Physics Workshop, May 18, early in the morning.

Sign Conventions for *Thin Lenses*

(1) The focal length is positive for converging (convex) lenses and negative for diverging (concave) lenses.

(2) The object distance is positive if it is on the side of the lens from which light is coming (this is usually the case, although when lenses are used in combination, it might not be so); otherwise, it is negative.

(3) The image distance is positive if it is on the opposite side of the lens from where the light is coming; if it is on the same side, i, is negative. Equivalently, the image distance is positive for a real image and negative for a virtual image.

(4) The height of the image, h_i, is positive if the image is upright, and negative if the image is inverted relative to the object. (h_o, the height of the object, is always taken as positive.)

(5) The magnification, m, of a lens is the ratio of the the image height to the object height, $m = h_i/h_o$. By similar triangles,

$$m = \frac{h_i}{h_o} = -\frac{d_i}{d_o}$$

For an upright image the magnification is positive, and for an inverted image m is negative.

Sign Conventions for *Spherical Mirrors*

(1) The focal length is half of the mirror's radius of curvature.

(2) When the object, image, or focal point is on the reflecting side of the mirror, the corresponding distance is positive. If any of these points is behind the mirror the corresponding distance is negative. Clearly object distances are positive for material objects, but in compound systems there are more possibilities.

(3) The image height, h_i, is positive if the image is upright, and negative if inverted, relative to the object (h_o is always taken as positive).

(4) The magnification, m, of a mirror is the ratio of the the image height to the object height, $m = h_i/h_o$. By similar triangles,

$$m = \frac{h_i}{h_o} = -\frac{d_i}{d_o}$$

For an upright image the magnification is positive, and for an inverted image m is negative.

Some Exercises

(1) A 1.50 cm-high rock is placed 20.0 cm from a concave mirror with radius of curvature 30.0 cm. Use ray tracing and calculations to determine the position and size of the image.

(2) A 1.00 cm-high beetle is placed 10.0 cm from a concave mirror whose radius of curvature is 30.0 cm. Draw a ray diagram to locate the image. Determine the position and size of the image analytically.

(3) Explain what happens when you move the "shaving mirror" closer to and farther away from your face.
(4) Explain, using ray diagrams, what happens to the pencil in water.
(5) Use ray diagrams and calculations to determine the position and size of the image of a 21.0 cm cup placed 75.00 cm from a 55.0-mm-focal-length camera lens.
(6) An object is placed 10 cm from a 15-cm-focal-length converging lens. Use ray diagrams and calculations to determine the image position and magnification.