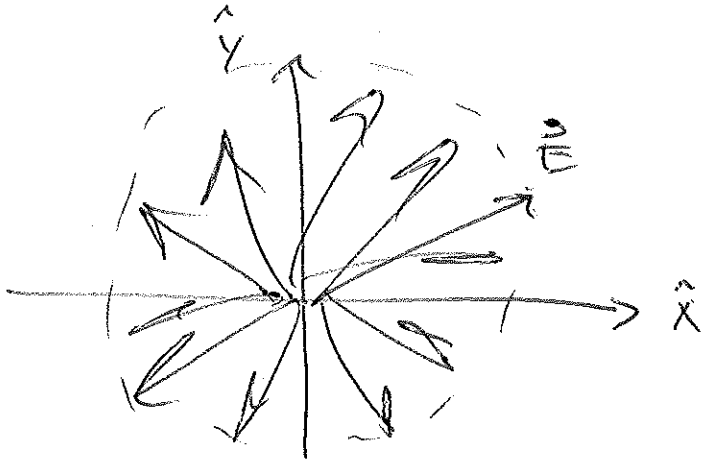
Linear Polarizer

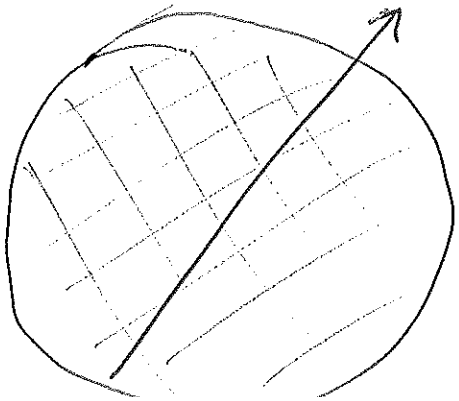
Typical sources of light (lightbulb, sun, candle) produce unpolarized light. The $\vec{E}$ field vector varies randomly in direction transverse to the direction of propagation:

Plane wave traveling out of the page:

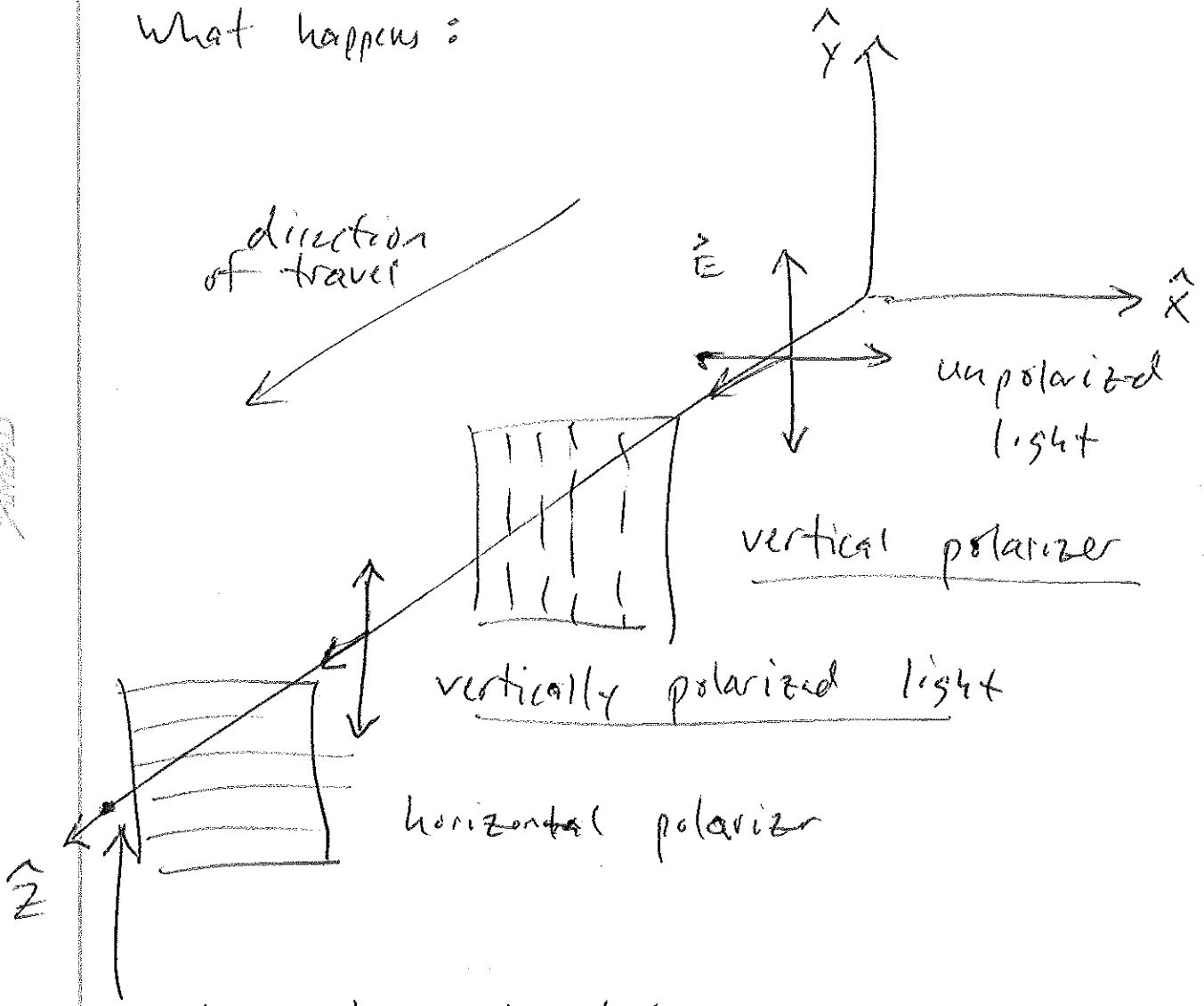


(traveling out).

A linear polarizer blocks all electric field components perpindicular to its transmission direction:



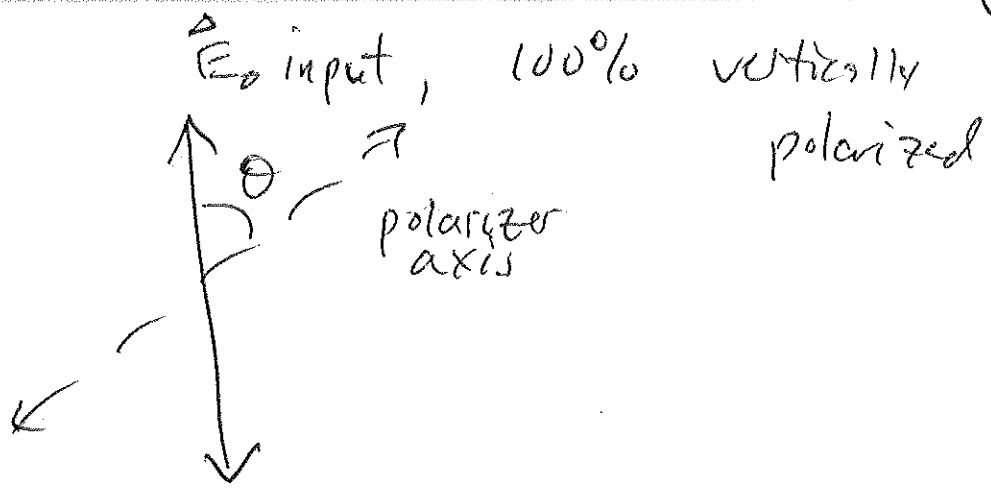
What happens:



no transmitted light!

How much light is passed?

Assume 100% Linearly polarized Light is input, and that the polarizer axis has an angle of θ compared to the polarization angle of the input light.



$$|\vec{E}_{transmitted}| = |\vec{E}_0| \cos\theta$$ (because of vector projection.

$$\text{Intensity transmitted} \sim |\vec{E}_{transmitted}|^2$$

$$I_{trans} \sim |\vec{E}_0|^2 \cos^2\theta$$

$$\boxed{I_{trans} = I_0 \cos^2\theta}$$ Malus' Law.

Question: In the lab the polarization axis of the polarizer is unmarked.

