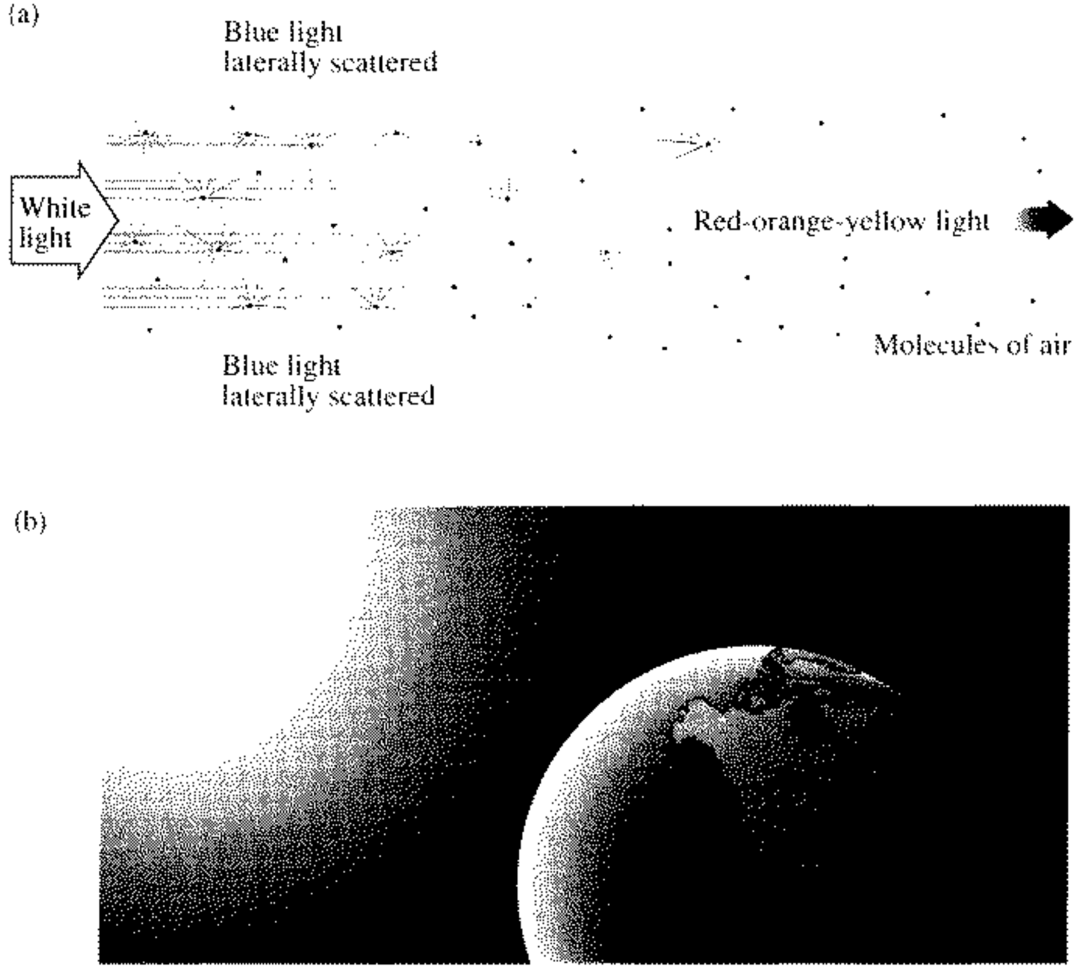


Figure 4.1 (*a*) Sunlight traversing a region of widely spaced air molecules. The light laterally scattered is mostly blue, and that's why the sky is blue. The unscattered light, which is rich in red, is viewed only when the Sun is low in the sky at sunrise and sunset. (*b*) Solar rays reach about 18° beyond the daytime terminator because of atmospheric scattering. Over this twilight band the skylight fades to the complete darkness of night.

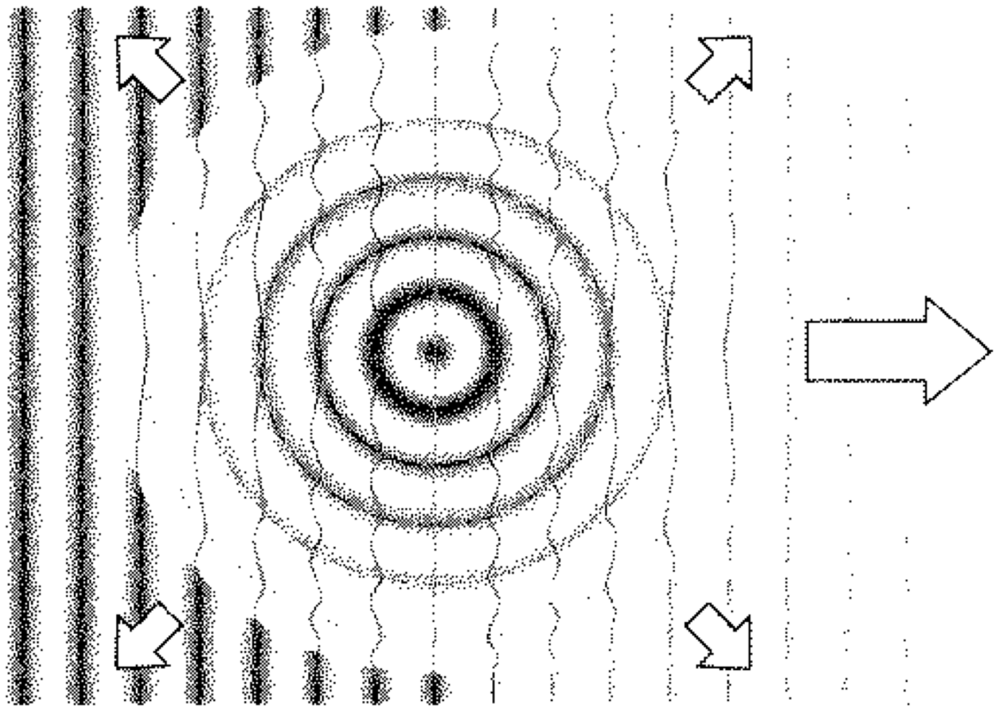


Figure 4.2 A plane wave, incident from the left, sweeps across an atom and spherical wavelets are scattered. The process is continuous, and hundreds of millions of photons per second stream out of the scattering atom in all directions.

