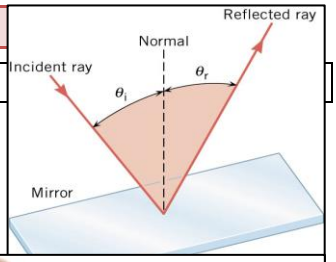
Physics 11-03 The Laws of Reflection and Refraction Name: _____

Reflection



Law of Reflection: $\theta_r = \theta_i$

- _____ Reflection
  - _____ light rays are reflected _____
- _____ Reflection
  - _____ light rays are _____ by irregularities in the surface.
- Plane Mirror
  - Image is _____
  - Image is _____ size
  - Image is _____ as far _____ the mirror as you are in _____ of it

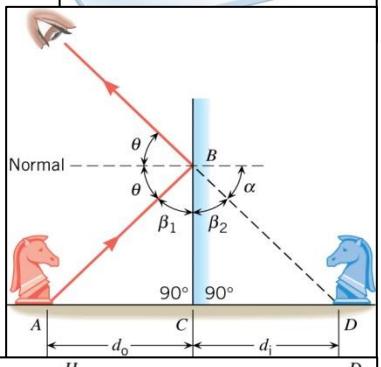
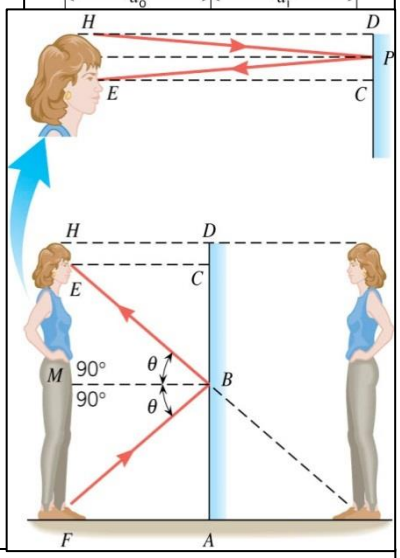


Table 25.1 Index of Refraction in Various Media

Medium	n
Gases at 0°C , 1 atm	
Air	1.000293
Carbon dioxide	1.00045
Hydrogen	1.000139
Oxygen	1.000271
Liquids at 20°C	
Benzene	1.501
Carbon disulfide	1.628
Carbon tetrachloride	1.461
Ethanol	1.361
Glycerine	1.473
Water, fresh	1.333
Solids at 20°C	
Diamond	2.419
Fluorite	1.434
Glass, crown	1.52
Glass, flint	1.66
Ice at 20°C	1.309
Polystyrene	1.49
Plexiglas	1.51
Quartz, crystalline	1.544
Quartz, fused	1.458
Sodium chloride	1.544
Zircon	1.923

- Since light rays appear to come from _____ mirror, the image is called a _____ image.
- If light rays _____ to come from a _____ location, the image is called a _____ image.
- Real images can be _____ on a screen, virtual images _____.
- _____ mirrors only produce _____ images.

How long must a plane mirror be to see your whole reflection?



Refraction

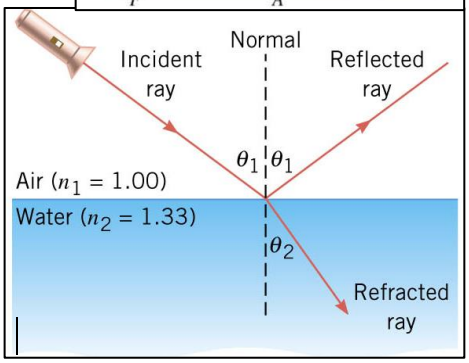
- Speed of light in a vacuum: $c = 3.00 \times 10^8 \frac{m}{s}$
- Light travels _____ through materials due to light _____, absorbed by, emitted by, and scattered by _____.

Index of Refraction

- _____to indicate relative _____ of light in a _____

$$n = \frac{c}{v}$$

- When light hits the surface of a material part of it is _____
- The other part goes into the _____
- The transmitted part is _____ (_____)



Snell's Law (The Law of Refraction)

$$n_1 \sin\theta_1 = n_2 \sin\theta_2$$

Where n_1 = index of refraction of incident medium, n_2 = index of refraction of second medium, θ_1 = angle of incidence (measured to normal), θ_2 = angle of refraction (measured to normal)

You shine a laser into a piece of clear material. The angle of incidence is 35°. You measure the angle of refraction as 26°. What is the material?

What is the speed of light in the material?

