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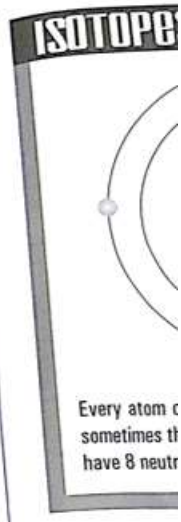

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Experiment No= 01

AIM OF THE EXPERIMENT:

To find the value of u for different values of u in case of a concave mirror and to find its focal length by plotting graph.

i) between u and v

ii) between $\frac{1}{u}$ and $\frac{1}{v}$

APPARATUS REQUIRED:

concave mirror, a mirror holder, two optical needles, a metal scale.

THEORY:

From mirror formula

$$\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$$

$$f = \frac{uv}{u+v}$$

where, f = focal length of concave mirror

v = distance of image needle from the pole.

u = distance of object needle from the pole of the mirror

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Ray diagram:-

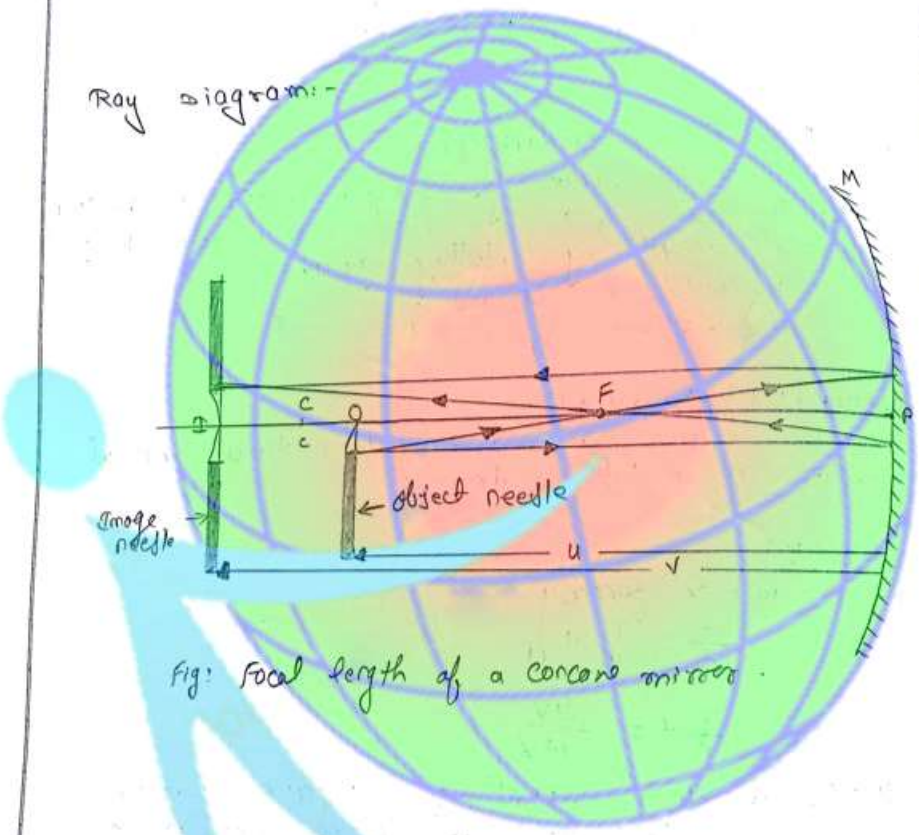

Fig: Focal length of a concave mirror.

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1.)

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4.)

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PROCEDURE:

To determine rough focal length -

1.) The concave mirror is mounted in mirror holder.
2.) mirror is faced towards a distance tree or building.
3.) The image of the tree is obtained on a white painted wall or screen. Mirror is adjusted by moving forward and backward.
4.) The adjustement of the distance will give rough focal length.

To set the mirror -

1.) The fixed upright is placed near zero of the optical bench with two other uprights near the other end.
2.) The holder is clamped with the mirror in the fixed upright keeping mirror face towards other end of the bench and surface perpendicular to its length.
3.) The mirror surface is made vertical using levelling screws of the optical bench. The principal axis of mirror should be horizontal and parallel to the optical bench.
4.) The position of the index is noted and is marked on the base of mirror upright.

