

## Rough versus Smooth Lab

### Teacher's Guide

**Topic:**

Reflection and Mirrors

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

**Question:**

How does reflection of light off a paper surface compare to the reflection of light off a plane mirror surface? What if the paper is uniformly wet?

**Purpose:**

To compare the reflection of light off a dry mirror surface, a dry paper surface and a wet paper surface and to explain the observed differences.

A complete lab write-up includes a Title, a Purpose, a Data section, and a Conclusion/Discussion. The Data section should include a collection of well-documented observations regarding the reflection of light off paper, mirror, and wet paper. The Conclusion/Discussion section should include a well-written discussion comparing and contrasting the reflection of light off paper, mirror and wet paper. A reasonable and thorough explanation of the differences should be given.

**Materials Required:**

Laser; plane mirror; piece of paper; plane mirror; water mister or *fog in a can*.

**Description of Procedure:**

Students obtain a laser and set it to BEAM setting (as opposed to LINE setting). A plane mirror and a sheet of paper are placed on the table; the mirror is *facing* the ceiling. The laser beam is directed at the mirror. The location of contact is carefully observed. Students look at the ceiling and view the appearance of the laser on the ceiling. The procedure is repeated for the mirror. Observations are recorded in words and/or a diagram. When requested by students, the teacher visits the table and uses a spray bottle of water to spray mist into the air in order to illuminate the incident and reflected rays for the mirror and for the paper. Observations are made of the beams and of the presence or absence of a laser dot on the ceiling. Students document all their observations using words and/or a diagram.

**Alternative Materials and Procedure:**

If supplies are limited, this lab can just as easily be performed as a demonstration lab. Students can crowd around a lab table as the teacher (and a student volunteer) conducts the procedure. Students make observations and document the findings in their own lab notebook.

**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:**

## The Laboratory

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. 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" x 5" strips for a cost of approximately \$2 per mirror. Avoid scratching the mirror during the cutting process.
3. A spray bottle can be set to a mist setting and filled with water. The water can be sprayed from the can to illuminate the laser light's path. A more professional looking solution involves the use of [Fog in a Can](#) - a product available from most science supply houses. The fog is sprayed into the air to illuminate the laser path. The aerosol is non-toxic (according to the directions on the can) and more stable than a water mist.
4. Avoid having students use the mister. There is a collection of observations which need to be made in the following order. Guide the *misting session* at the student lab tables. First, have a student direct a beam at the mirror. Spray a quick *pulse of water* into the air, allowing students to see the incident and reflected beams. Repeat the process, making sure that students view both beams and see the *laser dot* on the ceiling. Once convinced, continue spraying the mist. As the mist lands upon the mirror, the reflected rays tend to scatter; the reflected beam is no longer seen; the *laser dot* on the ceiling is no longer visible. Repeating the same procedure for the paper results in the opposite trend. At first, neither the reflected beam nor the *laser dot* on the ceiling are seen. Instead, a *mysterious halo* of light is seen emerging from the paper at the location of contact. Once the paper becomes wet, the reflected beam becomes visible and a *laser dot* is seen on the ceiling. The water has filled in the crevices within the paper, turning it into a specular reflector. (It may be necessary to smooth the precipitated mist about the paper with your finger in order to get this effect.)
5. As an extension to this lab, demonstrate the reflection of light off a laminated sheet of paper. Ask students to make a prediction prior to the demonstration.
6. 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:

None

### Scoring Rubric:

<b>RM3. Plane Mirror Image Lab</b>	<b>Score</b>
<p>___ Included, labeled and organized all parts of the lab report.</p> <p>___ Data section includes a clear communication of how light from a single point reflects off mirror AND extension lines to show that the image location is where reflected rays seem to come from AND clearly-stated measurements of image and object distance. Class data for object and image distances are recorded and labeled. Object and image locations are labeled; arrowheads are placed on all rays. Results are reasonably accurate.</p> <p>___ Conclusion states the relationship between the object and image distance.</p> <p>___ Discussion of Results discusses the experimental evidence which supports the conclusion. It includes an error analysis in which the results are evaluated for accuracy. A percent difference calculation is shown as a part of the error analysis; calculation is accurate; work is shown.</p>	___/___

### Connections to The Physics Classroom Tutorial:

The following reading is a suitable accompaniment to this lab:

## **The Laboratory**

<http://www.physicsclassroom.com/Class/refln/u1311d.cfm>

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

Sublevel 4 of the Reflection and Mirrors module is a suitable accompaniment to this lab:

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