72 Shades

Purpose

To investigate the effects of polarized light.

Required Equipment/Supplies

3 small polarizing filters
light source
small plane mirror

Discussion

The vibrations of light waves reaching your eyes are mostly randomly oriented; they vibrate in many planes at once. In polarized light, the light waves vibrate in one plane only. Polarized light can be made by blocking all the waves except those in one plane with polarizing filters. The filters can also be used to detect polarized light.

Activity

Procedure

Step 1: Position one polarizing filter between your eyes and a light source. Slowly rotate the filter 360°. Observe the intensity of the light as seen through the filter. Note any intensity changes as you rotate the filter.

1. What happens to the intensity of the light as you rotate the filter?

Step 2: Arrange one filter in a fixed position in front of the light source. Slowly rotate a second filter held between your eyes and the fixed filter. Note any intensity changes of the light as you rotate the filter 360°.

Rotate second filter.

2. What happens to the intensity of the light as you rotate the filter?

Rotate other filter.

Step 3: Hold the filter at your eye in a fixed position while your partner slowly rotates the other filter next to the light source 360°. Note any intensity changes of the light as the filter as rotated.

3. What happens to the intensity of the light as the filter as rotated?

Rotate both filters.

Step 4: Rotate both of the filters through one complete rotation in the same direction at the same time. Note any intensity changes.

4. What happens to the intensity of the light as you rotate both filters together?

Rotate both filters in opposite directions.

Step 5: Rotate both of the filters through one complete rotation at the same time, but in opposite directions. Note any intensity changes.

5. What happens to the intensity of the light as you rotate both filters in opposite directions?

Rotate single filter for light reflected off a mirror.

Step 6: Repeat Step 1, except arrange the light source and a mirror so that you observe only the light coming from the mirror surface. Note any intensity changes of the light as you rotate the filter.

6. What happens to the intensity of the light as you rotate the filter?

7. Is the light reflected off a mirror polarized?

View sky through filter.

Step 7: View different regions of the sky on a sunny day through a filter. Rotate the filter 360° while viewing each region.

CAUTION: *Do not look at the sun!*

8. What happens to the intensity of the light as you rotate the filter?

9. Is the light of the sky polarized? If so, where is the region of maximum polarization in relation to the position of the sun?

Step 8: View a liquid crystal display (LCD) on a wristwatch or calculator using a filter. Rotate the filter 360°, and note any intensity changes.

View LCD with filter.

10. What happens to intensity of the light as you rotate the filter?

11. Is the light coming from a liquid crystal display polarized?

Analysis

12. Why do polarized lenses make good sunglasses?

Name Period Date

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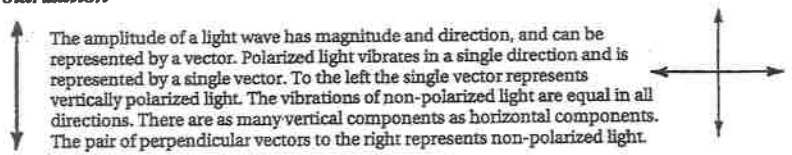
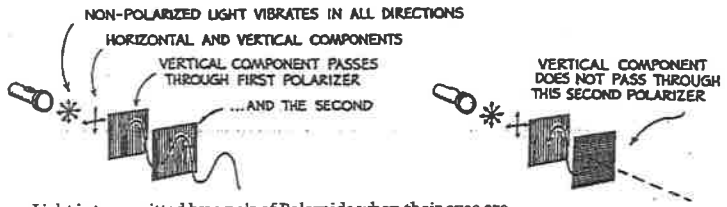
Polarization



The amplitude of a light wave has magnitude and direction, and can be represented by a vector. Polarized light vibrates in a single direction and is represented by a single vector. To the left the single vector represents vertically polarized light. The vibrations of non-polarized light are equal in all directions. There are as many vertical components as horizontal components. The pair of perpendicular vectors to the right represents non-polarized light.

