Name: Section Date

REFRACTION OF LIGHT

OBJECTIVE:

1. Describe how light bends when it travels from one medium to another.
2. Measure the index of refraction of different materials

MATERIALS Bending Light 1.1.20 PhET simulation, spreadsheet

ONLINE RESOURCES Bending Light 1.1.20 PhET simulation : https://phet.colorado.edu/sims/html/bending-light/latest/bending-light_en.html

PROCEDURE

Refraction

1. Open the Bending Light PhET simulation and select the "More Tools" tab.
2. Set the following parameters:

Medium 1	Air
Medium 2	Water
Laser View	Ray
Wavelength	650 nm
Normal Line	Enabled
Angles	Enabled

3. Turn on the laser source.

4. Using the protractor in the "Toolbox" measure the angle of incidence, I, (the angle between the normal line and the ray of light from the source), the angle of reflection, (The angle between the normal line and the reflected ray), and the angle of refraction, r, (the angle between the normal line and the transmitted ray).

	Angle of Incidence	Angle of Reflection	Angle of Refraction
Air to Water			
Water to Air			

5. Using the Speed Meter in the Toolbox, measure the speed of the incident ray, reflected ray, and refracted ray.

	Speed of Incident Ray	Speed of Reflected Ray	Speed of Refracted Ray
Air to Water			
Water to Air			

6. Repeat procedures (3) – (5), but this time, select "Water" as the first medium and "Air" as the second medium.

Guide Questions:

Name: Section Date

1. What happens to the light from the laser when it strikes the boundary between air and water?
2. What relationship exists between the angle of incidence and the angle of reflection?
3. How does light bend when it travels from air to water? water to air?
4. What happens to the speed of light when it travels from air to water? water to air?

Index of Refraction and Angle of Refraction

1. Set the following parameters:

Medium 1	Air
Medium 2	Water
Laser View	Ray
Wavelength	650 nm
Normal Line	Enabled
Angles	Enabled

2. Turn on the laser and using the protractor measure the angle of incidence and the angle of refraction.
3. Increase the angle of incidence by moving the laser away from the normal. Observe what happens to the angle of refraction as the angle of incidence increases.
4. Using the protractor, measure the angle of refraction at different angles of incidence, $3° < i \leq 40$. Repeat the procedure for light travelling from air to glass.

Direction of Propagation of Light	Angle of Incidence, i (degrees)	Angle of Refraction, r (degrees)	sin i	sin r
Air to Water				
Air to Glass				

5. Using a spreadsheet, plot the values of sin i (along the y-axis) against the values of sin r (along the x-axis) for each case. Describe the shape of each graph.
6. Calculate the slope of each graph and compare these slopes to the refractive index of water and refractive index of glass.

Guide Questions:

- What happens to the angle of refraction as the angle of incidence increases?

Name: Section Date

- What do the graphs of sin i against sin r suggest about the relationship between sin i and sin r? Express the relationship as a mathematical expression.

- How does the index of refraction of water compare with the slope of the graph for light travelling from air to water?

- In which material, water or glass, does light bend more? How does the amount of bending depend on the indices of refraction of the two media (air-to-water, air-to-glass)?

CONCLUSION(S)

GOING FURTHER

1. Determine, experimentally, the indices of refraction of Material A and Material B. Which has a higher index of refraction?

2. Does the refractive index of a certain material depend on the color of light incident on it? Using the simulation, design an experiment to investigate the dependence of the material's refractive index on the color of light incident on it.