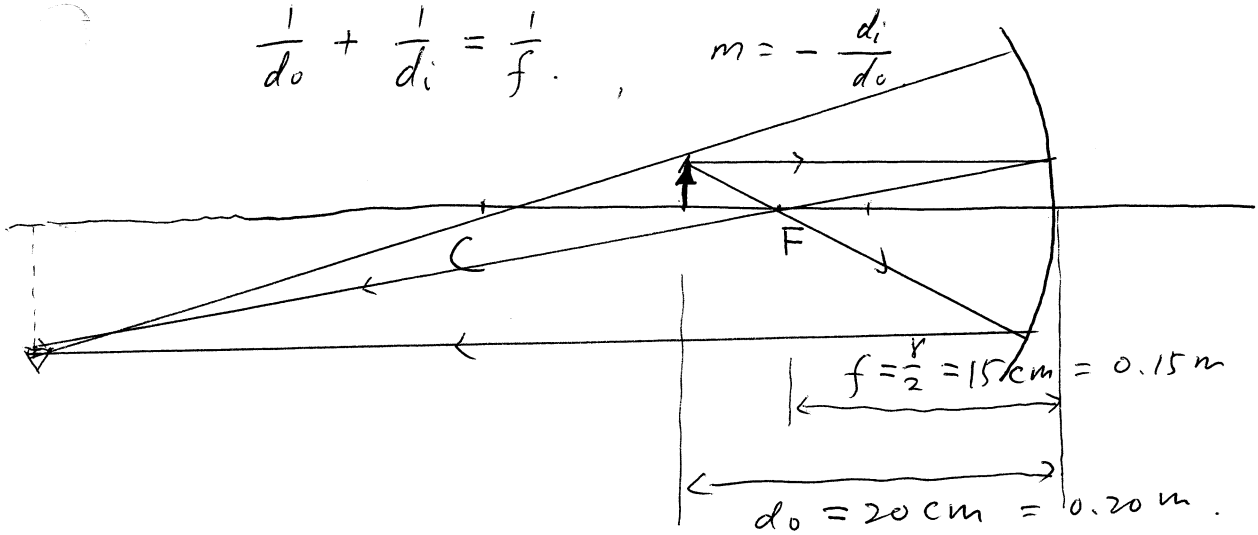
e.g. . Image in a concave mirror .

$\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f}$, $m = -\frac{d_i}{d_o}$



a) . $d_i = ?$

$$\frac{1}{d_i} = \frac{1}{f} - \frac{1}{d_o} = \frac{d_o - f}{f d_o}$$

$$d_i = \frac{f d_o}{d_o - f} = \frac{0.15 \times 0.2}{0.20 - 0.15} = \frac{0.03}{0.05} = 0.60\,m = 60\,cm .$$

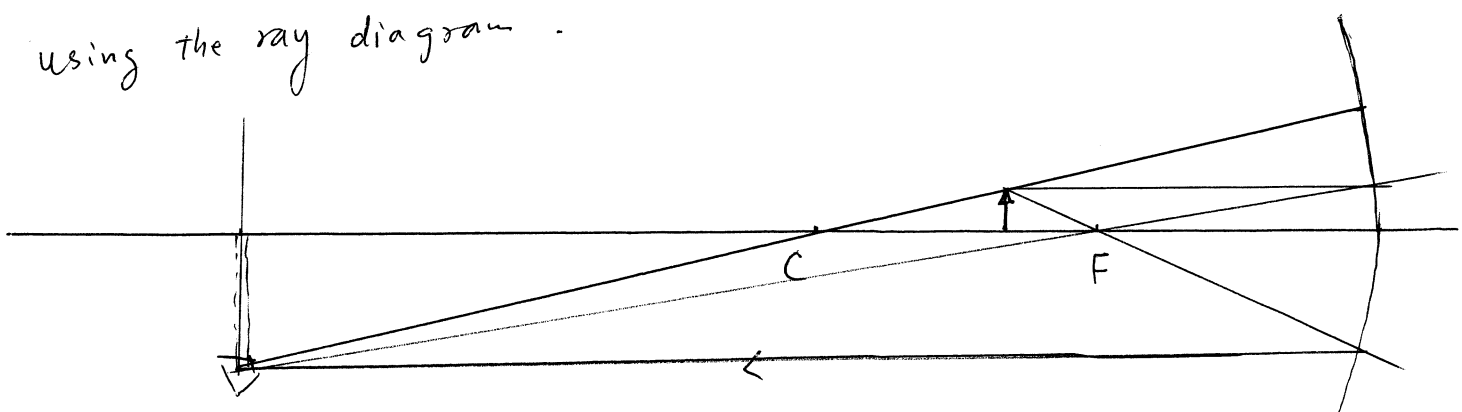
b) . $m = -\frac{d_i}{d_o} = -\frac{0.60}{0.20} = -3$. $\frac{h_i}{h_o} = m$.