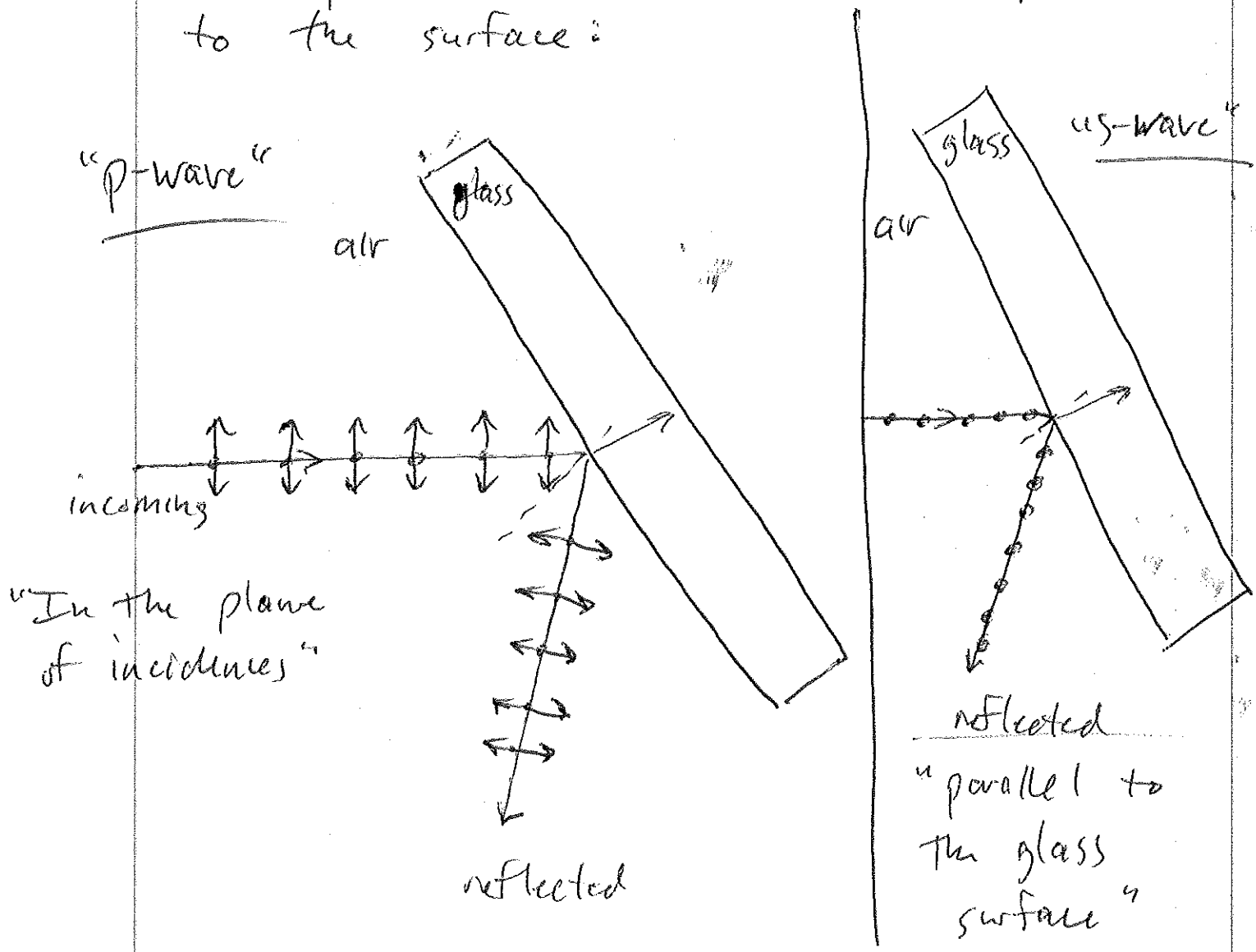
How can we determine the direction of a polarizer if the axis is unmarked?

Answer: You need a source of light which is at least partially polarized, and whose polarization axis is already known to you.

