

### Direction of Bending

Read from **Lesson 1** of the **Refraction and Lenses** chapter at **The Physics Classroom**:

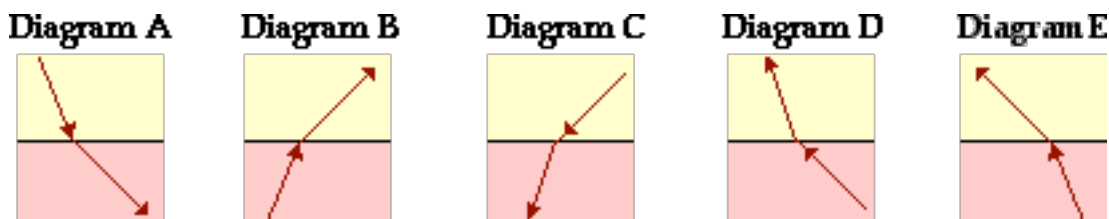
- <http://www.physicsclassroom.com/Class/refrn/u14l1d.html>
- <http://www.physicsclassroom.com/Class/refrn/u14l1e.html>
- <http://www.physicsclassroom.com/Class/refrn/u14l1f.html>

**MOP Connection:** Refraction and Lenses: sublevels 2 and 3

1. 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.
2. 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.
 

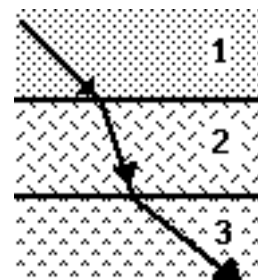
$$v = \frac{c}{n} = \frac{3.00 \times 10^8 \text{ m/s}}{n}$$

  - 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.



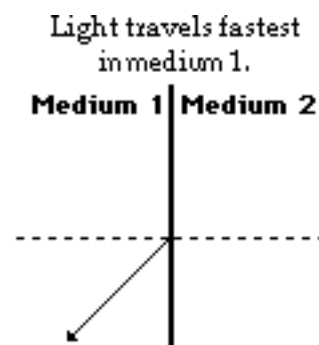
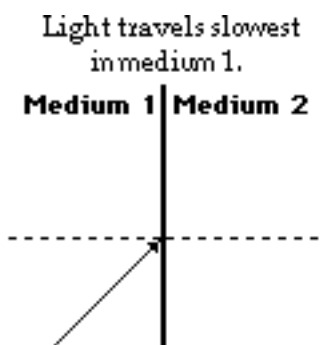
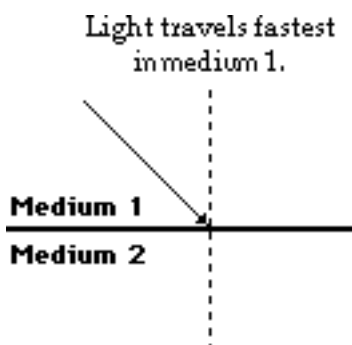
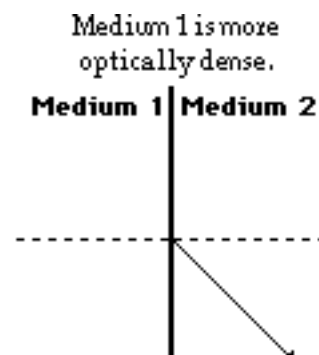
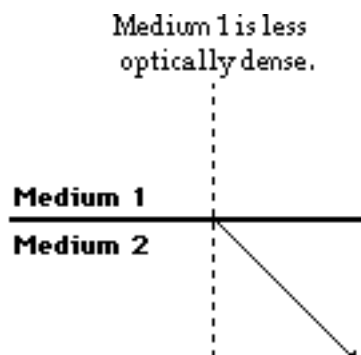
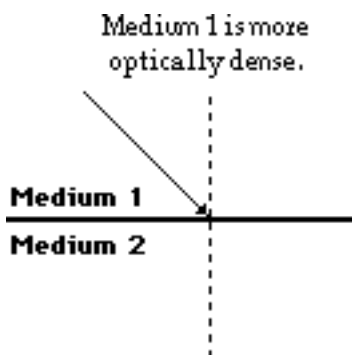
Consider the diagram at the right in answering the next four questions.

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



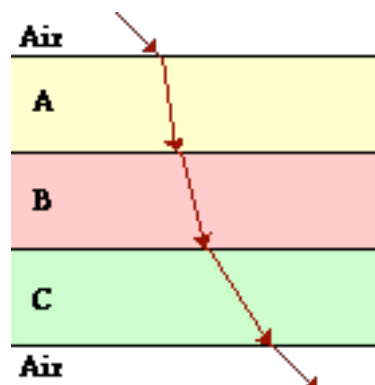
## Light, Refraction and Lenses

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.



12. A ray of light is shown passing through three consecutive *layered* materials. Observe the direction of bending at each boundary and rank the three materials (A, B and C) in order of increasing index of refraction.

\_\_\_\_\_ < \_\_\_\_\_ < \_\_\_\_\_  
smallest largest



13. Arthur Podd's method of fishing involves spearing the fish while standing on the shore. The apparent location of a fish is shown in the diagram below. Because of the refraction of light, the observed location of the fish is different than its actual location. If Arthur is to successfully spear the fish, must he aim at, below, or above where the fish appears to be? \_\_\_\_\_ Explain.

