

BENDING LIGHT

Teaching Guidelines

Summary: Students make measurements to explore how light bends as it enters water or glass, and look for a pattern.

Subject: Geometry

Topics: Triangles

Grades: 7-10

Concepts

- Angle
- Ratio

Knowledge and Skills:

- Students can measure angles
- Students can create triangles and determine ratios of sides

Subject: Physical Science

Topics: Optics

Grades: 7 - 12

Concepts

- Refraction

Knowledge and Skills:

- Students understand that the angle of refraction of light as it moves from air into another material is dependent on the incoming angle and the type of material.

Procedure

Use the “straw in a glass of water” demonstration to show students how the image of an object seen in water can be changed or distorted. Ask students if they can explain what they see, and guide the resulting discussion to understanding that the light from the straw is being bent as it travels from the straw to the eye.

Explain to students that scientists have long known that light bends when it moves out of one substance and into another (as when it moves from the water to the glass, and then from the glass to the air), and that this bending of light is called “refraction”.

Ask if students can think of examples of refraction, and in the discussion that follows ensure that students understand that eyeglass lenses, contact lenses, and the lenses used in binoculars all work on the basis of refraction of light.

Tell students that sometimes it is important to limit the amount of refraction that occurs, and ask them to watch for that idea in the short movie you are about to show. Then play the movie “Science and Sunglasses” all the way through.

At the end of the movie, ask students if they can explain why you would want to limit refraction of light in sunglasses. Discuss some answers, and display “Bending Light Diagram #1”, and explain how it shows how light refraction through a material that is placed in front of the eye can cause an apparent shift in the position of objects.

Tell students they are going to explore some of the characteristics of refraction in a team activity. Arrange students into teams of 2-3 members each, and distribute the handouts for “water” and “glass”. (Note: To save time, You may wish to have some teams analyze only the “water” diagrams, and other teams analyze the “glass” diagrams.)

Each diagram represents how a beam of light bends as it moves from air into water. In each case, students should do a three-step analysis of the diagram:

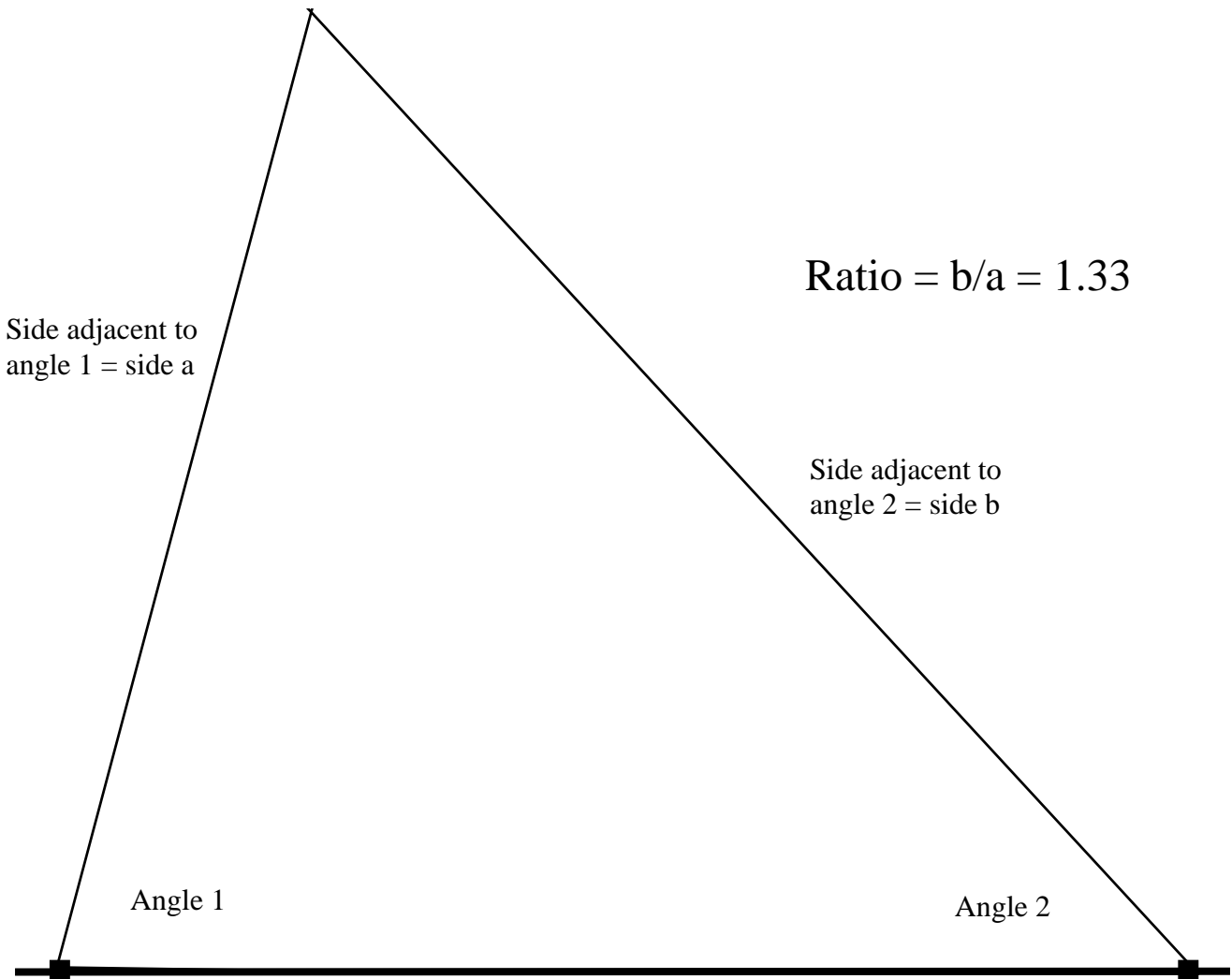
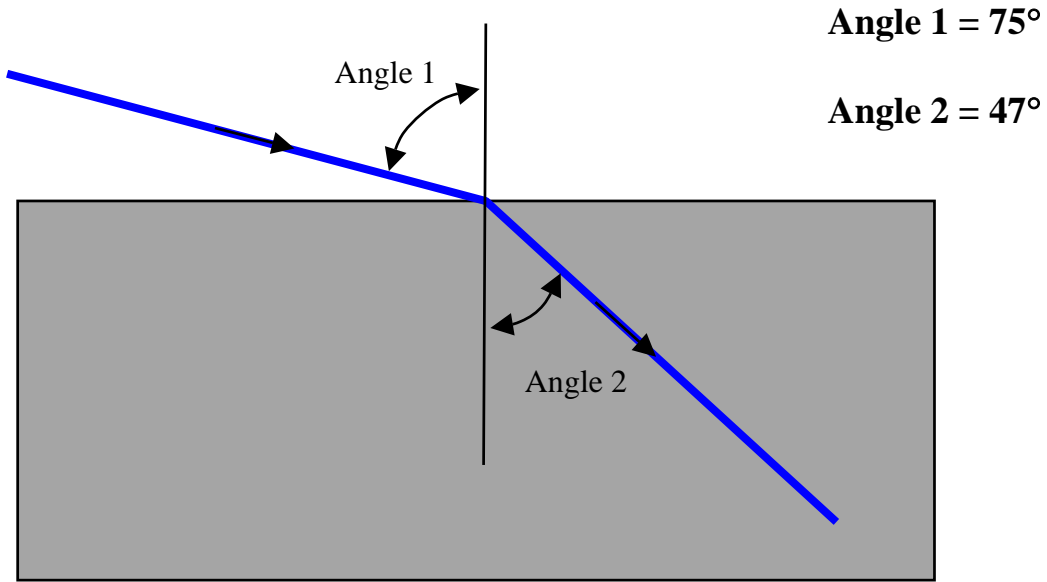
- 1) Measure angle #1 and angle #2
- 2) Create a triangle with those same two angles, using the line at the bottom of the sheet as the side of the triangle between the two angles, and the two indicated points as vertices.
- 3) Find the ratio of the other two sides of the triangle, with the side adjacent to angle #2 in the numerator of the ratio and the side adjacent to angle #1 in the denominator. (see example below).