Polarization of Reflected Light : Brewster's Angle

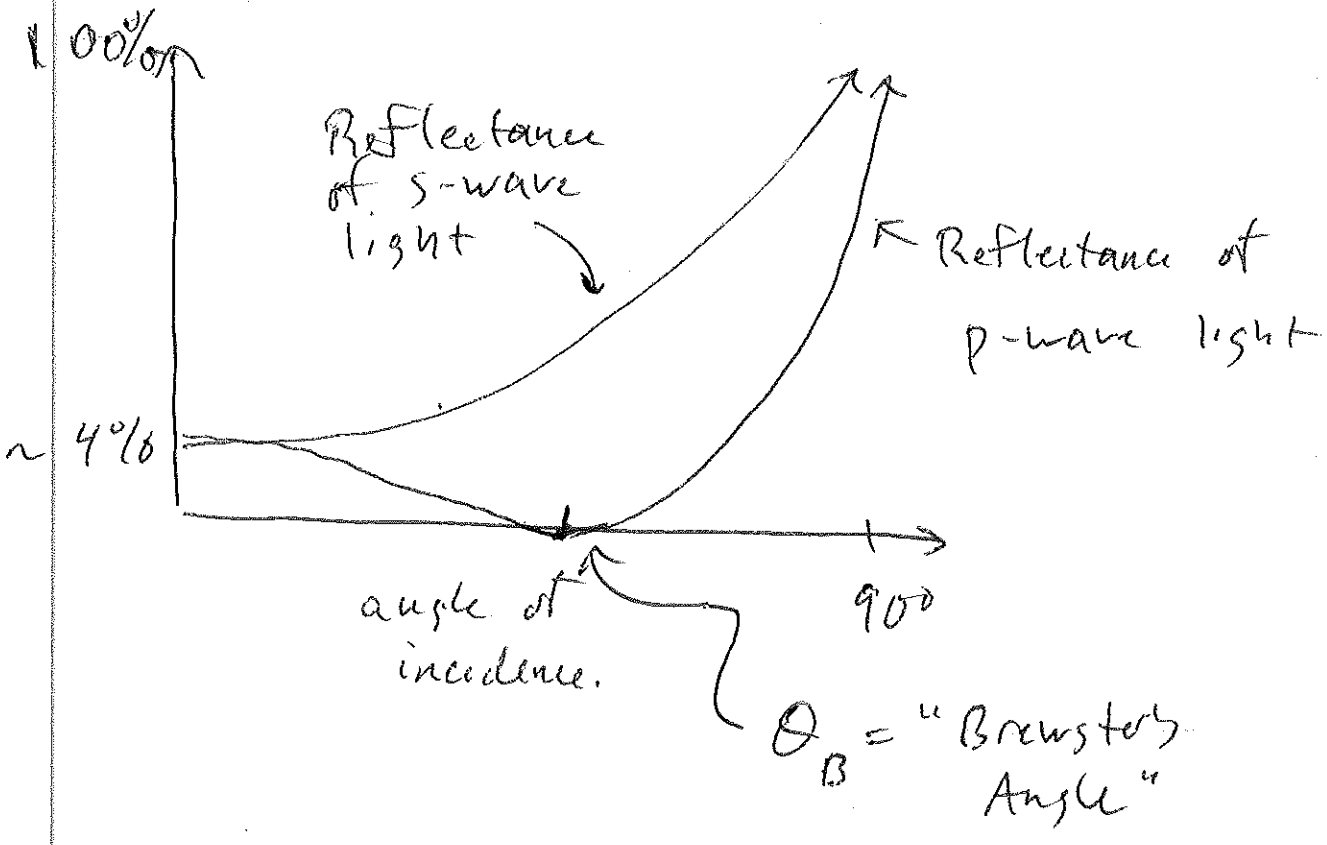
In general, whenever light is reflected from a surface, its polarization is altered in some way.

To study this, we must define the two polarization directions with respect to the surface:



Reflectance as a function of angle of incidence

Described by the Fresnel Equations. For a smooth dielectric surface like glass, it looks like this:



⇒ At Brewster's Angle, no p-wave light will reflect.

⇒ When angle of incidence = θ_B, p-wave reflectance is zero.

