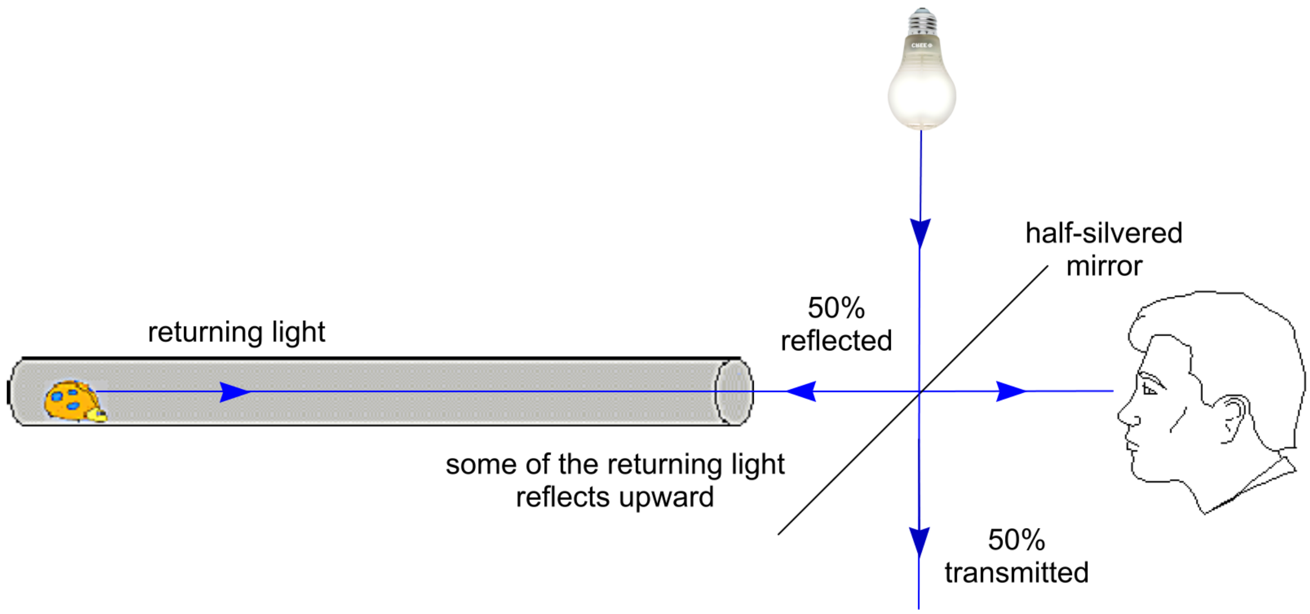
