Scientist: _____ Date: _____

Unit 4.2: Electromagnetic Spectrum and Wave Behavior

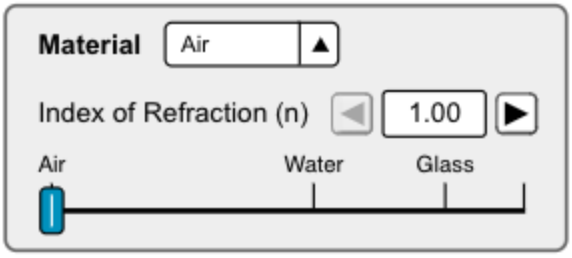
Observation Station: Classwork

What do you think?

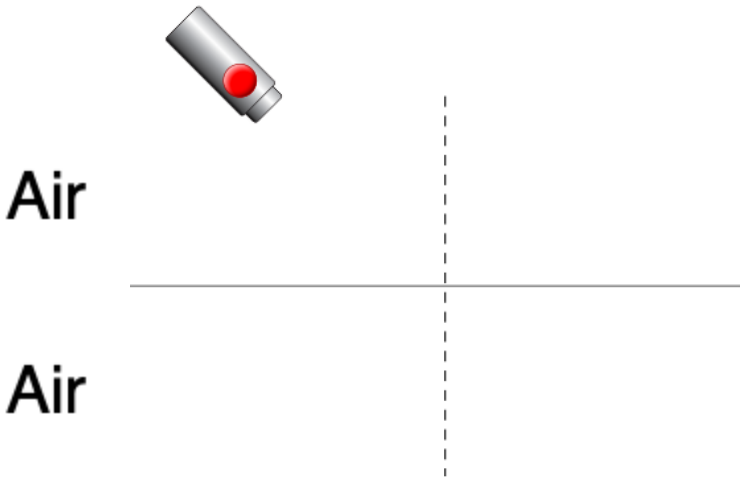
- Are all light waves the same? If not, what might be different about them?
- Do you think light always moves in a straight line?
- How does a mirror work?

Part 1: Laser Beam through the Same Material

1. Go to the PhET: Bending Light. Click on “Intro”. In this simulation you will explore what happens as a laser beam travels through two materials. You have the option of changing both types of materials in the boxes on the right that look like this:



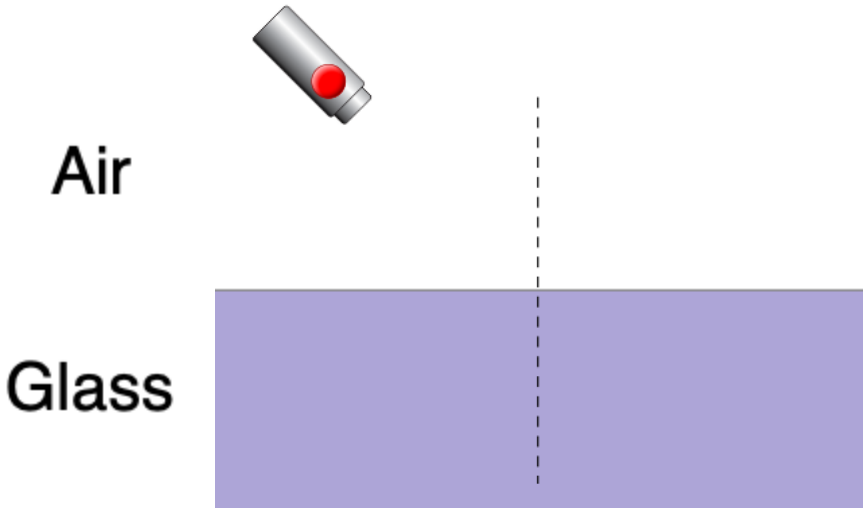
2. Select “Air” for both materials. Then turn the laser on by clicking the red button. Sketch a picture of what you see in the space below.



3. Move the laser left and right. Describe what happens to the laser beam.

Part 2: Laser Beam through Different Materials

4. Select “Air” for the top material and “Glass” for the bottom material. Then turn the laser on by clicking the red button. Sketch a picture of what you see in the space below.



