Total Internal Reflection

Purpose: To investigate the variables that affect the relative amount of reflection and refraction at a boundary between two media.

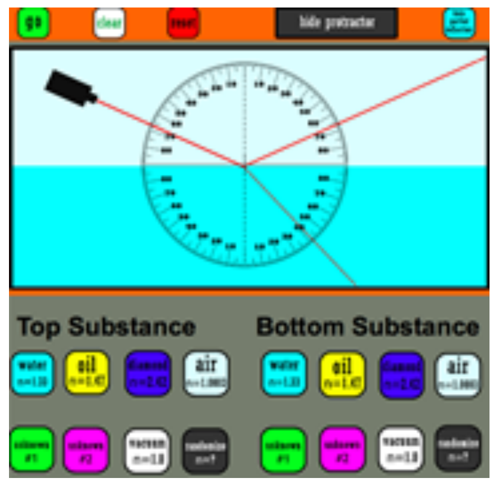
Getting Ready: Navigate to the **Refraction** simulation found in the **Physics Interactives** section of **The Physics Classroom**.

http://www.physicsclassroom.com/Physics-Interactives/Refraction-and-Lenses/Refraction/

Navigation:
www.physicsclassroom.com => Physics Interactives => Refraction and Lenses => Refraction

Getting Acquainted:
Launch the simulation and resize it to whatever size is most comfortable. Experiment with the interface and become acquainted with how to ...

- use the Go button to turn the laser on.
- move the laser and change the angle of incidence.
- move the laser into the bottom material.
- hide/show/move the protractor so as to measure an angle of incidence and refraction.
- alter the substance that occupies the region above and below the boundary.



Procedure:
Once you have experimented and mastered the interface, tap on the Show Partial Reflection button so that the reflected ray is shown. Then explore the following questions.

1 Pick any two substances that you wish ... as long as they are different. What angles of incidence - small (close to 0°) or large (approaching 90°) result in the brightest, most noticeable reflected ray?

2. At a boundary, light can do a combination of reflect and refract or just reflect. Shine light from water to air and determine which of the incident angles below result in reflection and refraction (R & R) or only reflection (Refln Only). Circle your observations.

$\Theta_i = 10°$	$\Theta_i = 30°$	$\Theta_i = 40°$	$\Theta_i = 50°$	$\Theta_i = 70°$
R & R Refln Only	R & R Refln Only	R & R Refln Only	R & R Refln Only	R & R Refln Only

From the above, one would conclude that incident light will undergo only reflection (a.k.a. **total internal reflection**) for ___________________ (smaller, larger) angles.

3. Experiment with the Interactive in order to complete the following statement:

   For light passing from a _____________ (more, less) dense to a _____________ (more, less) dense medium, the refracted ray is bent away from the normal line. This means that the angle of refraction will be _____________________ (greater, less) than the angle of incidence. As the angle of incidence is increased, the angle of refraction will ____________________ (increase, decrease). For such situations, there will be an angle of incidence for which the angle of refraction is 90 degrees. This incident angle is called the **critical angle**.

4. For the listed boundaries below, determine ...

   - ... the **critical angle** - that is, the angle of incidence for which the angle of refraction is 90° (you will need to do an estimate ... within 1-degree)
   - ...which of the two media that light must be incident within for total internal reflection to occur.

Boundary	Critical Angle (°)	Incident Medium
Air (n=1.00) - Water (n=1.33)		
Air (n=1.00) - Oil (n=1.47)		
Air (n=1.00) - Diamond (2.42)		
Water (n=1.33) - Oil (n=1.47)		
Water (n=1.33) - Diamond (n=2.42)		

5. From the above data, one would conclude that total internal reflection will occur when light is passing from the ____________ (more, less) dense medium with the ________________ (highest, lowest) n value to the ______________ dense medium with the ________________ n value.

   From the above data, one would conclude that the critical angle is smallest for two materials having the _________________________ (smallest, greatest) difference in index of refraction value.

6. Use the Interactive to complete the following statement:

   Total internal reflection occurs only if the angle of incidence is

   ___________________ (smaller, greater) than the critical angle. .