Experiment (4)

Determination of the refractive index of a liquid by a liquid lens method

Objective:-

Determine the refractive index of a liquid.

Apparatus:-

Convex lens, liquid, plane mirror, retort stand with clamp and pin, meter rule.

Theory:-

A spherometer: is an instrument for the precise measurement of the radius of a sphere. This experiment is one of the most important experiments to find the refractive index for all the liquids. As we know that the light pass in vacuum with constant speed which is equal 3×10^8 M/Sec (300000 Km/Sec) and the light pass also in different material which is transparent like (Air, water, glass) because the atoms of this material has ability to absorb the light and retransmission and dispersion it, for this reason the light pass through different materials in different speeds less than its speed in vacuum.

The speed of light depend on the nature of material, for that reason when the light pass from one medium to another, a change in speed will occur and change in direction happened, this phenomena called refraction, and controlled by "Snell's law of refraction "and to explain the change in light speed when it pass from vacuum to certain medium, we used a physical quantity called refractive index or index of refraction of material (n) is the ratio of the light speed in vacuum to its speed in a material .

Below are the materials having the values of refraction index are more than one because the speed of light in vacuum is large than its speed in materials:

Refraction index	**Material**
1.501	C_6H_6
1.461	CCL_4
1.362	CH_3OH
1.333	H_2O

Let the focal length of the convex (glass) lens be f1 and the focal length of the combination of this lens and the Plano concave liquid lens be f. then:

$$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2} \quad \ldots\ldots\ldots\ldots \quad (1)$$

Since f_1 and f are known, the value of (f_2) can be calculated from (1).

Now $\frac{1}{f_2} = (n_\ell - 1)\left(\frac{1}{r} + \frac{1}{\infty}\right) = \frac{n_\ell - 1}{r}$ (where f_2 and r are both negative)

i.e. $$n_\ell = 1 + \frac{r}{f_2} \quad \ldots\ldots\ldots\ldots \quad (2)$$

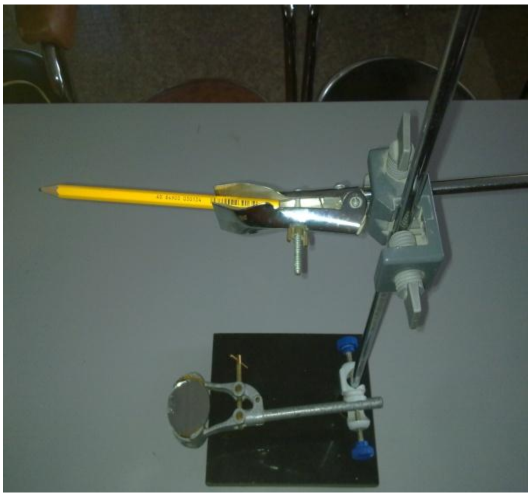

Figure (1): The experimental setup

Procedure:-

1:- The plane mirror is placed on the base of the stand with the pin held horizontally by the clamp above see figure (1 and 2).

2:-The convex lens is then placed on the mirror, and its focus is found by locating the position of the pin where it coincides with its own image. By measuring from this point to the lens, its focal length (f_1) is found.

3:- The lens is now removed, and a few drops of liquid are placed on the mirror. On placing the convex lens on the liquid, a combination of a convex (glass) and a Plano-concave (liquid) lens results.

4:- The focal length (f) of the combination is found as above, and the focal length (f_2) of the liquid lens calculated from f and f_1 (eq. (1)).

5:- The radius of curvature (r) of the lens surface in contact with the liquid is now obtained by a spherometer and its equal to 6.7cm

6:- Calculate the refractive index of liquid from equation (2).

7:- Find the percentage error of (n):

$$p.e = ((n_{th} - n_{exp})/n_{th}) \times 100\%$$

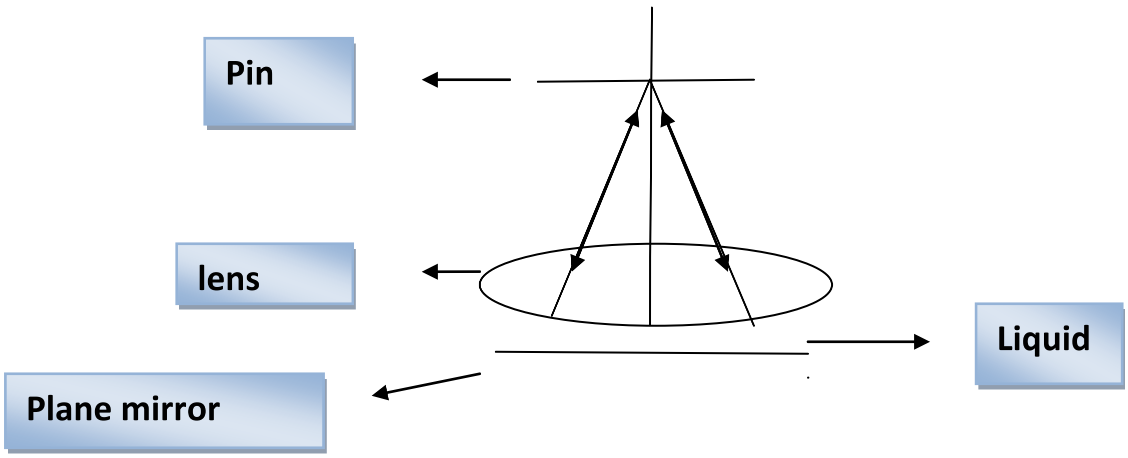

Figure (2): Schematic diagram of the experimental.

<u>Discussion:-</u>

Q1:- Discuss the results in the experiment?

Q2:- What is the effect of the convex lens in this experiment?