Polarization

Unit: Light & Optics

MA Curriculum Frameworks (2016): N/A

AP® Physics 2 Learning Objectives: 6.A.1.3

Mastery Objective(s): (Students will be able to…)

- Explain how and under which circumstances light can be polarized.

Success Criteria:

- Explanation accounts for the filtering of waves of other orientations and for the specific direction.

Language Objectives:

- Explain how polarized sunglasses work.

Tier 2 Vocabulary: polarized

Labs, Activities & Demonstrations:

- polarizing filters

Notes:

Normally, light (and other electromagnetic waves) propagate in all directions. When the light is passed through a special filter, called a polarizer, it blocks light waves in all but one plane (direction), as shown in the following diagram:

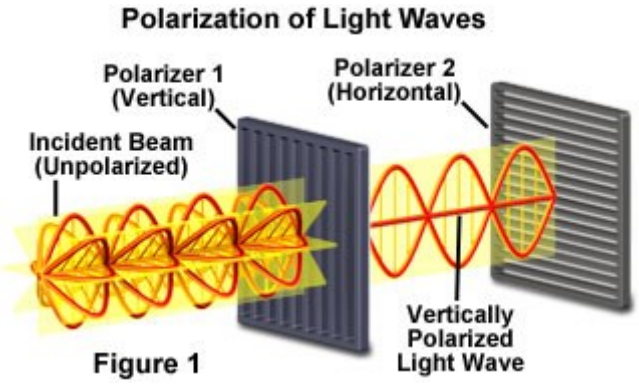

Figure 1

Light that is polarized in this manner is called plane-polarized light.

Note that if you place two polarizers on top of each other and turn them so they polarize in different directions, no light can get through. This is called crossed polarization.

Use this space for summary and/or additional notes:

A flat surface can act as a polarizer at certain angles. The Scottish physicist Sir David Brewster derived a formula for the angle of maximum polarization based on the indices of refraction of the two substances:

$$\theta_B = \tan^{-1}\left(\frac{n_2}{n_1}\right)$$

where:

θ_B = Brewster's angle, the angle of incidence at which unpolarized light striking a surface is perfectly polarized when reflected.

n_1 & n_2 = indices of refraction of the two substances

The two pictures below were taken with the same camera and a polarizing filter. In the picture on the left, the polarizing filter is aligned with the light reflected off the window. In the picture on the right, the polarizing filter is rotated 90° so that none of the reflected light from the window can get to the camera lens.

Another example is light reflecting off a wet road. When the sun shines on a wet road at a low angle, the reflected light is polarized parallel to the surface (*i.e.,* horizontally). Sunglasses that are polarized vertically (*i.e.,* that allow only vertically polarized light to pass through) will effectively block most or all of the light reflected from the road.

Yet another example is the light that creates a rainbow. When sunlight reflects off the inside of a raindrop, the angle of incidence is very close to Brewster's angle. This causes the light that exits the raindrop to be polarized in the same direction as the bows of the rainbow (*i.e.,* horizontally at the top). This is why you cannot see a rainbow through polarized sunglasses!

Use this space for summary and/or additional notes: