619.

Problem 44.27 (RHK)

A converging lens with a focal length of +20 cm *is located* 10 cm *to the left of a diverging lens having a focal length of* -15 cm. *A real object is located* 40 cm *to the left of the first lens. We have to locate and describe the image formed.*

Solution:

We will solve this problem in two steps. In the first step we will find the image formed by the first lens of a real object which is 40 cm to the left of the lens of focal length +20 cm. Let i be the distance of the image from the first lens. Using the thin lens formula, we have

$$\frac{1}{40\ \text{cm}} + \frac{1}{i} = \frac{1}{20\ \text{cm}},$$

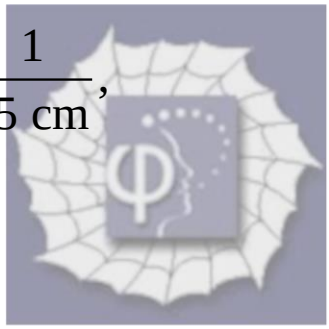
or

$$i = 40\ \text{cm}.$$

This image is real and inverted and is formed at location 40 cm to the right of the first lens.

But, this image will not be seen as such as there is intervention of the second lens of focal length -15 cm, which is located 10 cm to the right of the first lens.
As the image formed by the first lens is in the 'transmitted-side' of the second lens, it will be virtual with respect to it and therefore the object distance of the image formed by the first lens with respect to the second lens will be $o_2 = -30$ cm, and as $f_2 = -15$ cm, the image distance i_2 will be given by

$$-\frac{1}{30\text{ cm}}+\frac{1}{i_2}=-\frac{1}{15\text{ cm}},$$



or

$i_2 = -30$ cm.

The final image formed by the two lenses will be virtual and at a distance of 20 cm to the left of the first lens.
We next work out the lateral magnification.

$$m = m_1 m_2 = \left(\frac{-40}{40}\right)\times\left(-\frac{(-30)}{(-30)}\right)=1.$$

We thus find that the final image will be virtual and of the same size as the object and will be formed at a distance of 20 cm to the left of the first lens.