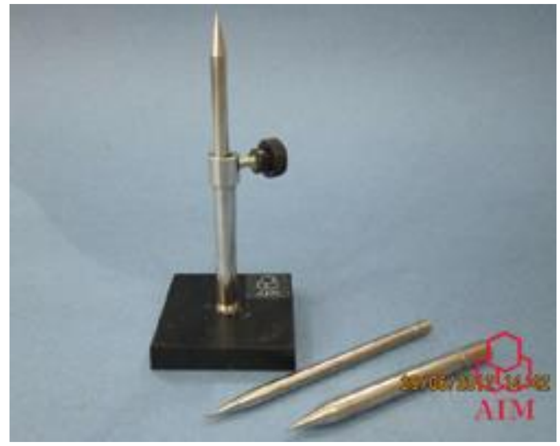
AIM

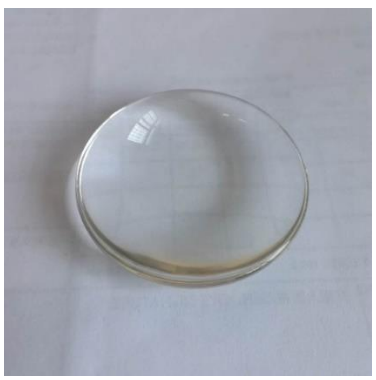
To find the focal length of a convex mirror using a convex lens.

APPARATUS AND MATERIAL REQUIRED

An optical bench



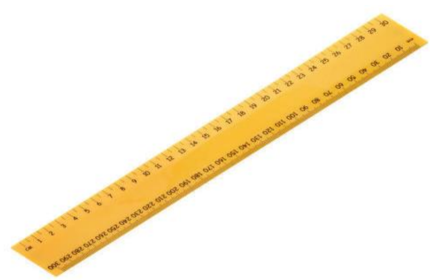
two sharp-edged needle (pins)



convex lens

three uprights (with clamps)

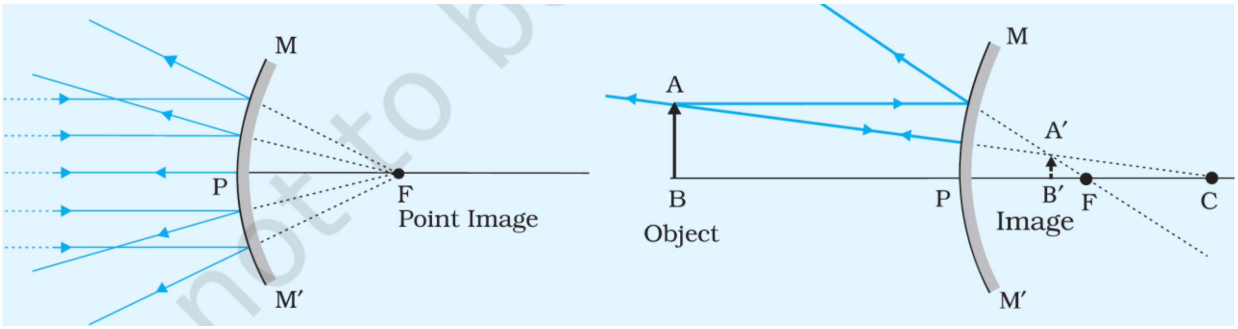
Convex mirror



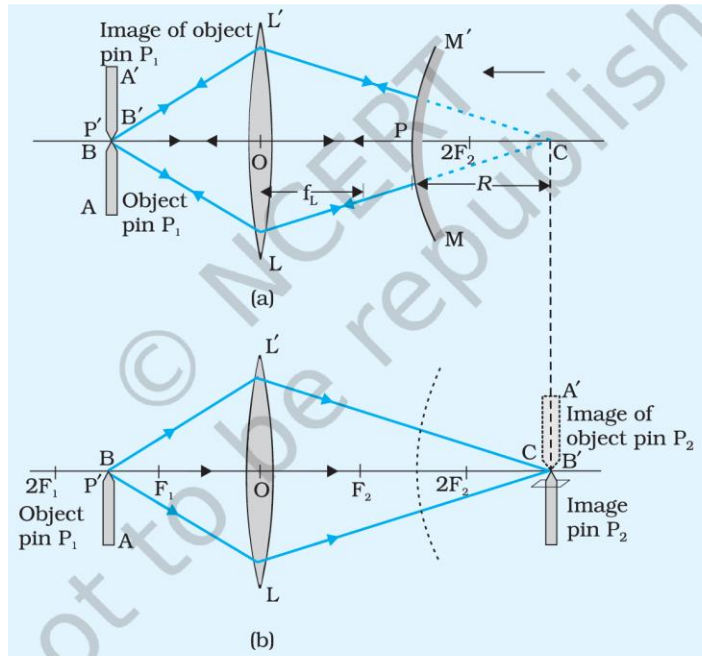
metre scale

PRINCIPLE

As the image formed by a convex mirror is always virtual and erect, so, its focal length cannot be determined directly. However, it can be determined by introducing a convex lens in between the object and the convex mirror.



