

SIMG-712-01-20042      Homework #4  
Due W, 1/12/2005

1. Consider a planar glass plate (i.e., the faces of the plate are parallel) of index  $n$  immersed in air
  - (a) Show that a ray incident at angle  $\theta$  to the surface will emerge from the plate at the same angle.
  - (b) If the thickness of the plate is  $d$  units, derive an expression for the physical displacement  $a$  of the emerging ray relative to the original ray as a function of the incident angle.
2. A thin lens is made of glass with index  $n = 1.53$ . In air, the lens has a focal length  $f = 254$  mm. What is its focal length when it is totally immersed in water ( $n = 1.33$ )?
3. A convex thin lens with focal length  $f_1 = 300$  mm and a concave thin lens with focal length  $f_2 = -200$  mm are placed in contact.
  - (a) Determine the focal length of the system.
  - (b) Locate the principal points and focal points.
  - (c) Characterize the image formed by this system of an object located  $s_1 = 400$  mm away.
4. A system consists of two thin lenses  $L_1$  ( $f_1 = -60$  mm) and  $L_2$  ( $f_2 = ?$ ) separated by  $t = 120$  mm. Lens  $L_2$  is made of glass with  $n = 1.5$  and is plano-convex; the radius of the curved side is  $R = 60$  mm.
  - (a) Locate and describe the image of an object that is 5 mm high located 180 mm "in front" of the first lens.
  - (b) Determine the focal length of the system and find the focal points and principal points.
5. Two thin lenses having focal lengths  $f_1 = +150$  mm and  $f_2 = -150$  mm are separated by  $t = 600$  mm.
  - (a) A page of print is held 250 mm in front of the positive lens. For paraxial rays, determine the location, orientation, and magnification of the image of the print.
  - (b) Determine the focal length of the system and find the focal points and principal points.
6. The images generated by a biconvex lens in air from objects at  $s_1 = \infty$  and  $s_1 = 200$  mm are located 8 mm apart. Determine the focal length of the lens.

MORE→→→

7. Three lenses with focal lengths  $f_1 = +100$  mm,  $f_2 = -100$  mm, and  $f_3 = +100$  mm are placed in that order and each is separated from the next by  $t_n = 20$  mm.
- (a) Determine the focal length of the system.
  - (b) Locate the principal and focal points.
8. A gypsy has a crystal ball, of index of refraction  $n = 1.6$  and diameter 200 mm that may be used as a lens. Locate the principal and focal points.
9. The surfaces of a thin equiconvex lens have equal radius of curvature:  $|R_1| = 150$  mm. The second surface is aluminized to reflect light. Find the location of the image of an object located 400 mm to the left of the first surface.