

Refraction

Name: _____

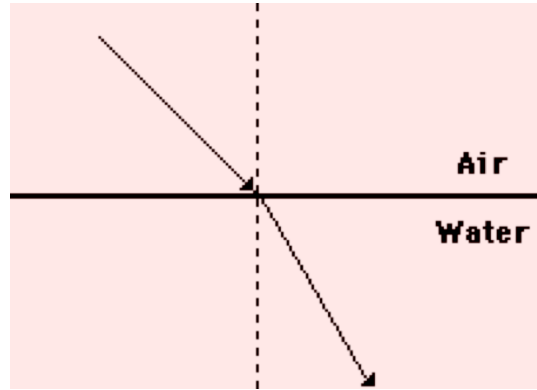
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Date: _____

- Write a one-word synonym for **refraction**. _____
- Refraction occurs when light crosses the boundary between one material and another material. What is the primary cause for this refracting of light upon crossing a boundary?

The diagram below shows the path of a light ray as it travels through air, across the air-water boundary, and through the water. Use the diagram to answer questions #3-#6.

- On the diagram, label ...
 - the air-water boundary with a **B**
 - the normal line with an **N**
 - the incident ray with an **I**
 - the refracted ray with an **R**
 - the angle of incidence with a θ_i
 - the angle of refraction with a θ_r
- How many media are there in this diagram? _____
Name them.



- What is meant by the term "medium" in this context?
- Place a noticeable dot at the location where refraction of light takes place.

- For the three situations below, draw a normal line and measure and record the angles of incidence and the angles of refraction.

$\theta_i =$ _____	$\theta_i =$ _____	$\theta_i =$ _____
$\theta_r =$ _____	$\theta_r =$ _____	$\theta_r =$ _____

- As light passes from one medium into another, it refracts. There is only one condition in which light will cross a boundary but not refract. State this condition.

- The **optical density** is the property of a medium that provides a relative measure of the speed at which light travels in that medium. Light travels _____ (fastest, slowest) in media with a greater optical density.
- Every transparent material is characterized by a unique **index of refraction** value (**n**). The index of refraction value is a numerical value that provides a relative measure of the speed of light in that particular material. Light travels _____ (fastest, slowest) in media with a higher index of refraction value.

3. The speed of light (v) in a material is determined using the speed of light in a vacuum (c) and the index of refraction (n) of the material. Calculate the speed of light in the following materials.

$$v = \frac{c}{n} = \frac{3.00 \times 10^8 \text{ m/s}}{n}$$

- a. water ($n = 1.33$): _____ b. glass ($n = 1.50$): _____
 c. ice ($n = 1.31$): _____ d. diamond ($n = 2.42$): _____
4. When light passes into a medium in which it travels faster, the light will refract _____ the normal. When light passes into a medium in which it travels slower, light will refract _____ the normal.
 a. towards, away from b. away from, towards
5. When light passes into a medium that is more optically dense, the light will refract _____ the normal. When light passes into a medium that is less optically dense, the light will refract _____ the normal.
 a. towards, away from b. away from, towards
6. Consider the refraction of light in the five diagrams below. In which case is the light bending towards the normal line? Circle all that apply.

Diagram A

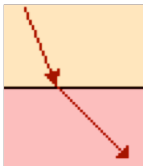


Diagram B

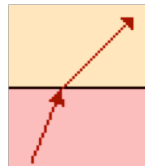


Diagram C

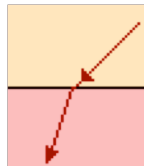


Diagram D

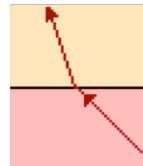
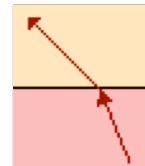
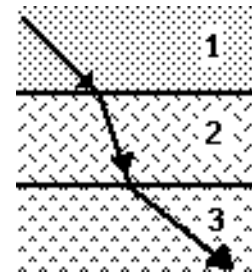


Diagram E



Consider the diagram at the right in answering the next four questions.

7. There are ___ (1, 2, 3, ...) media shown in the diagram.
 8. There are ___ (1, 2, 3, ...) boundaries shown in the diagram.
 9. Light must travel _____ in medium 1 compared to medium 2.
 a. slower b. faster c. insufficient info
 10. Light must travel _____ in medium 2 compared to medium 3.
 a. slower b. faster c. insufficient info



11. In each diagram, draw the "missing" ray (either incident or refracted) in order to appropriately show that the direction of bending is towards or away from the normal.