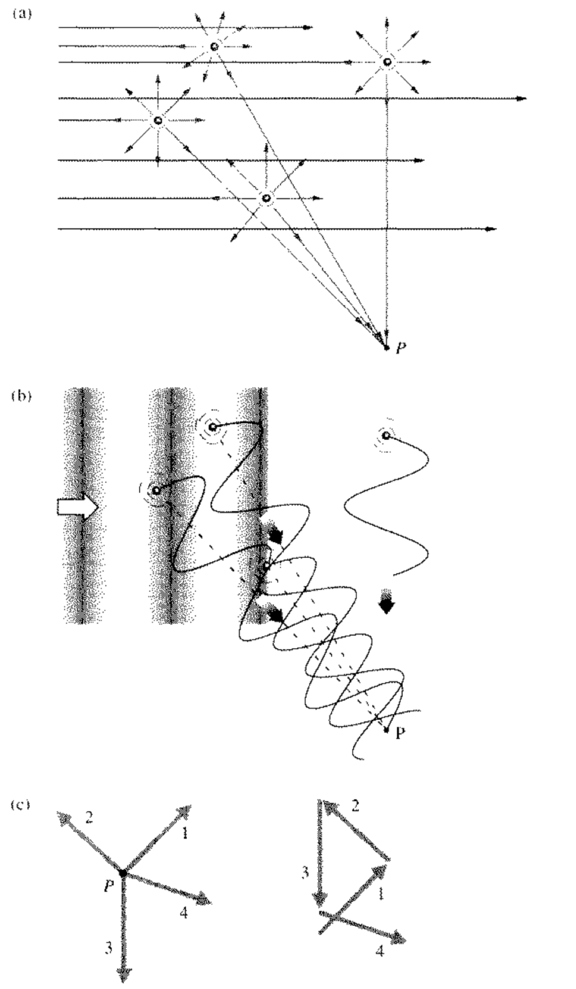


Figure 4.3 (*a*) The scattering of light from a widely spaced distribution of molecules. (*b*) The wavelets arriving at a lateral point *P* have a jumble of different phases and tend not to interfere in a sustained constructive fashion. (*c*) That can probably be appreciated most easily using phasors. As they arrive at *P* the phasors have large phase angle differences with respect to each other. When added tip-to-tail they therefore tend to spiral around keeping the resultant phasor quite small. Remember that we are really dealing with millions of tiny phasors rather than four substantial ones.

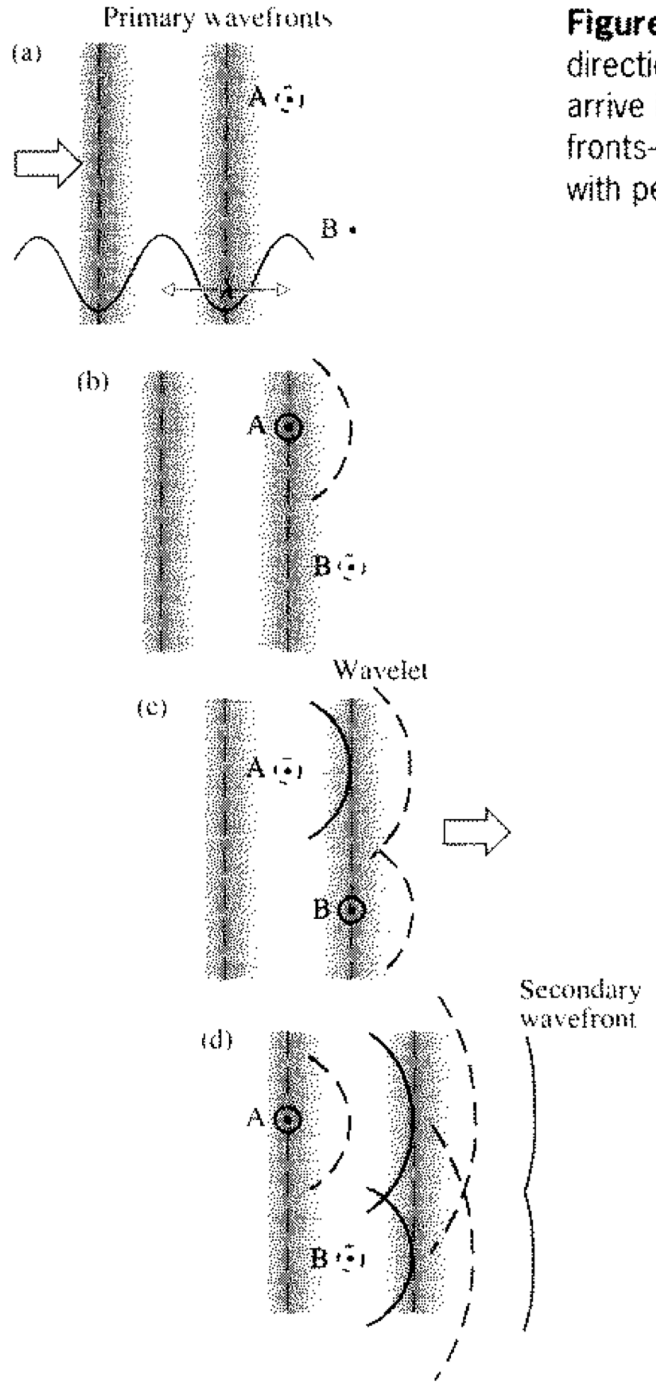


Figure 4.5 In the forward direction the scattered wavelets arrive in-phase on planar wavefronts—trough with trough, peak with peak.

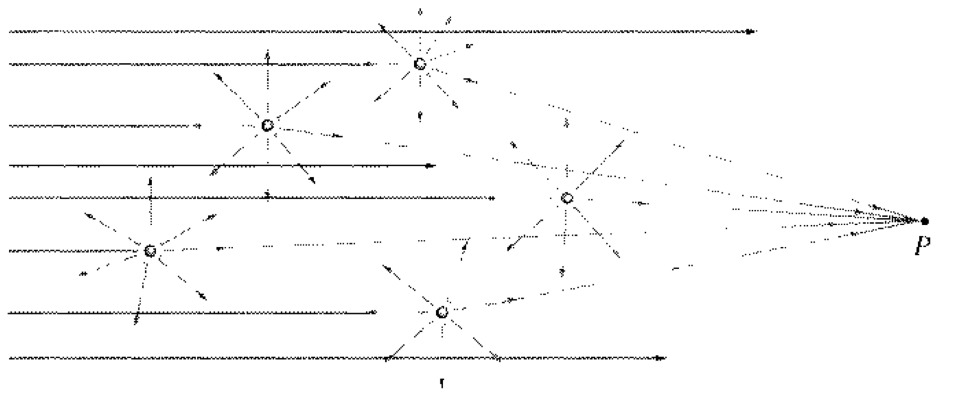


Figure 4.4 Scattering in the forward direction doesn't change the light paths very much, and the waves all arrive at *P* pretty much in-phase.

