# Engineering Optics

## Lecture 18

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# Production of linearly polarized light

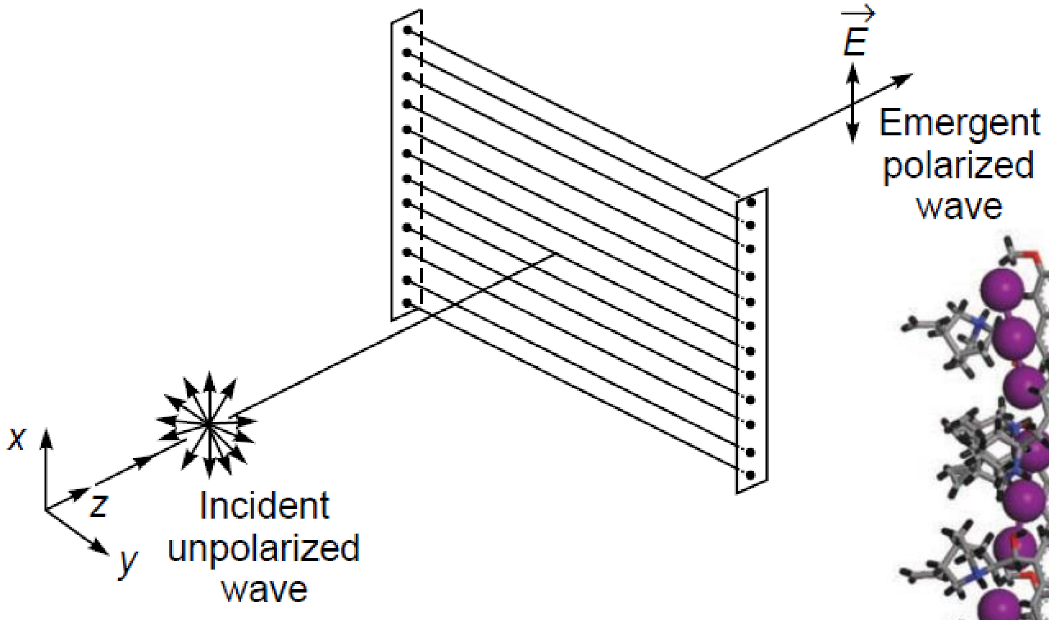



**Fig. 22.8** The wire grid polarizer.

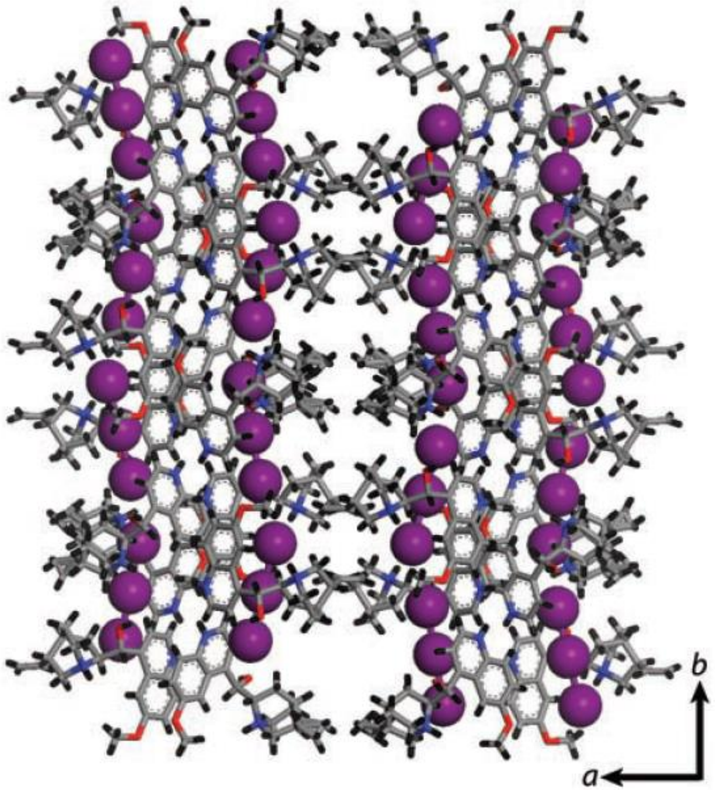
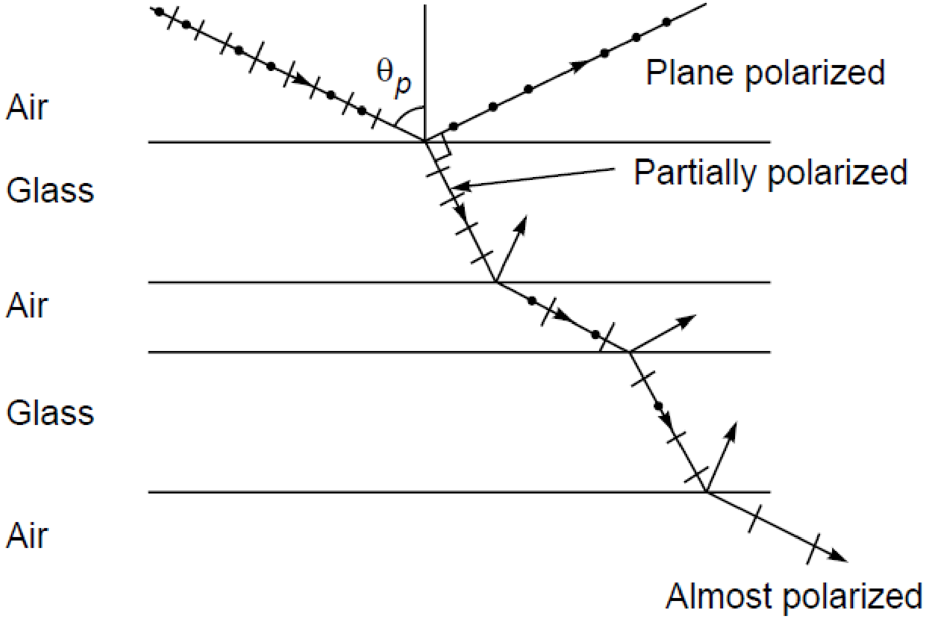



**Fig. 1.** The crystal structure of herapathite. Iodine atoms are purple spheres. The absorbing axis is vertical. Solvent molecules and sulfate ions have been removed for clarity. See also figs. S2 and S3.




$$\boxed{\theta = \theta_p = \tan^{-1}\left(\frac{n_2}{n_1}\right)}$$

*Brewster's law*

Optics, Ghatak

# Problem:1

What will be the Brewster angle for a glass slab immersed in water?

# Answer:

The expression for the Brewster's angle is,

$$\theta_p = \tan^{-1}\left(\frac{n_2}{n_1}\right)$$

Substitute $\frac{4}{3}$ for $n_1$ and 1.5 for $n_2$ .

