## LENS MAKER'S FORMULA

**The Lens Maker's Formula for paraxial rays in thin lenses relates the radii of curvature of both surfaces and the index of refraction to the resultant focal length.**

$$1/f = (n-1)(1/r1 - 1/r2)$$

$$\frac{1}{f} = (n-1)\left(\frac{1}{r1} - \frac{1}{r2}\right)$$

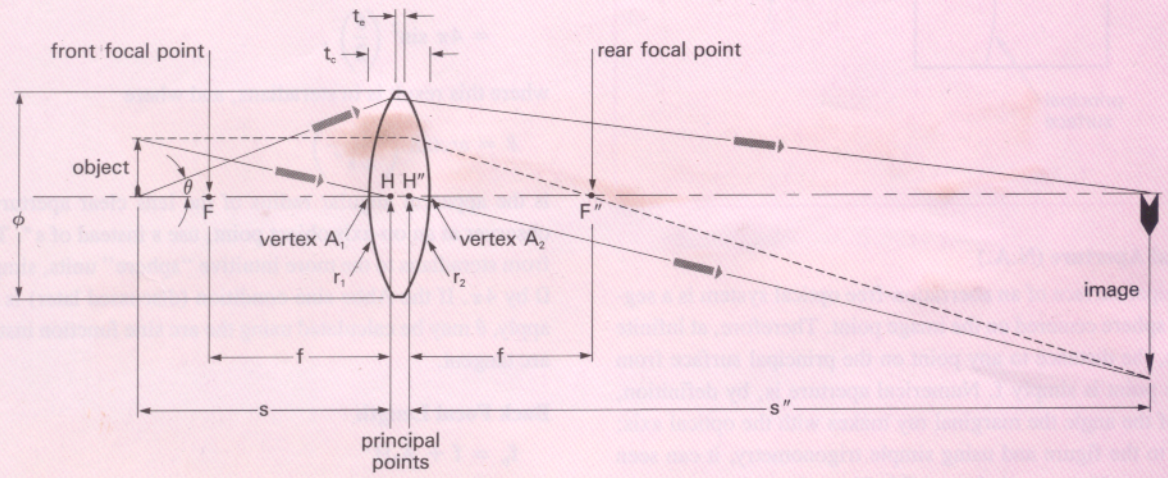
**Study the picture below and the box to the side for the relationship of the variables.**

### SIGN CONVENTION

The validity of the lens formulas that follow is dependent on adherence to the sign convention shown here:

- s is + for object to left of H
- s is − for object to right of H
- s″ is + for image to right of H″
- s″ is − for image to left of H″
- $r_1$ is + for center of curvature to right of surface
- $r_1$ is − for center of curvature to left of surface
- $r_2$ is + for center of curvature to right of surface
- $r_2$ is − for center of curvature to left of surface
- $A_1H$ is + for first principal point H to right of vertex $A_1$ (interior to lens)
- $A_1H$ is − for first principal point H to left of vertex $A_1$ (exterior to lens)
- $A_2H''$ is + for secondary principal point H″ to right of secondary vertex $A_2$ (H″ exterior to lens)
- $A_2H''$ is − for secondary principal point H″ to left of secondary vertex $A_2$ (H″ interior to lens)

*Other authors may use a different sign convention for conjugate distances, for focal length, and in their aberration formulas.*




Note location of object and image relative to front and rear focal points.

$\phi$ = Lens diameter

$r_1$ = Radius of curvature of 1st surface (positive if center of curvature is to right)

$r_2$ = Radius of curvature of 2nd surface (negative if center of curvature is to left)

$r_2$ = $-r_1$ for symmetric lens

m = s″/s = magnification = conjugate ratio, said to be infinite if either s″ or s is infinite

$\theta$ = Arctan ($\phi$/2s)

s = Object distance, positive for object (whether real or virtual) to the left of principal point H

s″ = Image distance (s and s″ are collectively called conjugate distances, with object and image in conjugate planes), positive for image (whether real or virtual) to the right of the principal point H″

$t_c$ = Center thickness

$t_e$ = Edge thickness

f = Effective focal length (EFL), may be positive (as shown or negative. f represents both FH and H″F″, assuming lens to be surrounded by medium of index 1.0

**IMAGING PROPERTIES OF SIMPLE LENS at finite conjugate ratio.**