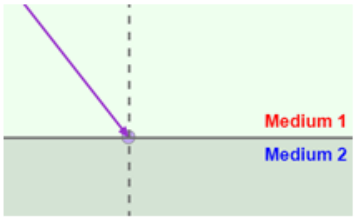
Student Exploration: Refraction



Turn off **View wave fronts**. Set **Index of refraction 2** to 3.0.

1. Click **Play** (▶). Observe the ray of light as it passes from **Medium 1** to **Medium 2**.

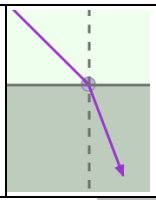
   A. What happens to the speed of the light wave? _____

   B. What happens to the direction of the light wave? _____

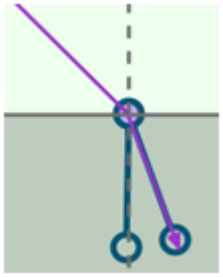
   The bending of the light ray you see is called **refraction**.

2. Click **Reset** (↺) and turn on **View wave fronts**. A **wave front** is an imaginary line that connects the crests or troughs of a wave. The **wavelength** of a wave is the distance between wave fronts.

   Click **Play**. What happens to the wavelength of the wave as it passes into **Medium 2**?

Activity A: **Angle of refraction**	Get the Gizmo ready: • Click **Reset**. Turn off **View wave fronts**. • Make sure **View normal** is selected. • Make sure **Index of refraction 1** is 1.0 and **Angle of incidence** is 45°. • Set **Index of refraction 2** to 2.0.	

Introduction: The normal is an imaginary line perpendicular to the boundary between two media. The **angle of incidence** is the angle between the light ray in medium 1 and the normal. The **angle of refraction** is the angle between the ray in medium 2 and the normal.



Question: What affects how much light waves refract?

1. Measure: Click **Play**. To measure the angle of refraction, turn on **Click to measure angles**. Drag the protractor's vertex to the intersection of the ray and the normal. Align the protractor's legs to the ray and the normal in **Medium 2**. What is the angle of refraction? _____

2. Gather data: For each angle of incidence listed in the table below, use the Gizmo to find the angle of refraction. Then, fill in the "Change of direction" column by subtracting the angle of refraction from the angle of incidence.

Angle of incidence	Angle of refraction	Change in direction
20°		
40°		
60°		
80°		

3. Analyze: What patterns do you notice?

4. Explain: Do you think refraction would occur if the angle of incidence is 0°? Explain.

5. Predict: The **index of refraction** indicates how fast light can travel through a medium. The higher the index is for a medium, the slower light will travel through that medium. How do you think increasing a medium's index of refraction might affect the angle of refraction?

_____

6. Gather data: Keep the **Index of refraction 1** set to 1.0. Set the **Angle of incidence** to 60°. For each **Index of refraction 2** listed in the table below, use the Gizmo to find the angle of refraction and the change in direction.

Index of refraction 2	Angle of refraction	Change in direction
1.0		
2.0		
3.0		

7. Analyze: What patterns do you notice?

8. Explain: Why does no refraction occur when the media have the same index of refraction?

9. Explore: Set the **Index of refraction 2** to 1.0. Set the **Angle of incidence** to 25°. Collect data for each **Index of refraction 1** listed in the table below.

Index of refraction 1	Angle of refraction	Change in direction
1.5		
2.0		
3.0		

10. Analyze: What did you notice about the change in direction in the first two trials?

11. What happened in the third trial?

12. When the angle of refraction is greater than 90°, the beam of light will reflect off of the surface instead of refracting through the surface. This is called **total internal reflection**.