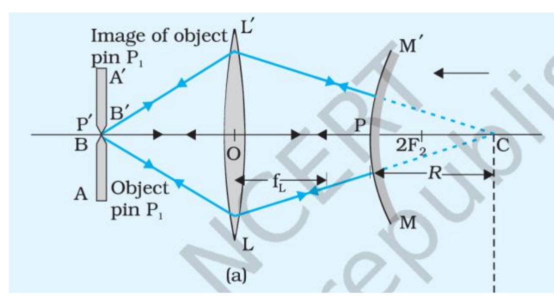
- An object AB is placed at point P’ in front of a thin convex lens such that it’s real, inverted and magnified image A’B’ is formed at position C on the other side of the lens.
- Now a convex mirror is introduced between the convex lens and point C and so adjusted that the real and inverted image A’B’ coincides with the object AB at point P’.
- This is possible if the light rays starting from the tip of the object, after passing through the lens, fall normally on the reflecting surface of the convex mirror and retrace their path.



- Any normal ray (perpendicular) to a spherical surface has to be along the radius of that sphere so that point C must be the centre of curvature of the convex mirror. Therefore, the distance PC is the radius of curvature *R* and half of it would be the focal length of the convex mirror. That is, f = PC/2 =R/2

PROCEDURE

1. Obtain approx. value of the focal length of the thin convex lens by focusing the image of a distant object.
2. Place the optical bench on a rigid table or on a platform. Make it horizontal with the help of levelling screws provided at the base of the bench.
3. Place the uprights mounted with pin P_1 (object pin), convex lens LL’, & convex mirror MM’ on the horizontal optical bench [Fig. (a)].



4. Check that the lens, mirror, and pin P_1 are vertically placed on the optical bench. Also verify that the tip of the pin, optical centre O of the convex lens LL’, and pole P’ of the convex mirror MM’ lie on the same horizontal straight line, parallel to the optical bench.

5. Determine the index correction between upright holding of the convex mirror and image pin respectively, using an index needle.
6. Place the object pin P_1 from the convex lens LL’ at a distance slightly greater than the focal length of the lens.
7. Adjust the position of the convex mirror MM’ till the light rays reflected back from the mirror pass through the lens and form a real and inverted image coinciding with the object pin P_1, as shown in Fig. (a). Remove the parallax between the image and object pins.
8. Read the position of uprights holding the object pin P_1, convex lens LL’, and convex mirror MM’ and record the observations in the observation table.
9. Remove the convex mirror from its upright and fix image pin P_2 on it. Adjust the height of pin such that the tips of the pins P_1 and P_2 and the optical centre O of the convex lens, all lie on a straight horizontal line parallel to the length of the optical bench.
10. You may put a small piece of paper on image pin P_2 to differentiate it from the object pin P_1.
11. Using the method of parallax and without changing the position of lens LL’ and object pin P_1, adjust the position of image pin P_2 on the other side of the lens so that it coincides with the real and inverted image of the object pin P_1 formed by the convex lens [Fig.(b)]. Note the position of the image pin.
12. Repeat the experiment by changing the separation between the pin P_1 and lens LL’ and the mirror MM’. In this manner, take five sets of observations.

Link: https://youtu.be/GsksrRsD_08 (best) / https://youtu.be/p2Eu4CW5gPk / https://youtu.be/g0HN9GQsI1o

OBSERVATIONS

1. Focal length of the convex lens, f (estimated/ given) = ... cm
2. Actual length of the index needle, l = ... cm
3. Observed length, l_0 = Position of mirror upright – position of pin upright on scale = ... cm – ... cm =...cm
4. Index correction, e = Actual length (l) – observed length (l') = ... cm

Determination of radius of curvature of convex mirror

S.No.	Upright position of				Observed R’ = c – d (cm)	Corrected R = R’ + e (cm)	Focal length f (cm)	Δf
	Object pin a(cm)	Convex lens b(cm)	Convex mirror c(cm)	Image pin d (cm)				
1								
2								
3								
4								
					Mean			

CALCULATIONS

- Calculate the mean value of radius of curvature of the convex mirror, *R*, and determine its focal length using the following relation, f =R/2 = … cm
- Error: $f = \frac{R'+l}{2} = \frac{(c-d)+(l-l')}{2}$

  $$\frac{\Delta f}{f} = \frac{\Delta c}{c} + \frac{\Delta d}{d} + \frac{\Delta l}{l} + \frac{\Delta l'}{l'}$$

  when Δc, Δd, Δl and $\Delta l'$ are the least counts of the measuring instruments. Maximum of the five values of Δf is to be reported with the result as the experimental error.

RESULT

The focal length of the given concave mirror is $f \pm \Delta f$ = ...cm (here *f* is mean value of the focal length)

PRECAUTIONS (ANY 2)

1. The uprights supporting the pins, lens and mirror must be rigid and mounted vertically.
2. The apertures of the given convex lens and convex mirror should be small, otherwise the image formed will be distorted.
3. The focal length of the lens used in this experiment should neither be too small nor too large.
4. Eye should be placed at a distance of about 25 cm or more from the image pin.

SOURCES OF ERROR

1. The tip of the inverted image of the object pin should just touch the tip of the image pin and must not overlap. This should be ensured while removing the parallax.
2. Personal eye defects may make removal of parallax tedious.
3. The convex mirror should preferably be front-coated. Otherwise, multiple reflections may take place.