crystal. For substances that polarize light by transmission, the line along which light is polarized is called the *transmission axis* of the substance. Only light waves that are linearly polarized with respect to the transmission axis of the polarizing substance can pass freely through the substance. All light that is polarized at an angle of 90° to the transmission axis does not pass through.

When two polarizing films are held with the transmission axes parallel, light will pass through the films, as shown in **Figure 23(a).** If they are held with the transmission axes perpendicular to each other, as in **Figure 23(b),** no light will pass through the films.

A polarizing substance can be used not only to linearly polarize light but also to determine if and how light is linearly polarized. By rotating a polarizing substance as a beam of polarized light passes through it, a change in the intensity of the light can be seen (see **Figure 24**). The light is brightest when its plane of polarization is parallel to the transmission axis. The larger the angle is between the electric-field waves and the transmission axis, the smaller the component of light that passes through the polarizer will be and the less bright the light will be. When the transmission axis is perpendicular to the plane of polarization for the light, no light passes through.

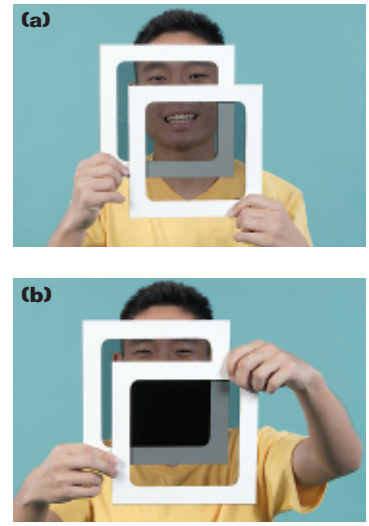

Figure 23
(a) Light will pass through a pair of polarizing films when their polarization axes are aligned in the same direction. **(b)** When the axes are at right angles to one another, light will not get through.

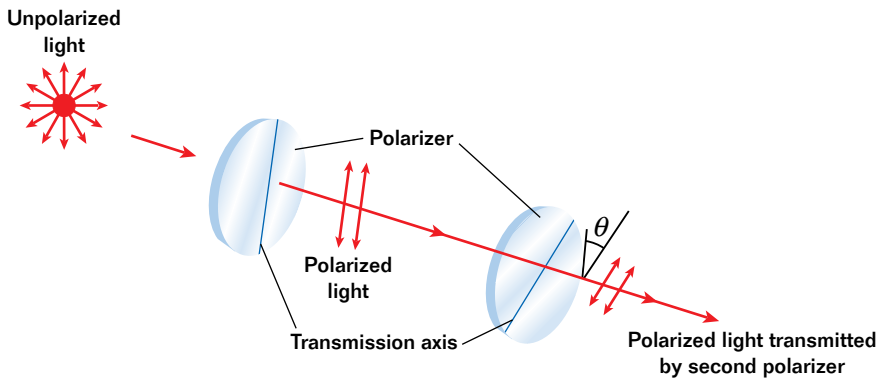

Figure 24
The brightness of the polarized light decreases as the angle, θ, increases between the transmission axis of the second polarizer and the plane of polarization of the light.

Light can be polarized by reflection and scattering

When light is reflected at a certain angle from a surface, the reflected light is completely polarized parallel to the reflecting surface. If the surface is parallel to the ground, the light is polarized horizontally. This is the case with glaring light that reflects at a low angle from roads, bodies of water, and car hoods.

Quick Lab

Polarization of Sunlight

MATERIALS LIST

- **a sheet of polarizing filter or sunglasses with polarizing lenses**

SAFETY

Never look directly at the sun.

During mid-morning or mid-afternoon, when the sun is well above the horizon but not directly overhead, look directly up at the sky through the polarizing filter. Note how the light's intensity is reduced.

Rotate the polarizer. Take note of which orientations of the polarizer make the sky darker and thus best reduce the amount of transmitted light.

Repeat the test with light from other parts of the sky. Test light reflected off a table near a window. Compare the results of these various experiments.