

# *MND Physics*

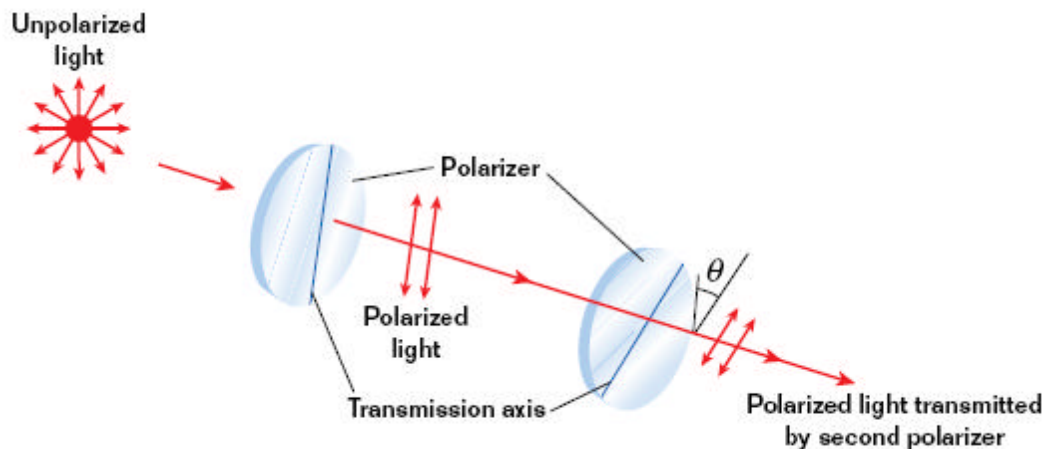
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## Polarized Light

While at the beach or pool, you probably have noticed the bright reflection of the sun's rays from the water's surface. If you wear polarizing sunglasses, you would also notice that this glare is greatly reduced. Light reflected from the water's surface is partially polarized by the reflection effect. Polarizing filters or lenses can be used to eliminate polarized light rays if oriented in the proper way.

Only transverse waves can be polarized, or made to vibrate in one plane. Since light is a transverse electromagnetic wave, it can be polarized by absorption, reflection, or scattering from shiny or semi-diffuse objects. Light is also polarized when it passes through certain materials, such as polarizing filters.

A single polarizing filter reduces the light intensity passing through it by 50%. With two such filters, you can further control how much light is transmitted (allowed to pass through the filters), from 50% to 0%, by orienting the angle of one filter with respect to the other.



**EQUIPMENT:**

2 polarizing filters, calcite crystal, light bulb and socket, plane mirror, glass plate, clear plastic, metric ruler, protractor.

**PROCEDURE:**

1. Hold one polarizing filter between the light bulb (which is an unpolarized light source) and your eyes. Rotate the polarizing filter through 360 degrees. Observe the intensity of light as you rotate the filter. Record your observations.

ANSWER THESE QUESTIONS:

- a. Are there any changes in the intensity as you rotate the filter?
- b. What does your answer tell you about the light coming from the bulb?

2. Place two polarizing filters between your eye and the light bulb; hold one filter in your left hand and one filter in your right hand. The two filters should be approximately 5-10 cm apart; the light path should be from the bulb, through the filter in your left hand, through the filter in your right hand, then to your eye. While holding the filter in your left hand still, rotate the filter in your right hand. Record your observations.

ANSWER THESE QUESTIONS:

- a. Are there any changes in the intensity as you rotate the filter in your right hand?
- b. What does your answer tell you about the light coming through the filter in your left hand?

3. Now, keeping the setup the same as in step 2, this time hold the filter in your right hand still and rotate the filter in your left hand. Record your observations.

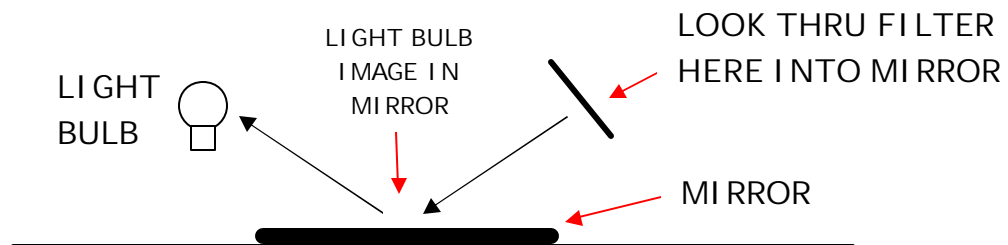
ANSWER THESE QUESTIONS:

- a. Are there any changes in the intensity as you rotate the filter in your left hand?
- b. What does your answer tell you about the light coming through the filter in your right hand?
- c. Compare the results between steps 2 and 3.

