

# Reflection

## Introduction

Students will explore the properties of mirrors.

## Materials

Mini-Laser or narrow beam flashlight

Flat mirrors

Small cardboard boxes (one to support the mirror and another to serve as a "target")

Butcher paper, about 2 by 3 feet per sheet

Ruler or straight edge

Protractor

Pencil

Notebook – to record the experiment, data, analysis, and conclusions

Extension Activity: aluminum foil, manila folder, tape, wooden ruler, laser or flashlight, and two blackboard erasers

## Preparation

Start by proposing a guiding question that will lead to a student investigation: “What happens when a light beam strikes a mirror?” Students may respond “it reflects” – but where does it go? Continue with a discussion that further whittles down and refines the response until the class formulates a hypothesis based on their everyday experience and prior knowledge about what happens to the reflected beam.

## Experiment Setup – Test the Hypothesis

If you would like to keep the activity open ended, ask the students to suggest materials necessary to explore their hypothesis with an experiment. There are a few things to consider:

- Variables – what am I measuring? (incident and reflected angles)
- Experiment setup – how am I going to assemble the materials and measure the variables? (trace the light path and measure angles with a protractor)
- Materials – what will I need to set up the experiment, measure the variables, record and organize the data? (light source, mirror, protractor, pencil, butcher paper, graph paper, etc.)

Notice how the experiment setup and materials are inter-related. This is similar to how science (variables and experiment setup) and technology (materials and tools) are related, with one affecting the other.

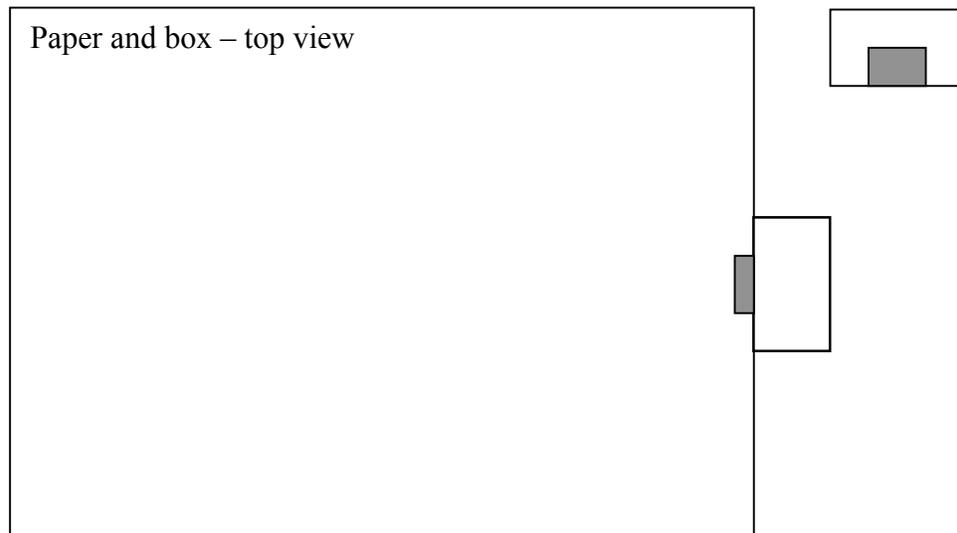
An example: Variables: incident and reflected beam angles

Experiment setup:

1. On a tabletop, lay out the butcher paper. Students will later trace the beam paths onto this paper with a pencil.

2. Attach the flat mirror to a small box in order to hold it upright and perpendicular to a tabletop. The mirror bottom should be flush with the bottom of the box, so that it touches the butcher paper.
3. Place the mirror box on the butcher paper and mark its position with a pencil line along the bottom of the mirror. Or simply place it along a straight edge of the butcher paper.

Paper and box – side view

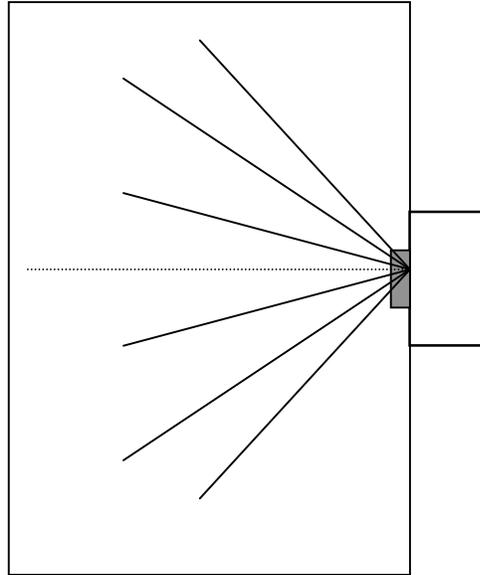


### Predict, Trace, and Measure

Once the class has agreed on an experimental setup and procedure, break them up into lab groups of no more than four students. The following is an example procedure.

1. Select and mark a spot on the butcher paper to place the laser.
2. Predict where the reflected laser beam will go, and place the target box so that the reflected beam will hit it. Mark this spot on the paper with a pencil mark.
3. Test the prediction by putting the mini-laser to small flashlight along the incident line. Trace the path the light follows on the butcher paper from the laser, to the mirror, and to the target. Students may want to draw a vertical line on the target box so that they may easily mark the reflected beam on the butcher paper.
4. Measure the angles with respect to the mirror and a perpendicular line.
5. Repeat for several different incident angles. Make sure that students hit the mirror in the same place for each test. Otherwise their beam tracings will not clearly show the relationship between incident and reflected angles.

