EXPERIMENT NO. 6
TRAVELLING MICROSCOPE

Aim: To determine the refractive index of glass and water by using a travelling microscope.

Apparatus: A travelling microscope, a glass slab, a beaker, water, lycopodium powder or saw dust.

Figure:

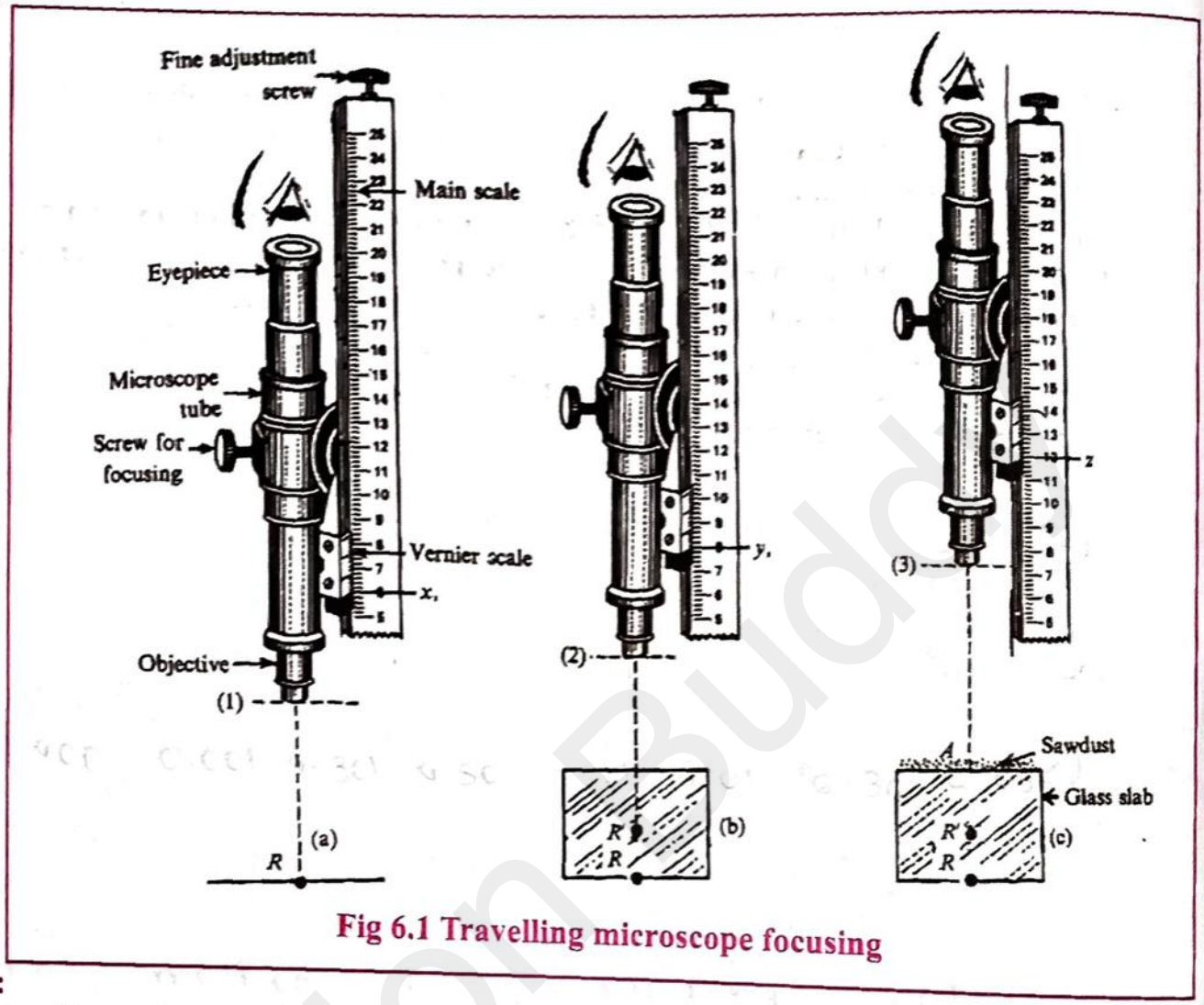


Fig 6.1 Travelling microscope focusing

Theory:

