Answer on Question #59194, Physics / Optics

If the focal length of a convex lens is 1 m, what is the maximum thickness of the lens?

Find: : d_{max}– ?

Given:

f=1 m

Solution:

For not thin lenses fair value:

$$\frac{n_{environment}}{f} = (n_{lens} - n_{environment}) \times \left(\frac{1}{R_1} - \frac{1}{R_2} + \frac{(n_{lens}-n_{environment})d}{n_{lens}R_1R_2}\right) (1),$$

where n_{lens} – absolute index of lens' refractive,

$n_{environment}$ – absolute index environment' refractive,

f – focal length,

R_1, R_2 – radii of curvature of the lenses surfaces

By task: $R_1>0$, $R_2>0$ (2)

Believe that lens is symmetric: $R_1=R_2=R$ (3)

(2) and (3) in (1): $\frac{n_{environment}}{f} = (n_{lens} - n_{environment}) \times \left(\frac{(n_{lens}-n_{environment})d}{n_{lens}R^2}\right)$ (4)

Of (4) $\Rightarrow$ $d = \frac{n_{lens}R^2n_{environment}}{f(n_{lens}-n_{environment})^2}$ (5)

We believe that a lens is glass and placed in the air.

n_{air} =1,0 (6)

Tabular data: n_{glass} =1,5 - 1,9 (7)

Of (5) and (7) $\Rightarrow$ d_{max} if n_{glass} minimum

Of (5) $\Rightarrow$ if n_{glass} =1,5 than d_{max}

Of (5) $\Rightarrow$ $d_{max} = \frac{6R^2}{f}$

Answer:

The general formula: $d = \frac{n_{lens}R^2n_{environment}}{f(n_{lens}-n_{environment})^2}$

The simplified formula (n_{air} =1,0): $d = \frac{n_{lens}R^2}{f(n_{lens}-1)^2}$

Maximum thickness (n_{glass} =1,5): $d_{max} = \frac{6R^2}{f}$

Numeric value of maximum thickness for this task (f=1 m): $\{d_{max}\}= 6R^2$