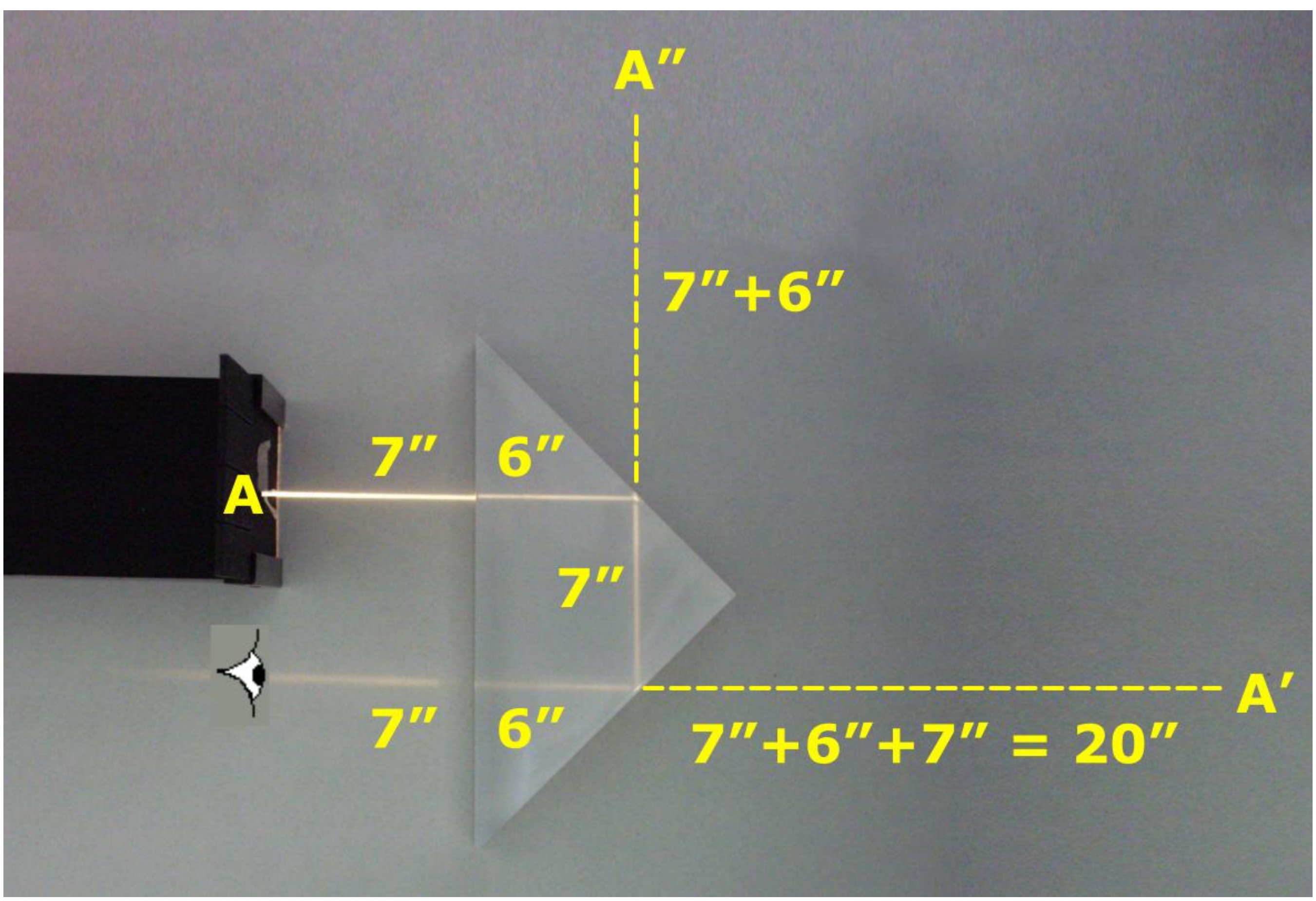


