Experiment 6
Polarisation of Light

SAFETY

Make sure that you have read the **General Safety Notes**, in the Introductory section of this manual, before you begin.

Do not, **under any circumstances,** attempt to repair or dismantle any of the equipment. If you suspect equipment to be faulty, turn it off at the power point and talk to your demonstrator.

ADDITIONAL HAZARDS

Over the course of this experiment, the lamps you use will become **very hot**. Take care not to burn yourself.

Outline of Experiment

From sunglasses, to calculator and computer screens, we use the physical property of polarisation daily. Polarisation is essential in much of our technology and lives and this extends to 3D movies and optical fibres and much more. In this experiment you will be investigating the wave-like property of polarisation in light, how polarisers (or polaroids) work and how some materials have optical activity and can rotate the polarisation of light.

✓***Pre-lab exercises:*** *Read the laboratory exercise, complete the questions below, then submit the pre-lab task online (LMS or http://fyl.ph.unimelb.edu.au/prelabs) for this experiment. [Your marks for the pre-lab will be based on the answers to the online questions, which are taken from the pre-lab work in the manual]*

Learning Goals

- To relate observations of physical phenomena with a theoretical model through graphical means.
- To consider how external conditions influence and experiment and incorporate this into the mathematical model.
- To develop an understanding of the nature of polarisation of lights with the use of polarisers.

Introduction

Before beginning your experiment go to the following link: hyperphysics.phy-astr.gsu.edu/hbase/phyopt/polarcon.html and click on the words: Polarisation, linear polarisation, cross polarizers, reflection, polariser and optical activity to explore the ideas of this lab.

✓ **Pre-lab question 1**

Consider a linearly-polarised light wave with electric field magnitude E_0, incident on a polariser at angle θ to the transmission axis. Write down the magnitude E of the electric field that emerges from the polariser, in terms of E_0 and θ.

✓ **Pre-lab question 2**

Write down the intensity I of the electric field that emerges from the polariser, in terms of E_0 and θ.

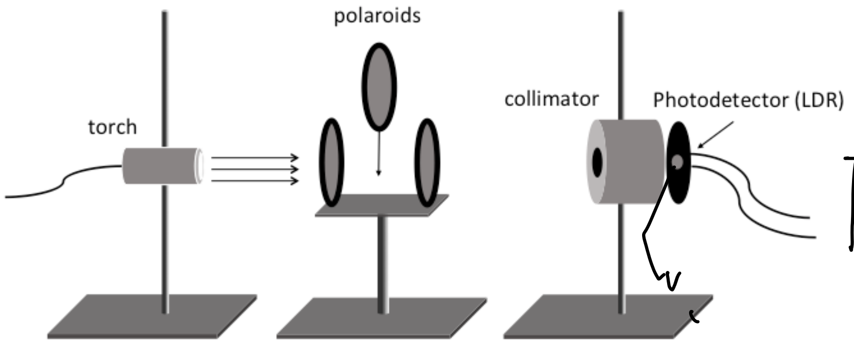
Section A: Investigating Polarisation

In this first experiment you will be investigating polarisation through consecutive lenses of variable polarisation axes. Using a voltage divider as an intensity meter you can measure the light intensity on a multimeter, with the units taken as arbitrary light units.

Experimental Set-up

Align a light source onto the photodetector connected to a multimeter.

Before turning on the light source measure the background voltage produced on the photodetector. Why is this important?



I

V.

Turn on the light source (Your light source has 3 settings check to make sure you're on the highest intensity setting). Measure the maximum intensity (i.e. with no polarisers).

$E \propto V$

$I \propto \cos^2\theta \propto E^2 \propto V^2$

Place a polariser in front of the source and measure the intensity. What value would you expect this to be? Why?

Add a second polariser. Turn one of the polarisers and comment on the light passing through to the photodetector. Plot the angle versus intensity using Excel.

Align the two polarisers such that the measured voltage is minimised.

Add a third polariser between the other two. Rotate the middle polariser and comment on the results.

Data

✓ Plot the intensity vs angle of rotation for angles from 0 to 180 degrees for both two and three polarisers.

Analysis

✓ With two polarisers, could you completely block out the light? Why would you think that this may happen? no, the light source is not fully polarised

✓ With 3 polarisers, what did you notice when rotating the middle polariser? Why would this happen?

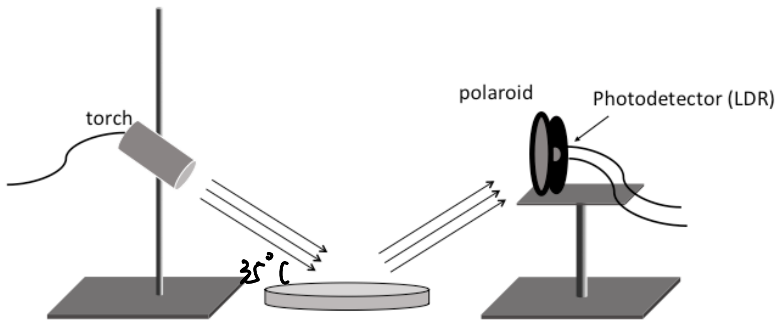
✓ Discuss your results.

Section B: Polarisation Through Reflection

If you have ever seen the surface of water through polarised sunglasses you will know that reflections can polarise light. In this section you will be investigating the reflection of polarised light and measuring the amount of polarisation from a reflected source.

Experiment

Fill a petrie dish with water and set up the following experiment. Angle the light source at approximately 35 degrees to the desk's surface.



Measure the background voltage produced.

Rotate the polariser until the voltage is at its minimum.

Calculate the level of polarisation of the water's reflection. Is it perfectly polarising? Why or why not?

Analysis

✓ Is water a perfect polariser or as good as one of the polarisers you have on your bench? Justify your response. You can do some measurements to justify this.

Can you think of any better ways to measure background light?

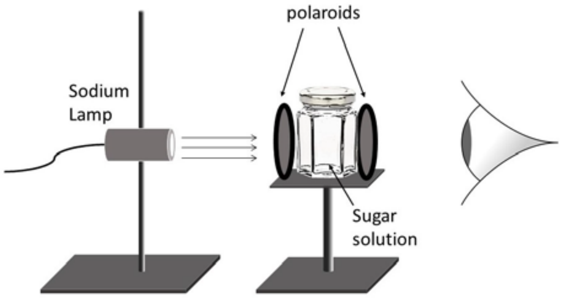
Section C: Optical Activity: Polarisation Rotation Through a Medium

Technologies such as LCDs rely on the rotation of polarised light through a medium. This can be done using solutions such as sugar dissolved in water. A material which rotates the polarisation of light is said to have optical activity. There is only one of these set up per lab, so you will need to take turns.

Experiment

Using a similar setup as Section A where the polarisers are cross-polarised, replace the middle polariser with a jar of sugar solution.

Using the final polariser rotate the angle until you see the light at a minimum again.



Using this we can find the concentration, C using the following formula:

$$\theta = CL\,\alpha$$

Where α is 66.47 degrees $dm^{-1}\ cm^3\ g^{-1}$, L is the length of the optically active medium and θ is the angle of rotation of polarised light through the solution.

Analysis

Discuss your results and compare to the concentration supplied by your demonstrator.

Conclusion

Write a final, short summary of your results from all the sections in this lab.

$\theta = 24^\circ\ 24^\circ$