Date 03-02-2022

Expt. No. 6 Page No.

"Nodal - slide"

Aim :- To determine (i) the focal length of the two given lenses L_1 and L_2

(ii) the combination of L_1 and L_2 seperated by distance d.

(iii) To locate the positions of first and second principal points H and H' with the help of nodal slide arrangement and to verify the formulae for F and α & β.

Apparatus used :- Nodal slide assembly and two Convex lenses L_1 and L_2.

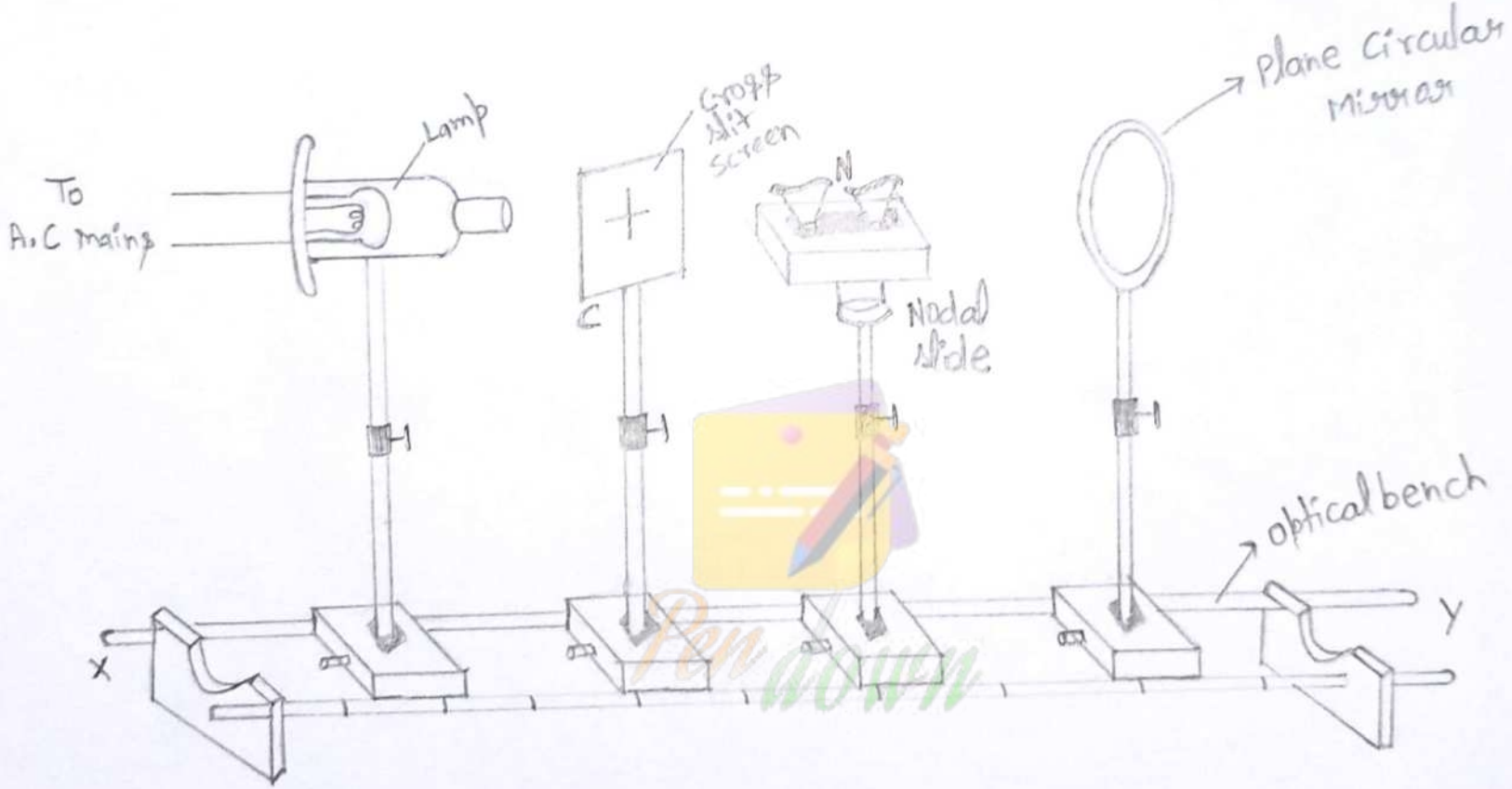
Formula used :- The second focal length F of the combination of two lenses L_1 and L_2 of second focal lengths f_1 and f_2 respectively seperated by distance d and the distances of the first and second principal points H and H' from respective lenses L_1 and L_2 are given by -

