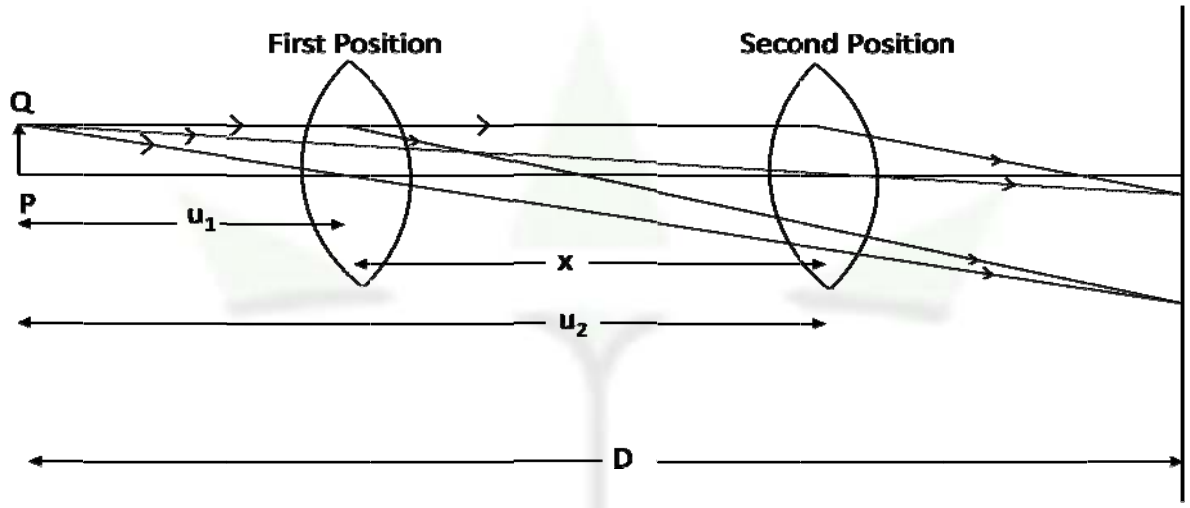
Two Positions Of Lenses For Same Position Of Object and Image

Two Positions of the lenses for given object and image:

For the given position of object and screen (where image will be formed) there may be two different positions of a convex lens in between for which the image may be formed on the screen provided that the distance between the object and the screen is greater than four times the focal length of the given lens.



$m = \frac{v}{u} = \frac{h_i}{h_o}$ it can be proved that if $D > 4f$ then only there will be two positions of the lens.

$\frac{1}{u} + \frac{1}{(D-u)} = \frac{1}{f}$ or $\frac{D - u + u}{u(D - u)} = \frac{1}{f}$

or $fD = uD - u^2$

or $u^2 - uD + fD = 0$

or $u = \frac{-(-D) \pm \sqrt{(-D)^2 - 4.1.fD}}{2}$

Let u_2 and u_1 be the values of u then

$u_2 = \frac{D}{2} + \frac{\sqrt{D^2 - 4fD}}{2}$

$u_1 = \frac{D}{2} - \frac{\sqrt{D^2 - 4fD}}{2}$

Both the values will be real of $D > 4f$

The displacement of the lens

$x = u_2 - u_1 = \sqrt{D^2 - 4fD}$

$x^2 = D^2 - 4fD$

$f = \frac{D^2 - x^2}{4D}$

Focal length of a convex lens can be determined in this way known as displacement method.