



### Problem P8.4

The gas laser depicted in Fig. 2 uses “Brewster angle” quartz windows on the gas discharge tube in order to minimize reflection losses. Determine the angle  $\theta$  if the index of refraction for quartz at the wavelength of interest is  $n = 1.46$ . Because of these windows, the laser output is almost completely linearly polarized. What is the direction of polarization, i.e., is  $\vec{E}$  parallel or perpendicular to the paper? Why?

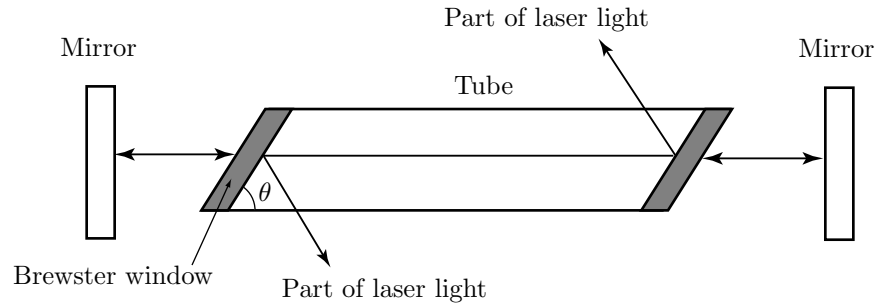


Fig. 2. A gas laser with Brewster windows.

### Problem P8.5

Consider a plane wave incident from a dielectric region with permittivity  $\epsilon = 3\epsilon_o$  upon a halfspace with  $\epsilon = \epsilon_o$  as shown in Fig. 3.

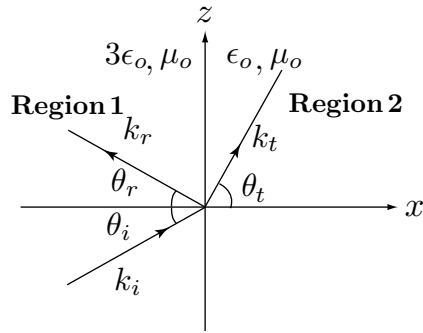


Fig. 3.

- Find the Brewster angle for Region 1.
- Suppose the transmitted electric field is given by

$$\vec{E}_t = \hat{y} \frac{E_0}{\sqrt{2}} e^{ik_{tx}x + ik_{tz}z} + E_0 \frac{\hat{z} - \hat{x}\sqrt{3}}{2\sqrt{2}} e^{ik_{tx}x + ik_{tz}z - i\frac{\pi}{2}}$$

- Determine the incident and transmitted angles,  $\theta_i$  and  $\theta_t$ .
  - What is the polarization of the transmitted field? Be sure to specify the handedness (left or right) if necessary.
  - What is the polarization of the reflected wave? Be sure to specify the handedness (left or right) if necessary.
  - Give an expression for the incident electric field,  $\vec{E}_i$ , and the reflected electric field,  $\vec{E}_r$ .
- (c) For this part, assume that the incident wave is a TE wave with magnitude,  $|\vec{E}| = E_0$  and  $\theta_i = \theta_c$  where  $\theta_c$  is the critical angle.
- Find the Goos-Hänchen phase shift of the reflected wave.
  - Make a sketch of the electric field amplitude,  $E_y$ , for  $x > 0$ .