Students should find that for all three examples of air-to-water refraction, the ratio of the sides of the triangle is close to 1.3, and that for air-to-glass refraction, the ratio of the sides of the triangle is close to 1.65.

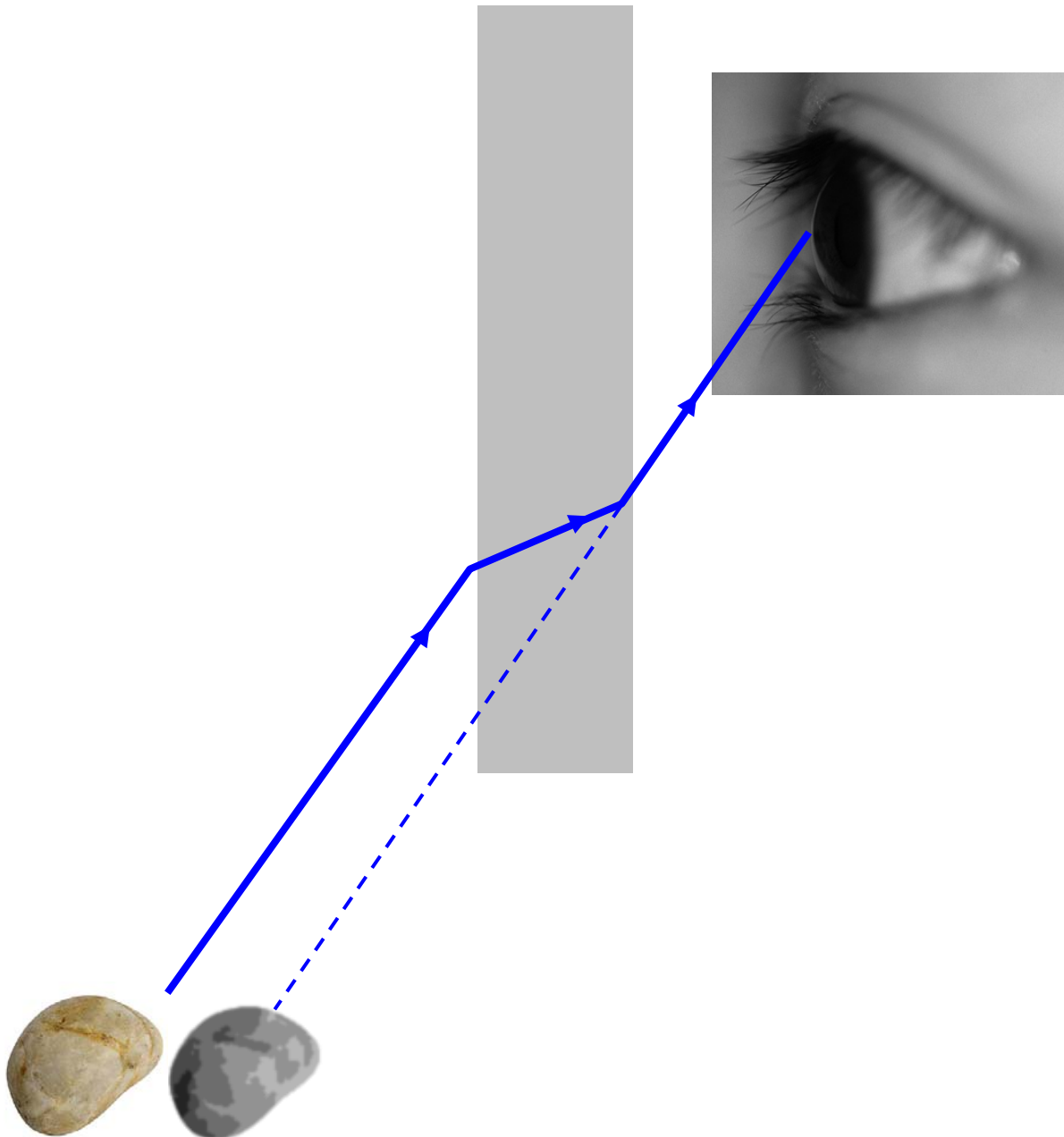
In discussing results, explain to students that every material has its own characteristic ratio for the bending of light. Ask, “How would you use what you’ve learned to make a pair of sunglasses that does not distort vision?”, and guide the discussion to understanding that their observations indicate two principles that can be used:

- 1) Choose a material that has a ratio as close to 1 as possible, so that angle 2 is nearly equal to angle 1.
- 2) Shape the sunglass so that the angle of incoming light (angle #1) is as small as possible, because the smaller angle 1 is, the less the light is bent.