HW-D1. Half-Silvered Mirror.



HW-D2. Porro Prism.



HW-D3. Concave Mirror. (a) Math. Use mathematics to determine the distance s_o that an object needs to be placed in front of a concave mirror with focal length f so that the magnification is -3, i.e., 3 times as large but inverted. Also find the distance s_i that the image is from the mirror. (b) Ray Diagram.

$$M = -\frac{s_i}{s_o} = -3 \quad \text{and} \quad \frac{1}{f} = \frac{1}{s_o} + \frac{1}{s_i}$$

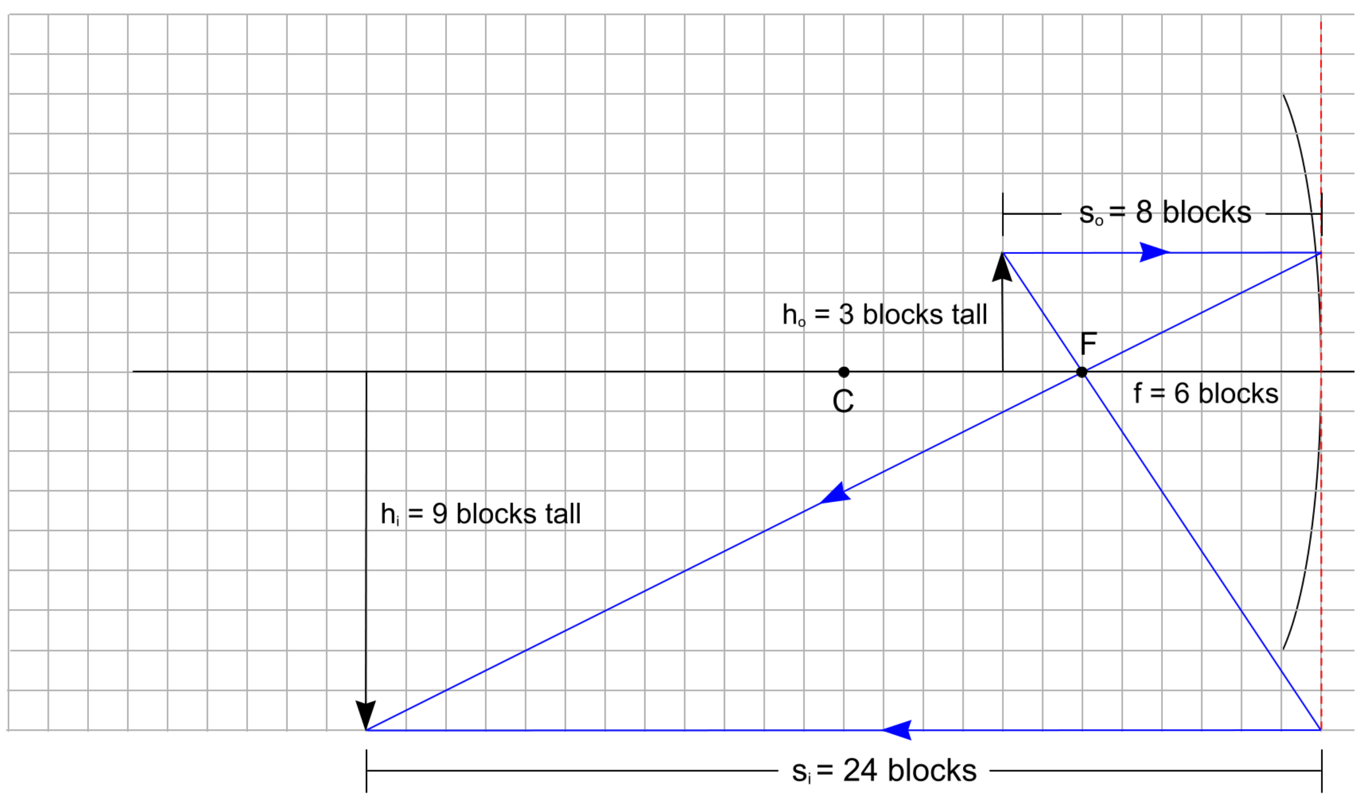
From the M equation $\frac{s_i}{s_o} = 3$, i.e., $s_i = 3s_o$.

Then $\frac{1}{f} = \frac{1}{s_o} + \frac{1}{s_i}$ becomes $\frac{1}{f} = \frac{1}{s_o} + \frac{1}{3s_o} = \left[1 + \frac{1}{3}\right]\frac{1}{s_o} = \frac{4}{3}\frac{1}{s_o}$ and $s_o = \frac{4}{3} f$.

Below I chose $f = 6 \text{ blocks}$ and $h_o = 3 \text{ blocks}$.

Then $s_o = \frac{4}{3} f = \frac{4}{3} \cdot 6 = 8 \text{ blocks}$ and $s_i = 3s_o = 24 \text{ blocks}$.

The ray diagram illustrates these values and the rays show that the image height is indeed triple: $h_i = 9 \text{ blocks}$.



HW-D4. Concave Mirror Engineering Design. Design a magnifying wall make-up mirror so that when an actor is 20 cm from the mirror, the magnification is 3x and upright.

a) Math. Use mathematics to determine the radius of curvature for the mirror.

$$M = -\frac{s_i}{s_o} = +3 \quad \text{and} \quad \frac{1}{f} = \frac{1}{s_o} + \frac{1}{s_i}$$