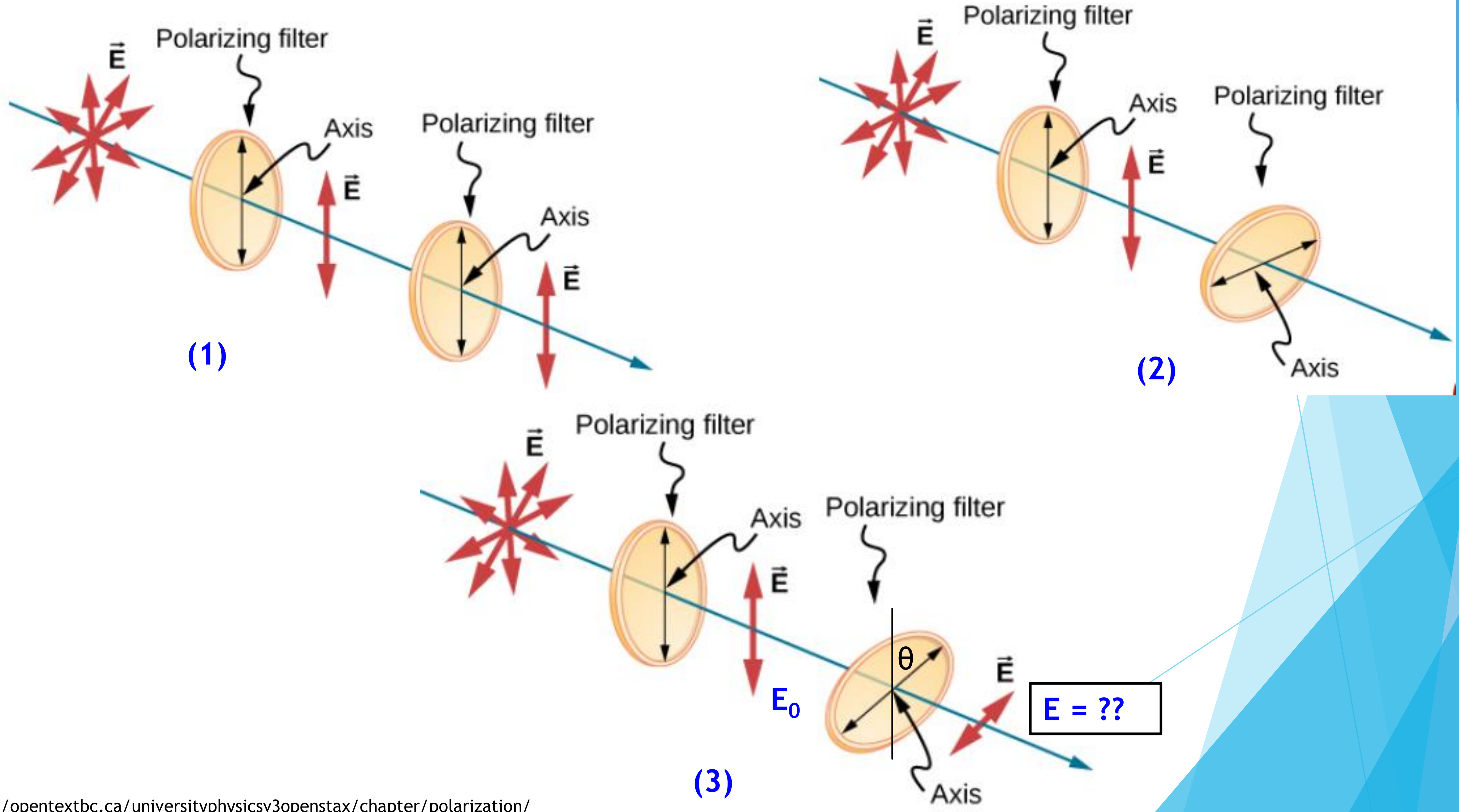
$$\theta_p = \tan^{-1}\left(\frac{1.5}{\left(\frac{4}{3}\right)}\right)$$

$$= \tan^{-1}(1.125)$$

$$= 48.4^\circ$$

Hence, the Brewster's angle is $\boxed{48.4^\circ}$ .

