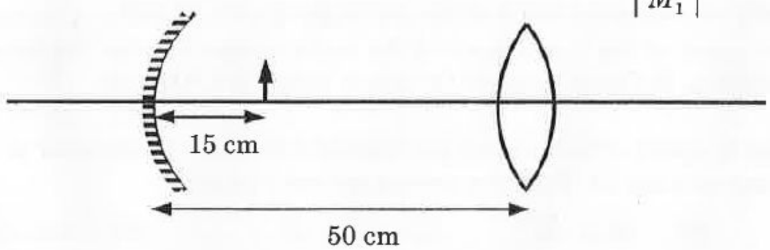
Consider a concave mirror and a convex lens (refractive index = 1.5) of focal length 10 cm each, separated by a distance of 50 cm in air (refractive index = 1) as shown in the figure. An object is placed at a distance of 15 cm from the mirror. Its erect image formed by this combination has magnification M_1. When the set-up is kept in a medium of refractive index 7/6, the magnification becomes M_2. The magnitude $\left|\frac{M_2}{M_1}\right|$ is



Solution

For mirror, $\frac{1}{v}+\frac{1}{15}=\frac{1}{10}$, $\therefore v=30$ cm

The image from the mirror located at 50 - 30 = 20 cm distance fro the lens acts as object for the lens.

For lens, $v_1 = 20$ cm as object is located at the centre of curvature of the lens.

Also for lens, $\frac{1}{f_1}\propto 1.5-1$ & $\frac{1}{f_2}\propto \frac{1.5}{7/6}-1$ $\left\{\because \frac{1}{f}=\left(\frac{\mu_{material}}{\mu_{medium}}-1\right)\left(\frac{1}{R}-\frac{1}{R'}\right)\right\}$

$\therefore \frac{f_2}{f_1}=\frac{0.5}{\frac{9}{7}-1}=\frac{7}{4}$, $\therefore f_2=\frac{7}{4}\times 10=\frac{35}{2}$ cm

Again for lens, $\frac{1}{v_2}-\frac{1}{-20}=\frac{1}{35/2}$

$\therefore v_2 = 140$ cm

Now, $\left|\frac{M_2}{M_1}\right|=\left|\frac{(m_{mirror}m_{lens})_2}{(m_{mirror}m_{lens})_1}\right|=\left|\frac{(m_{lens})_2}{(m_{lens})_1}\right|=\left|\frac{v_2/-20}{v_1/-20}\right|=\left|\frac{v_2}{v_1}\right|=\left|\frac{140}{20}\right|=7$