$$f = \frac{f_1 f_2}{f_1 + f_2 - d} \quad \text{---- (1)}$$

$$L_1H = \alpha = \frac{Fd}{F_2}$$

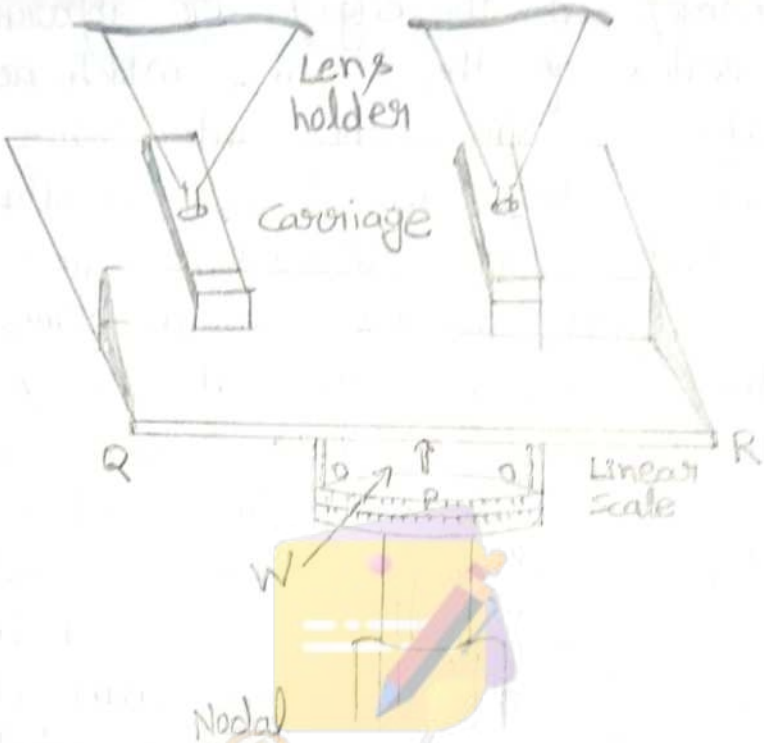
$$L_2H = \beta = -\frac{Fd}{F_1}$$

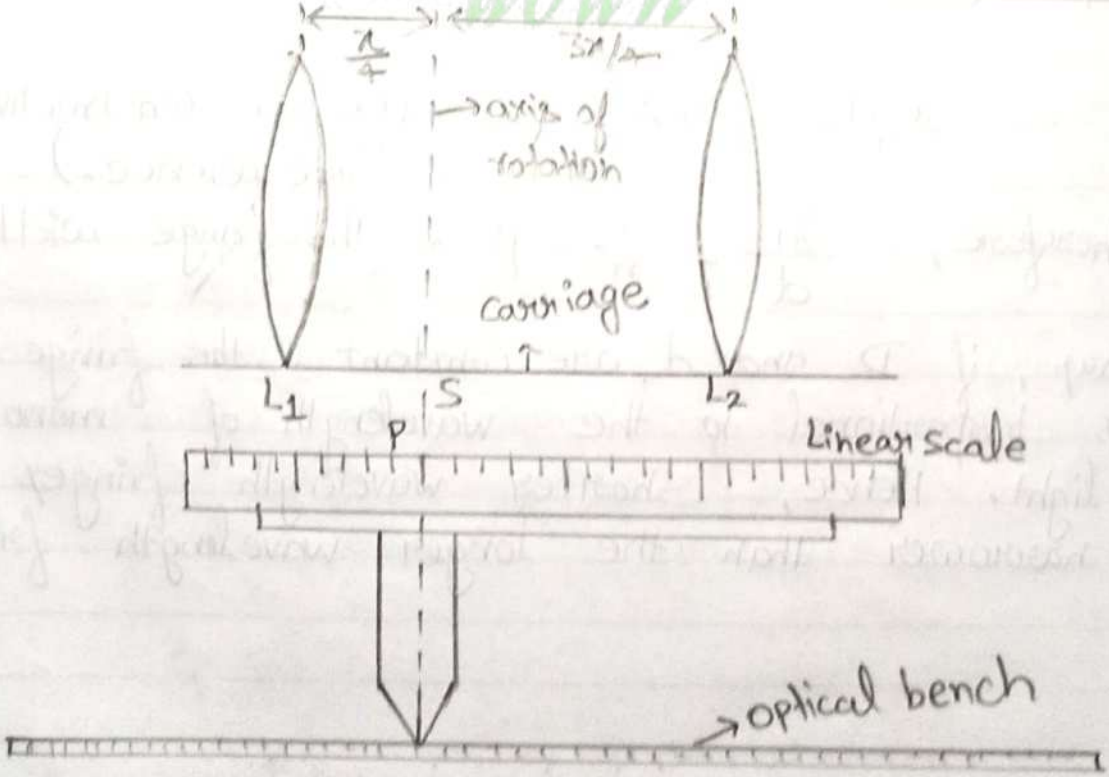
Teacher's Signature:

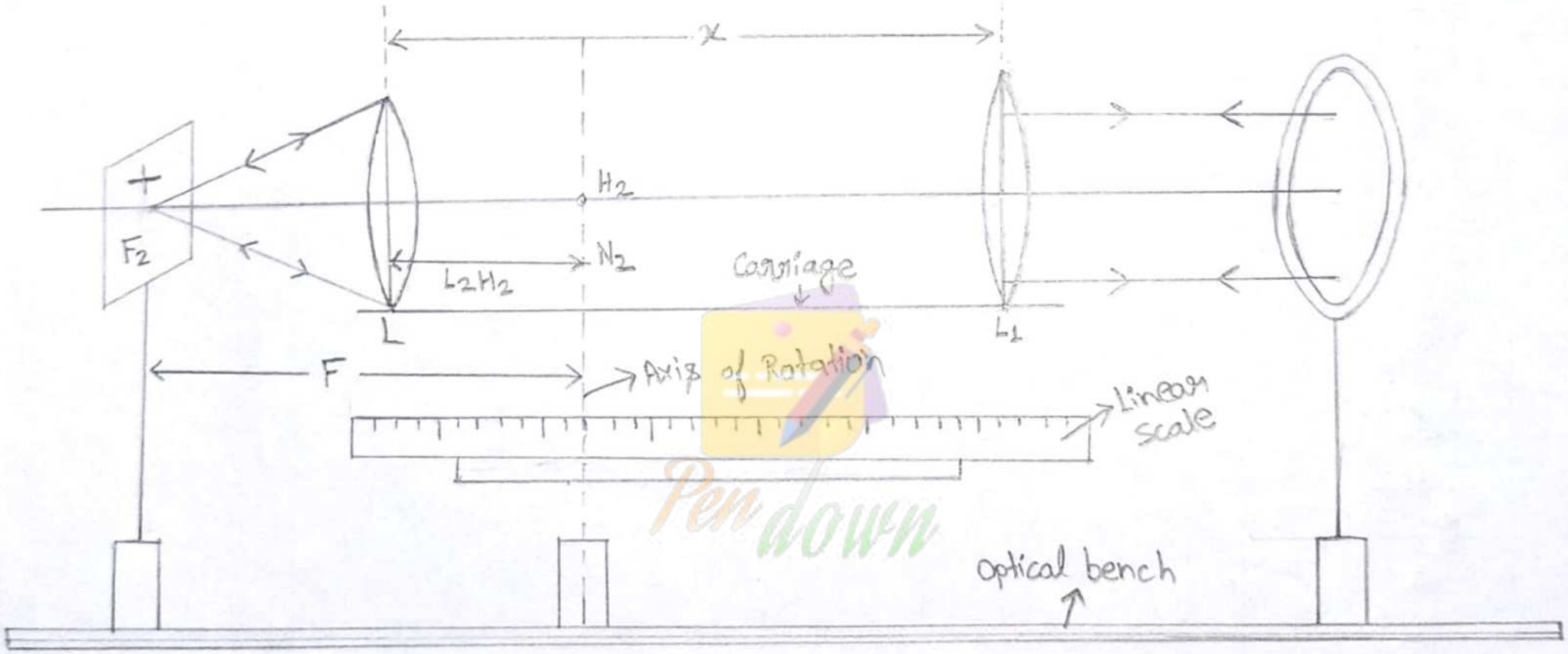


Apparatus.

Nodal slide :-







Principal Points

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Procedure :- (i) Level the optical bench and adjust the heights of lamp, the cross slit, the nodal slide and the plane mirrar at the same height. switch on the lamp and mount lens L_1 on the nodal slide.

(ii) Fix the cross slit at some position on the optical bench. Adjust the nodal slide so that well defined image of cross-slit is obtained in the plane of cross-slit.

(iii) slowly rotate the nodal slide by few degrees about its axis of rotation and see whether the image of the cross slit moves laterally in the same or opposite direction or remains stationary. If it moves laterally in the opposite direction of rotation of the nodal slide, then with the help of rack and pinion arrangement move the nodal slide towards the cross slit and then focus the Image by moving the nodal slide upright in opposite direction of the bench and again see the lateral shift of the Image of cross-slit by giving a slight rotation to the nodal slide. Do the adjustment till no shift of the Image of the cross-slit is obtained.

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(iv) Take the reading of the position of the cross-slit and the nodal slide uprights on the optical bench. Now rotate the Nodal slide by 180° so that light is now incident on the other face of L_1 and repeat step (iii) and note down the reading of the position of the cross slit and the nodal slide uprights of the optical bench.