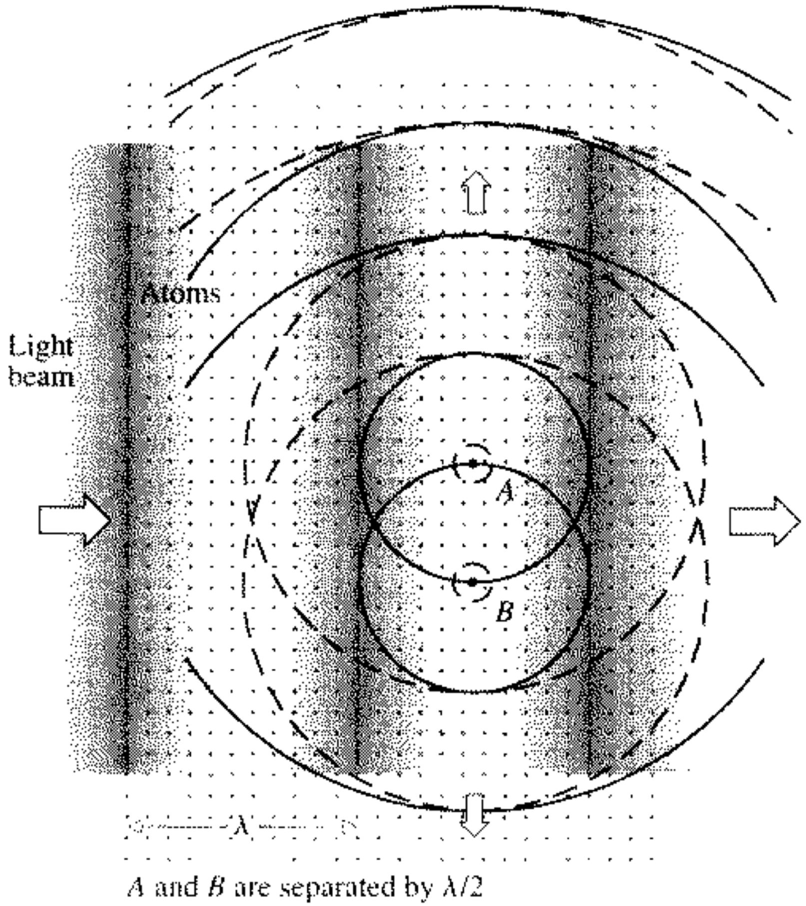


Figure 4.6 A plane wave impinging from the left. The medium is composed of many closely spaced atoms. Among countless others, a wavefront stimulates two atoms, *A* and *B*, that are very nearly one-half wavelength apart. The wavelets they emit interfere destructively. Trough overlaps crest, and they completely cancel each other in the direction perpendicular to the beam. That process happens over and over again, and little or no light is scattered laterally.

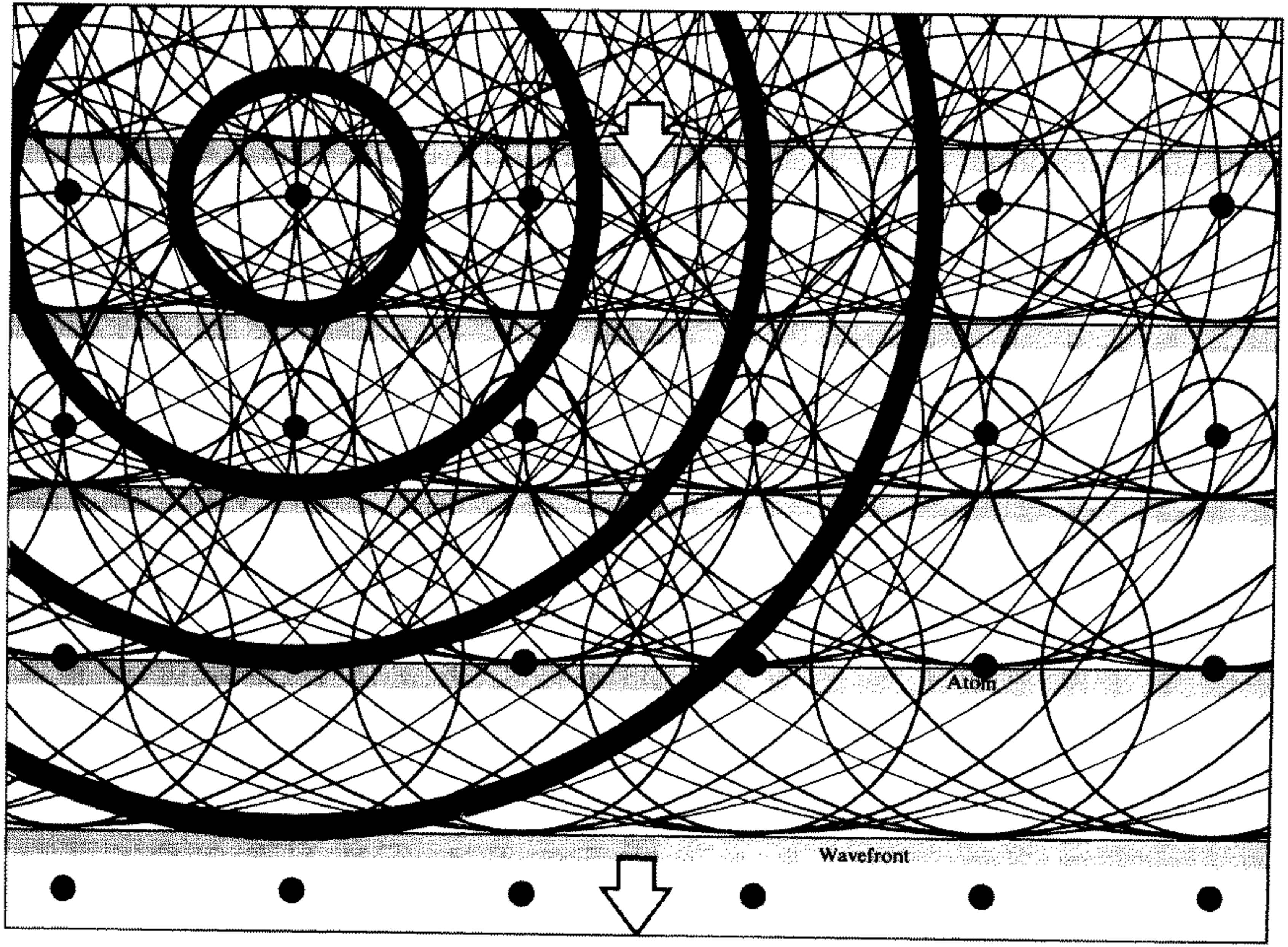
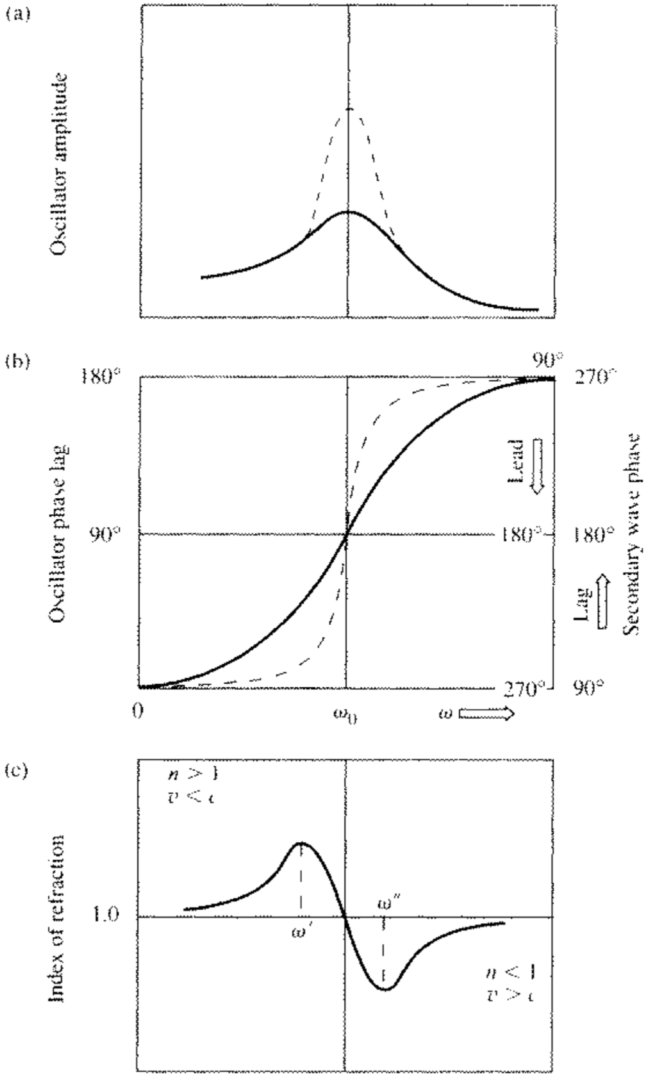


