When light moves from a material in which its speed is higher to a material in which its speed is lower, such as from air to glass, the ray is bent toward the normal, as shown in **Figure 2(a).** If the ray moves from a material in which its speed is lower to one in which its speed is higher, as in **Figure 2(b),** the ray is bent away from the normal. If the incident ray of light is parallel to the normal, then no refraction (bending) occurs in either case.

Note that the path of a light ray that crosses a boundary between two different media is reversible. If the ray in **Figure 2(a)** originated inside the glass block, it would follow the same path as shown in the figure, but the reflected ray would be inside the block.

Refraction can be explained in terms of the wave model of light

In the previous chapter on light and refraction, you learned how to use wave fronts and light rays to approximate light waves. This analogy can be extended to light passing from one medium into another. In **Figure 3,** the wave fronts are shown in red and are assumed to be spherical. The combined wave front (dotted line connecting the individual wave fronts) is a superposition of all the spherical wave fronts. The direction of propagation of the wave is perpendicular to the wave front and is what we call the *light ray.*

Consider wave fronts of a plane wave of light traveling at an angle to the surface of a block of glass, as shown in **Figure 3.** As the light enters the glass, the wave fronts slow down, but the wave fronts that have not yet reached the surface of the glass continue traveling at the speed of light in air. During this time, the slower wave fronts travel a smaller distance than do the wave fronts in the air, so the entire plane wave changes directions.

Note the difference in wavelength (the space between the wave fronts) between the plane wave in air and the plane wave in the glass. Because the wave fronts inside the glass are traveling more slowly, in the same time interval they move through a shorter distance than the wave fronts that are still traveling in air. Thus, the wavelength of the light in the glass, λ_{glass}, is shorter than the wavelength of the incoming light, λ_{air}. The frequency of the light does *not* change when the light passes from one medium to another.

Did you know?

The speed of light in a vacuum, *c*, is an important constant used by physicists. It has been measured to be about 3.00×10^8 m/s. Inside of other mediums, such as air, glass, or water, the speed of light is different and is less than *c*.

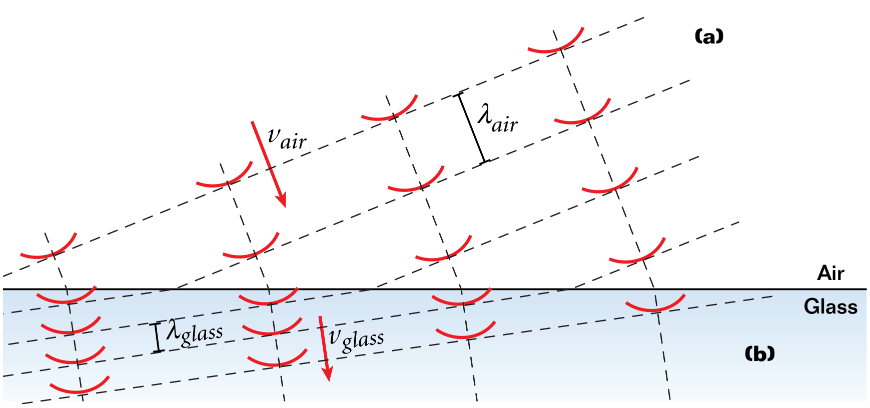

Figure 3
A plane wave traveling in air **(a)** has a wavelength of λ_{air} and velocity of v_{air}. Each wave front turns as it strikes the glass. Because the speed of the wave fronts in the glass **(b),** v_{glass}, is slower, the wavelength of the light becomes shorter, and the wave fronts change direction.