To Find the Refractive Index Of a Liquid By Using Convex Lens & Plane Mirror

Aim

To find the refractive index of a liquid by using convex lens and plane mirror.

Apparatus

A convex lens, a plane mirror, clean transparent liquid in a beaker, an optical needle, (a thick knitting needle passed through a rubber cork), an iron stand with base and clamp arrangement, plumb line, plane glass slab, a spherometer, half metre scale etc.

Theory

If f_1 and f_2 be the focal length of glass convex lens and liquid lens and F be the focal length of their combination then,

$$\frac{1}{F}=\frac{1}{f_1}+\frac{1}{f_2} \quad \text{or} \quad \frac{1}{f_2}=\frac{1}{F}-\frac{1}{f_1}$$

Liquid lens formed is a planoeconcave lens with R_1= R (radius of curvature of convex lens surface), R_2 =∞

From lens maker's formula

$$\frac{1}{f_2}=(n-1)\left[\frac{1}{R_1}-\frac{1}{R_2}\right]$$

We have,

$$\frac{1}{f_2}=\frac{(n-1)}{R} \quad \text{or} \quad n=1+\frac{R}{f_2}$$

Putting value of f_2, n can be calculated.

Diagram

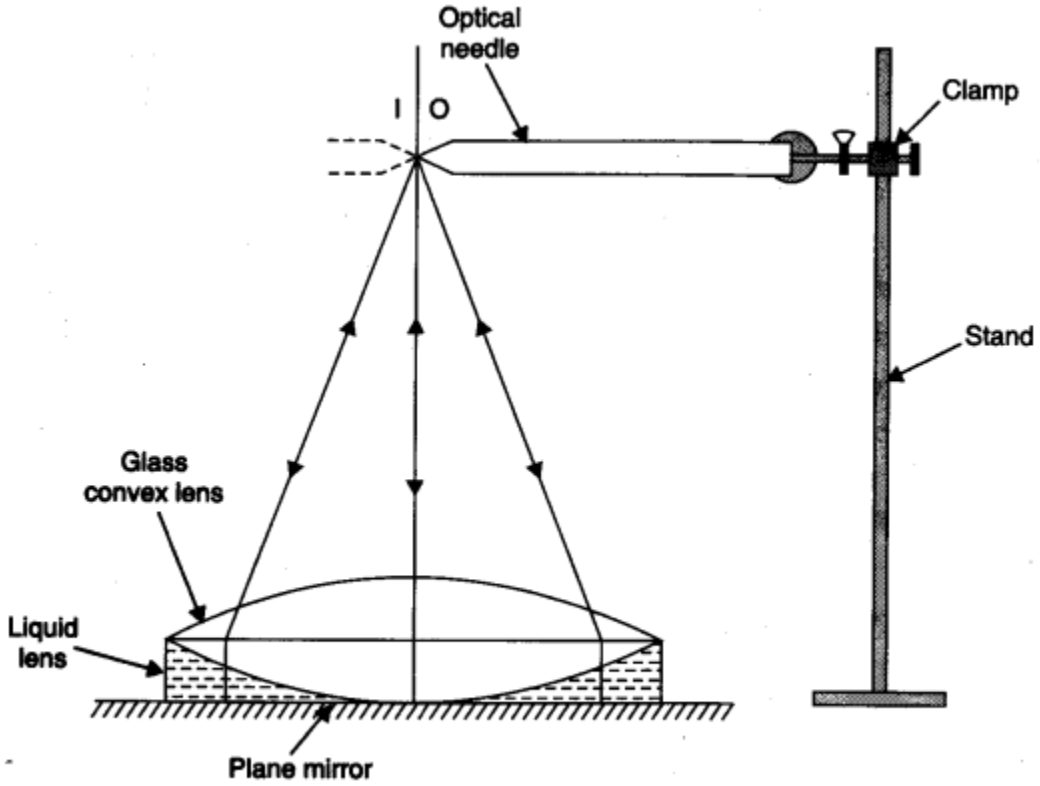

Fig. Focal length of glass convex lens and liquid lens combination.

Procedure

(a) For focal length of convex lens

1. Take any one convex lens and find its rough focal length.
2. Take a plane mirror and place it on the horizontal base of the iron stand.
3. Place the convex lens on the plane mirror.
4. Screw tight the optical needle in the clamp of the stand and hold it horizontally above the lens at distance equal to its rough focal length.
5. Bring the tip of the needle at the vertical principal axis of the lens, so that tip of the needle appears touching the tip of its image.
6. Move the needle up and down and remove parallax between tips of the needle and its image.
7. Measure distance between tip and upper surface of the lens by using a plumb line and half metre scale.
8. Also measure distance between tip and the surface of its plane mirror.

(b) For focal length of the combination

1. Take a few drops of transparent liquid on the plane mirror and put the convex lens over it with its same face above as before (A piano concave liquid lens is formed between plane mirror and convex lens).
2. Repeat steps 6, 7 and 8.
3. Record your observations as given below.

(c) For radius of curvature of convex lens surface

Observations

1. Rough focal length of convex lens =…… cm.
2. **Table for distance of needle tip from lens and mirror**

Arrangement	Distance of needle tip			Focal length x (cm)
	From lens surface x_1 (cm)	From plane mirror x_2 (cm)	Mean $x = \frac{x_1 + x_2}{2}$ (cm)	
(1)	(2a)	(2b)	(2c)	(3)
Without liquid				f_1 = ...
With liquid				F = ...

Radius of curvature

R = ... cm.

Calculations

$$\frac{1}{f_2} = \frac{1}{F} - \frac{1}{f_1},$$

$$n = 1 + \frac{R}{f_2}$$

Precautions

The liquid taken should be transparent.

1. Only few drops of liquid should be taken so that its layer is not thick.
2. The parallax should be removed tip to tip.

Sources of error

Liquid may not be quite transparent.
The parallax may not be fully removed.