Figure 4.8 A downward plane wave incident on an ordered array of atoms. Wavelets scatter in all directions and overlap to form an ongoing secondary plane wave traveling downward.



ure 4.9 A schematic representation of (*a*) amplitude and (*b*) phase versus driving frequency for a damped oscillator. The dashed curves respond to decreased damping. The corresponding index of refrac- is shown in (*c*).

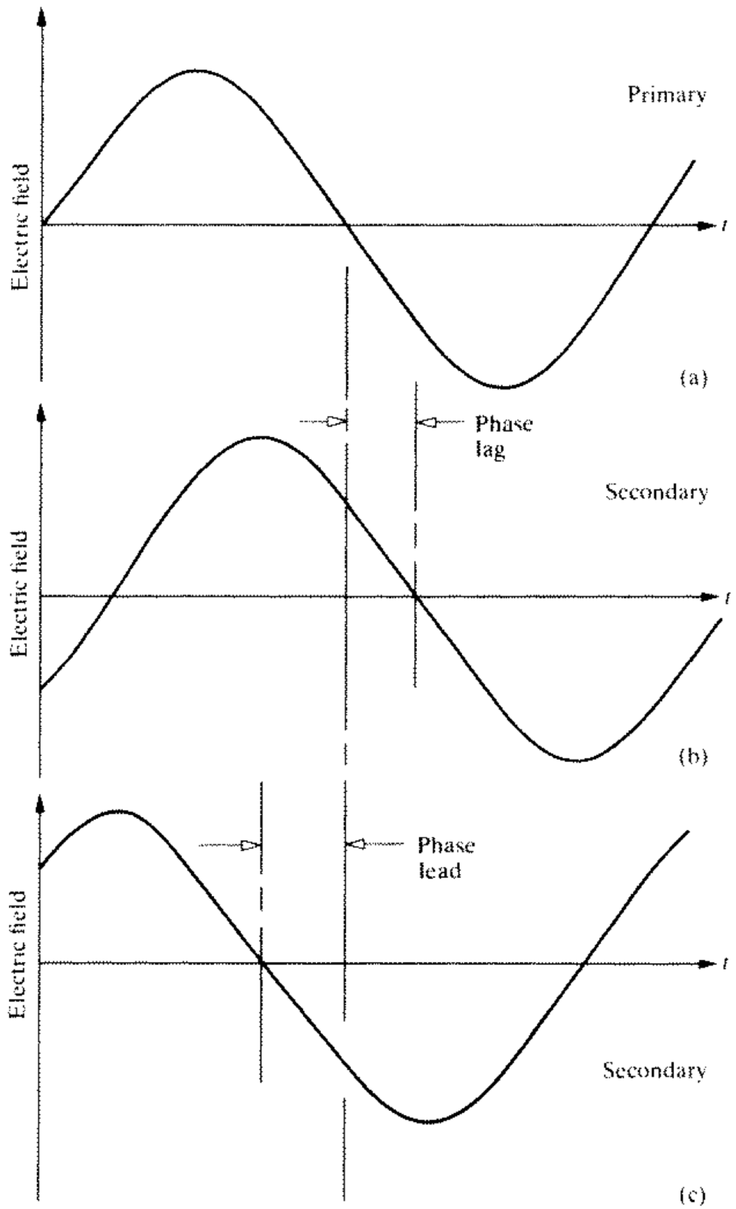


Figure 4.10 A primary wave (*a*) and two possible secondary waves. In (*b*) the secondary lags the primary—it takes longer to reach any given value. In (*c*) the secondary wave reaches any given value before (at an earlier time than) the primary; that is, it leads.

