**CHAPTER**
16   Physics Lab 16-1

Safety Precautions

Materials

- two polarizing filters
- lightbulb with socket and cord
- plane mirror
- safety goggles
- glass plate
- protractor (optional)
- ruler (optional)

How can you reduce glare?

While at the beach or swimming pool you probably have noticed the bright reflection of light from the water. Light reflected from the water's surface is partially polarized by the reflection effect.
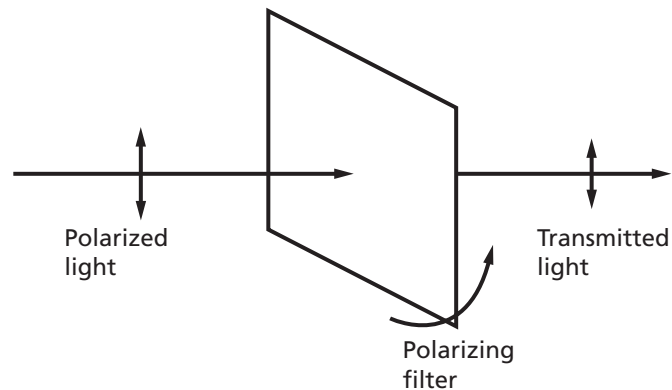
Figure A

Polarized light varies in intensity when it is viewed through a rotating polarizing filter.

Only transverse waves can be polarized, or made to vibrate in one plane. Since light travels in transverse waves, it can be polarized by absorption, reflection, or scattering from shiny objects or materials. Light is also polarized when it passes through certain materials. If you rotate a polarizing filter while observing a light beam, the light intensity may vary from dark to light. Light waves affected in this manner are polarized. If light observed through the rotating filter does not change in intensity, it is unpolarized.

Objectives

- **Observe** light through polarizing filters.
- **Determine** a light's polarity.
- **Describe** applications for polarizing filters.

Procedure

1. Hold one polarizing filter between a light source and your eyes. Rotate the polarizing filter through 360°. Observe the intensity of light as you rotate the filter. Record your observations in **Table 1.**

2. Repeat step 1, adding a second filter. Observe what happens to the intensity of light as you rotate the filter closer to the light source. Record your observations in Table 1.

3. Repeat step 2 and this time rotate the polarizing filter closer to your eye. Record your observations in Table 1.

4. Using only one polarizing filter, rotate the filter while observing light reflected from a plane mirror. Record your observations of light intensity in **Table 2.**

5. Using only one polarizing filter, rotate the filter while observing light reflected from a glass plate. Then observe light reflected from a shiny tabletop. Record your observations of light intensity in Table 2.

Data and Observations

Table 1
Observations of light source with one polarizing filter
Observations of light source with two polarizing filters, rotating the filter closer to the light
Observations of light source with two polarizing filters, rotating the filter closer to your eye

Table 2
Observations of light reflected from plane mirror
Observations of light reflected from glass plate
Observations of light reflected from shiny tabletop

Analysis and Conclusions

1. Is light from a lightbulb polarized? Give a reason for your answer.

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2. What happens to the intensity of light viewed through two polarizing filters as one filter rotates? Does it matter which filter rotates? How far must one filter rotate for transmitted light to go from maximum to minimum brightness?

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3. Malus's law states that the intensity of light coming out of a second polarizing filter is equal to the intensity of light coming out of the first multiplied by the cosine, squared, of the angle between the polarizing axes of the two filters. Do your results appear to confirm Malus's law? Explain why or why not.

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4. Is light reflected from a plane mirror polarized? Give a reason for your answer.

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5. Is light reflected from a glass plate or shiny laboratory surface polarized? Give a reason for your answer.

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Extension and Applications

1. Describe an orientation of polarizing material on cars that would enable drivers to use their high-beam lights at all times.

2. Use a single polarizing filter to observe light reflected from a glass plate. Examine various angles of reflection until the reflected light is entirely eliminated, as shown in **Figure B.** With your protractor, measure this angle, θ_p. When unpolarized light strikes a smooth surface and is partially reflected, the light is partially, completely, or not polarized, depending on the angle of incidence. The angle of incidence at which the reflected light is completely polarized is the polarizing angle. The law of reflection states that the angle of incidence and the angle of reflection are equal. An expression relating the polarizing angle, θ_p, to the index of refraction, n, of the reflecting surface is $n = \tan \theta_p$, which is Brewster's law.
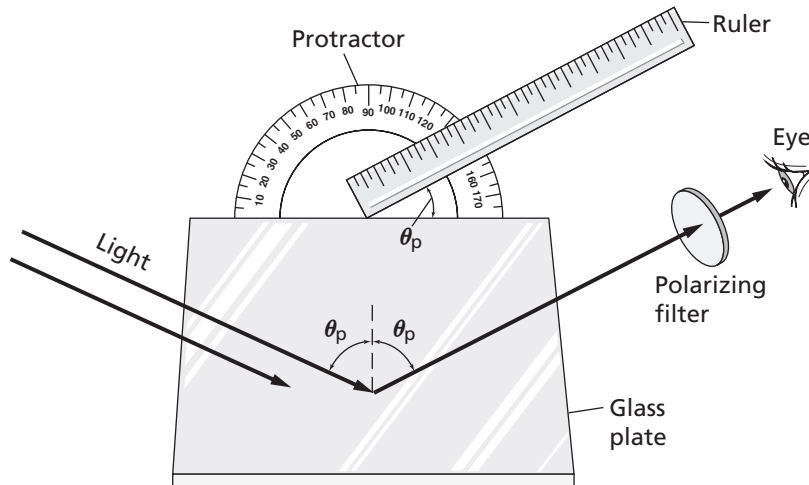

Figure B

Using the measured angle of reflection, calculate the index of refraction for the glass plate. Substitute a beaker of water and measure the angle of incidence at which reflected light is completely polarized. Calculate the index of refraction of water.