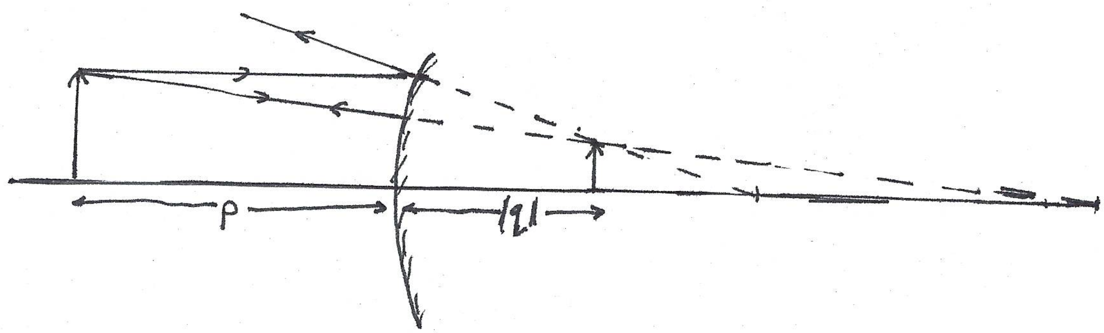
6. **[10pts]** The distance between an object and its upright image is 18.0 cm. If the magnification is 0.500,

(a) what kind of mirror is being used to form the image? [1 pt]

(b) what is the focal length of the mirror? [9 pts]

a) image is upright and smaller $\Rightarrow$ convex mirror.

b)



Let $d = 18.0\,\text{cm}$

then $p + |q| = 18.0\,\text{cm} = d$

$p - q = d$ (1) (q is a -ve #)

(image is virtual, light rays do not actually converge at the location of the image, rather, diverging rays reflected off the mirror appear to have come from the image)

$\frac{1}{2} = M = \frac{-q}{p}$ (2)

(1)/p : $1 - \frac{q}{p} = \frac{d}{p}$

using (2) :

$1 + M = \frac{d}{p}$

$p = \frac{d}{(1+M)}$

$= \frac{18.0}{(1+\frac{1}{2})}$

$p = 12\,\text{cm}$

$q = p - d$

$q = -6\,\text{cm}$

$\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$

$f = \frac{pq}{p+q}$

$= \frac{(12\,\text{cm})(-6\,\text{cm})}{(12\,\text{cm} - 6\,\text{cm})}$

$f = -12\,\text{cm}$

(-ve sign indicates convex mirror)

3. The magnification of the image formed by a refracting surface is given by

$$M = -\frac{n_1 q}{n_2 p}.$$

A paperweight is made of a solid glass hemisphere with index of refraction 1.50. The radius of the circular cross section is 4.00 cm. The hemisphere is placed on its flat surface, with the center directly over a 2.50-mm-long line drawn on a sheet of paper. What is the length of this line as seen by someone looking vertically down on the hemisphere?

Since the center of curvature of the surface is on the side the light comes from, $R < 0$ giving $R = -4.00$ cm. For the line, $p = 4.00$ cm; then,

$$\frac{n_1}{p} + \frac{n_2}{q} = \frac{n_2 - n_1}{R}$$

becomes

$$\frac{1.00}{q} = \frac{1.00 - 1.50}{-4.00 \text{ cm}} - \frac{1.50}{4.00 \text{ cm}}$$

or $\quad q = -4.00$ cm

Thus, the magnification $M = \frac{h'}{h} = -\left(\frac{n_1}{n_2}\right)\frac{q}{p}$ gives

$$h' = -\left(\frac{n_1 q}{n_2 p}\right)h = -\frac{1.50(-4.00 \text{ cm})}{1.00(4.00 \text{ cm})}(2.50 \text{ mm}) = \boxed{3.75 \text{ mm}}$$