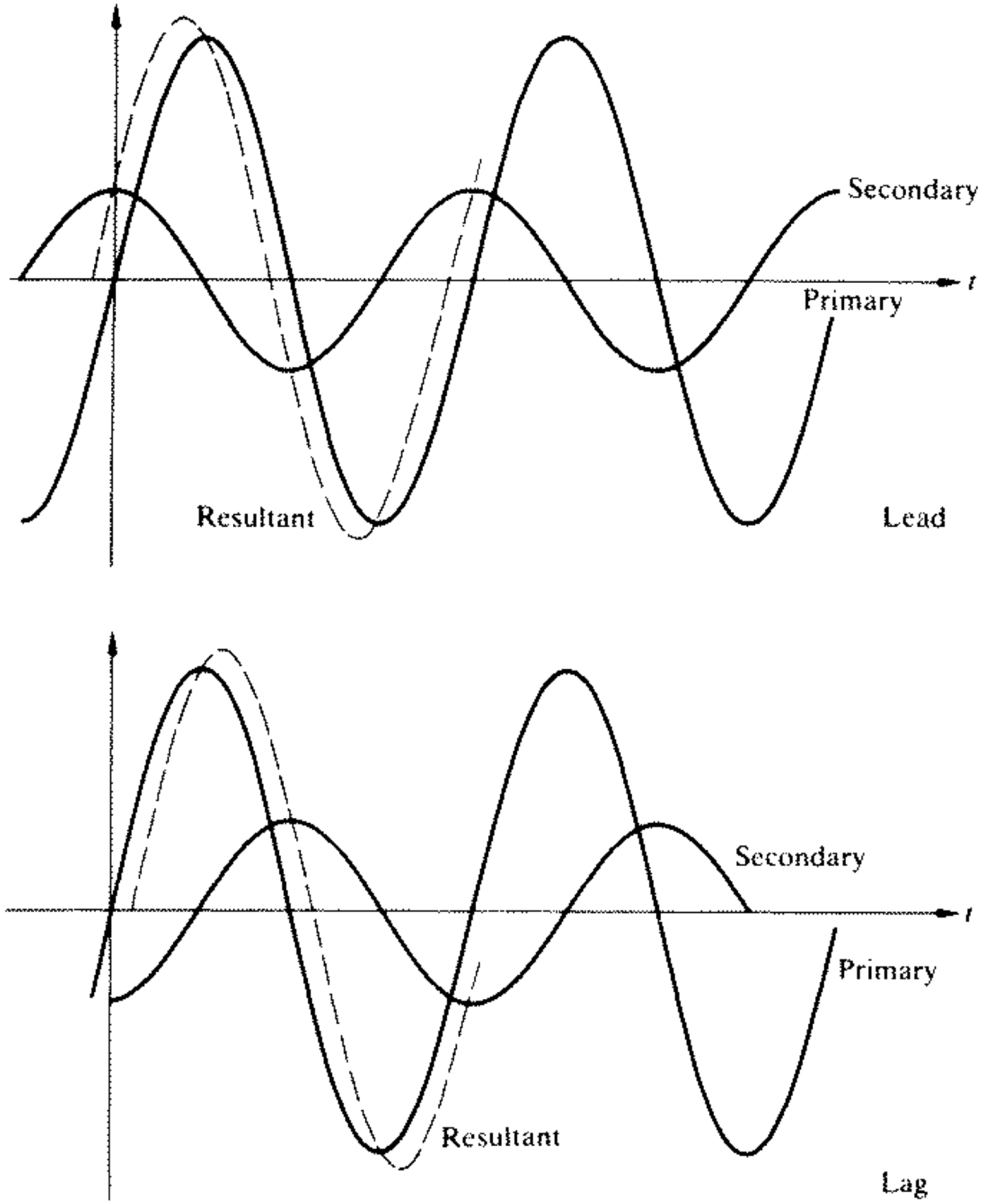


Figure 4.11 If the secondary leads the primary, the resultant will also lead it.

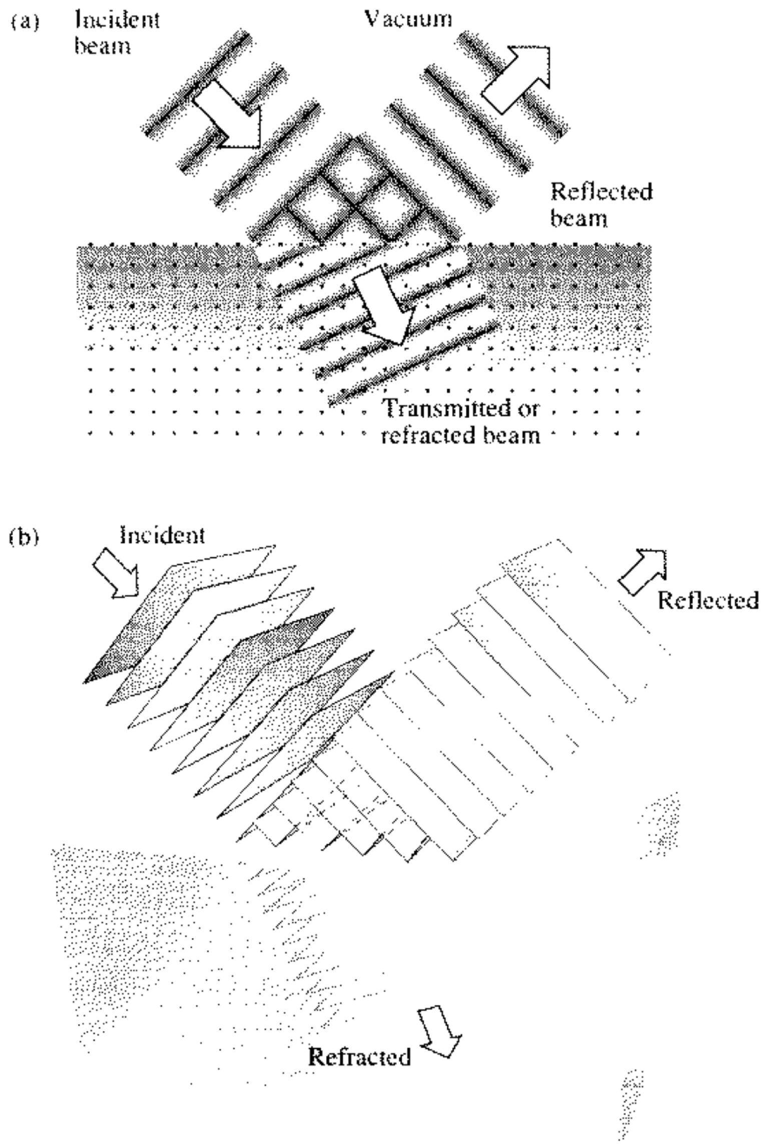


Figure 4.13 A beam of plane waves incident on a distribution of molecules constituting a piece of clear glass or plastic. Part of the incident light is reflected and part refracted.