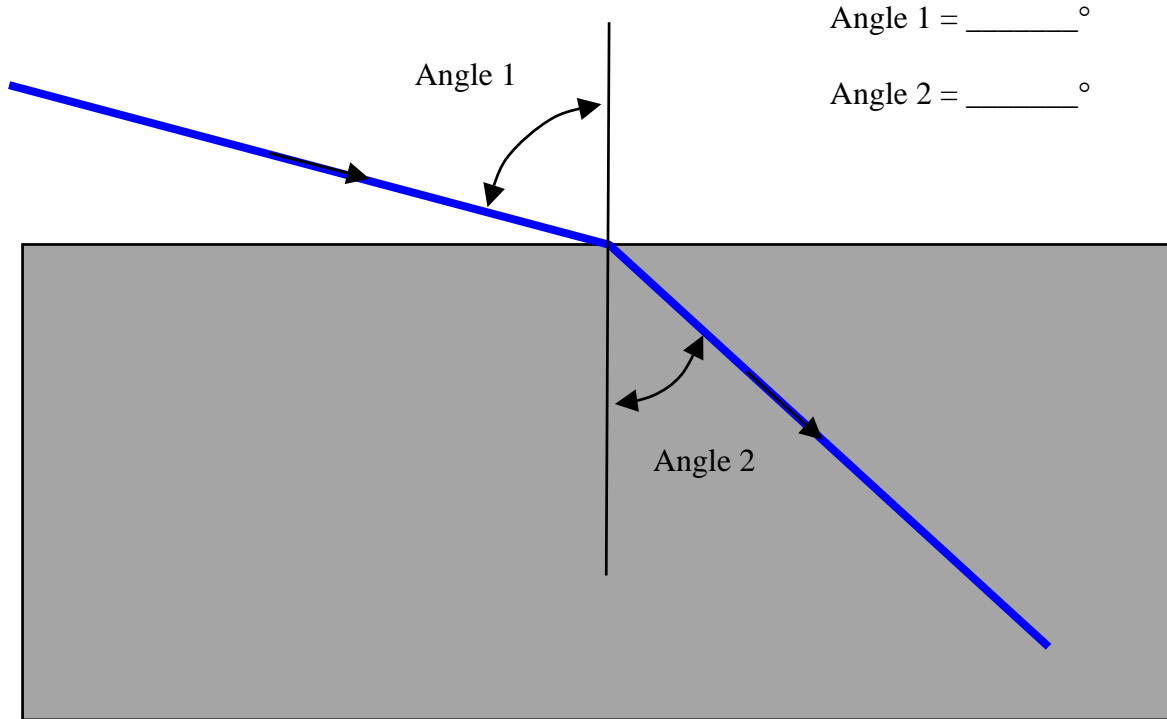
Regarding point #2, you may wish to relate this to the curvature of the sunglasses shown in the movie, and explain how curving the surface affects the refraction of light through the lens.



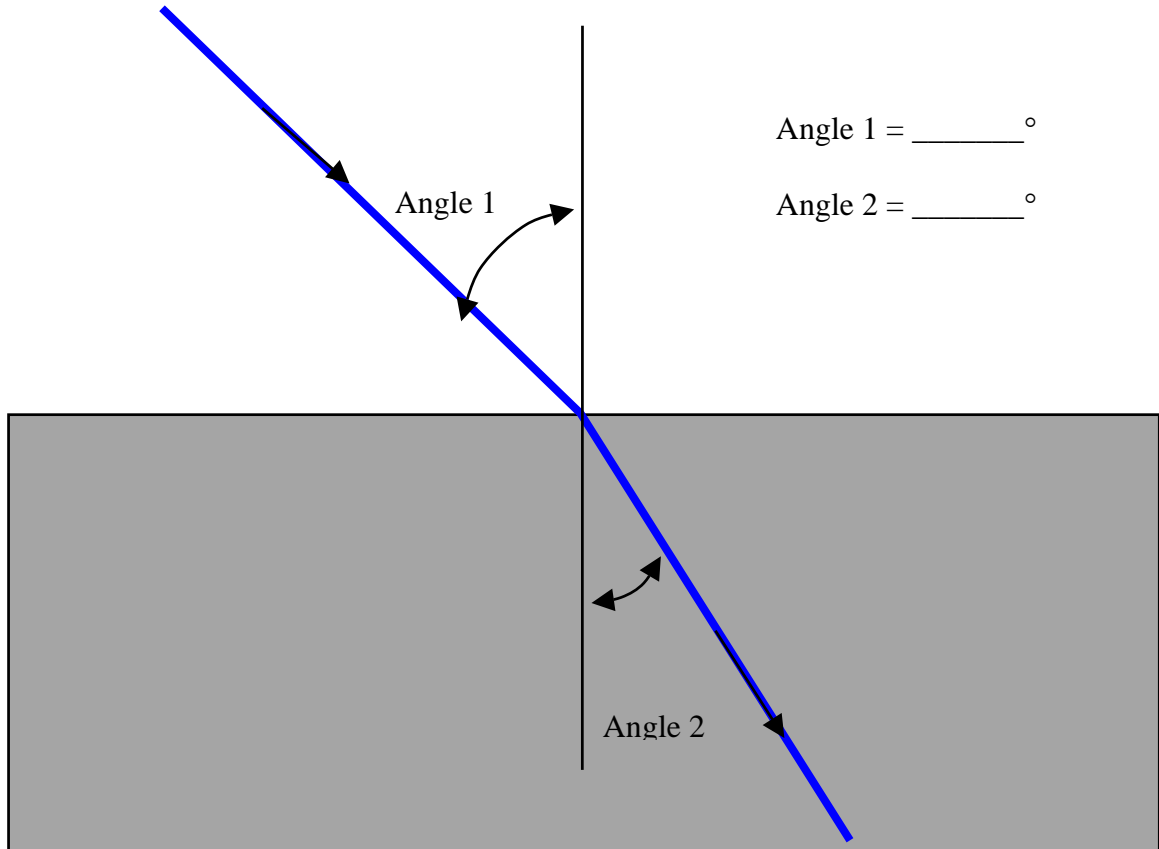
Bending Light Diagram 1



Bending Light: Water #1



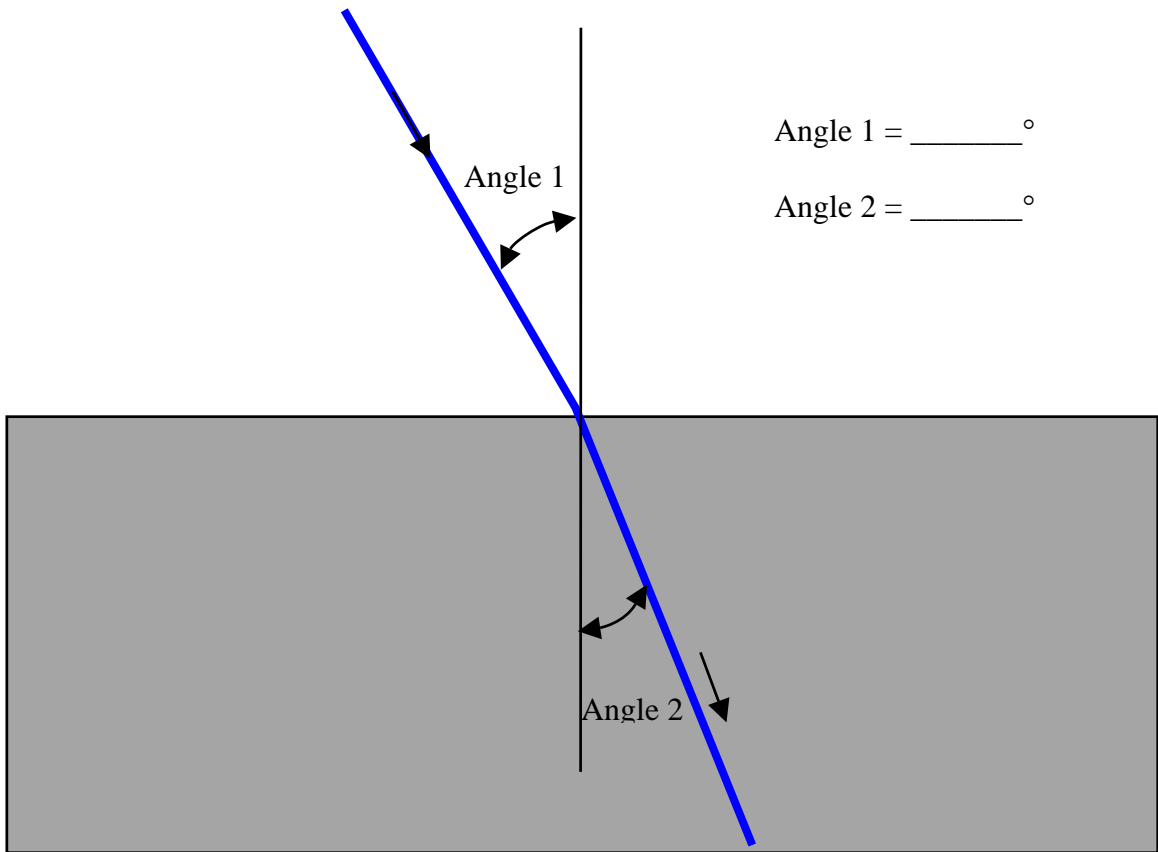
