

## index of refraction

the ratio of the speed of light in a vacuum to the speed of light in a given transparent medium

## Did you know?

The index of refraction of any medium can also be expressed as the ratio of the wavelength of light in a vacuum,  $\lambda_0$ , to the wavelength of light in that medium,  $\lambda_n$ , as shown in the following relation.

$$n = \frac{\lambda_0}{\lambda_n}$$

## THE LAW OF REFRACTION

An important property of transparent substances is the **index of refraction**. The index of refraction for a substance is the ratio of the speed of light in a vacuum to the speed of light in that substance.

### INDEX OF REFRACTION

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

$$\text{index of refraction} = \frac{\text{speed of light in vacuum}}{\text{speed of light in medium}}$$

From this definition, we see that the index of refraction is a dimensionless number that is always greater than 1 because light always travels slower in a substance than in a vacuum. **Table 1** lists the indices of refraction for different substances. Note that the larger the index of refraction is, the slower light travels in that substance and the more a light ray will bend when it passes from a vacuum into that material.

Imagine, as an example, light passing between air and water. When light begins in the air (high speed of light and low index of refraction) and travels into the water (lower speed of light and higher index of refraction), the light rays are bent toward the normal. Conversely, when light passes from the water to the air, the light rays are bent away from the normal.

Note that the value for the index of refraction of air is nearly that of a vacuum. For simplicity, use the value  $n = 1.00$  for air when solving problems.

**Table 1** Indices of Refraction for Various Substances\*

Solids at 20°C	<i>n</i>	Liquids at 20°C	<i>n</i>
Cubic zirconia	2.20	Benzene	1.501
Diamond	2.419	Carbon disulfide	1.628
Fluorite	1.434	Carbon tetrachloride	1.461
Fused quartz	1.458	Ethyl alcohol	1.361
Glass, crown	1.52	Glycerine	1.473
Glass, flint	1.66	Water	1.333
Ice (at 0°C)	1.309		
Polystyrene	1.49	<b>Gases at 0°C, 1 atm</b>	<b><i>n</i></b>
Sodium chloride	1.544	Air	1.000 293
Zircon	1.923	Carbon dioxide	1.000 450

\*measured with light of vacuum wavelength = 589 nm