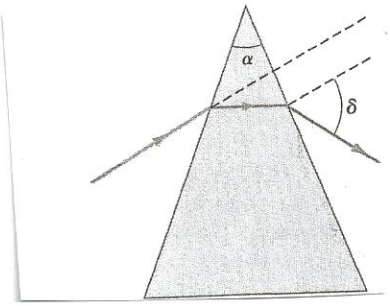
4C Problem set 7 – The Nature and Propagation of Light

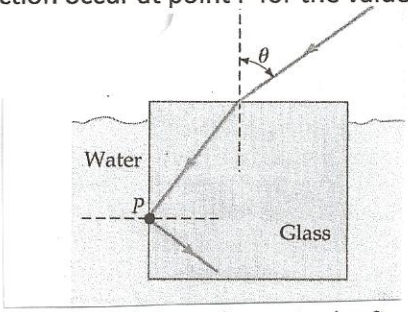
1. Show that a light ray transmitted through a glass slab emerges parallel to the incident ray but displaced from it. For an incident angle of 60°, glass of index of refraction n = 1.5 and a slab thickness of 10cm, find the displacement measured perpendicularly from the incident ray.

2. Light passes symmetrically through a prism having an apex angle of α as shown. Show that the angle of deviation δ is given by: $sin\frac{\alpha+\delta}{2} = n\, sin\frac{\alpha}{2}$

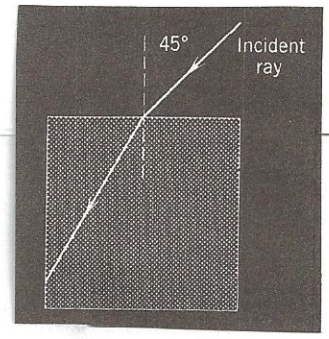


3. For a light ray inside a transparent medium having a planar interface with a vacuum, show that the polarizing angle and the critical angle for internal reflection satisfy $tan\theta_p = sin\theta_c$

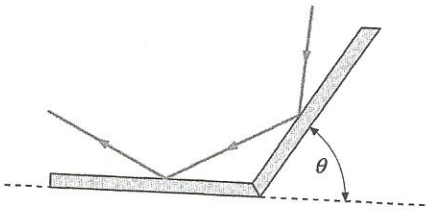
4. A ray of light falls on a rectangular glass block (n = 1.5) that is almost completely submerged in water (n = 1.33) as shown. (a) Find the angle θ for which total internal reflection just occurs at point P. (b) Would total internal reflection occur at point P for the value of θ found in part (a) if the water were removed? Explain.



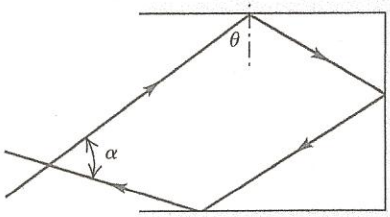
5. A light ray falls on a square glass slab as shown in the figure. What must the index of refraction of the glass be if total internal reflection occurs at the vertical face?



6 Two plane mirrors make an angle θ with one another as shown. Show that the angle between the incident and reflected rays is 2θ.



7. Three plane mirrors intersect at right angles as shown. A laser beam strikes the first surface at an angle θ. Show that when this ray is reflected off of the other two mirrors and crosses the original ray, the angle α between the two rays will be $\alpha = \pi - 2\theta$.



8. A swimmer at the bottom of a pool 3m deep looks up and sees a circle of light. If the index of refraction of the water in the pool is 1.33, find the radius of the circle.

9. Light is initially in a medium (such as air) with an index of refraction n_1. It is incident at angle θ_1 on the surface of a liquid (such as water) of index of refraction n_2. The light passes through the layer of water and enters glass of index of refraction n_3. If θ_3 is the index of refraction in the class, show that $n_1 \sin\theta_1 = n_3 \sin\theta_3$. That is, show that the second medium can be neglected when finding the angle of refraction in the third medium.