

Answer on Question#55521 - Physics - Optics

An object is placed in front of two convex lenses one by one at a distance 'u' from the lens. The focal lengths of lenses are $f_1 = 30\text{cm}$ and $f_2 = 15\text{cm}$ respectively. If the size of image formed in two cases is same, then 'u' is-

Solution:

The magnification of the object at the object distance u in front of the lens with focal length f is given by

$$M = \frac{f}{f - u}$$

It's given that $|M_1| = |M_2|$, that is

$$\frac{f_1}{|f_1 - u|} = \frac{f_2}{|f_2 - u|}$$

This equation is equivalent to the following system:

$$\begin{cases} \frac{f_1}{f_1 - u} = \frac{f_2}{f_2 - u} \\ \frac{f_1}{f_1 - u} = \frac{f_2}{u - f_2} \end{cases}$$

$$\begin{cases} \frac{30\text{cm}}{30\text{cm} - u} = \frac{15\text{cm}}{15\text{cm} - u} \\ \frac{30\text{cm}}{30\text{cm} - u} = \frac{15\text{cm}}{u - 15\text{cm}} \end{cases}$$

$$\begin{cases} 30\text{cm} - 2u = 30\text{cm} - u \\ 2u - 30\text{cm} = 30\text{cm} - u \end{cases}$$

$$\begin{cases} u = 0\text{cm} \\ u = 20\text{cm} \end{cases}$$

$u = 0\text{cm}$ is inconsistent therefore the answer is $u = 20\text{cm}$.

Answer: 20cm.