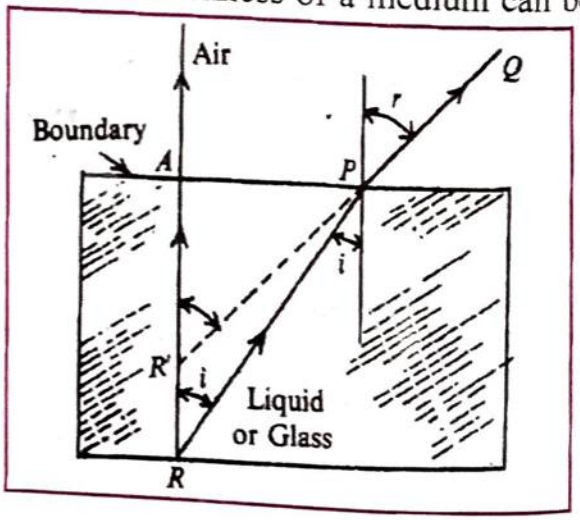
A travelling microscope essentially consists of a compound microscope fit with a Vernier calipers. By using the Vernier calipers, the displacement of the microscope tube can be recorded when it is successively focused at different locations, (say x, y and z) as shown in the figure above.

For small angles of incidence, the refractive index of certain thickness of a medium can be approximately related as,

$$n = \frac{\text{(Real depth)}}{\text{(Apparent depth)}}$$

Thus,as per the earlier and following figures,

$$n = \frac{AR}{AR'} = \frac{(z-x)}{(z-y)}$$



To record AR and AR', we need to focus the microscope at the levels A, R and R.

For level (R), we make a cross mark (×) on a plane paper and focus the microscope on it.

For locating level (R), the glass slab (or the thin walled transparent beaker containing water) is kept on the cross mark and apparent position of the cross mark is focused as R.

To locate the topmost position (A), some lycopodium powder or saw dust is to be spread on the top surface and microscope should be focused on the powder particles (smallest possible).

Differences between the corresponding microscope readings give us AR and AR'. Thus, refractive index n can be calculated.

Remarks:

(A) Doubtful Vernier reading: Quite often the Vernier divisions of a travelling microscope are so close that it is difficult to locate the exact coinciding division. In such cases, restrict your doubt to three divisions and use the middle one as the coinciding division (Figures II and III).

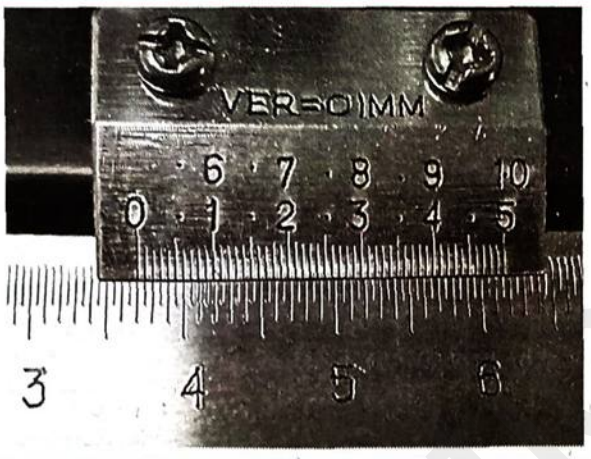
(B) Doubtful main scale reading: If zero of the Vernier scale is close to a division on the main scale, it may be difficult to make out whether that main scale division is complete or not. In such cases, first record the coinciding Vernier scale division. If it is within first 10, the apparent main scale division is complete (Figure II). If the coinciding division is in last 10 (in forties), the apparent main scale division is not complete, i.e., Vernier zero is just before that. In this case, the previous division is to be recorded. (Figure III).

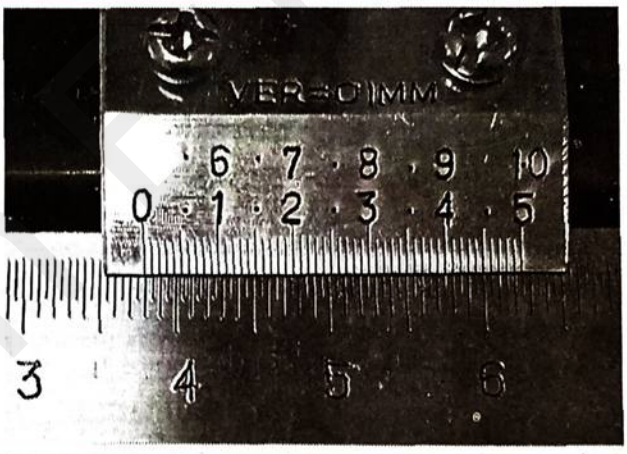
(II) Just after the main scale division:

Main scale reading = 3.70 cm
Coinciding division = 4
Vernier scale reading = 0.004 cm
Total reading = 3.704 cm

(III) Just before the main scale division:

Main scale reading = 3.75 cm
Coinciding division = 45
Vernier scale reading = 0.045 cm
Total reading = 3.795 cm





Procedure:

1. Determine least count (L.C.) of the travelling microscope.
2. Focus the travelling microscope on the cross mark (×) on a plane paper and record the reading as x.
3. Initially use glass slab as the transparent material. Keep the glass slab on the cross mark and look for the apparent position of the cross mark. Focus the microscope on the apparent position and record the reading as y.
4. Spread some saw dust on the top surface. Record the reading as z by focusing the microscope on the smallest saw-dust particles.
5. Repeat the steps 3 and 4 for water and record corresponding values of y and z for water.
6. Separately calculate the refractive indices of glass and water.

Observations:

1. Least count of the travelling microscope (For vertical scale).
2. L.C. = (Length of one main scale division) – (Length of one Vernier scale division)
   = (..... cm) – (..... cm) = ... cm.
3. 50 division of Main Scale = 25 mm.
4. 50 division of Vernier Scale = 24.5 mm.
5. Difference between 50 division of M.S. and V.S. = 0.5 mm.
6. Difference between each division = $\frac{0.5}{50}$ = 0.01mm = 0.001 cm.

---------- **OR** ----------

1. L.C. = $\frac{\text{(Length of one main scale division)}}{\text{(Total number of divisions on the vernier scale)}}$ = $\frac{(0.05\text{ cm})}{(50)}$ = ..0.001... cm.
2. Abbreviations used: M.S.R. = Main Scale Reading.
3. V.S.R. = Vernier Scale Reading = Coinciding division 'n'×Least count.
4. T.R. = Total Reading = M.S.R. + V.S.R.
5. Obs. No. = Observation number.

Observation table:

Obs. No.	Micrometer readings								
	x			y			z		
	M.S.R. cm	V.S.R. cm	T.R. cm	M.S.R. cm	V.S.R. cm	T.R. cm	M.S.R. cm	V.S.R. cm	T.R. cm
For glass slab									
1	4.00	0.001	4.301	4.80	0.01	4.01	6.30	0.035	
2									
3									
For water									
4									
5									
6									

Calculation table :

Obs. No.	Real depth R= z-x	Apparent depth A= y-x	Refractive index $n = \frac{(z-x)}{(z-y)}$	Mean refractive Index, n
For glass slab				
1	1.034	1.525	1.33	n_g = 1.33
2				
3				
For water				
4				
5				n_w = _____
6				

Calculations:

Refractive index : $n = \frac{(z-x)}{(z-y)}$

$= \frac{0.034}{1.625}$

$= 1.33$

Results:

$n_g =$ _____ $n_w =$ _____

Precautions:

1. The axis of the microscope tube should be vertical.
2. The microscope tube should be in the lowest possible position when the microscope is focused on the point on the paper or on the paint mark on the inner surface of the bottom of the beaker (when the beaker is empty).
3. The focusing screw should not be touched while raising the microscope tube.
4. The quantity of sawdust or lycopodium power added should be small. It should not form a thick layer on the surface of the glass slab or liquid.

Additional Experiment you can do :

1. Calculate the apparent shift due to refraction for glass and for water.
2. Measure sizes of very small objects such as thickness of needle, width of the bore of a capillary.

Multiple-choice Questions

1. Least count of travelling microscope (when smallest division on main scale is 0.1cm and number of divisions on Vernier scale is 100) is ...0.001cm...

a) 0.001cm b) 0.001m c) 0.01cm d)0.01m

Questions

1. Why should the focusing screw not disturbed after noting the reading X ?

The pitch of a screw guage is a 5mm and there 50 division of circular scale is CB inside. With screw guage and in this situation with screw guage and in this situation zero of main

2. What are the factors on which the refractive index depends?

Refractive index of a medium depends upon the refractive index of surrounding further the outside the lightray passing from the surrounding into the medium) optical density, wave length of the light and temperature.

3. Can you use this method of determining refractive index of a highly volatile liquid? Explain.

The method of determining refractive index a highly volatile liquid passing generates refractive Recording law of refraction, that the refractive index is measured. 4.05 cm the highest refractive index for the element Cerminimum.

Remark and sign of teacher: .....