Tell me how to derive lens maker equation.

Answer:

Lensmaker's equation:

The focal length of a lens *in air* can be calculated from the **lensmaker's equation**:

$$\boldsymbol{P = \frac{1}{f} = (n-1)\left[\frac{1}{R_1} - \frac{1}{R_2} + \frac{(n-1)d}{nR_1R_2}\right]},$$

Where:

$\boldsymbol{P}$ – is the power of the lens,

$\boldsymbol{f}$ – is the focal length of the lens,

$\boldsymbol{n}$ – is the refractive index of the lens material,

$\boldsymbol{R_1}$ – is the radius of curvature of the lens surface closest to the light source,

$\boldsymbol{R_2}$ – is the radius of curvature of the lens surface farthest from the light source, and

$\boldsymbol{d}$ – is the thickness of the lens (the distance along the lens axis between the two surface vertices).

Sign convention of lens radii R_1 and R_2

The signs of the lens' radii of curvature indicate whether the corresponding surfaces are convex or concave. The sign convention used to represent this varies, but in this article if R_1 is positive the first surface is convex, and if R_1 is negative the surface is concave. The signs are reversed for the back surface of the lens: if R_2 is positive the surface is concave, and if R_2 is negative the surface is convex. If either radius is infinite, the corresponding surface is flat. With this convention the signs are determined by the shapes of the lens surfaces, and are independent of the direction in which light travels through the lens.

Thin lens equation

If d is small compared to R_1 and R_2, then the thin lens approximation can be made. For a lens in air, f is then given by

$$\boldsymbol{\frac{1}{f} \approx (n-1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]}$$

The focal length f is positive for converging lenses, and negative for diverging lenses. The reciprocal of the focal length, $1/f$, is the optical power of the lens. If the focal length is in metres, this gives the optical power in dioptres (inverse metres).