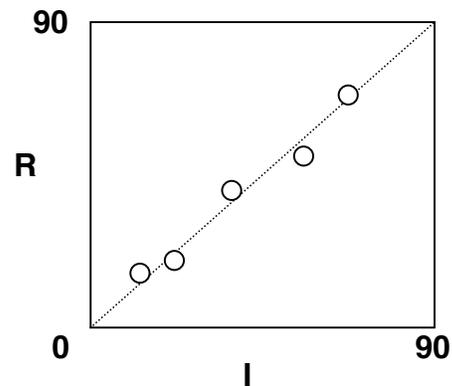
Do this in a slightly darkened room. Use a water mister or chalk dust to make the laser beam more visible (or skim the beam along the paper).



## Analysis

Students have two sources of data: the light path tracings on the butcher paper and their measurements of incident and reflected angles. Ask the groups for suggestions on how to analyze the data, with a question in mind: how does the angle of incidence compare with the angle of reflection? One way is to construct a table and plot the angle measurements on a graph.

R	I
20	19
25	27
45	44
50	52
75	75



To compliment the graph, refer back to the tracings on the butcher paper.

1. Look for patterns: What do the data points suggest about the relationship between the angles?
2. Pick another incident angle. Where should the measurement of the reflected angle show up on this graph? Test your prediction with an experiment.
3. Thinking about experimental errors:
  - Why do you think the data points stagger around a little?
  - Why do they not perfectly lie on a straight line?
  - What could have caused this to happen?

## Conclusion

After analyzing their data, students should come to a conclusion about how the angle of incidence and reflection are related. Their task now is to distill their analysis into a clear and concise form. For instance:

$$\text{Angle of incidence} = \text{angle of reflection}$$

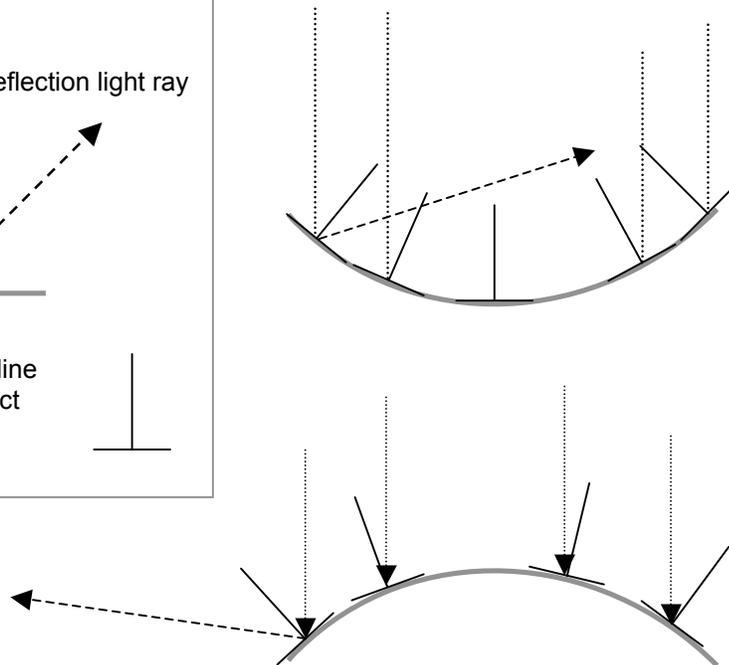
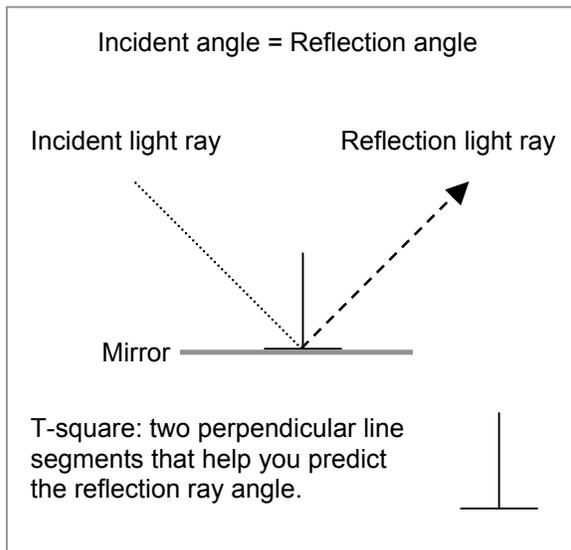
## Extend – Front-silvered versus back silvered mirrors

If the students are using standard mirrors that have their reflective coating on the back, they must be careful to measure all the angles from the coating rather than from the front of the mirror. Another alternative is to allow them to do the experiment twice – once with a front-silvered mirror and once with a regular back-silvered mirror. Then the difference is obvious if you attempt to measure the angles from the front of each mirror.

## Extend – Curved Mirror

How will a curved mirror reflect light?

Using the rule of reflection, students predict (form hypothesis) how the incident light reflects from a curved mirror.



The T-square has a normal line perpendicular to a tangent line.

## Curved Mirror

Each curved mirror is half of a circle, with a cross marking the center. Use your rule of reflection to predict the reflected path of the incident light rays. The reflecting surface is on the front of the mirror, where the incident ray strikes the mirror surface.