1. In the sketch below non-polarized light from a flashlight strikes a pair of Polaroid filters.



a. Light is transmitted by a pair of Polaroids when their axes are

(aligned) (crossed at right angles)

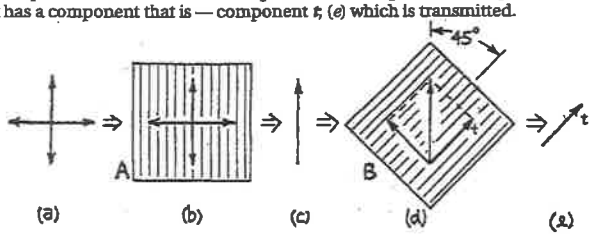
and light is blocked when their axes are

(aligned) (crossed at right angles)

b. Transmitted light is polarized in a direction

(the same as) (different than) the polarization axis of the filter.

2. Consider the transmission of light through a pair of Polaroids with polarization axes at 45° to each other. Although in practice the Polaroids are one atop the other, we show them spread out side by side below. From left to right: (*a*) Nonpolarized light is represented by its horizontal and vertical components. (*b*) These components strike filter A. (*c*) The vertical component is transmitted, and (*d*) falls upon filter B. This vertical component is not aligned with the polarization axis of filter B, but it has a component that is — component *t*; (*e*) which is transmitted.



a. The amount of light that gets through Filter B, compared to the amount that gets through Filter A is

(more) (less) (the same)

b. The component perpendicular to *t* that falls on Filter B is

(also transmitted) (absorbed)

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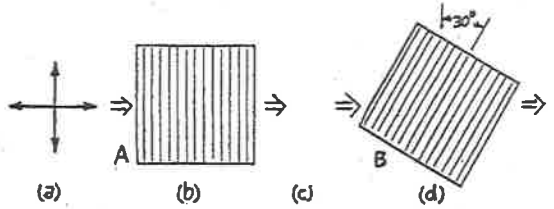
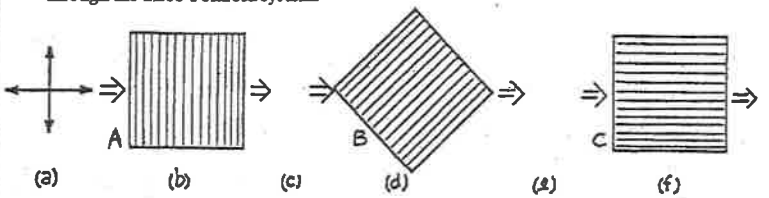
3. Below are a pair of Polaroids with polarization axes at 30° to each other. Carefully draw vectors and appropriate components (as in Question 2) to show the vector that emerges at *e*.



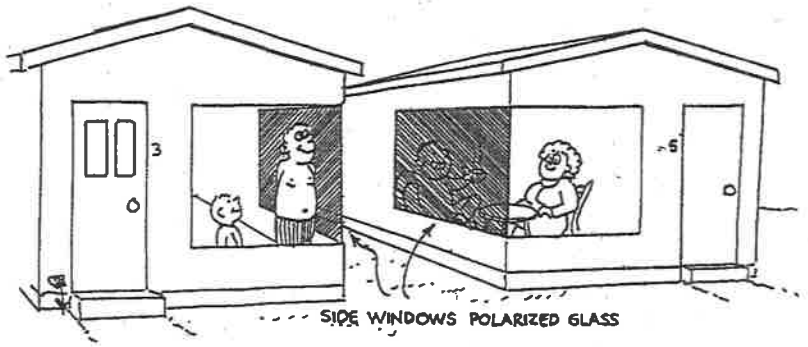
a. The amount of light that gets through the Polaroids at 30°, compared to the amount that gets though the 45° Polaroids is

(less) (more) (the same)

4. Figure 27.19 in your textbook shows the smile of Ludmila Hewitt emerging through three Polaroids. Use vector diagrams to complete steps *b* through *g* below to show how light gets through the three-Polaroid system.



5. A novel use of polarization is shown below. How do the polarized side windows in these next-to-each-other houses provide privacy for the occupants? (Who can see what?)



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