# Polarization of light




https://opentextbc.ca/universityphysicsv3openstax/chapter/polarization/

# Malus' Law

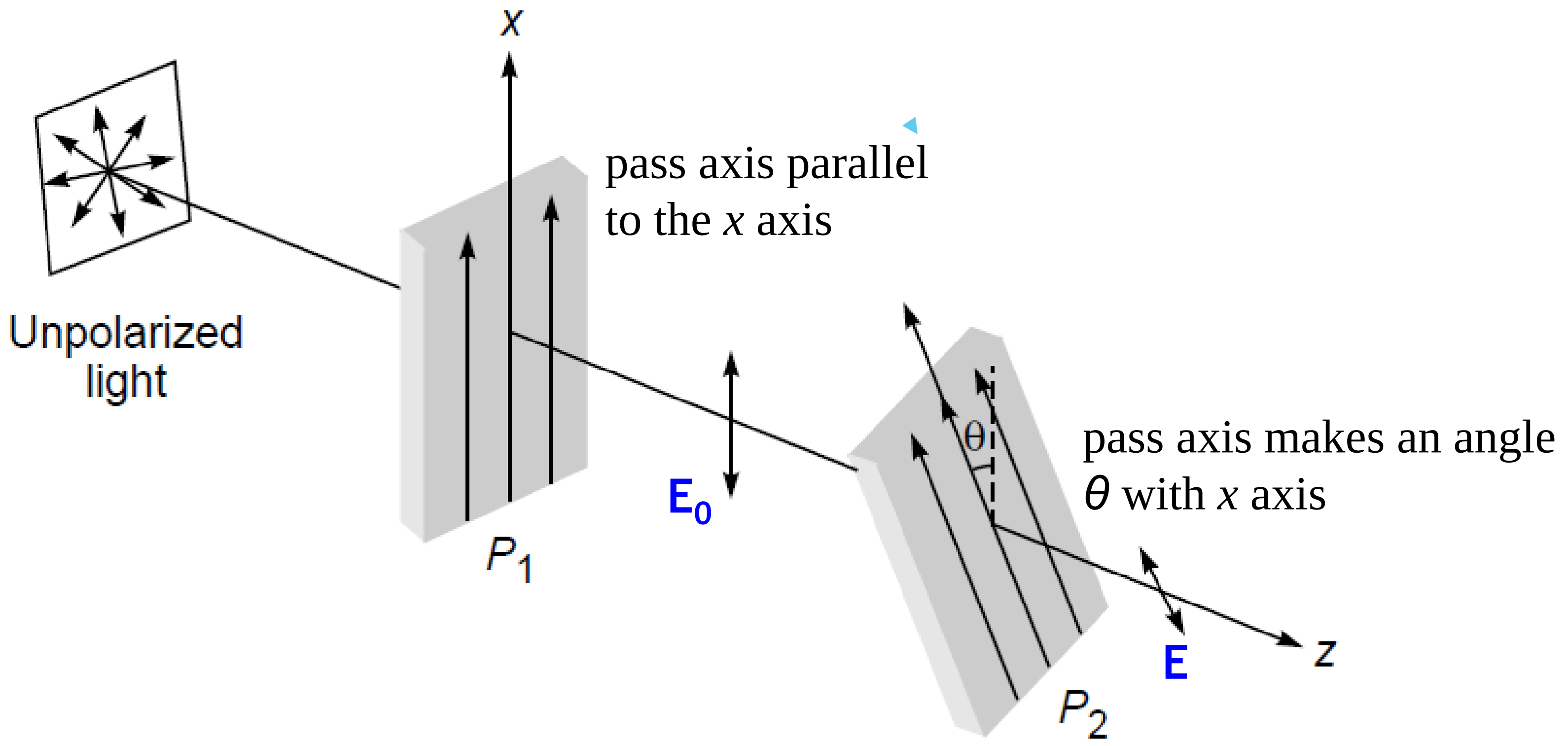



**Fig. 22.15** An unpolarized light beam gets $x$-polarized after passing through the polaroid $P_1$, the pass axis of the second polaroid $P_2$ makes an angle $\theta$ with the $x$ axis. The intensity of the emerging beam will vary as $\cos^2\theta$.

**Amplitude**

**$E = E_0 \cos\theta$**

**Intensity**

$$\boxed{I = I_0 \cos^2\theta}$$

**Malus' Law**

Optics, Ghatak

# Problem:2

The electric field of a 1000 W/m$^2$ linearly polarized lightbeam oscillates at $+10.0°$ from the vertical in the first and third quadrants. The beam passes perpendicularly through two consecutive ideal linear polarizers. The transmission axis of the first is at $-80.0°$ from the vertical in the second and fourth quadrants. And that of the second is at $+55.0°$ from the vertical in the first and third quadrants. (a) How much light emerges from the second polarizer? (b) Now interchange the two polarizers without altering their orientations and determine the amount of light that emerges. Explain your answers.

# Answer:

(a) The incident light (at $+10°$) is perpendicular to the transmission axis of the first polarizer (at $-80°$) and so no light leaves it and no light leaves the second polarizer. (b) With the polarizers interchanged, the light now oscillates at $45.0°$ to the transmission axis of the first polarizer, which, via Malus's Law, passes ($I_1$) where

$$I(\theta) = I(0)\cos^2\theta$$

and so here

$$I_1 = (1000\ \mathrm{W/m^2})\cos^2 45.0°$$

Hence

$$I_1 = 500\ \mathrm{W/m^2}$$

This light, oscillating at $+55.0°$, makes an angle of $45.0°$ with the transmission axis of the new second polarizer. Therefore the irradiance emerging from it ($I_2$) is

$$I_2 = (500\ \mathrm{W/m^2})\cos^2 45.0°$$

$$I_2 = 250\ \mathrm{W/m^2}$$

# Thank You