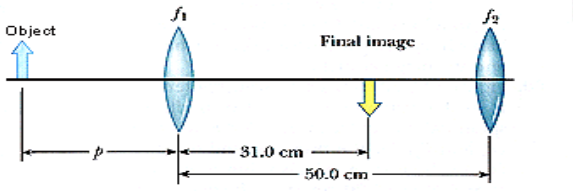
Q- Two converging lenses having focal lengths of f_1 = 10.0 cm and f_2 = 24.0 cm are placed 50 cm apart, as shown in the figure. The final image is to be located between the lenses, at the position indicated.
(a) How far to the left of the first lens should the object be positioned?

The image formed by the first lens will behave as object for the second lens.
For the second lens, 0bject distance u_2 =? Image distance v_2 = - (50.0 – 31.0) = - 19.0 cm (- ve because opposite to direction of incident rays) and Focal length f_2 = 24.0 cm

Using lens formula, we get



$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$$

Or $$\frac{1}{24.0} = \frac{1}{-19.0} - \frac{1}{u_2}$$

Or $$\frac{1}{u_2} = -\frac{1}{24.0} + \frac{1}{-19.0}$$

Or $$u_2 = \frac{24.0*19.0}{-19.0-10.0} = -10.60\ cm$$

Thus, the object for the second lens must be 10.60 cm in front. This means that the image of the object due to first lens must be 10.60 cm from the second lens or 50 – 10.6 = 39.40 cm from the first lens.

Now for the first lens, object distance u_1 =?, Image distance v_1 = (50.0–10.60)=39.40 cm
Focal length f_1 = 10.0 cm

Using lens formula, we get

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$$

Or $$\frac{1}{10} = \frac{1}{39.4} - \frac{1}{u_1}$$

Or $$\frac{1}{u_1} = -\frac{1}{10.0} + \frac{1}{39.4}$$

Or $$u_1 = \frac{10.0*39.4}{-39.4+10.0} = -13.4\ cm$$

Hence the object must be at 13.4 **cm** in front of the first lens.

(b) What is the overall magnification?

The magnification for the first lens is

$$m_1 = \frac{v_1}{u_1} = \frac{39.4}{-13.4} = -2.94$$

And that for the second lens

$$m_2 = \frac{v_2}{u_2} = \frac{-19}{-10.6} = 1.79$$

Hence the overall magnification will be

$$m = m_1 * m_2 = -2.94 * 1.79 = -5.27$$

Hence the magnification is **5.27** and negative sign shows that the final image is inverted