(v) Repeat steps (iii) and (iv) lens L_2.

(vi) Mount the lens L_1 and L_2 seperated by distance d on the nodal slide assembly.

(vii) Adjust the upright carrying the Nodal slide so that a well defined image of the cross-slit is formed in its plane.

(viii) slowly rotate the nodal slide assembly by few degrees and set it as above so that no shift of image is obtained.

(ix) Take the readings of the position of the cross-slit and the nodal slide upright on the optical bench. The difference gives F. Also read the position of axis of rotation, H', and the position of lens L_2 on the Nodal slide scale.

The difference gives $L_2H' = \beta$

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(x) Rotate the Nodal slide by 180° so that the light is now incident on lens L_2 and repeat step (vii), (viii) & (ix). Note down the position of the cross slit and nodal slide upright on the optical bench.

(xi) Rotate back the nodal slide so that lens L_1 is towards the plane mirror (incident beam) and note down the position of axis of rotation, H, and the position of lens L_1 on the nodal slide scale. The difference gives $L_1H = x$

(xii) Take three sets of observations for three different seperations of L_1 and L_2

Observation:-

Table 1 :- Focal length of lenses L_1 and L_2 :

Lens	light incident on	Position of the		Focal length F= (a-b) cm	Mean Focal length (cm)
		cross slit a (cm)	nodal slide b (cm)		
L_1	I st Face	123.9	108.4	15.5	F_1 = 15.45 cm
	2nd Face	123.9	108.5	15.4	
L_2	I st Face	123.9	104	19.9	F_2 = 20.15 cm
	2nd Face	123.9	103.5	20.4	

Table 2 :- Determination of focal length of combination of two lenses L_1 & L_2 and Position of H and H'.

set no.	light incident on lens	Position of the		Focal length of the combination 'F= a-b'		reading of L_1, L_2 & H, H' on the nodal slide scale		distance of seperation of lenses L_1 & L_2 'd' cm	observed value of $\alpha = L_1H$ cm & $\beta = L_2H'$ cm
		cross slit 'a' (cm)	Nodal slide 'b' (cm)	cm	Mean (cm)				
1	L_1	126.6	117	9.6	9.6	L_2 = 2	H'= -0.2	4.0	β = -2.2
	L_2	126.6	117	9.6		L_1 = 2	H= 0.5		α = 1.5
2	L_1	126.6	116	10.6	10.6	L_2 = 3	H'= -1.2	6.0	β = -4.2
	L_2	126.6	116	10.6		L_1 = 3	H= 0.4		α = 2.6
3	L_1	126.6	115	11.6	11.6	L_2 = 4	H'= -0.4	8.0	β = -4.4
	L_2	126.6	115	11.6		L_1 = 4	H= 1.2		α = 2.8

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Calculations :-

$$F = \frac{f_1 f_2}{f_1 + f_2 - d}, \quad L_1H = \alpha = \frac{fd}{F_2}, \quad L_2H = \beta = -\frac{fd}{F_1}$$

for set 1 :-

$$F = \frac{15.45 \times 20.15}{15.45 + 20.15 - 4.0} = 9.85\,cm$$

$$\alpha = \frac{9.85 \times 4}{20.15} = 1.95\,cm$$

$$\beta = -\frac{9.85 \times 4}{15.45} = -2.55\,cm$$

for set 2 :-

$$F = \frac{15.45 \times 20.15}{15.45 + 20.15 - 6.0} = 10.52\,cm$$

$$\alpha = \frac{10.52 \times 6.0}{20.15} = 3.13\,cm$$

$$\beta = -\frac{10.52 \times 6.0}{15.45} = -4.08\,cm$$

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for set 3:- $F = \frac{15.45 \times 20.15}{15.45 + 20.15 - 8.0} = 11.28\ cm$

$\alpha = \frac{11.28 \times 8}{20.15} = 4.48\ cm$

$\beta = -\frac{11.28 \times 8}{15.45} = -5.84\ cm$

Table 3:- Comparision of calculated and experimental values of F, β and α :-

set.no	Focal length F of the combination (in cm)		$\beta = -L_2H'$ (cm)		$\alpha = L_1H$ (cm)	
	theoretical	Experimental	theoretical	Experimental	theoretical	Experimental
1	9.85	9.6	-2.55	-2.2	1.95	1.5
2	10.52	10.6	-4.08	-4.2	3.13	2.6
3	11.28	11.6	-5.84	-4.4	4.48	2.8

Result:- The observed and calculated values of F, α and β has been Compared in Table 3.

Precautions:- (i) The height of the cross slit, the principal axis of the system of lenses and the mirror should be adjusted properly.

(ii) Rotation to the nodal slide should be given for few degrees only.