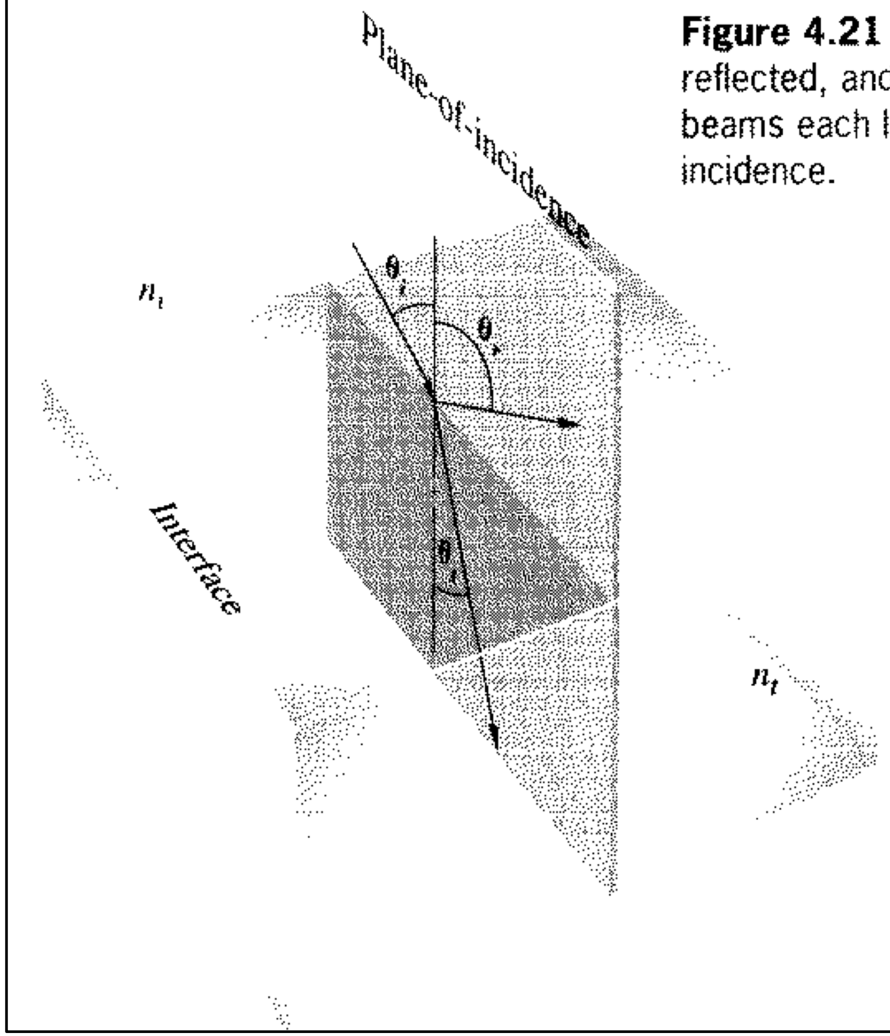


Figure 4.21 The incident, reflected, and transmitted beams each lie in the plane-of-incidence.

