EXPERIMENT

AIM

To determine the refractive index of a glass slab using a travelling microscope.

MATERIAL REQUIRED

Three glass slabs of different thicknesses but the same material, a travelling microscope and lycopodium

THEORY

A mobile microscope comprises an ordinary compound microscope, denoted as M, with the capability of traversing both vertically and horizontally. Its movements in either direction are measured using a stationary main scale (S) and a movable vernier scale (V). The instrument includes a horizontal metal platform, adjustable through leveling screws (L), and a small spirit level on the base for leveling. Vertical motion is governed by two screws: a fixing screw and a tangent screw. The latter induces slow motion only when the former is secured. Similarly, two screws control horizontal motion.

The compound microscope features a standard objective (O) and eyepiece (E). A crosswire within the field of view can be sharply focused by the eyepiece. During microscope focusing, adjustments are necessary to eliminate parallax between the cross wire and the object's image.

When a ray of light transitions from a rarer medium (air) to a denser medium (glass) at an oblique angle, both the path and speed of light change. The refractive index of the glass medium with respect to the air medium is defined as the ratio of the speed of light in air to that in the glass.

Consider a glass slab labeled abcd with a mark A placed below it. After refraction, the rays from A appear to emanate from B, making B the apparent image of A. The refractive index of air with respect to glass (${}_g\mu_a$) is given by:

$$ {}_g\mu_a = \frac{\sin i}{\sin r} = \frac{\frac{CD}{AD}}{\frac{CD}{BD}} = \frac{BD}{AD} $$

Consequently, the refractive index of glass with respect to air (${}_a\mu_g$) is calculated as:

$$ {}_a\mu_g = \frac{1}{{}_g\mu_a} = \frac{AD}{BD} $$

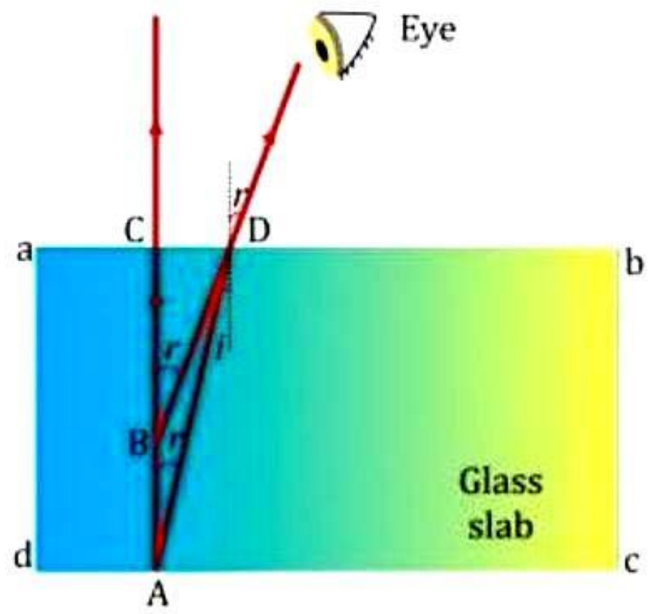
Considering point D is very close to point C, we approximate:

AD ≅ AC = Real thickness

BD ≅ BC = Apparent thickness

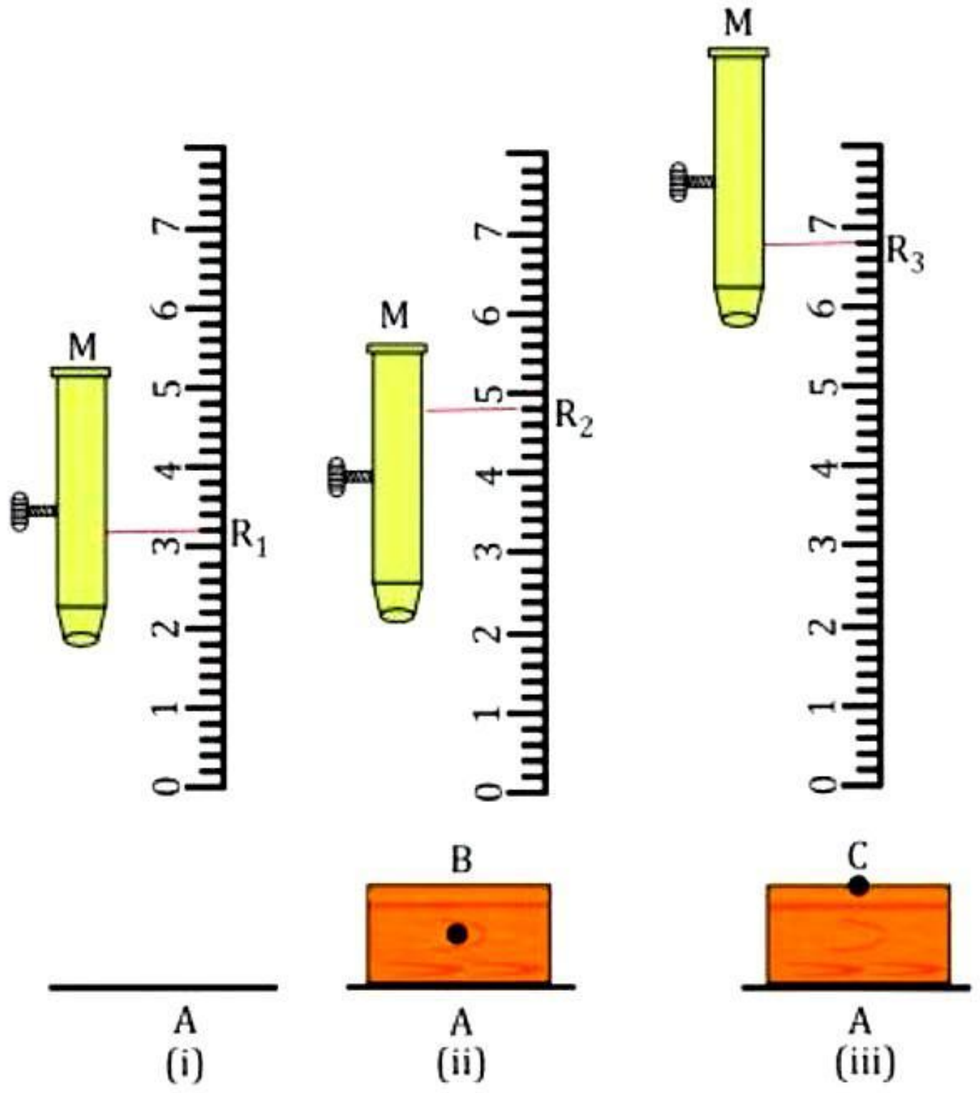
Thus, the refractive index of glass with respect to air can be expressed as:

$$ \boxed{ {}_a\mu_g = \frac{AC}{BC} = \frac{\text{Real thickness}}{\text{Apparent thickness}} } $$



PROCEDURE

1. The leveling of the traveling microscope platform is achieved by using a spirit level and adjusting the leveling screws until it is balanced.
2. The determination of the least count of the vertical scale involves employing the common principle of the vernier scale, expressed as $LC = 1MSD - 1VSD = \frac{S}{n}$. Here, S represents the smallest main scale division, and n is the total number of divisions in the vernier scale.
   For instance, if $S = \frac{1}{2}$mm or 0.05cm and $n = 50$, then the least count (LC) is calculated as $\frac{0.05}{50} =$ 0.001cm.
3. The eyepiece is adjusted to achieve clear images of the cross wires within the field of view. Initially, the microscope is focused on a cross mark O on a fixed piece of paper on the platform, and the corresponding reading R_1 is recorded on the vernier scale.
4. Placing the glass slab on mark O, the cross wire is re-focused by raising the microscope. The corresponding reading R_2 is noted on the vernier scale.
5. Without disturbing the glass slab, a small amount of lycopodium powder is sprinkled on its upper surface. The microscope is further raised to focus on the granules of lycopodium powder on the glass slab, and the final reading R_3 is recorded.
6. Steps 3 to 5 are repeated three times, each time placing a mark A at different locations on the paper.



OBSERVATIONS

1. Total number of divisions on the vernier scale = ...
2. Least count (LC) of the vernier scale = ... cm.
3. Record the readings R_1, R_2, and R_3 of the traveling microscope in a tabular form.

Variation of apparent thickness with real thickness of a glass slab to find the refractive index μ of the glass.

S. No.	Readings of the travelling microscope									Real thickness ($R_3 - R_1$)	Apparent thickness ($R_3 - R_1$)	$\mu = \frac{R_3 - R_1}{R_3 - R_2}$	Mean μ
	R_1(cm)			R_2(cm)			R_3(cm)						
	MSR (cm)	VSR (cm)	Total (cm)	MSR (cm)	VSR (cm)	Total (cm)	MSR (cm)	VSR (cm)	Total (cm)				
1.													
2.													
3.													
4.													
5.													
6.													
7.													

CALCULATIONS

The determination of the refractive index of the glass slab involves utilizing the readings obtained from the traveling microscope in the following formula:

$$\mu = \frac{R_3 - R_1}{R_3 - R_2}$$

RESULT

The refractive index of the specified glass slab is represented by $\mu = \cdots$.

PRECAUTIONS

1. Ensure that, for each observation, readings R_1, R_2, and R_3 are sequentially taken without shifting the glass slab. To prevent a backlash error, the microscope should be elevated exclusively, avoiding any downward movements.
2. Opt for a glass slab with a thickness that is not excessively large. An optimal thickness ranges from 2 to 3cm. The success of the experiment is compromised if the apparent thickness of the slab surpasses the focal length of the microscope objective.
3. Once the microscope is focused, refrain from displacing the tube relative to its position against the vertical main scale. This restriction is particularly crucial for instruments with a sliding arrangement for the tube.

SOURCE OF ERROR

1. The alignment of the microscope might not be perpendicular to the surface of the glass slab.
2. A thick layer of lycopodium powder or chalk dust on the glass slab may not accurately depict the top surface, leading to errors in the obtained results.

VIVA- VOCE

Q 1. Why a slab does not deviate and disperse light, whereas a prism does?

Ans. In a slab, the refracting faces are parallel. The emergent ray is parallel to the incident ray. There is no deviation or dispersion. In a prism, the refracting faces are not parallel. The emergent ray is not parallel to the incident ray. There is deviation and hence dispersion.

Q 2. Why is lycopodium power spread over the glass surface?

Ans. To focus the microscope accurately, otherwise, the bottom surface will be focused because of the transparency of the glass slab.

Q 3. What is the normal shift?

Ans. It is the difference between actual depth and apparent depth. Its S.I. unit is a meter.

Q 4. What is the cause of normal shift?

Ans. Due to refraction of light.

Q 5. On what factors, apparent depth depends?

Ans. 1. Nature of the medium (R.I.)
2. Thickness of medium (actual depth)
3. Colour of light.

Q 6. In general, for which colour do we take the refractive index of a material in lens and glass slabs?

Ans. Yellow colour. Since it is the mean colour of the visible spectrum.