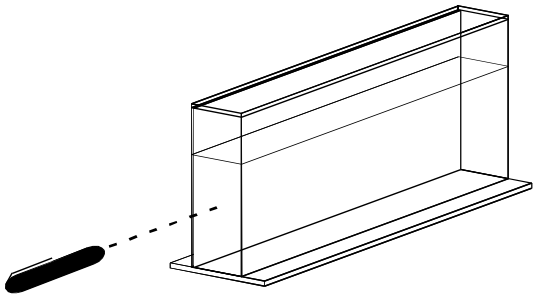
PhyzLab Springboard: Critical Angle 1 X

• Apparatus •

__Laser Beam Viewing System
  __acrylic tank with opaque white insert
  __laser pointer
__access to cold tap water
__water transport vessel (milk carton)
__stirrer (plastic or wood ruler with NO METAL)
__access to paper towels
__access to scattering agent



LASER USAGE WARNING! DO NOT EXPOSE EYES TO DIRECT LASER LIGHT OR SPECULAR REFLECTED LASER LIGHT AS THIS MAY CAUSE DAMAGE TO EYES. DO NOT AIM THE LASER BEAM AT PEOPLE OR ANIMALS. DIFFUSELY REFLECTED LASER LIGHT IS SAFE TO VIEW.

• Set Up •

1. Remove the insert and set it aside.

2. Fill the tank about half way with cold tap water.

• Observations •

1. Seeing the Light

a. Shine the laser beam on the board or screen as directed by your instructor. Try both "spot" mode and "underliner" mode.

i. Can you see the spot where the beam hits the board/screen? Why is this?

Yes, it undergoes diffuse reflection.

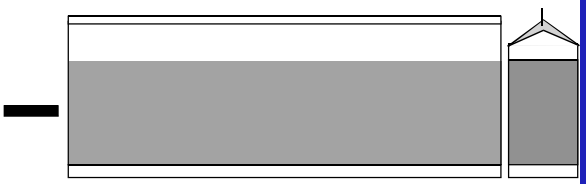
ii. Can you see the laser beam between the pointer and the board/screen? Why is this?

No, air is transparent; light passes through it without being reflected.

b. Position a "beam catcher" such as a milk carton at one end of the tank. Pass the laser beam horizontally through the water.

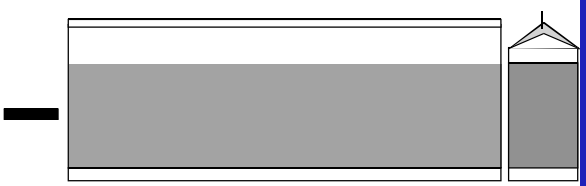
i. What do you observe? Describe and draw.

[The beam can be seen a little bit.]



ii. How can the situation be improved? Describe and draw.

Add a scattering agent (Boston™ Cleaner, powdered milk, Pine-Sol™.)

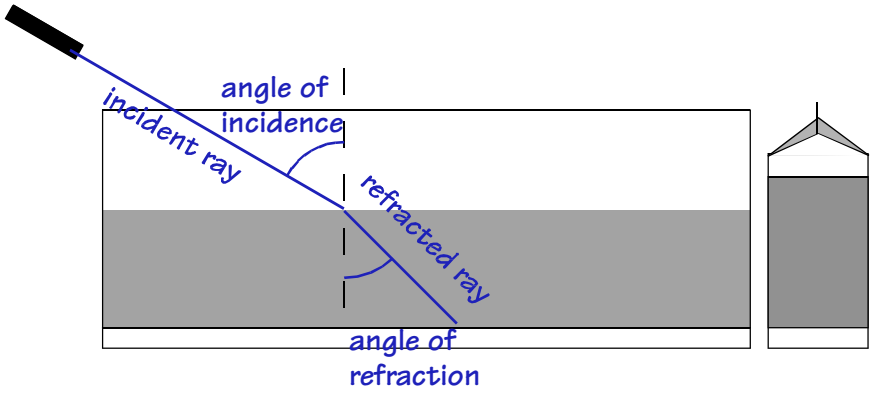


c. Observe the beam passing through the water. Observe the beam in underliner mode; rotate the beam to appreciate the dimensions of the underliner mode beam. Record your observations.

