Answer on Question #47618-Physics-Optics

1. The left end of a long glass rod 5.00 cm in diameter has a convex hemispherical surface $r = 2.50cm$ in radius. A glass rod ($n_2 = 1.6$) is immersed in oil ($n_1 = 1.45$) an object placed to the left on the rod's axis is to be imaged $s' = 1.20\ m$ inside the rod. How far from the left end of the rod must the object be located to form the image?

2. Determine distance and height of the image formed when an object of height $h_1 = 20cm$ and a distance of $s_1 = 20cm$ is placed in front of a concave surface with $n_2 = 1.45$ that has a $r = 7.20cm$ radius. (note: use $n_1 = 1.00029$)?

Solution

1. Use the equation for refraction at a single surface to relate the image and object distances:
$$\frac{n_1}{s} + \frac{n_2}{s'} = \frac{n_2 - n_1}{r}.$$
Solving for s yields:
$$s = \frac{n_1}{\frac{n_2 - n_1}{r} - \frac{n_2}{s'}} = \frac{1.45}{\frac{1.6 - 1.45}{0.025} - \frac{1.6}{1.20}} = 0.31\ m = 31\ cm.$$
2. Use the equation for refraction at a single surface to relate the image and object distances:
$$\frac{n_1}{s_1} + \frac{n_2}{s_2} = \frac{n_2 - n_1}{r}.$$
Solving for s_2 yields:
$$s_2 = \frac{n_2}{\frac{n_2 - n_1}{r} - \frac{n_1}{s_1}} = \frac{1.45}{\frac{1.45 - 1.00029}{-0.072} - \frac{1.00029}{0.2}} = -13\ cm.$$
where the minus sign tells us that the image is 13 cm in front of the surface and is virtual.
Find the magnification:
$$M = -\frac{s_2}{s_1} = -\frac{(-13\ cm)}{20cm} = 0.65.$$
The height of the image is
$$h_2 = Mh_1 = 0.65 \cdot 20cm = 13\ cm.$$