$$h_i = m \cdot h_o = (-3) \times (0.015) = -0.045\,m = -4.5\,cm$$

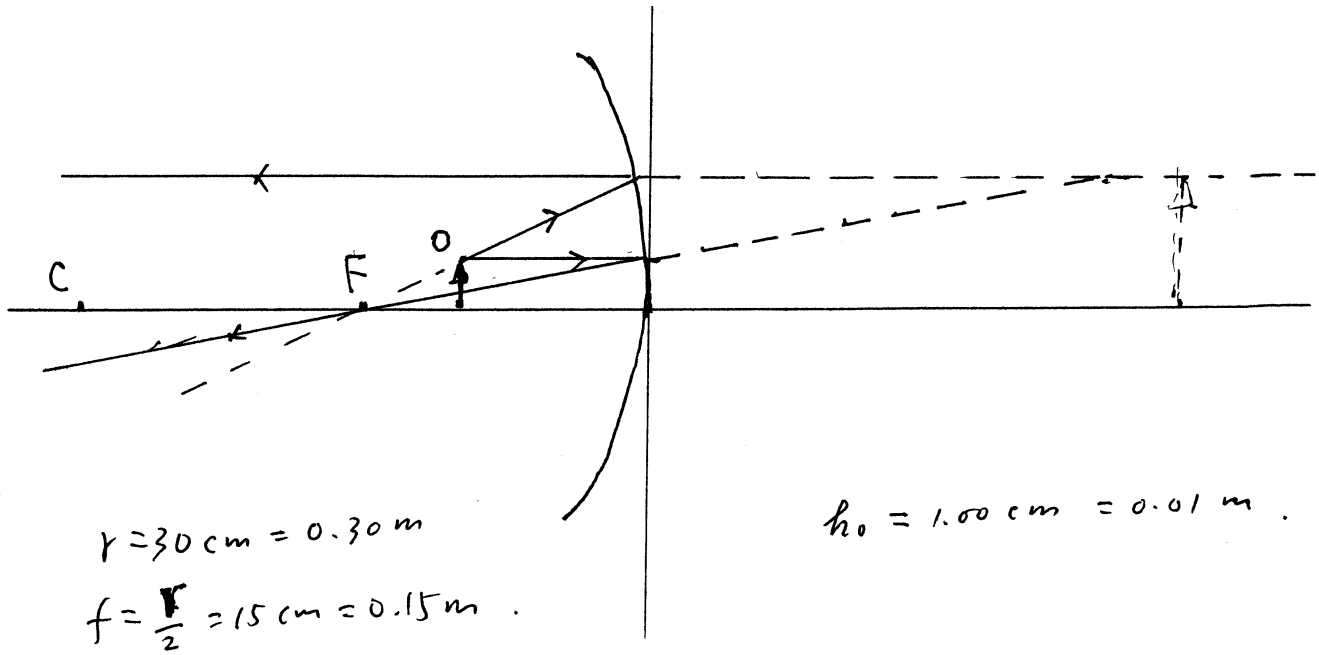
(inverted) .

check:

using the ray diagram .



e.g.



$r = 30\,cm = 0.30\,m$

$f = \frac{r}{2} = 15\,cm = 0.15\,m$.

$d_o = 10\,cm = 0.10\,m$.

$h_o = 1.00\,cm = 0.01\,m$.

