Geometric Optics Notes: Optics Notes 1

There are several definitions which are important to understand geometrical optics.

(1) Suppose an object has a height h, and its image has a height h'.

a) if h is positive, the object is upright.
b) if h' is positive, the image is upright

The magnification is defined by

$$M \equiv \frac{h'}{h}$$

We will later show that if s is the object distance and s' is the image distance, then

$$M \equiv \frac{h'}{h} = -\frac{s'}{s}$$

For now, we will use this.
Note: if M is positive, the image is ***upright.***
If M is negative, the image is ***inverted.***

For single element systems, we'll assume the light comes from the left side of the lens and goes toward the right side of the lens.

The ultimate equation which is important for understanding thin lenses is called the **Thin lens equation:**

$$\frac{1}{s} + \frac{1}{s'} = \frac{1}{f}$$

Here, the object distance is s, the image distance is s' and the focal length is f.

Below are some details that we will pick up later

We will later show that the focal length for a thin lens is given by

$$\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

where n is the index of refraction . The index of refraction is the speed of light in a vacuum divided by the speed of light in a medium:

$n = \frac{c}{v}$.

If the lens is immersed in something like, say water, then this equation is modified to become the relative index of refraction. R_1 and R_2 are the "Radii of curvature" which means the point that you need to hold a piece of string to draw the lens.

We will use the following convention for the sign of the focal length:
If the lens is converging (like a magnifying glass) then f is positive.
If the lens is diverging (like a diverging lens) then f is negative.
We also need to have a sign convention for the points s and s'

S is + in front of the lens (on the object side)
S is - behind the lens ... this will only happen if you have more than one lens.

S' is + if the image is behind the lens (for single lens systems, not on the object side)
S' is - if the image is in front of the lens (on the object side for single lens systems.)

A virtual image has a negative image distance (s'<0)
A real image has a positive image distance (s'>0)
A virtual object has a negative object distance (s<0) {not for single lens systems}
A real object has a positive object distance (s>) {the only case for single lens systems}