind the mirror in order to determine the image location.

### 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.

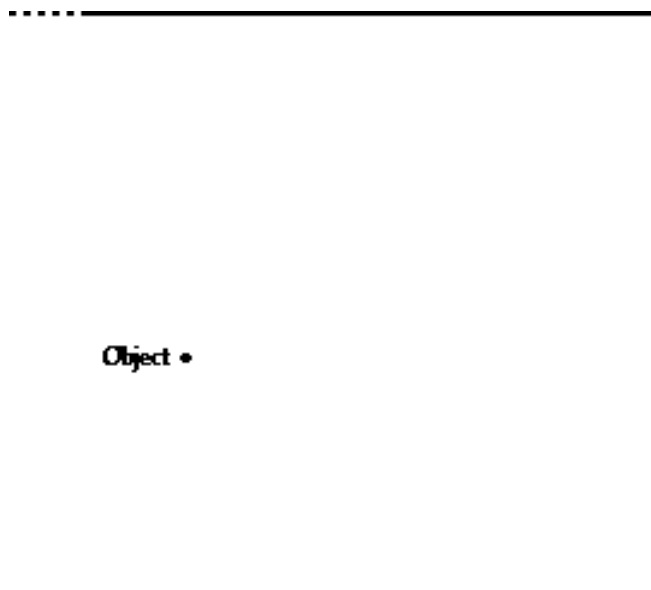
### Suggestions, Precautions, Notes:

1. 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.
2. 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.
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 is a perfect lab to be done without any previous discussion of right angle mirrors. The only necessary pre-lab information is that students should be aware of the presence of three images and know the focus of the lab is on the so-called middle image.
5. Use the provided diagram in the Auxiliary Materials section. If all students use the same diagram, then class results can easily be pooled. Make a transparency of the diagram. Once students identify the middle image location, place the transparency over their diagram and mark the location of their image with a marker. Once all lab groups have contributed, the class results can be viewed and a conclusion can more easily be made.
6. Once students begin tracing laser paths, it is very important that mirrors remain in a fixed position. A disturbance of a mirror from its original alignment is a common source of error.
7. 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.

### Auxiliary Materials:

The following page is provided to the student for completion and inclusion in the Data section of their lab notebook. Students should leave about 3 inches of space above the horizontal line and to the right of the vertical line.

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### Scoring Rubric:

<b>RM5. Right Angle Mirror Lab</b>	<b>Score</b>
<ul style="list-style-type: none"><li>___ Included, labeled and organized all parts of the lab report.</li><li>___ Data section included provided diagram with two sets of incident and double-reflected rays originating from the object location (included arrowheads). Each of the second reflected rays are extended backwards to identify the secondary image location. Measurements were included for individual results. Ray construction and image location is accurate.</li><li>___ Conclusion describes the location of the secondary image relative to the object and mirrors; a general rule which could be used to locate it is clearly stated.</li><li>___ Discussion of Results describes how the general rule stated in the Conclusion is consistent with the experimental evidence. Individual results were evaluated; possible causes of error were suggested (where appropriate).</li></ul>	___/___

### Connections to The Physics Classroom Tutorial:

The following reading is a suitable accompaniment to this lab:

<http://www.physicsclassroom.com/Class/refln/u13l2e.cfm>

### Connections to Minds on Physics Internet Modules:

There are no sublevels of Minds on Physics which pertain to right angle mirrors.