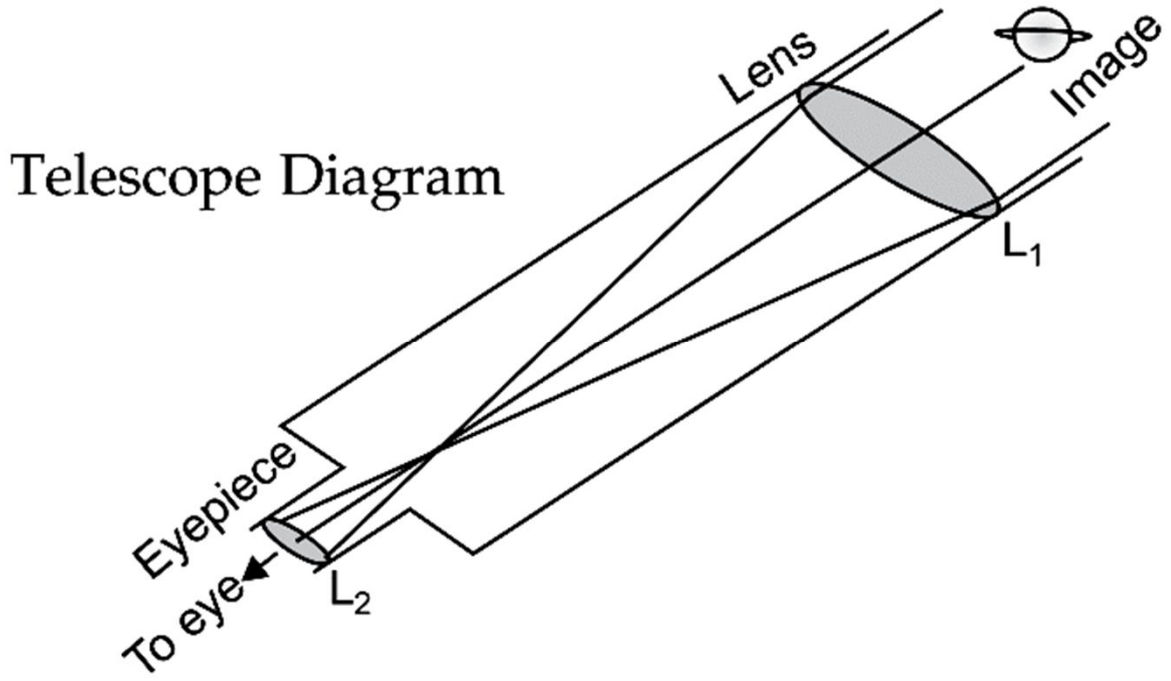
CASE STUDY QUESTION 03

Read the following and answer any four questions from (i) to (v)

Sumati wanted to see the stars of the night sky. She knows that she needs a telescope to see those distant stars. She finds out that the telescopes, which are made of lenses, are called refracting telescopes and the ones which are made of mirrors are called reflecting telescopes.

So she decided to make a refracting telescope. She bought two lenses, L_1 and L_2, out of which L_1 was bigger and L_2 was smaller. The larger lens gathers and bends the light, while the smaller lens magnifies the image. Big, thick lenses are more powerful. So to see far away, she needed a big powerful lens. Unfortunately, she realized that a big lens is very heavy. Heavy lenses are hard to make and difficult to hold in the right place. Also since the light is passing through the lens, the surface of the lens has to be extremely smooth. Any flaws in the lens will change the image. It would be like looking through a dirty window.



(i) Based on the diagram shown, what kind of lenses would Sumati need to make the telescope?

(a) Concave lenses (b) Convex lenses (c) Bifocal lenses (d) Flat lenses

Ans: (b) Convex lenses

(ii) If the powers of the lenses L_1 and L_2 are in the ratio of 4:1, what would be the ratio of the focal length of L_1 and L_2?

(a) 4:1 (b) 1:4 (c) 2:1 (d) 1:1

$$P_1 = \frac{1}{f_1} \text{ and } P_2 = \frac{1}{f_2}$$

$$\text{Given } \frac{P_1}{P_2} = \frac{4}{1}$$

$$\text{So, } \frac{\frac{1}{f_1}}{\frac{1}{f_2}} = \frac{4}{1} \qquad \text{Hence, } \frac{f_1}{f_2} = \frac{1}{4} \text{ or } 1:4$$

(iii) What is the formula for magnification obtained with a lens?
(a) Ratio of height of image to height of object
(b) Double the focal length.
(c) Inverse of the radius of curvature.
(d) Inverse of the object distance.

$$\text{Magnification } (m) = \frac{h'}{h} = \frac{v}{u}$$

(a) Ratio of height of image to height of object

(iv) Sumati did some preliminary experiment with the lenses and found out that the magnification of the eyepiece (L_2) is 3. If in her experiment with L_2 she found an image at 24 cm from the lens, at what distance did she put the object?

(a) 72 cm (b) 12 cm (c) 8 cm (d) 6 cm

Given $m = 3,\ v = 24,\ u = ?$

We know, $m = \frac{v}{u}$

$\Rightarrow \quad 3 = \frac{24}{u}$

Hence, $u = 8$ cm

(v) Sumati bought not-so-thick lenses for the telescope and polished them. What advantages, if any, would she have with her choice of lenses?

(a) She will not have any advantage as even thicker lenses would give clearer images.
(b) Thicker lenses would have made the telescope easier to handle.
(c) Not-so-thick lenses would not make the telescope very heavy and also allow considerable amount of light to pass.
(d) Not-so-thick lenses will give her more magnification.

(c) Not-so-thick lenses would not make the telescope very heavy and also allow considerable amount of light to pass.