EXPERIMENT PROCEDURE

- **Measure the intensity of light *I* transmitted through a polarising filter as a function of the angle of rotation of the filter.**
- **Verify Malus' law.**

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OBJECTIVE

Verify Malus' law for linearly polarised light.

SUMMARY

Malus' law describes how intensity *I* of polarised light with an initial intensity I_0, having passed through an analyser filter, depends on the angle of rotation of the filter. The intensity of the light is measured using a light sensor.

REQUIRED APPARATUS

Quantity	Description	Number	
1	Optical Precision Bench D, 50 cm	**1002630**	
4	Optical Rider D, 90/50	**1002635**	
1	Optical Lamp, Halogen	**1003188**	
1	Transformer 12 V, 60 VA (115 V, 50/60 Hz)	**1006780**	**or**
	Transformer 12 V, 60 VA (230 V, 50/60 Hz)	**1000593**	
2	Polarisation Filter on Stem	**1008668**	
1	Light Sensor	**1000562**	
1	3B NET*log*™ (230 V, 50/60 Hz)	**1000540**	**or**
	3B NET*log*™ (115 V, 50/60 Hz)	**1000539**	

BASIC PRINCIPLES

Light, being a transverse wave, can be polarised, for example by allowing it to pass through a polarising filter. In a linearly polarised light wave, both the electric field *E* and magnetic field *B* oscillate in distinct planes. The orientation direction of the electric field oscillation is called the polarisation direction.

In this experiment light passes through two filters termed the polariser and the analyser, which are aligned at an angle of φ to one another. The polariser only allows one linearly polarised component of the light to pass through it. The electric field of this component may be deemed to have an amplitude E_0.

The amplitude of the component after passing through the analyser filter is given by

(1) $$E = E_0 \cdot \cos\varphi$$

This is a measure of the amount of light which can pass through the analyser.

The intensity of the light corresponds to the square of the electric field strength. The intensity of light beyond the analyser is therefore as follows:

(2) $$I = I_0 \cdot \cos^2\varphi\ ,$$

where I_0 is the intensity of light after passing through the polariser.

Equation (2) is a statement of Malus' law. This will be verified in the experiment by measuring the light intensity using a light sensor. In this experiment, the intensity of light measured for an angle φ = 90° should be equal to that of the ambient light. This value should be subtracted from all the other intensity measurements.

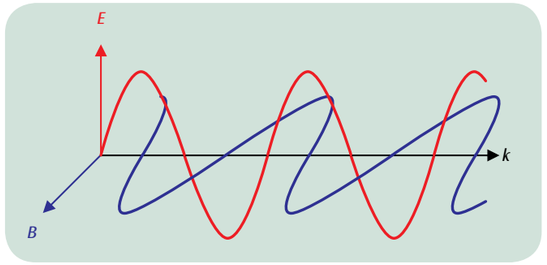

Fig. 1: Illustration showing the definition for direction of polarisation

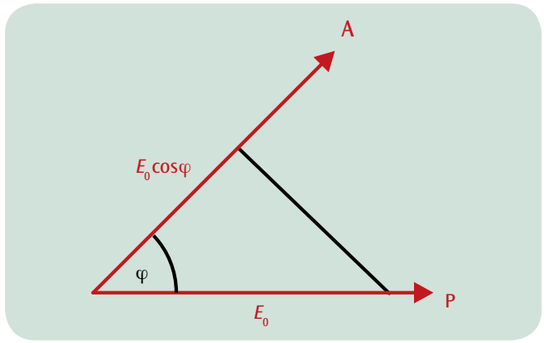

Fig. 2: Illustration of how the electric field beyond the analyser is calculated

EVALUATION

Once the ambient light intensity has been subtracted from all the measurements, they are then plotted as a function of φ. The curve should then be described by equation (2).

Intensity *I* is then plotted in another graph as a function of $\cos^2\varphi$. In this case, the measurements lie on a straight line through the origin which has a gradient I_0.

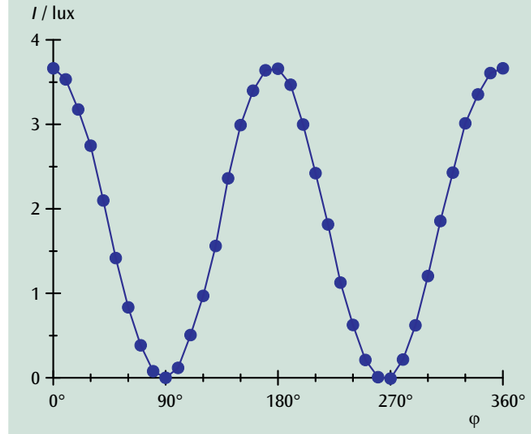

Fig. 3: Light intensity *I* as a function of the angle φ between the polariser and the analyser

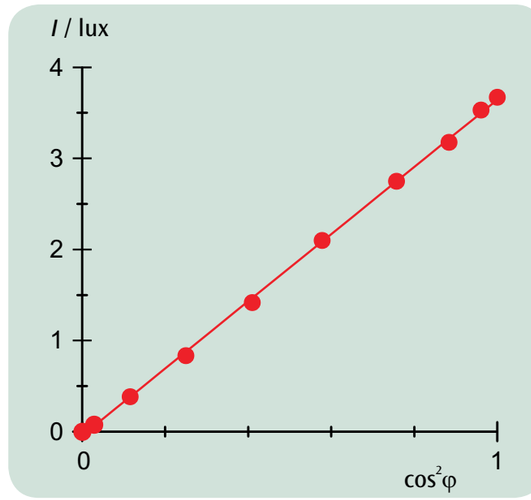

Fig. 4: Light intensity *I* as a function of $\cos^2\varphi$