2. Bending the Light

a. Replace the insert and make sure the laser pointer is in underliner mode. Aim the beam down toward the water at an oblique angle as shown below.

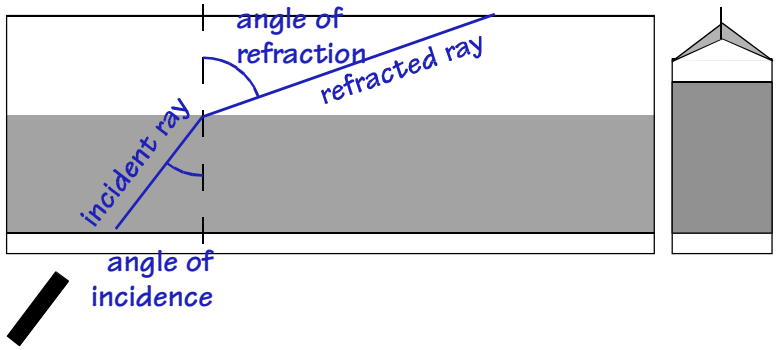
i. Sketch and label the
- incident ray
- refracted ray
- normal
- angle of incidence
- angle of refraction



ii. Compared to the path the beam would have taken if the water were not there, the beam was refracted __toward the normal ___away from the normal as it passed from air into the water.

b. Move one end of the tank just a few centimeters over the edge of the table. Aim the beam up through the water at a SMALL oblique angle as shown below.

i. Sketch and label the
- incident ray
- refracted ray
- normal
- angle of incidence
- angle of refraction



ii. Compared to the path the beam would have taken if it never made it to air, the beam was refracted __toward the normal ___away from the normal as it passed from water into air.

3. Which Would the Alligator Eat?

a. When light passes from air to water, which angle is greater: the angle of incidence or the angle of refraction?

Angle of incidence is greater than angle of refraction.

b. When light passes from water to air, which is greater: the angle of incidence or the angle of refraction?

Angle of refraction is greater than angle of incidence.

4. Beam Me Down

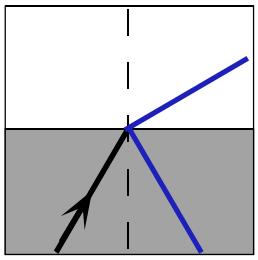
a. Aim the beam straight up through the water. The angle of incidence is now 0.

b. Gradually increase the angle of incidence. Observe the changing pattern of light.

c. Describe two distinct zones of beam behavior and add to the diagrams below.

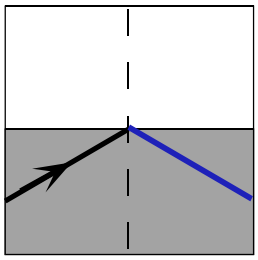
i. One is the behavior of the beam when the angle of incidence is 30° (and around 30°). What is this behavior?

Part of the beam reflects back into the water, part of the beam refracts out into the air.



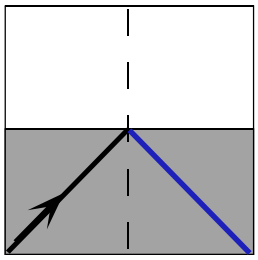
ii. One is the behavior of the beam when the angle of incidence is 60° (and around 60°). What is this behavior?

All of the beam reflects back into the water.



iii. There is a specific angle of incidence at which the behavior crosses over. This angle of incidence varies with the substance being used. And it has a special name. What is that name?

CRITICAL ANGLE!



iv. Give an approximate value for this angle when light passes from water to air.

Between 45° and 55° (~48°)