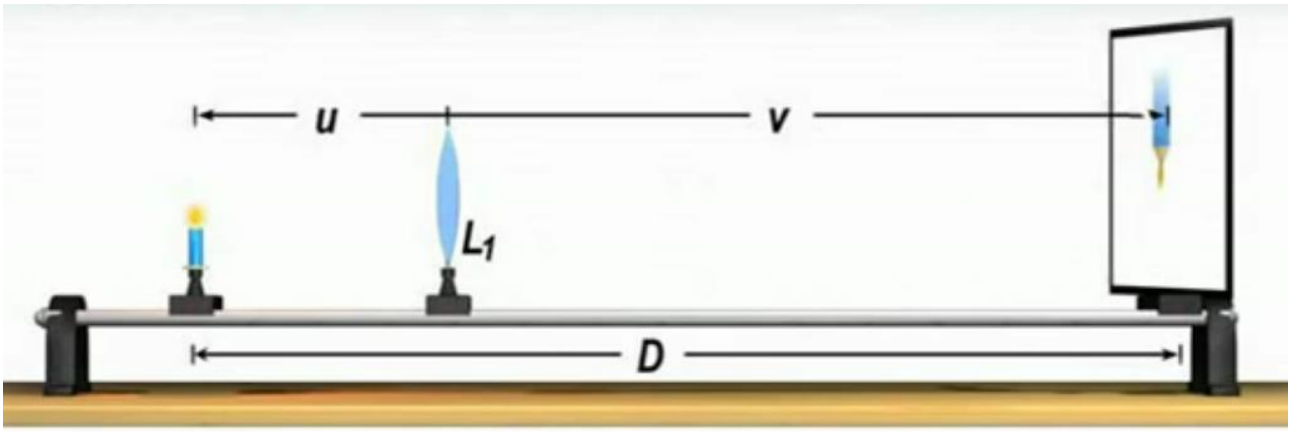
Answer on Question #71181, Physics / Optics

The magnifications produced by a convex lens for two different positions of an object are m1 and m2 respectively (m1>m2) if "d" is the distance of separation between the two positions of the object then focal length of the lens is

(1) √m1m2 (2) d/√m1-m2 (3) dm1m2/m1-m2 (4) d/m1-m2

correct answer is d/m1-m2 but how??

Solution:



Separation between object and image is

$$D = u + v$$

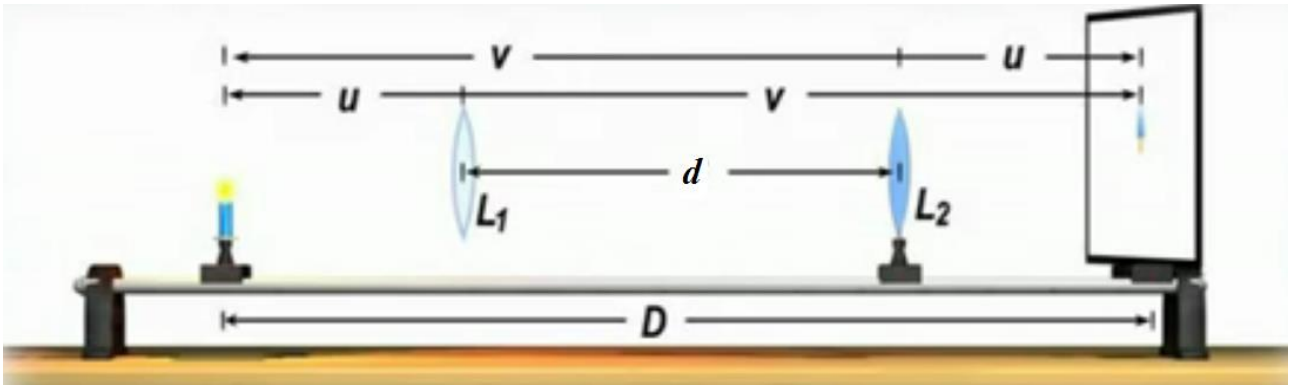
where *u* and *v* are the object and image distance.

So we have

$$m_1 = \frac{v}{u}$$

The second position of lens:

$$d = v - u$$



In this position:

$$m_2 = \frac{u}{v}$$

Thus,

$$m_1 m_2 = 1$$

From lens equation

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

$$v = m_1 u$$

$$\frac{1}{u} + \frac{1}{m_1 u} = \frac{1}{f}$$

So,

$$u = \frac{f(1 + m_1)}{m_1}$$

From

$$u = m_2 v$$

we have

$$v = \frac{f(1 + m_2)}{m_2}$$

$$d = v - u = f\left(\frac{1 + m_2}{m_2} - \frac{1 + m_1}{m_1}\right)$$

$$d = f\left(\frac{m_1 + m_1 m_2 - m_2 - m_1 m_2}{m_2 m_1}\right)$$

Thus, the focal length

$$f = \frac{d m_1 m_2}{m_1 - m_2}$$

In our case

$$m_1 m_2 = 1$$

$$f = \frac{d}{m_1 - m_2}$$

Answer: $f = \frac{d}{m_1 - m_2}$