Exercises for Experimental Physics 3 – IPSP

Prof. Dr. J. Käs, Dr. M. Zink

Exercise Sheet 9 (WS 2010/11)

Date of Issue to Students: Dec. 9th 2010

Date of Submission: Jan. 6th 2011

Submission Place: Marked mailbox next to room 302 (Linnestr. 5)
Submission Time: 11:00 a.m. at the submission day noted above

Please note: Write your name and matriculation number on EACH sheet of paper.
Only submit the calculations and results for exercise 1-3, exercise 4 + 5 will be discussed
during the instruction classes.

Exercises:

1. Convex mirrors are used in many stores to provide a wide angle of surveillance for a reasonable mirror size. Your summer job is at a local convenience store that uses the mirror shown in Figure 1. This setup allows you (or the clerk) to survey the entire store when you are 5.0 m from the mirror. The mirror has a radius of curvature equal to 1.2 m. Assume all rays are paraxial. (a) If a customer is 10 m from the mirror, how far from the mirror is his image? (b) Is the image in front of or behind the mirror? (c) If the customer is 2.0 m tall, how tall is his image? (5 Points)

2. Two light rays parallel to the optic axis of a concave mirror strike that mirror as shown in Figure 2. This mirror has a radius of curvature equal to 5.0 m. They then strike a small spherical mirror that is 2.0 m from the large mirror. The light rays finally meet at the vertex of the large mirror. Note: The small mirror is shown as planar, so as not to give away the answer, but it is not actually planar. (a) What is the radius of curvature of the small mirror? (b) Is that mirror convex or concave? Explain your answer. (5 Points)

3. The following thin lenses are made of glass that has an index of refraction equal to 1.60. Make a sketch of each lens and find each focal length in air: (a) $r_1 = 20.0$ cm and $r_2 = 10.0$ cm, (b) $r_1 = 10.0$ cm and $r_2 = 20.0$ cm, and (c) $r_1 = -10.0$ cm and $r_2 = -20.0$ cm. (5 Points)

4. A very long 1.75-cm-diameter glass rod has one end ground and polished to a convex spherical surface that has a 7.20-cm radius. The glass material has an index of refraction of 1.68. (a) A point object in air is on the axis of the rod and 30.0 cm from the spherical surface. Find the location of the image and state whether the image is real or virtual. (b) Repeat Part (a) for a point object in air, on the axis, and 5.00 cm from the spherical surface. Draw a ray diagram for each case.

5. An object is 17.5 cm to the left of a lens that has a focal length of +8.50 cm. A second lens, which has a focal length of -30.0 cm, is 5.00 cm to the right of the first lens. (a) Find the distance between the object and the final image formed by the second lens. (b) What is the overall magnification? (c) Is the final image real or virtual? Is the final image upright or inverted?
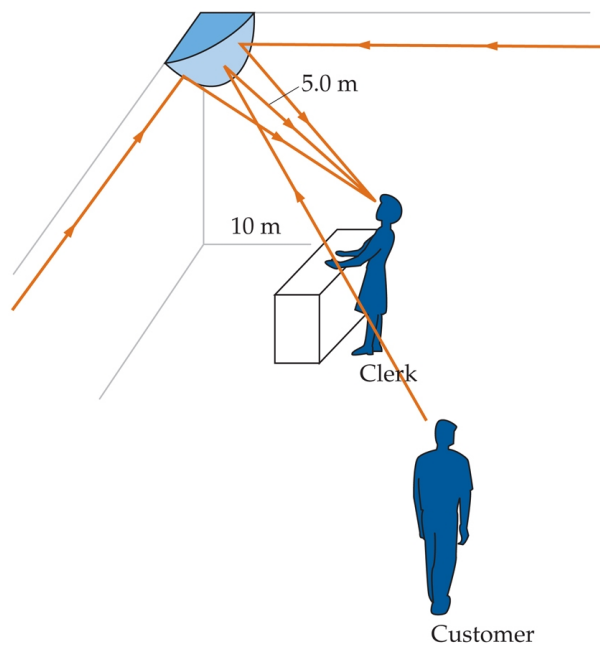
5.0 m

10 m

Clerk

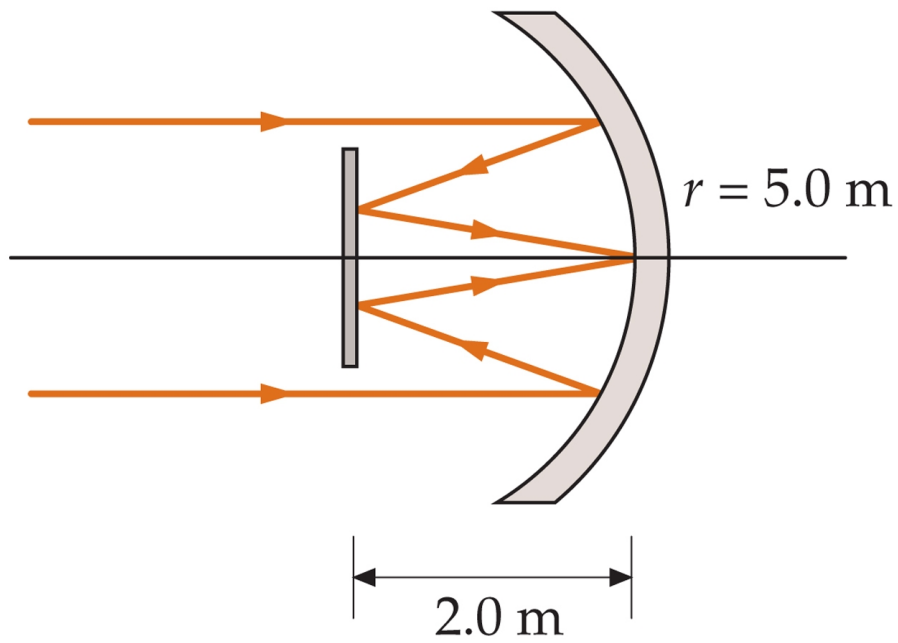Customer

Figure 1: Exercise 1

$r = 5.0$ m

2.0 m

Figure 2: Exercise 2