~~use cm as length unit~~ : $\frac{1}{d_i} + \frac{1}{d_o} = \frac{1}{f}$

$$\frac{1}{d_i} = \frac{1}{f} - \frac{1}{d_o} = \frac{d_o - f}{f d_o} = \text{—}$$

$d_i = \frac{f - d_o}{d_o f}$

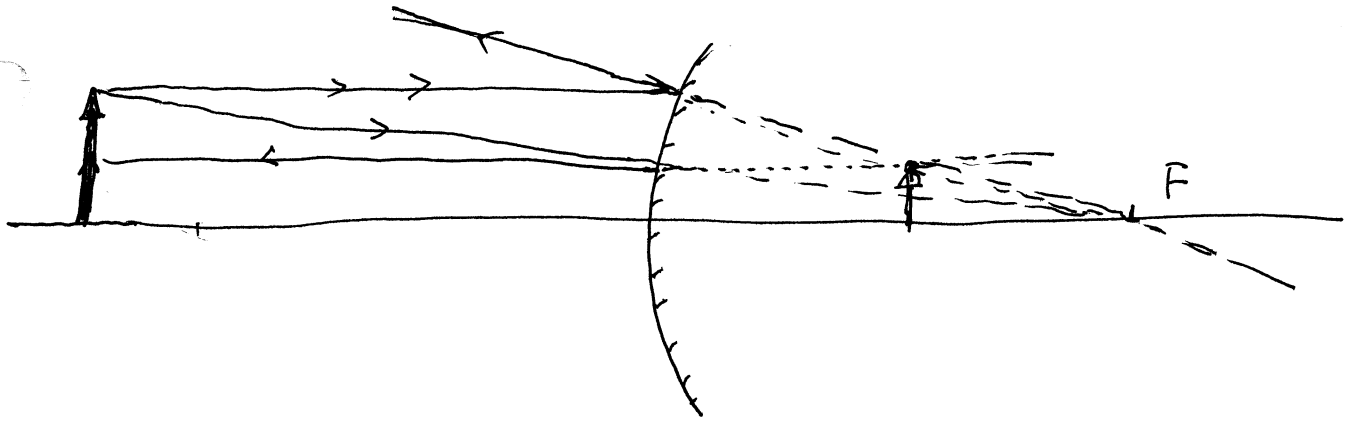
$$d_i = \frac{f d_o}{d_o - f} = \frac{0.15 \times 0.10}{0.10 - 0.15} = -0.30\,m = -30\,cm.$$

↑ "−": behind the mirror.

$$m = -\frac{d_i}{d_o} = -\frac{-0.30}{0.10} = 3.$$

+ : upright.

e.g. Convex rearview mirror



$r = -16.0$ m. ("$-$": Centre of curvature is behind the mirror)

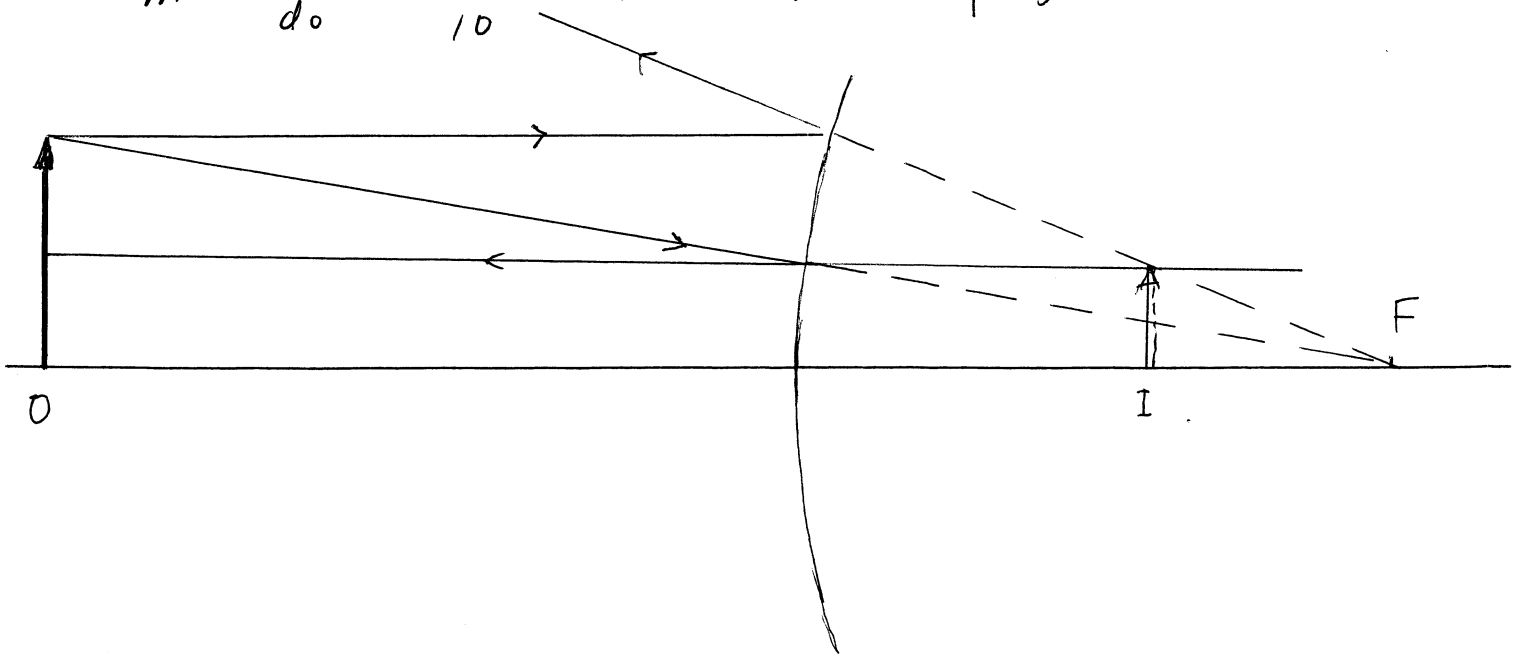
$f = \frac{r}{2} = -8.0$ m.