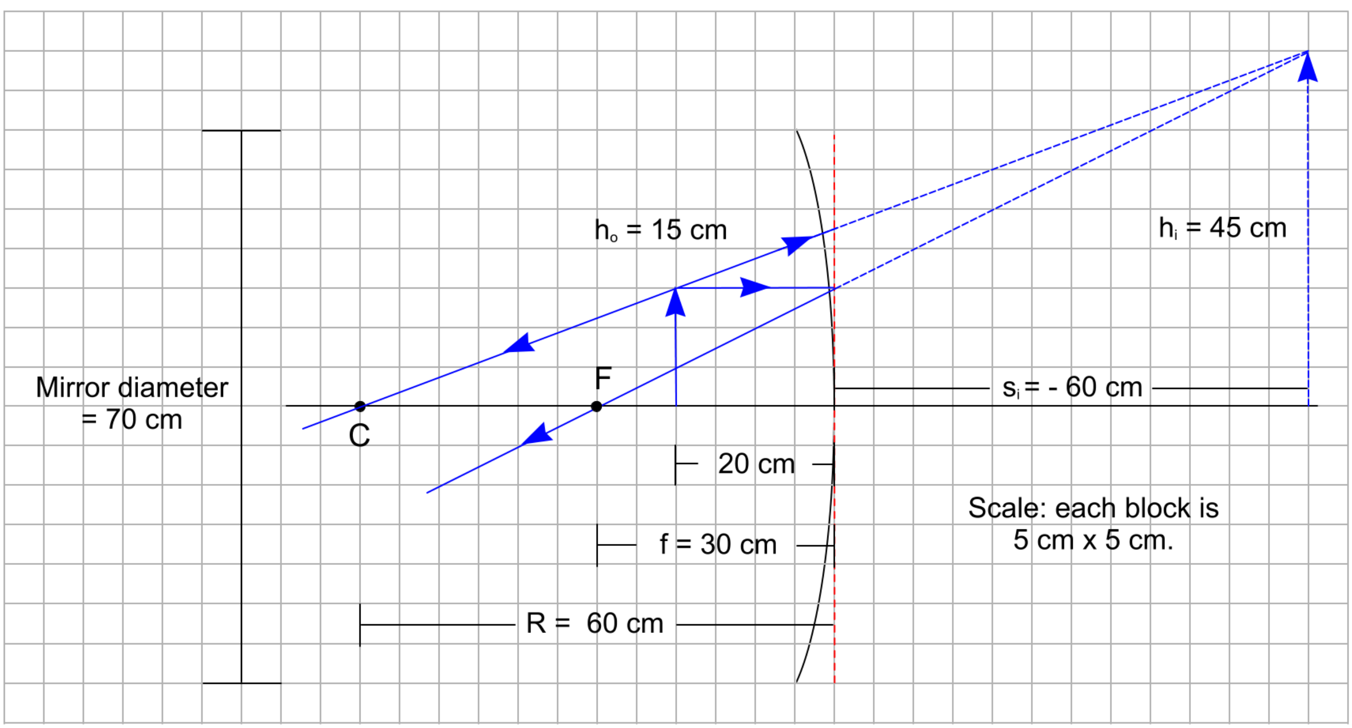
From the M equation $\frac{s_i}{s_o} = -3$, i.e., $s_i = -3s_o$.

Then $\frac{1}{f} = \frac{1}{s_o} + \frac{1}{s_i}$ becomes $\frac{1}{f} = \frac{1}{s_o} + \frac{1}{(-3s_o)} = \left[1 - \frac{1}{3}\right]\frac{1}{s_o} = \frac{2}{3}\frac{1}{s_o}$

and $f = \frac{3}{2}s_o = \frac{3}{2} \cdot 20 \text{ cm} = 30 \text{ cm}$.

Radius of curvature $R = 2f = 60 \text{ cm}$

b) Design Drawing.



HW-D5. Convex Mirror Engineering Design – Reverse Engineering.

Given:

$$s_o = 25 \text{ ft} \qquad h_o = 6 \text{ ft} \qquad M = \frac{1}{20}$$

$$M = -\frac{s_i}{s_o} = +\frac{1}{20} \qquad \text{and} \qquad \frac{1}{f} = \frac{1}{s_o} + \frac{1}{s_i}$$

From the M equation $\frac{s_i}{s_o} = -\frac{1}{20}$, i.e., $s_i = -\frac{s_o}{20}$.

$$\frac{1}{f} = \frac{1}{s_o} + \frac{1}{s_i} = \frac{1}{s_o} + \frac{1}{(-s_o/20)}$$

$$\frac{1}{f} = \frac{1}{s_o}\left[1-20\right] = -19\frac{1}{s_o}$$

$$f = -\frac{s_o}{19} = -\frac{25}{19} = -1.3 \text{ ft}$$

$$R = 2f = -2.6 \text{ ft}$$