10 10:40 11:30 1 36 17 19

(Malus's law

 $I = I_0 \cos^2 \theta$

()

		[Lux]			
Physics	Physics with Vernier 4th edition, Vernier, 2019, 28A-1 - 28B-4I				

David Homer, Michael Bowen-Jones, Oxford IB Diproma Programme 2014 edition

Physics, pp. 141-144

Experiment Characteristic of Light Polarization of light

Introduction

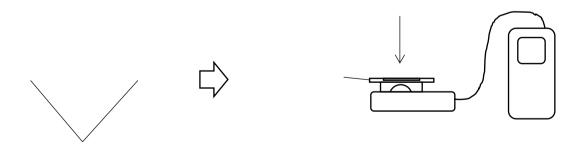
Perhaps you have seen a display of polarized sunglasses in a store. You can quickly test to see if the glasses are really polarized by looking through the lenses of two glasses and rotating one pair by 90°. If both pairs of glasses are polarized, the lenses will appear to go black. Why is that?

To explain the darkened lenses, we need to think of the light as an electromagnetic wave. An electromagnetic wave has varying electric and magnetic fields perpendicular to the direction the wave is traveling. This experiment focuses only on the electric field variation, represented by a vector. Light emitted from a typical source such as a flashlight is randomly polarized, meaning that the electric vector points in varying directions. An ideal polarizing filter will remove all but the electric fields that are parallel to the axis of the filter. The light remaining is then said to be *polarized*. A second filter can be used to detect the polarization; in this case, the second filter is called an *analyzer*. The transmission through the second filter depends on the angle between its axis and the axis of the first filter. In this experiment you will study the relationship between the light intensity transmitted through two polarizing filters and the angle between the filter axes.

In the 1800's Malus proposed a law to predict light transmission through two polarizing filters. The relationship is

$$I = I_0 \cos^2 \theta$$

where I_0 is the intensity when the angle θ between the polarizer axes is zero. In this experiment, you will see if this law is useful in describing your polarizing filters.



Objectives

- (1) Observe the change in light intensity of light passing through crossed polarizing filters.
- (2) Measure the transmission of light through two polarizing filters as a function of the angle between their axes and compare it to Malus's law.

Experiment data

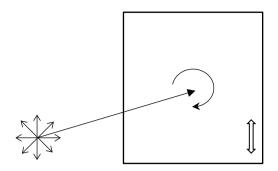
	Ie:Intensity	Ie I(90°)	cos ²	
0			1.00	
10			0.97	
20			0.89	
30			0.76	
40			0.60	
50			0.42	
60			0.2	
70			0 5	
80			0.	
90		0	G	

Analysis

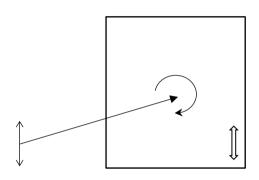
Describe your graph of light intensity vs., and \cos^2

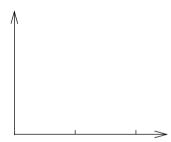
Extensions

1. A beam of unpolarized light of intensity \mathbf{I}_0 is incident on a polarizer. The polarization axes of the polarizer is initially vertical as shown. The polarizer is then rotated by 180° in the direction shown. Sketch a graph to show the variation with the rotation angle , of the transmitted light intensity \mathbf{I} , as varies from 0° to 180° . Label your sketch-graph with the letter \mathbf{U} .

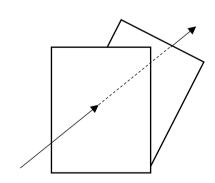


2. The beam in 1 is now replaced with a polarized beam of light of the same intensity. The plane of polarization of the light is initially parallel to the polarization axes of the polarizer. The polarizer is then rotated by 180° in the direction shown. On the same axes in 1, sketch a graph to show the variation with the rotation angle, of the transmitted light intensity I, as varies from 0° to 180°.





3. (difficult) Unpolarized light if intensity I_0 is incident on a polarizer. The transmitted light is then incident on an analyzer. The axes of the analyzer makes an angle of 60° to the axes of the polarizer. Calculate the intensity I emitted by the analyzer.



Reference

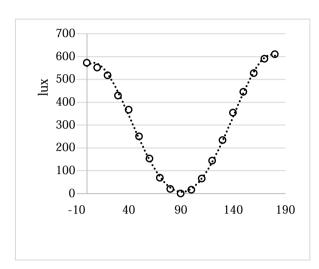
Physics with Vernier 4th edition, Vernier, 2019, 28A-1 – 28B-4I

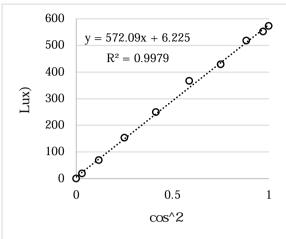
David Homer, Michael Bowen-Jones, Oxford IB Diproma Programme 2014 edition Physics, pp.141-144

Class () No.() Name ()

Instructor information

Results



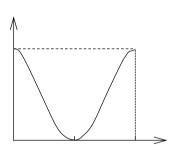


Extensions

(1)



(2)



(3) The first polarizer restricts the intensity to $I_0/2*$. Using Malus's law $I=I_0cos^2$, $cos^260^\circ=0.25$, thus $I=0.25\times I_0/2=0.125I_0$

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(Malus's law IB

 \sin^2

0° 90° 90° 180°

 I/I_0