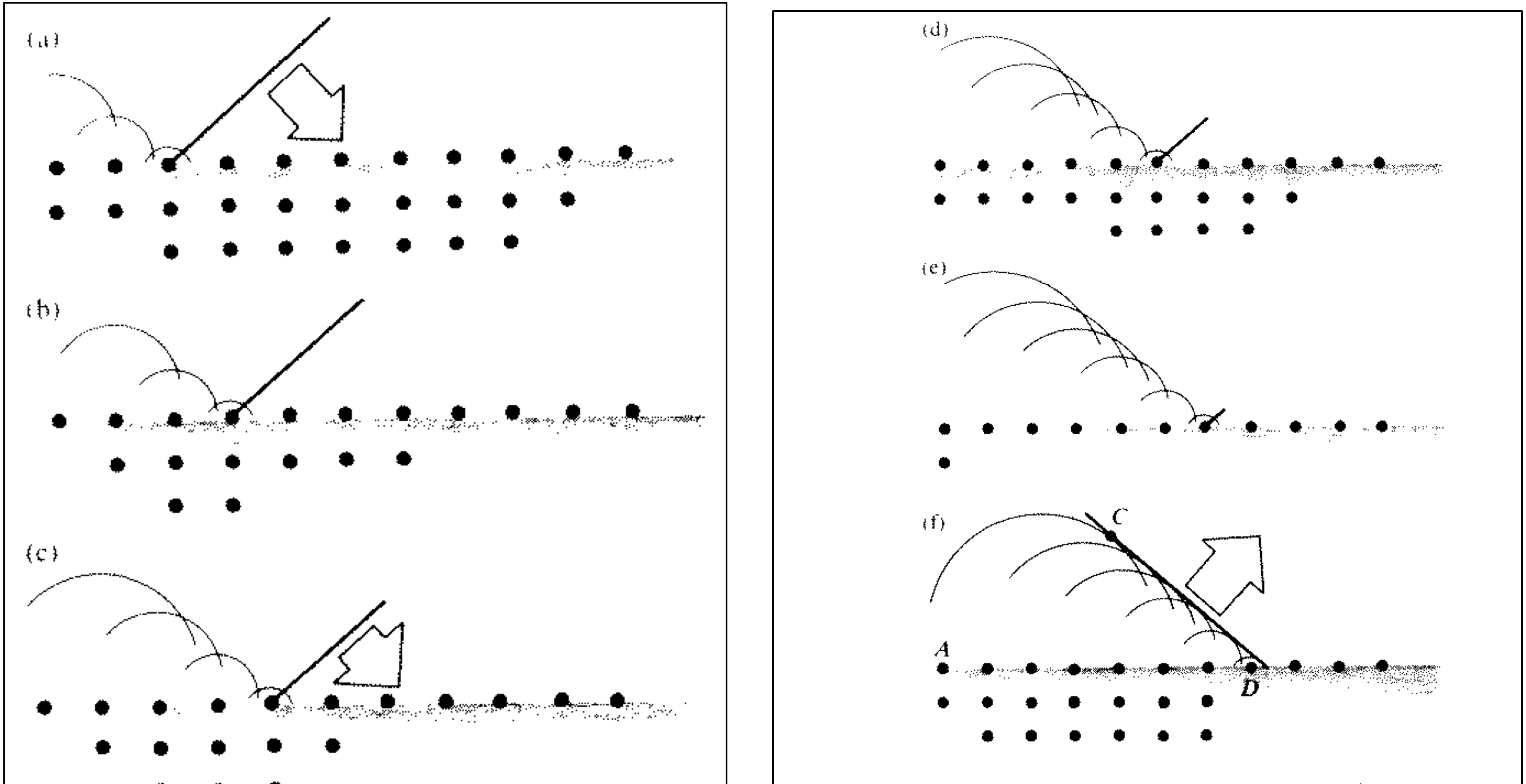


Figure 4.15 The reflection of a wave as the result of scattering.

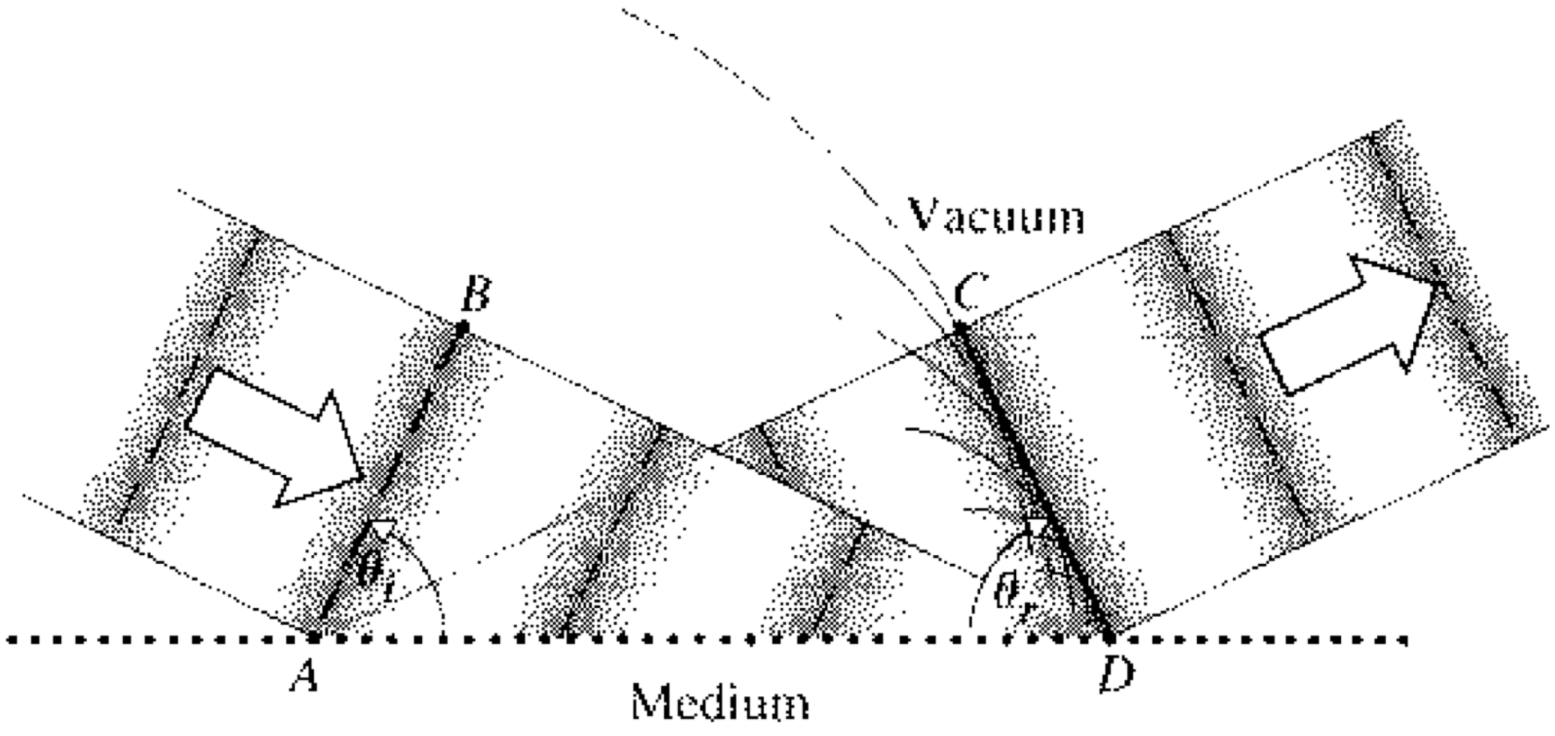


Figure 4.16 Plane waves enter from the left and are reflected off to the right. The reflected wavefront $\overline{CD}$ is formed of waves scattered by the atoms on the surface from *A* to *D*. Just as the first wavelet arrives at *C* from *A*, the atom at *D* emits, and the wavefront along $\overline{CD}$ is completed.

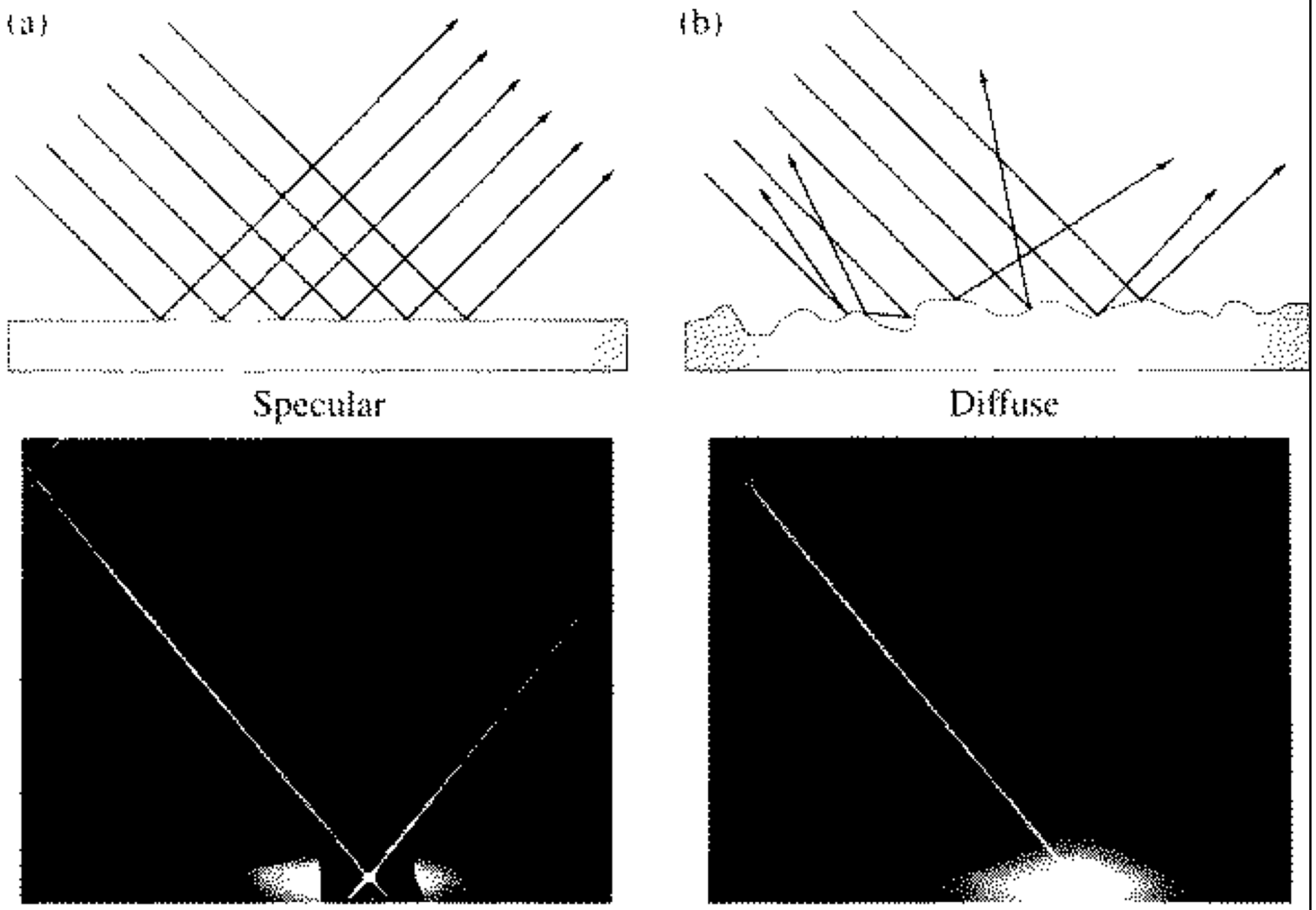


Figure 4.18 (*a*) Specular reflection. (*b*) Diffuse reflection.
(Photos courtesy Donald Dunitz.)

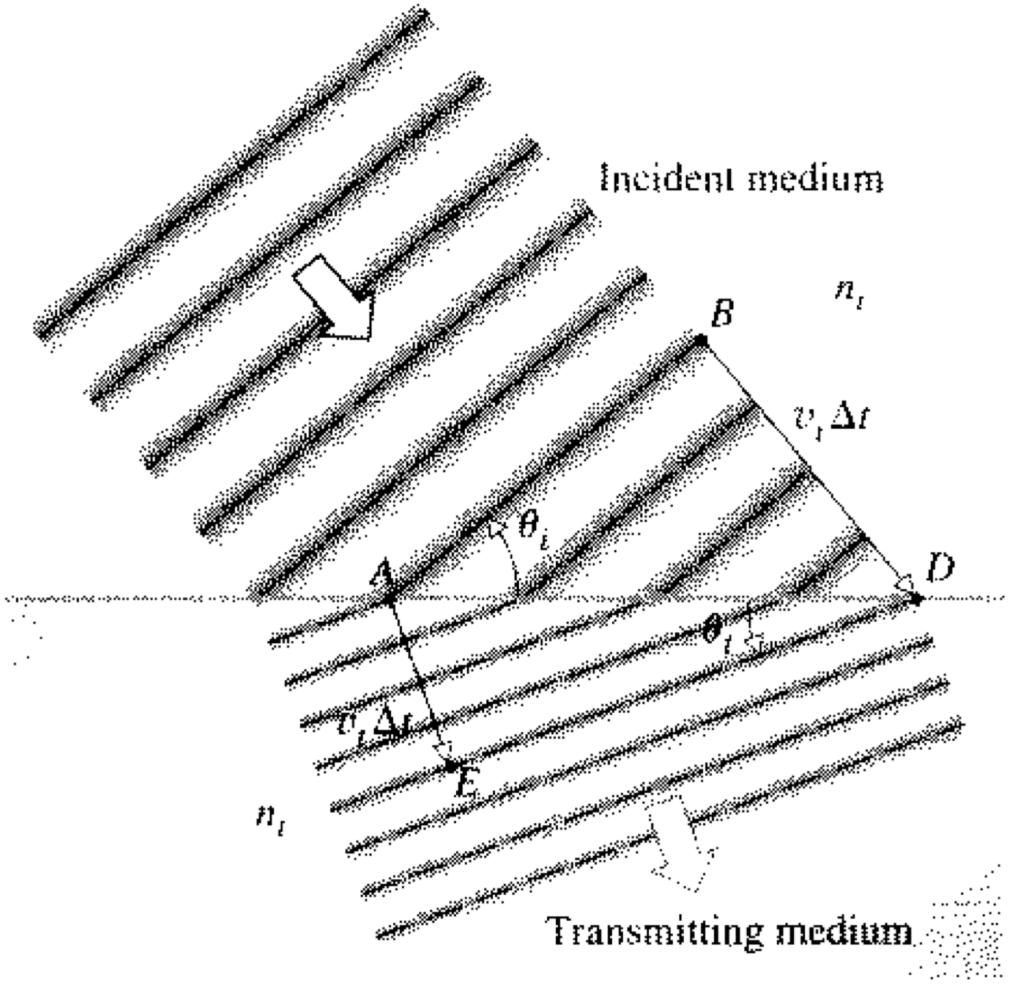


Figure 4.19 The refraction of waves. The atoms in the region of the surface of the transmitting medium reradiate wavelets that combine constructively to form a refracted beam.