Virtual Lab: Refraction in water

Purpose:

To discover which direction light bends when moving from one substance to another.

Hypothesis:

Predict :

a) In which direction will light bend when going FROM air TO a more dense substance? Choose…

   a. Towards the normal

   b. Away from the normal

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   a. Towards the normal

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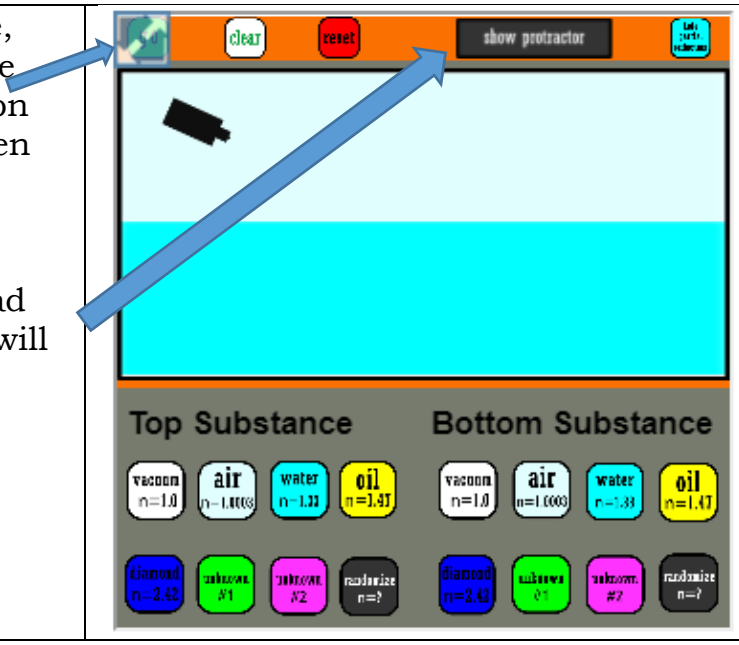
Procedure:

Go to the following site: [Refraction Lab Simulator]

When you get to the site, scroll down to this image and click the "GO" button to take you to Full-Screen mode.

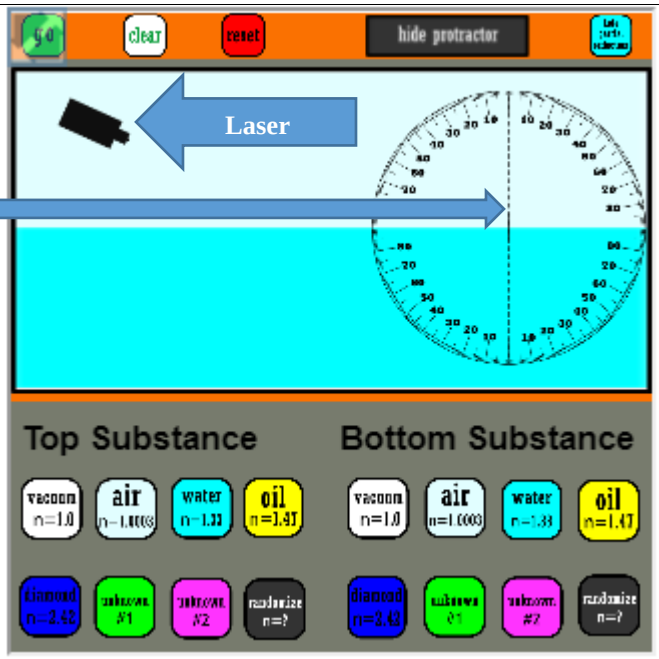
Also, click the "Show Protractor" button to load the protractor that you will use to measure angles.



You should see this.

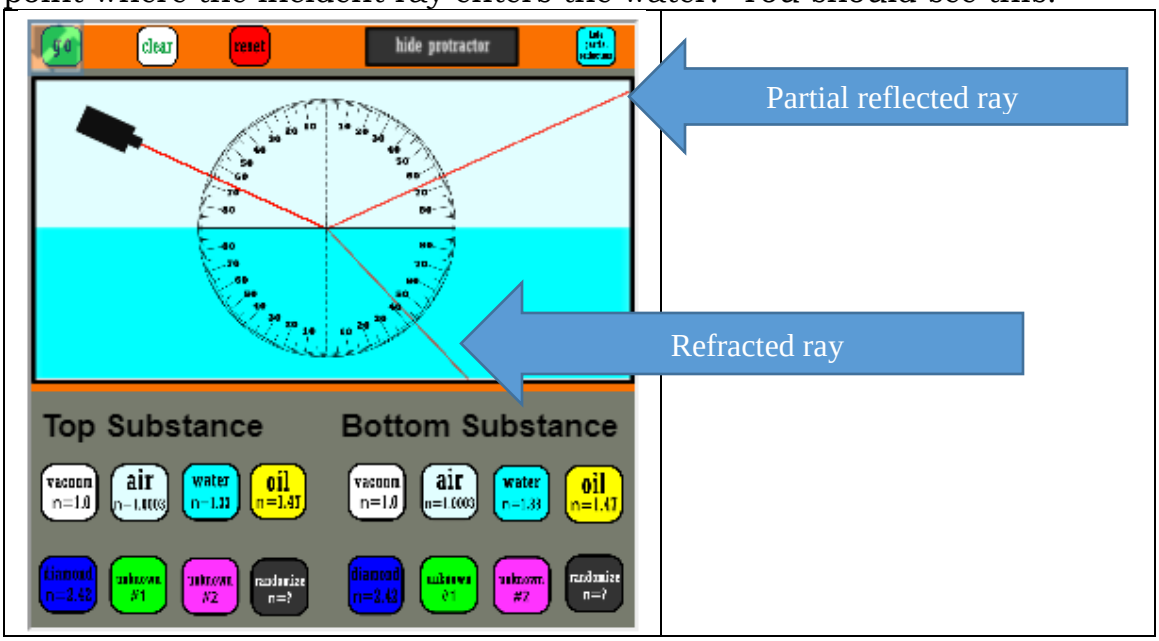
You can drag and drop the protractor as you need, to measure your angles of incidence and refraction. Please note, the “normal” is drawn on the protractor.

You can also move the laser around the screen to change the angles.

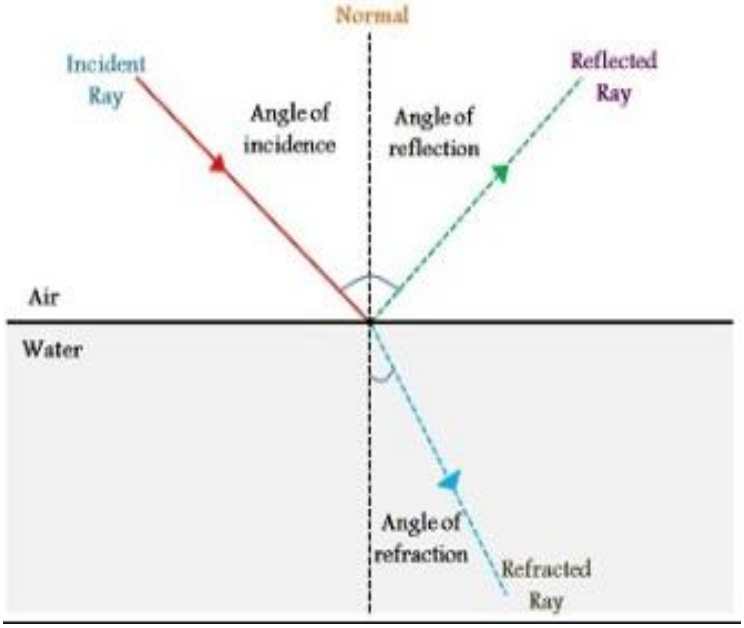


To begin, follow these instructions, as an example:

1. Leave the laser in the starting position. If you have moved it, hit “reset” to start over.
2. The top surface should be air, the bottom surface should be water.
3. Click the “Go” button to activate the light. Please note, some of the light is reflected back off the water, into the air. Position the protractor at the point where the incident ray enters the water. You should see this:



4. Next, we must measure the angles. To do this, please note the angles you must measure:

For the Angle of Incidence – you measure from the TOP **Normal to the left.** You should see **66°** on your protractor above. For the Angle of Refraction – you measure from the **BOTTOM Normal to the right.** You should have **43°.** For the Angle of Reflection – you measure from the **TOP Normal to the right**. You should have **66°.**	

Your Turn:

1. **Click the reset button and, then, the "oil button" under Bottom Substance.**
2. **Then, click "Go" to activate the laser beam.**
3. **Then, activate the protractor and measure the angles and record in the table below.**
4. **Note: 'n=x' on each substance represents density.**
5. **Repeat these steps for the other substances. Click "clear" between each.**

Substance		Angle of Incidence	Angle of Refraction	Angle of Reflection
Top	**Bottom**	**(i)**	**(r)**	**If present**
Air	**Water**	**66°**	**43°**	**66°**
Air	**Oil**			
Air	**Diamond**			
Air	**Unknown 1**			
Air	**Unknown 2**			

Questions based on Table 1, above:

1. What are the densities (n) for:

   Air: _____

   Water: _____

   Oil: _____

   Diamond: _____

2. What happens to the angle of refraction as the beam goes from a lower density to a higher density substance?

   _____

   _____

   _____

3. What does this suggest about the effect of the density of a substance on the speed of light?

   _____

   _____

   _____

4. As the density of the substance on the bottom increases, the refracted beam gets:
   a. Closer to the normal
   b. Farther from the normal

5. A. Based on your understanding of density and its effect on refraction, which "Unknown" substance is denser: 1 or 2? _____

   B. Explain how you know in question "A" above.

   _____

   _____

   _____

   _____

6. Why do you think there are no reflected rays in some substances?

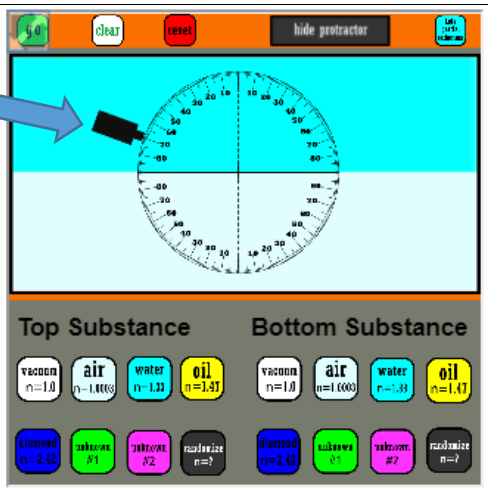
   _____

   _____

Now, reset your workspace to complete the sections below.

1. Open the protractor and place the laser on the 70° Point and click "Go"

   What happens? Why, do you think this happens?



2. Now repeat this task with the laser on:
   a. 50°. What happens?

   _____

   b. 40°. What happens?

   _____

   c. At what point does the light begin to refract?

   _____

Using this information, complete the table.

Substance		Angle of Incidence	Angle of Refraction	Angle of Reflection
Top	**Bottom**	**(i)**	**(r)**	**If present**
Oil	**Air**			
Diamond	**Air**			
Unknown 1	**Air**			
Unknown 2	**Air**			

3. As light goes from a denser to a less dense substance, does it bend:

   A. Towards the normal
   B. Away from the normal

Conclusions: Wave theory of light

When light waves pass through different substances, like air, water, or oil, how does the density of the substances affect the speed of these waves?

How does the change of speed of these waves cause refraction?