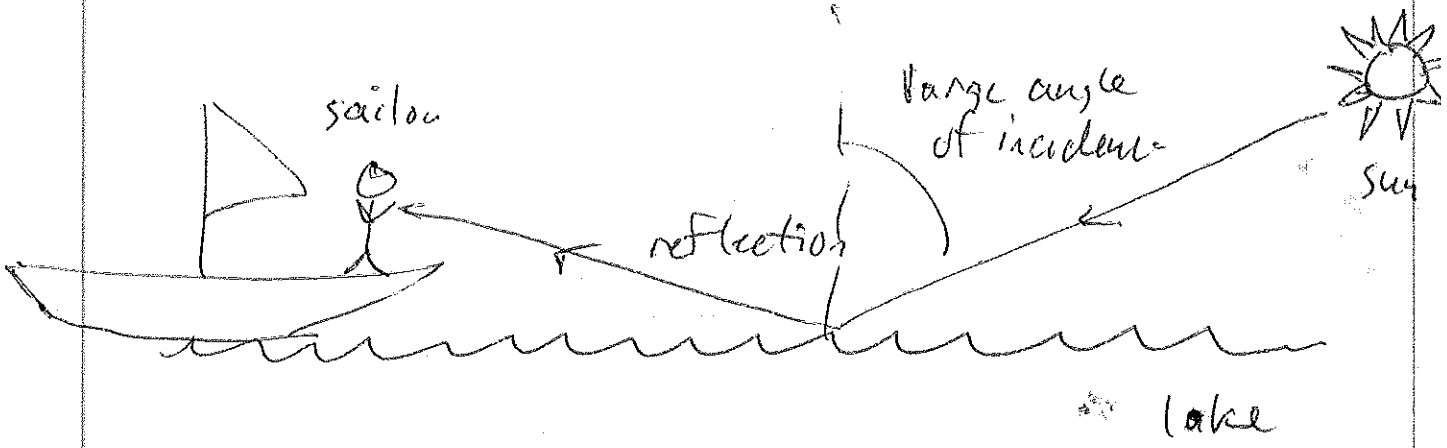
Question:
What determines the value of Brewsters Angle?

Answer: The ratio of the indices of refraction:

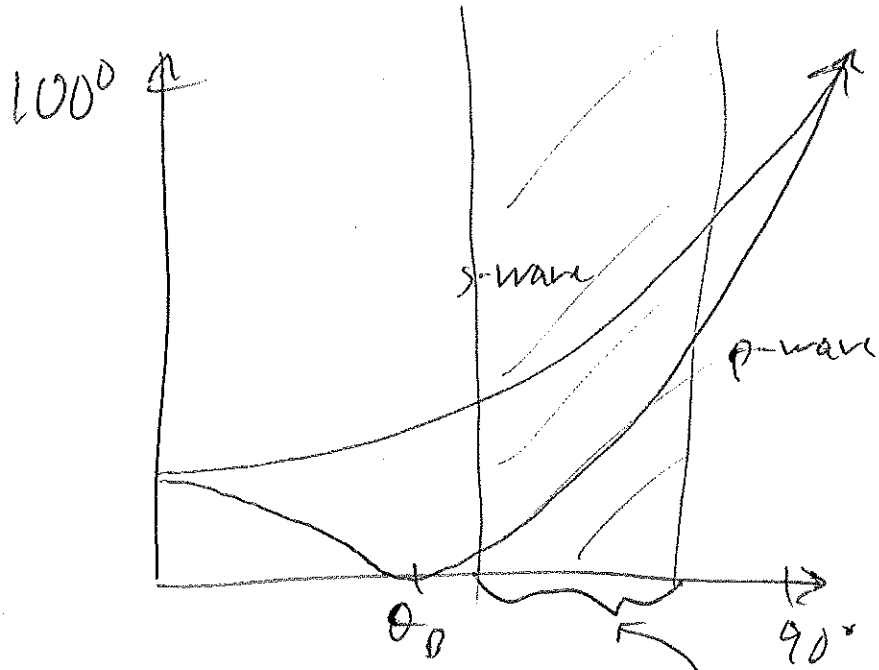
$$\tan \theta_B = \frac{n_2}{n_1}$$

Consequence: by measuring Brewsters angle in the lab, we can measure the index of refraction.

Glare: Glare is a reflection that happens at large angles of incidence.



Recall how reflection affects the polarization



Reflected light is enriched in s-wave light, depleted in p-wave light.

Question:

How can you use this fact to determine the polarization axis of a mystery polarizer?