EXPERIMENT

AIM

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

MATERIALS REQUIRED

A vertical adjustable clamp stand with an index pin, plumb line and scale accompanies a concave mirror with a relatively larger radius of curvature (focal length 15-20 cm).

DIAGRAM

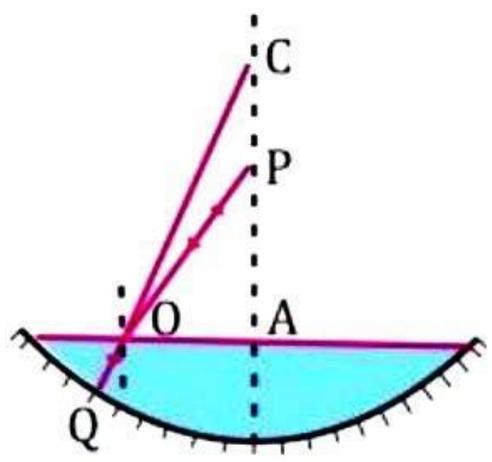

Fig. Image formation by the concave mirror filled with water

THEORY

When a few droplets of water are deposited onto the concave surface of a concave mirror, the water takes on the form of a plano-convex lens. The convex side of the liquid lens has a radius of curvature identical to the concave mirror's radius of curvature R. The upper surface of the liquid lens is flat, with a radius of curvature extending to infinity. This relationship can be expressed as:

$$\frac{1}{f} = \frac{\mu - 1}{R} \qquad \text{.....(i)}$$

Here, μ represents the refractive index of the liquid, R is the radius of curvature of the concave mirror, and f is the focal length of the resulting liquid lens.

Additionally, we have:

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v} \qquad \text{.....(ii)}$$

where u, v, and R are measurable, allowing for the calculation of μ.

The ray PO emanating from point P strikes point O on the liquid surface. It undergoes refraction, bending towards the normal on the plane face to form OQ. If OQ is incident perpendicularly on the curved surface, extending backward, it intersects C, the center of curvature of the concave mirror. However, upon retracing its path, it creates a real image at point P while C serves as the location of a virtual object. Therefore, $AP = v$ and $AC = \mu = -R$. Combining equations (i) and (ii), we obtain:

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v} = \frac{\mu - 1}{R}$$

By substituting $u = -R$, the result is:

$$\boxed{\mu = \frac{R}{v}} \qquad \text{.....(iii)}$$

PROCEDURE

1. Position the pointer P horizontally on the retort stand and place the concave mirror vertically beneath it, en

suring the reflecting face is facing upward.

2. Align the pointer P until the inverted image of its tip, created by the concave mirror, coincides precisely with the actual tip of the pointer, eliminating any parallax.
3. Utilize the plumb line and scale to measure the distance between the pointer and the mirror's pole. This measured distance represents the radius of curvature (R) of the concave mirror. Conduct the procedure three times and calculate the average value of R.
4. Introduce a few drops of water into the concave mirror, creating a thin liquid lens. Adjust the height of pointer P until the tip of its inverted image aligns with the pointer tip again, without any parallax.
5. Measure the distance between the pointer and the lower surface of the liquid lens using the plumb line and scale. Repeat the procedure three times and calculate the average distance. This distance corresponds to the image distance (v) when a virtual object is positioned at the mirror's center of curvature, i.e., u = -R.

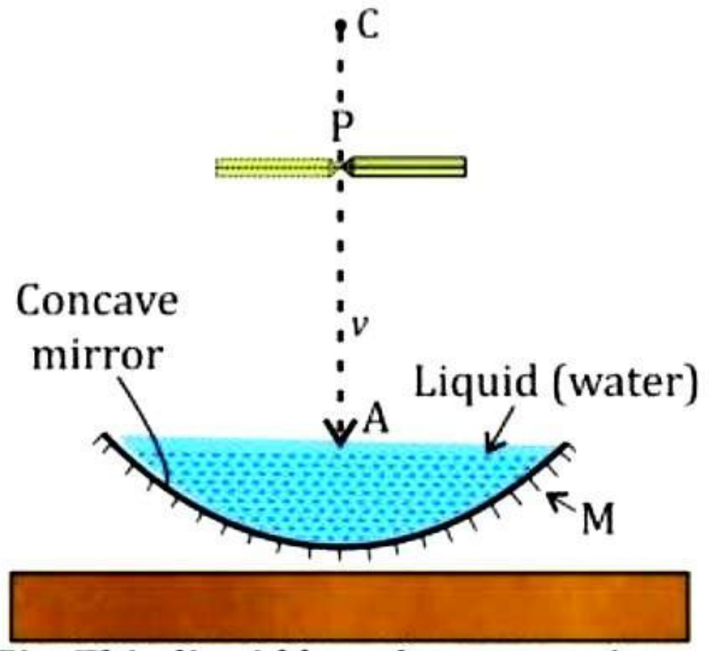

Fig. Thin liquid lens (concave mirror and water) and its image

OBSERVATIONS

1. The radius of curvature's average value is $R = \cdots$ cm.
2. The image distance, v = (i) ... cm + (ii) ... cm + (iii) ... cm = $\cdots$ cm.

CALCULATION

Determine the refractive index μ using the formula:

$$\mu = \frac{R}{v}$$

RESULT

The refractive index of the provided liquid (water) is μ = ...

PRECAUTION

1. Use only a small quantity of liquid to create a slender lens.
2. Eliminate parallax by aligning the tips.
3. Maintain the index pin in a horizontal position, and ensure that the principal axis of the mirror is vertical.

SOURCE OF ERROR

1. The line joining PC may not be vertical.
2. The plane mirror may not be horizontal.

VIVA- VOCE

Q 1. What is the refractive index of the air?

Ans. The refractive index of the air is 1.0003.

Q 2. What is the refractive index of glass?

Ans. The refractive index of glass is 1.52.

Q 3. Does the refractive index vary with wavelength?

Ans. Yes. The refractive index varies with wavelength.

Q 4. Why is the speed of light in water faster than the speed of light through glass?

Ans. The speed of light in water is faster than the speed of light through glass because the refractive index of water is lesser than that of glass.

Q 5. What is the formula for finding the absolute refractive index of the medium?

Ans. The absolute refractive index of the medium is given by the formula:

$$n_m = \frac{c}{v}$$

Q 6. Give the Snell's law formula.

Ans. Snell's law is given by the formula:

$$\frac{\sin i}{\sin r} = \text{constant} = \mu$$

Q 7. What is the unit of the refractive index?

Ans. The refractive index does not have a unit. It is dimensionless.

Q 8. What is optics?

Ans. Optics is the branch of physics that deals with the behaviour and properties of light along with its interactions with matter.