Exp. 10: Polarization of Light

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Abstract

A study was done to analyze the effects of polarizing filters on a light source. By setting up a light sensor receiving polarized light attached to a rotary motion tool, the intensity of the light at various rotational positions of the filter can be measured and compared to the values given by Malus’ Law, . Additionally, Brewster’s angle was calculated by setting up a glass plate which reflected polarized light into the sensor. This angle was measured to be ~50º by experiment and 56.3º by Brewster’s Law, .

Introduction

When light is emitted from a source, the waves propagate out from a central axis running directly from the source. Certain materials are known as polarizing materials, meaning that their chains of molecules are oriented parallel to each other on a particular axis. When light passes through a polarizing material, any waves running perpendicular to the material are blocked. Any light that passes through is referred to as polarized. By rotating a piece of polarizing material with respect to another piece, the intensity of the light passing through will vary according to Malus’ Law. This states that , where *I* is the intensity of the light varying with , the angle difference between the two polarizing materials.

Additionally, when light is reflected at a non-normal angle, the remaining light becomes polarized parallel to the reflective surface. By changing the angle of incidence of the reflective surface, a point can be reached where the reflected light is maximally polarized. If the index of refraction of the reflective material is known, this angle can also be calculated by Brewster’s Law, which states that , where is Brewster’s Angle and *n* is the index of refraction (which is approximately 1.5 in this experiment).

Procedure

In this experiment, a lamp was used as a light source. The light from this lamp was first shone through two pieces of polarizing material, a polarizer and an analyzer. Behind the analyzer was a light sensor attached to a rotary motion tool. By rotating the light sensor at a consistent rate, a graph of the intensity of the light as a function of the angle of the analyzer was created. Data points for the light intensity were then taken for every 10 degrees, from 0-350 degrees of measurement. These same data points were then calculated by hand using Malus’ Law, , and compared to previously measured points. The minimum and maximum values for the intensity of the light were also measured.

After this, the lamp was aimed at a reflective glass plate, which was rotated until the reflected light was directed at the analyzer. The glass plate was then rotated until the reflected light reached its minimum intensity. The angle of incidence of the glass plate was then taken and compared to the value found by Brewster’s Law, , using 1.5 as the index of refraction of the glass plate.

Results

As can be seen in this graph comparing the experimental and equation values of the light intensity, the values for both are very similar through the entire graph. The experimental values (blue) for the light intensity are slightly larger on average than the equation values (orange). Additionally, the minimum light intensity was measured to be 39 lux, while the maximum light intensity was measured to be 558 lux. Brewster’s Angle from experiment was approximately 50º and 56.3º calculated by Brewster’s Law.

Question A: The intensity decreases.

Question B: The filter is blocking some of the light.

Question C: Yes.

Question D: 90 and 300 degrees.

Question E: The filters are set perpendicular to each other.

Question F: 30 and 180 degrees.

Question G: The intensity remains the same.

Question H: Yes.

Question I: The intensity of light can’t be negative.

Question J: We checked if the graph took a sinusoidal shape.

Question K: The angles are fairly similar.

Questions to Be Answered

1. Yes, because the middle material can be set at an angle between 0 and 90 degrees to act as an analyzer and control the angle of the light before it passes through the third material.
2. The material would have to be set at a vertical axis to block the horizontal waves producing glare from various surfaces, such as the road.
3. The light would have been absorbed or scattered in various directions by the glass so randomly that the light was difficult to see.