5. Describe what you see happening when the laser beam hits the boundary between two materials.

6. In physics, the ray of light that travels from a light source is called the **incident ray**. When a ray of light *bounces* off of a material it is called the **reflected ray**. Lastly, when a ray of light *bends* as it goes through a different material it is called the **refracted ray**.

7. Label the **incident ray**, **reflected ray**, and **refracted ray** in your picture from #4.

8. Move the laser left and right. Describe what happens to the **reflected ray** and the **refracted ray**.

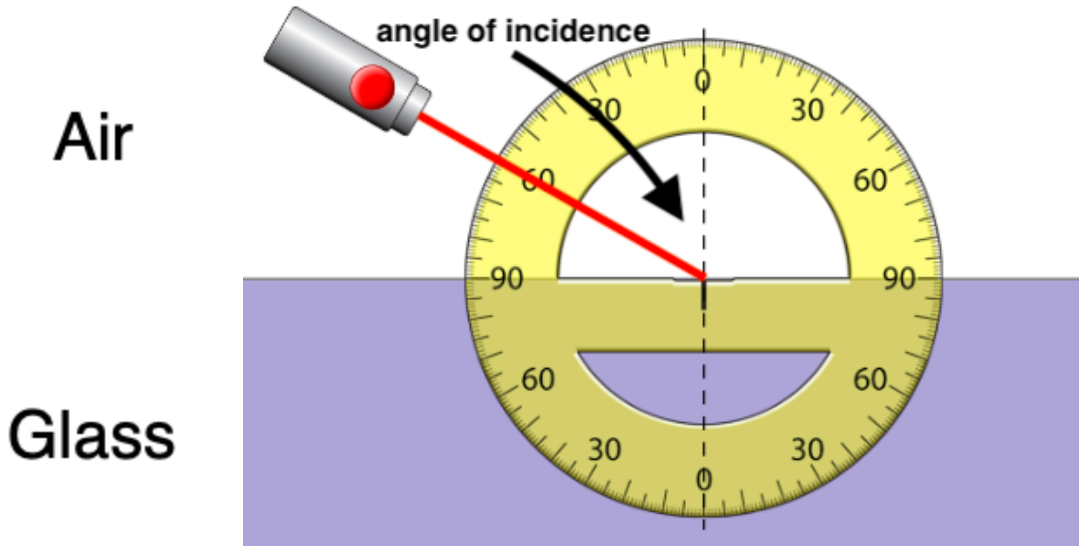
Part 3: Measuring Angles

9. To describe the position of rays, physicists use angles. You may have talked about angles in math class as well. An angle is the space between two lines or rays. Angles are measured using a protractor (name of tool) and the units of an angle are degrees.

10. To measure angle in the simulation click and drag the yellow protractor from the bottom left corner. Place the protractor so that the 0 degree marks lines up with the dotted line (called the normal line). Make sure the 90 degree marks line up with the boundary between the two materials. See the image below to help you.

11. Select “Air” for the top material and “Glass” for the bottom material. Then turn the laser on by clicking the red button.

12. Move the laser so that the angle between the incident ray and the normal line (the **angle of incidence**) is 60 degrees. Draw the **reflected ray** and the **refracted ray**, making sure your drawing is accurate with the angles in the simulation.



13. **Angle of reflection** is the angle between the reflected ray and the normal line.

a) Label the angle of reflection in your picture from question 12.

b) Is the **angle of reflection** less than, equal to, or greater than the **angle of incidence**?

c) Move the laser beam around between 0 and 90 degrees. What relationship do you always see between the **angle of reflection** and the angle of incidence.

14. **Angle of refraction** is the angle between the refracted ray and the normal line.

a) Label the angle of refraction in your picture from question 12.

b) Is the **angle of refraction** less than, equal to, or greater than the **angle of incidence**?

c) Move the laser beam around between 0 and 90 degrees. What relationship do you always see between the **angle of refraction** and the angle of incidence.

15. Move the laser beam back to a 60 degree angle of incidence. Keep the top material as “Air”. Change the bottom material to “Water”, “Glass”, “Mystery A”, and “Mystery B”.

a) As you change the material, does the **reflected ray** move?

b) Do you think the angle of reflection depends on the material the light is bouncing off of? Explain your reasoning.

c) As you change the material, does the **refracted ray** move?

d) Do you think the angle of refraction depends on the material the light is bouncing off of? Explain your reasoning.