4. Place a calcite crystal over a printed word in your textbook or lab report. Draw what you see.
5. Hold one polarizing filter over the calcite crystal. Observe the printed word in the crystal and rotate the filter through 360 degrees. Record your observations.

ANSWER THESE QUESTIONS:

- a. What is calcite? (internet research this)
  - b. What you used in this lab was an Iceland spar crystal. What is Iceland spar? (internet research this)
  - c. What is a possible explanation of the observed phenomena?
6. While rotating one polarizing filter, observe light reflected from a mirror (look at the reflected image of the light bulb in the mirror).



Record your observations regarding any change in light intensity as you rotate the filter.

ANSWER THESE QUESTIONS:

- a. Are there any changes in the intensity as you rotate the filter?
- b. What does your answer tell you about the reflected light coming from the mirror (which is a highly specular surface)?

7. While rotating one polarizing filter, observe light reflected from a glass plate. Record your observations regarding the change in light intensity as you rotate the filter.

ANSWER THESE QUESTIONS:

- a. Are there any changes in the intensity as you rotate the filter?
- b. What does your answer tell you about the reflected light coming from the glass plate?

8. While rotating one polarizing filter, observe light reflected from the black table top (which is a diffuse surface). Record your observations regarding the change in light intensity as you rotate the filter.

ANSWER THESE QUESTIONS:

- a. Are there any changes in the intensity as you rotate the filter?
- b. What does your answer tell you about the reflected light coming from the diffuse table top?

9. Compare and contrast your light intensity observations from steps 6, 7, and 8. Do the various surfaces studied effect the polarization of light differently?

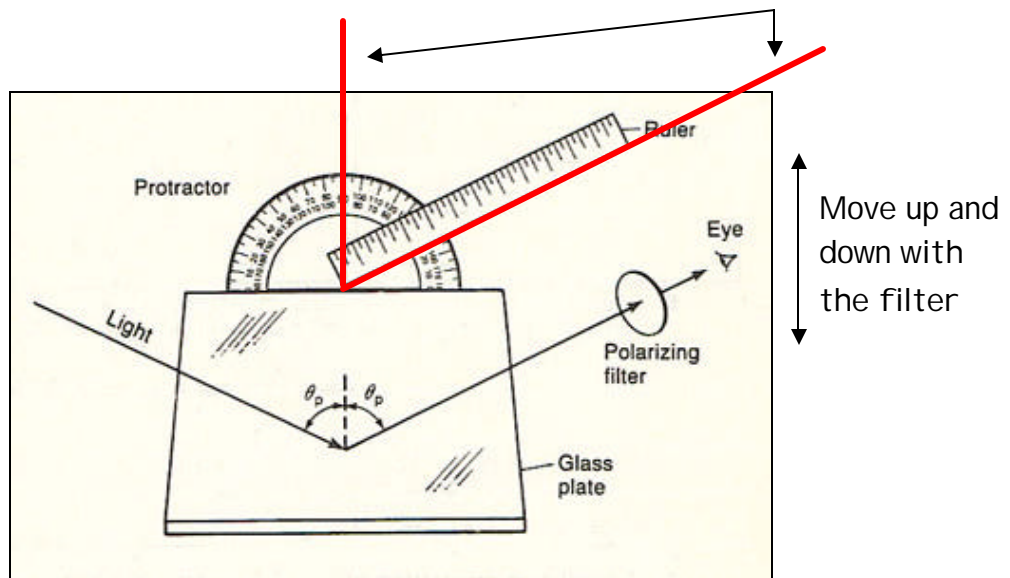
10. The amount of polarization in the reflected beam depends on the reflected angle. Polarization varies from none at normal incidence to 100% at an angle known as the polarizing angle  $q_p$ . This polarizing angle  $q_p$  is related to the index of refraction,  $n$ , of the material that reflects the ray. Assuming a ray of light travels through air and strikes the surface of some substance, the index of refraction of that substance,  $n$ , is given by:

$$n = \tan q_p$$

The angle is  $q_p$  also known as Brewster's angle after Scottish physicist David Brewster (1781-1868).

Set up an experiment **to measure the index of refraction for the glass plate** using the polarizing angle for light on that glass plate. With a single polarizing filter, observe the reflected light from a glass plate. Begin observing at a low angle relative to the table top. Slowly, move upward while continuing to observe the reflection of the bulb in the glass plate. Locate the spot where the light intensity is minimal. Use a protractor and metric ruler to locate and measure this polarizing angle (the angle at which the reflected intensity of light is least).

The polarizing angle is the angle formed between these two red lines.



Calculate the index of refraction for plate glass. Is your calculation reasonable? Defend your answer with known values for similar materials.