# REFRACTIVE INDEX OF WATER BY CONVEX LENS

**Aim:** To determine the refractive index of water using convex lens and plane mirror.

**Apparatus:** Plane mirror, convex lens, laboratory stand with rigid base and clamp arrangement, water, a pin, a plumb line, spherometer and a meter scale.

**Principle:** The reciprocal of the equivalent focal length of the combination of the lens is the equal to the sum of the reciprocal of focal lengths of individual lenses.

In figure – 1, OF = f is the focal length of the convex lens. In figure- 2, OF' = f ' is the equivalent focal length of combination of convex lens and the plano – concave lens of water. If $f_w$ is the focal length of plano – concave lens of water.

$$\frac{1}{f'} = \frac{1}{f} + \frac{1}{f_w}$$

$$\frac{1}{f_w} = \frac{1}{f'} - \frac{1}{f}$$

$$\therefore f_w = \frac{ff'}{f-f'}$$

From lens maker formula the focal length of Plano – concave water lens

$$\frac{1}{f_w} = (n_w - 1)\left(\frac{1}{R}\right)$$ Where $F_w$ – magnitude of the focal length of plano-concave water lens

$$n_w = 1 + \frac{R}{|f_w|}$$

**Formula:**

1. Focal length of Plano-concave water lens, $f_w = \frac{ff'}{f-f'}$
2. Refractive index of water, $n_w = 1 + \frac{R}{f_w}$

Where: f – Focal length of convex lens.

f ' – Equivalent focal length of combination of convex lens and Plano-concave water lens.

**Procedure:**

1. A plane mirror is placed on the base of laboratory stand keeping its reflecting surface upward.
2. A convex lens is placed on the plane mirror as shown in figure.
3. A sharp edged bright pin AB is placed horizontally just above the optic center (O) of the convex lens and clamped.
4. The position of the pin AB is adjusted such that it coincide with its image A'B' without parallax.
5. The vertical distance between the optic center (O) of convex lens and pin is measured using plumb line. It's equal to the focal length *f* of convex lens.
6. A few drops of water are put under the lens with the help of syringe so that the space between the mirror and lens is filled with water.
7. The position of the pin AB is raised such that it coincides with its image A"B" without parallax.
8. Then vertical distance between the optic center (O) of convex lens and pin AB is measured by plumb line, which is equal to the effective focal length f ' of combination of convex lens and water lens.
9. The focal length of water lens is calculated using the relevant formula.
10. The radius of curvature of the spherical surface of the convex lens in contact with water is found by using spherometer.
11. Refractive index of water is calculated using the formula.

**Diagram:**

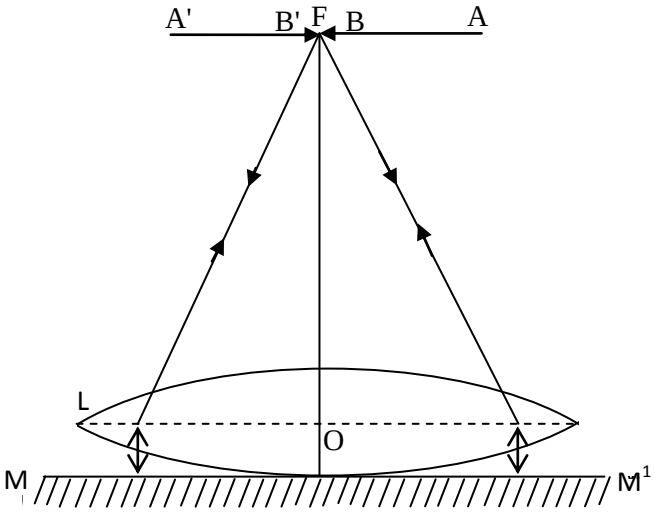


Figure-1

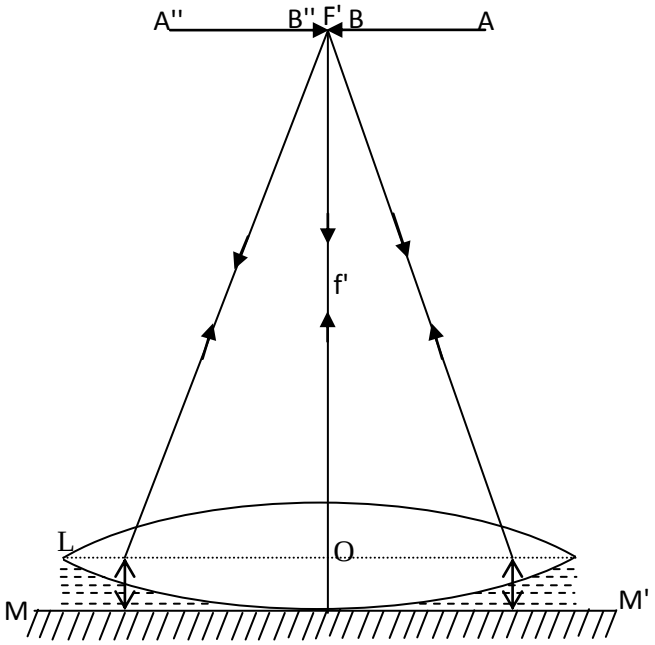


Figure-2

Where:

L – convex lens, MM' – plane mirror, AB- object Pin , A'B' – image by convex lens,

A"B" – image by combination of water lens end convex lens, O- optic centre

**Observations:**

**1.** The radius of curvature of the given convex lens (R) = …….cm

**To measure the focal length of water lens:**

| S. No | Position of pin with respect to the optical center O | | | | | | $f_w = \frac{f\,f'}{f-f'}$ in cm |
|---|---|---|---|---|---|---|---|
| | Distance of the pin without water from | | | Distance of the pin with water from | | | |
| | Upper surface of the lens ($d_1$cm) | Plane mirror ($d_2$ cm) | $f = \frac{d_1 + d_2}{2}$ in cm | Upper surface of the lens ($d'_1$cm) | Plane mirror ($d'_2$ cm) | $f' = \frac{d'_1 + d'_2}{2}$ in cm | |
| 1 | | | | | | | |
| 2 | | | | | | | |

Mean $f_w$ = …….cm

**Calculation:**

Focal length of the plano-concave lens of water $f_w = \frac{f\,f'}{f-f'}$

Refractive index of water $n_w = 1 + \frac{R}{f_w}$

Precautions:

1. The parallax should not be there
2. Meter scale should be straight while taking reading.
3. Air Bubbles should not be there in water.

Sources of error:

1. Formation air bubbles in water
2. Impurities in water.