Physics 233 – General Physics 3 Homework for Unit O

One per lab section due by e-mail on Friday, November 13th at 4 pm. Also, each group should review lab 1 and make sure they have all the right answers.

Problems

1. A luminous point is moving at speed v_0 toward a spherical mirror with radius of curvature r, along the central axis of the mirror. Assume that the mirror is concave, with r = 15 cm, and let v_0 = 5.0 cm/s.
    a. Show that the image of this point is moving at speed $v_1 = -\frac{r^2}{(2p-r)^2} v_0$, where p is the distance of the luminous point from the mirror at any given time.
    b. Find the speed of the image when p = 30 cm (far outside the focal point).
    c. Find the speed of the image when p = 8.0 cm (very near the mirror).
2. (17 from lab 1) Parallel light from a distant object strikes a large, concave, spherical mirror with radius 5 m and is reflected by a small mirror that is 2 m from the large mirror (measured along the axis of the spherical mirror). The small mirror is also spherical. The light is focused on the vertex of the large mirror.
    a. What is the radius of curvature of the small mirror?
    b. Is it convex or concave?
3. What is meant by a negative object distance? How can it occur? Find the image distance and magnification and state whether the image is virtual or real and erect of inverted for a thin lens in air when s = -20 cm, f = +20 cm and s = -10 cm, f = -30 cm. Draw a ray diagram for each of these cases.
4. A praying mantis preys along the central axis of a thin symmetric lens, 20 cm from the lens. The magnification of the mantis provided by the lens is -0.25, and the index of refraction of the lens material is 1.65.
    a. Determine the type of image produced by the lens; the type of lens; whether the object (mantis) is inside or outside the focal point; on which side of the lens the image appears; and whether the image is inverted.
    b. What are the two radii of curvature of the lens?
5. An object is 15 cm in front of a positive lens of focal length 15 cm. A second positive lens of focal length 15 cm is 20 cm from the first lens. Find the final image and draw a ray diagram.
6. A disadvantage of the astronomical telescope for terrestrial use is that the image is inverted. A Galilean telescope uses a converging lens as its objective, but a diverging lens as its eyepiece. The image formed by the objective is behind the eyepiece at its focal point so that the final image is virtual, erect, and at infinity.
    a. Show that the magnifying power is $M = -f_0/f_e$, where f_0 is the focal length of the objective and f_e is that of the eyepiece (Which is negative).
    b. Draw a ray diagram to show that the final image is indeed virtual, erect, and at infinity.
7. Excercises 6.2, 7.1, 7.2, and 7.3 from lab manual.