Homework

1. Using the law of reflection, explain how powder takes the shine off of a person's nose. What is the name of the optical effect?
2. Diffusion by reflection from a rough surface is described in this chapter. Light can also be diffused by refraction. Describe how this occurs in a specific situation, such as light interacting with crushed ice.
3. Will light change direction toward or away from the perpendicular when it goes from air to water? Water to glass? Glass to air?
4. Explain why an object in water always appears to be at a depth shallower than it actually is? Why do people sometimes sustain neck and spinal injuries when diving into unfamiliar ponds or waters?
5. Suppose a man stands in front of a mirror. His eyes are 1.65 m above the floor, and the top of his head is 0.13 m higher. Find the height above the floor of the top and bottom of the smallest mirror in which he can see both the top of his head and his feet. How is this distance related to the man's height? (OpenStax 25.1) **bottom 0.825 m, top 1.715 m; not related**
6. Show that when light reflects from two mirrors that meet each other at a right angle, the outgoing ray is parallel to the incoming ray, as illustrated in figure 1. (OpenStax 25.2) **See below**

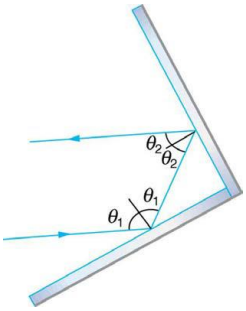


Figure 1

7. Light shows staged with lasers use moving mirrors to swing beams and create colorful effects. Show that a light ray reflected from a mirror changes direction by 2θ when the mirror is rotated by an angle θ. (OpenStax 25.3) **See below**
8. What is the speed of light in water? In glycerine? (OpenStax 25.5) $\mathbf{2.25 \times 10^8}$ **m/s,** $\mathbf{2.04 \times 10^8}$ **m/s**
9. Calculate the index of refraction for a medium in which the speed of light is 2.012×10^8 m/s, and identify the most likely substance based on Table 25.1. (OpenStax 25.7) **1.490, polystyrene**
10. In what substance in Table 25.1 is the speed of light 2.290×10^8 m/s? (OpenStax 25.8) **ice at 0° C**
11. Components of some computers communicate with each other through optical fibers having an index of refraction n = 1.55. What time in nanoseconds is required for a signal to travel 0.200 m through such a fiber? (OpenStax 25.11) **1.03 ns**
12. (a) Using information in Figure 2, find the height of the instructor's head above the water, noting that you will first have to calculate the angle of incidence. (b) Find the apparent depth of the diver's head below water as seen by the instructor. (OpenStax 25.12) **2.93 m, 1.37 m**
13. Suppose you have an unknown clear substance immersed in water, and you wish to identify it by finding its index of refraction. You arrange to have a beam of light enter it at an angle of 45.0°, and you observe the angle of refraction to be 40.3°. What is the index of refraction of the substance and its likely identity? (OpenStax 25.13) **1.46, fused quartz**

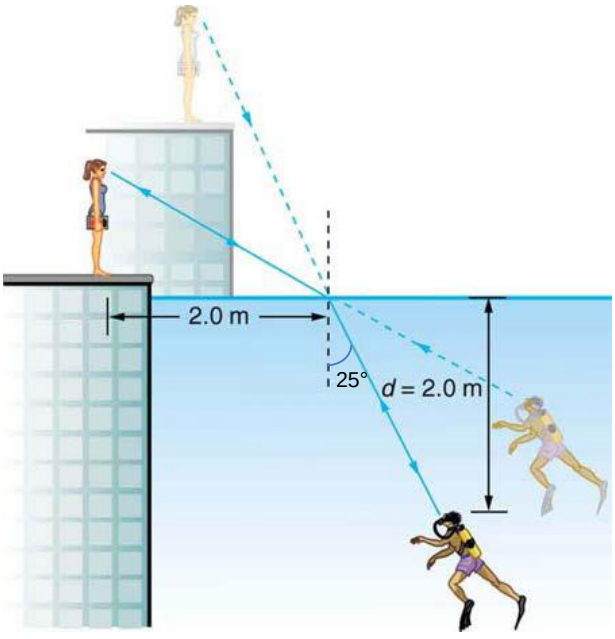


Figure 2

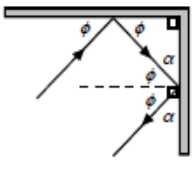


Figure 3 Answer to #6

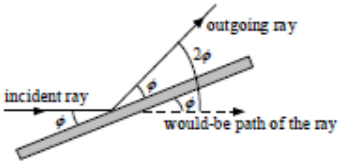


Figure 4 Answer to #7