Bending Light: Water #2



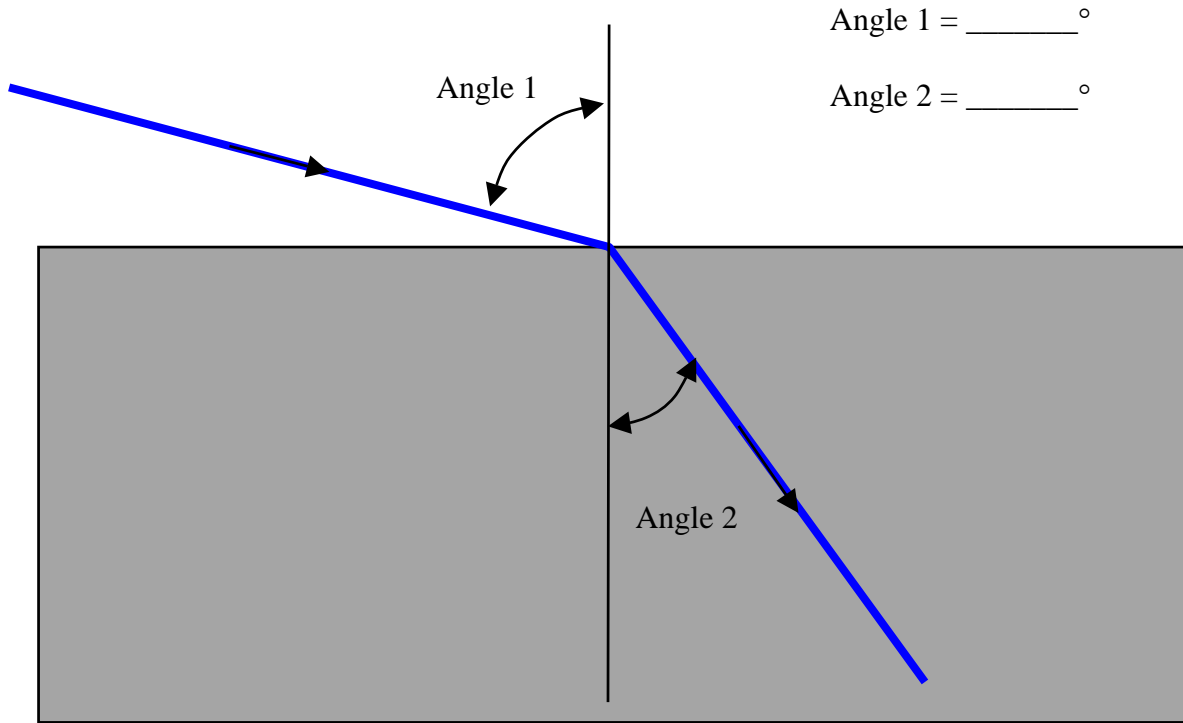
Angle 1

Angle 2

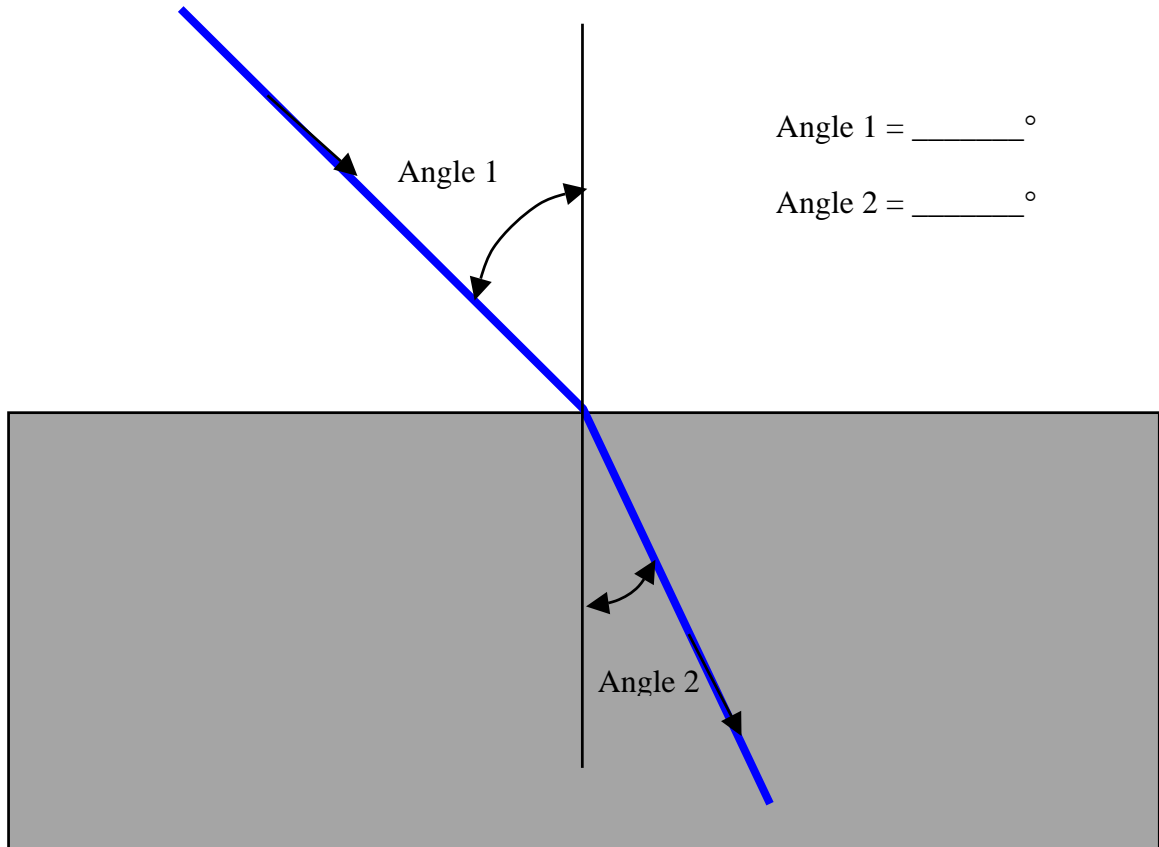
Bending Light: Water #3



Bending Light: Glass #1



Bending Light: Glass #2



Bending Light: Glass #3

