# Unit 13 · Polarization

HARDER PRACTICE QUESTIONS

Full marks 27

Write your answers on separate paper. Show your working.

## 1 Spot the error [3]

Find the mistake in the working and correct it.

Unpolarized light of intensity 50 W/m$^2$ passes through a polarizer and an analyzer at 45° to it. Ritesh finds the light leaving the analyzer:
"$I = I_0 \cos^2 45° = 50 \times 0.5 = \mathbf{25\ W/m^2}$."

## 2 Show that [2]

Show that for any material in air, the polarizing angle $\theta p$ and the critical angle C are related by $\tan \theta p = 1/\sin C$.

## 3 Predict, then explain [3]

Write your prediction first, then explain it.

Two polarizers are crossed, so no light gets through. A third is slipped between them with its axis at 30° to the first. Predict: does light get through? If 50 W/m$^2$ of unpolarized light falls on the first, how much leaves the last?

## 4 Check the readings [3]

Answer from the data.

Plane-polarized light passes an analyzer, and Pooja reads the intensity with a light meter:

| Angle (°) | 0 | 30 | 45 | 60 | 90 |
|---|---|---|---|---|---|
| Intensity (W/m$^2$) | 24.0 | 18.0 | 12.0 | 9.0 | 0 |

i. Which reading doesn't follow Malus's law? What should it be?
ii. At what angle would the meter read 3.0 W/m$^2$?

## 5 A real setting [3]

A photographer wants to remove the reflection of the sky from a shop window of glass with refractive index 1.52. At what angle to the glass's normal should she stand, and how should her polarizing filter be turned? Is the light passing into the shop polarized too?

## 6 Work backwards [2]

Light reflected from a liquid is completely polarized when the angle of refraction is 31.2°. Find the liquid's refractive index.

## 7 What if? [3]

Light inside a block of glass ($\mu = 1.60$) meets the glass–air surface from inside. At what angle of incidence is the reflected light completely polarized? Would the light get out into the air at that angle?

## 8 Correct the misconceptions [3]

The paragraph has three mistakes. Write each mistake and correct it.

> Shristi wrote: “A polaroid’s long chain molecules are like slits, so light vibrating along them gets through. At Brewster’s angle the refracted light is completely polarized. And a polarizer dims polarized and unpolarized light alike as you turn it.”

## 9 Design it [3]

Design a pair of polarizers for a dimmer that lets through exactly 15% of the unpolarized light falling on it. At what angle should the analyzer be set? What is the least light this dimmer can pass, and the most?

## 10 Make your own [2]

Make up a material and give its refractive index so that its polarizing angle in air is more than 60°. Find its polarizing angle.