$d_o = 10$ m.

d_i: $\frac{1}{d_i} + \frac{1}{d_o} = \frac{1}{f}$, $\frac{1}{d_i} = \frac{d_o - f}{f d_o}$, $d_i = \frac{f d_o}{d_o - f}$

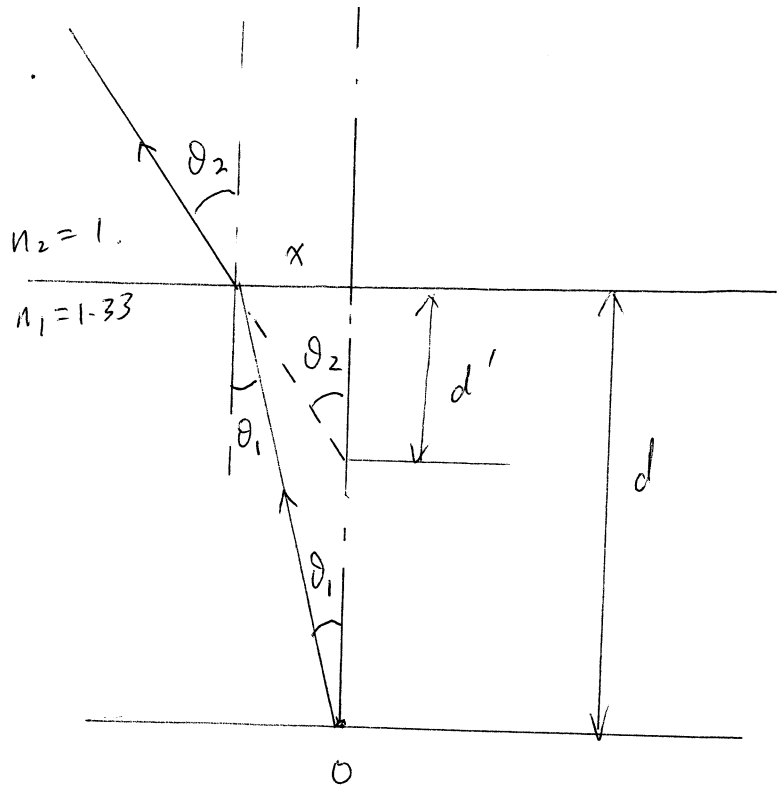
$$d_i = \frac{10 \times (-8.0)}{10 - (-8.0)} = \frac{-80}{18} = -4.4 \text{ m}.$$

$$m = -\frac{d_i}{d_o} = -\frac{(-4.4)}{10} = 0.44.$$ upright, smaller.



e.g.

Apparent depth of a pool.



$n_1 \sin\theta_1 = n_2 \sin\theta_2$

$n_1 \sin\theta_1 = \sin\theta_2$.

Small angle. $\sin\theta \approx \theta$.

$n_1 \theta_1 = \theta_2$.

$\frac{\theta_2}{\theta_1} = n_1 = n$.

$\frac{x}{d'} = \tan\theta_2 \approx \theta_2$

$\frac{x}{d} = \tan\theta_1 \approx \theta_1$.

$$\frac{\theta_2}{\theta_1} = n = \frac{\frac{x}{d'}}{\frac{x}{d}} = \frac{d}{d'}.$$

$$\therefore \quad d' = \frac{d}{n}.$$