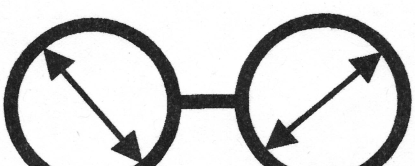
Two Kinds of Polaroid Glasses

by

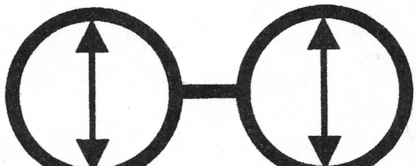
John Pitre

Department of Physics, University of Toronto, Toronto, ON
Email: pitre@faraday.physics.utoronto.ca

When polarized light is discussed, polarizing plastic sheet filters are always mentioned. Dur ing manufacture,this material which contains long chain molecules is mechanically stretched into sheets resulting in the alignment of the molecules. Electrons can travel along the axis of the molecules but cannot jump from molecule to molecule. When light is incident on a polaroid sheet, the component of the electric field which is parallel to the axis of the long chain molecules causes the electrons to move, and that component is absorbed; the component which is perpendicular to the axis of the molecules is unaffected. Thus, polaroid sheets have a preferred direction, or transmission axis, which is perpendicular to the axis of the long chain molecules.



Polaroid 3D Glasses



Polaroid Sun Glasses

When light reflects from a non metallic surface, components of the electric field parallel and perpendicular to the plane of incidence, called parallel and perpendicular components, are reflected differently and the amount of reflection depends on the angle of incidence (the plane of incidence is the plane containing the incident ray and a normal to the reflecting surface). For the perpendicular component, the amount of reflected light increases with the angle of incidence but for the parallel component, at any given angle, the amount of reflected light is less than for the perpendicular component. In particular, there is one angle of incidence called Brewster's angle (53 for water) for which none of the parallel component is reflected. Note that the vibrations of the electric field of the perpendicular component are in the plane of the reflecting surface, so at Brewster's angle, reflected light is completely polarized and the vibrations of the electric field are in the plane of the reflecting surface. By wearing polaroid sun glasses with the transmission axis of both "lenses" vertical as in the diagram, the majority of the reflected light from surfaces which we experience as glare can be eliminated.

On a recent scientific expedition I discovered another kind of polaroid glasses while viewing "Terminator-3D", a 3D film staring Arnold Swartzenegger at Universal Studios in Orlando, Florida. Depth perception is a result of binocular vision since objects subtend slightly different angles at either eye. Older 3D glasses were fitted with coloured filters, red for one eye and green for the other. Two slightly displaced pictures, one red and the other green were projected and each eye saw its appropriate picture although the composite colour was completely unrealistic.

The new 3D glasses have polaroid filters in place of the lenses with the transmission axes perpendicular to each other as shown in the diagram. Two pictures are transmitted with mutually perpendicular polarizations rather than different colours, but the principle is the same. Because both my wife and I saved our glasses as souvenirs I have two pairs to demonstrate in class. When two pairs of glasses with the same orientation are placed on an overhead the image is bright, and colour is rendered faithfully when a coloured tranparency is used underneath the glasses. If one of the pairs of glasses is rotated 180 the lens areas become black.

I don't know if glasses of this sort can be purchased but since this is the 25th anniversary of Disneyland I'm sure that someone in your school will be in Orlando this year. Why not encourage some scientific collecting to increase your repertoire of demonstrations!

Column Editor: Ernie McFarland, Physics Dept., University of Guelph, Guelph, Ontario, N1G 2W1
Email: elm@physics.uoguelph.ca

Submissions describing demonstrations will be gladly received by the column editor.