Name _____

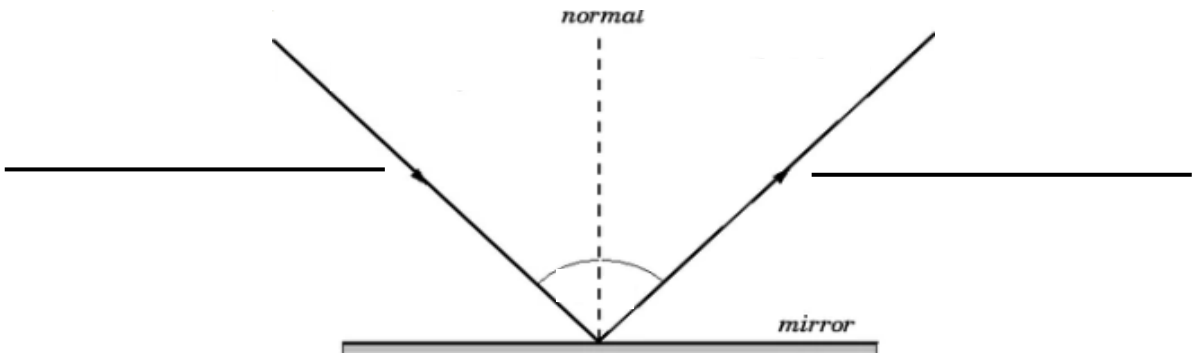
Law of Reflection

The law of reflection states: "The angle of incidence is always equal to the angle of reflection."

Demonstration: Single Mirror

Using a single mirror, a laser, and the illustration below, observe the following: incident ray, reflected ray, normal line, angle of incidence, and angle of reflection.

Label the image with "incident ray" and "reflected ray."



Experiment 1: Test the Law of Reflection

Use two mirrors at right angles to each other and test the law of reflection (see video).

Based on what you have just learned about the law of reflection, complete the following hypothesis.

Hypothesis

IF... an incident ray strikes a mirror at an angle of 45˚ to the normal (teacher explains)

THEN... the _____ ray will go out of the mirror at an angle of ____˚ to the normal

Did you confirm the law of reflection? _____

Experiment 2: The Law of Internal Reflection

Cloudy glass of water demonstration

Two-liter bottle and stream of water demonstration

Describe what you saw?

_____

_____

Using the law of internal reflection, explain why the ray could not escape the stream?

_____

_____

Review:

- ✓ What is an incident ray? _____
- ✓ What is the reflected ray? _____
- ✓ What is total internal reflection?

  _____
- ✓ At what angles do we get total internal reflection? **<**_____

Name _____

Law of Reflection

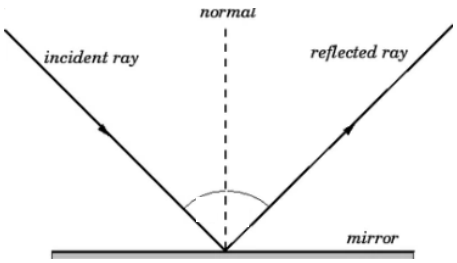
The law of reflection states: "The angle of incidence is always equal to the angle of reflection."

Demonstration: Single Mirror

Using a single mirror, a laser, and the illustration below, explain the following: "incident ray," "reflected ray," "normal line," "angle of incidence," and "angle of reflection" (see video).

Teach:

In the image to the right, the "incident ray" is the one that hits the mirror. The "angle of incidence" is the angle between the incident ray and the dotted line labelled "normal." The "reflected ray" is the ray that leaves the mirror. The "angle of reflection" is the angle made between the reflected ray and the "normal."



Experiment 1: Test the Law of Reflection

Use two mirrors at right angles to each other and test the law of reflection.

Based on what you have just learned about the law of reflection, complete the following hypothesis.

Hypothesis:

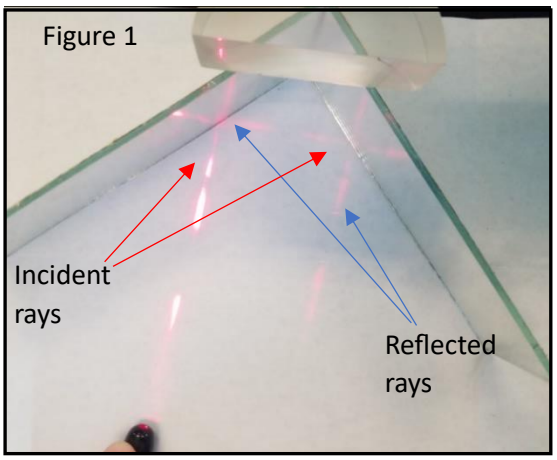
***IF*... an incident ray strikes a mirror at an angle of 45˚ to the normal** (teacher explains)

***THEN*...the** reflected ray **will leave the mirror at an angle of** 45˚ **to the normal**

Teach

Set up. Draw two large lines perpendicular to each other on a large piece of white paper. Place two mirrors at 90° to each other over the lines (see figure 1). Use the laser pointer and direct the beam into one of the mirrors at about 30°, making sure it also reflects into the other mirror. The beams should be also be touching the white paper, allowing the students to see them.

Students now trace the incident and reflected rays (a total of 3 beams), and measure the angles of incidence and reflection for all the beams (4 angles). Have them also label all three beams. Make sure they understand that the second ray is both incident and reflected!



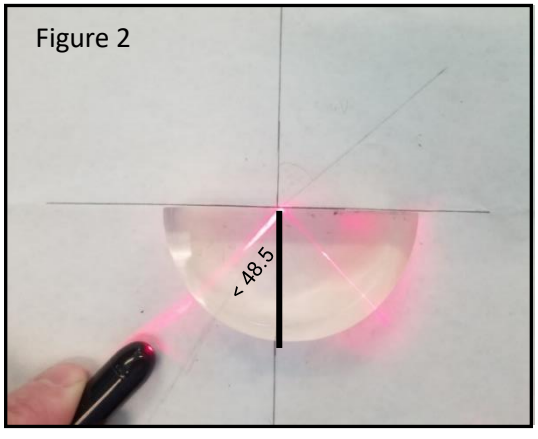
Did you confirm the law of reflection? _____

Experiment 2: The Law of Internal Reflection

Cloudy glass of water demonstration

Teach

Fill a glass with cloudy water (usually a bit of liquid bleach is enough to make the water cloudy). Now shine a laser into the water from the side of the glass, making sure that the beam is striking the *underneath* surface of the water (see video). For angles less than 48.5˚ to the normal (the thick black line in figure 2), the beam will shoot out into the air (pointing the laser straight up, for example, and the beam will hit the ceiling), but when we reach the "critical angle" of 48.5˚ (different depending on the medium), the ray will travel along the boundary of the water and the air. With angles *greater* than the critical angle, the ray will reflect back into the water! This is demonstrated in figure 2. Although the beam is going through plastic and not water, the principle is the same. As the laser is moved farther away from the normal (thick black line), the angle will approach 90˚ but the ray will continue to reflect back into the medium. This is a "boundary" property of light that occurs when light travels through a dense medium (water or plastic as in figure 2) that also interfaces with a less dense medium (air).



You can make all this clear by illustrating it on the board. Show the beam coming out of the water at angles less than 48.5˚(keep in mind the beam is bent or refracted. Do a Google search for lots of pics). But once the angle gets to 48.5˚, the ray exiting into the air will hug the boundary between the air and the water. Angles *greater* than the critical angle, and the ray will reflect back into the water (see video for example).

Two-liter bottle and stream of water demonstration

For the actual experiment, use a large 2-liter plastic bottle. Drill a small pea-sized hole in the very bottom of the bottle and place sticky tape over it (see video). Place on a stand so that when you remove the tape, the water will flow into a bucket. Now shine a laser through the entire bottle and into the hole. It is best if the laser is mounted. The laser light will go through the hole and into the water flow (the denser medium) but when it hits the water/air boundary, it will reflect back into the stream. This is because the angles of incidence are always greater than the critical angle which means the light cannot escape the stream!

Describe what you saw? *The light beam did not escape the flow.*

Or, the light ray reflected off of the inside surface of the flow back into the water.

Using the law of internal reflection, explain why the ray could not escape the stream? *Because all the incident rays were greater than the critical angle.*

Review:

- ✓ What is an incident ray? *The ray that strikes the surface*
- ✓ What is the reflected ray? *The ray that leaves the surface*
- ✓ What is total internal reflection? *This occurs when the incident ray is reflected into the medium*
- ✓ At what angles do we get total internal reflection? **<** *48.5˚*