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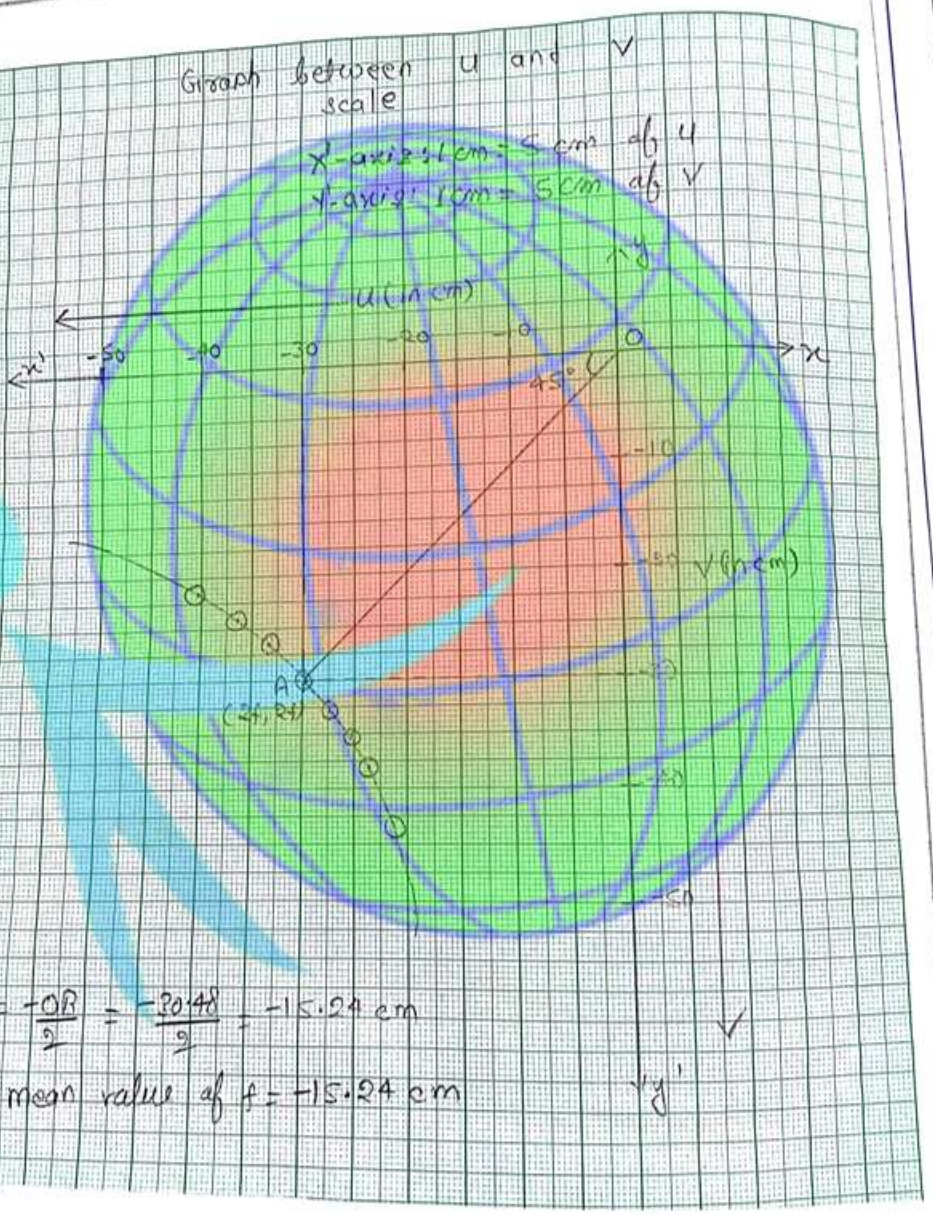
Graph between u and v

scale

X-axis: 1 cm = 5 cm of u

Y-axis: 1 cm = 5 cm of v



$f = \frac{-OB}{2} = \frac{-30.48}{2} = -15.24$ cm

∴ mean value of $f = -15.24$ cm

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TO SET THE OBJECT NEEDLE:-

1.) A thin optical needle is taken as object needle(O), it is mounted on second upright.
2.) Object needle upright is moved and is clamped at a distance nearly 1.5 times the obtained rough focal length of mirror.
3.) The height of the object needle is as adjusted that it becomes horizontal with the pole of mirror.
4.) With right eye(only) the other end of the optical length bench is viewed. The inverted and enlarged image, with tip of the image lying in the middle of the mirror is observed.
5.) Position is noted.

TO SET THE IMAGE NEEDLE:-

1.) The thick optical needle called image needle is mounted in third upright and moved near the optical bench at the other end.
2.) The height is adjusted, so that the tip of the image needle and tip of the image is seen in a line.
3.) Eye is removed, the top get's repeated

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there is parallax, which is removed by relatively shifting the image needle.

4.) Position is noted.

OBSERVATIONS:-

Rough focal length of the given concave mirror = 15 cm.

1.5f = 1.5 × 15 = 22.5 cm

2f = 2 × 15 = 30 cm

3.5f = 3.5 × 15 = 52.5 cm

SL No.	OBJECT DISTANCE(u)	IMAGE DISTANCE(v)	u+v	uv	$f = \frac{-uv}{u+v}$	AVERAGE (f)
1.)	23	45.25	68.25	1040.25	-15.25	
2.)	24	41.82	65.82	1002.68	-15.25	
3.)	25	39	64	975	-15.24	
4.)	26	36.5	62	949	-15.24	
5.)	27	35	61	945	-15.24	-15.24cm
6.)	30	31	61.13	930	-15.24	
7.)	32	29.13	62	928	-15.24	
8.)	34	28	62.4	952	-15.24	
9.)	36	26.4	62.7	950.4	-15.24	
10.)	39	25	64	975	-15.24	

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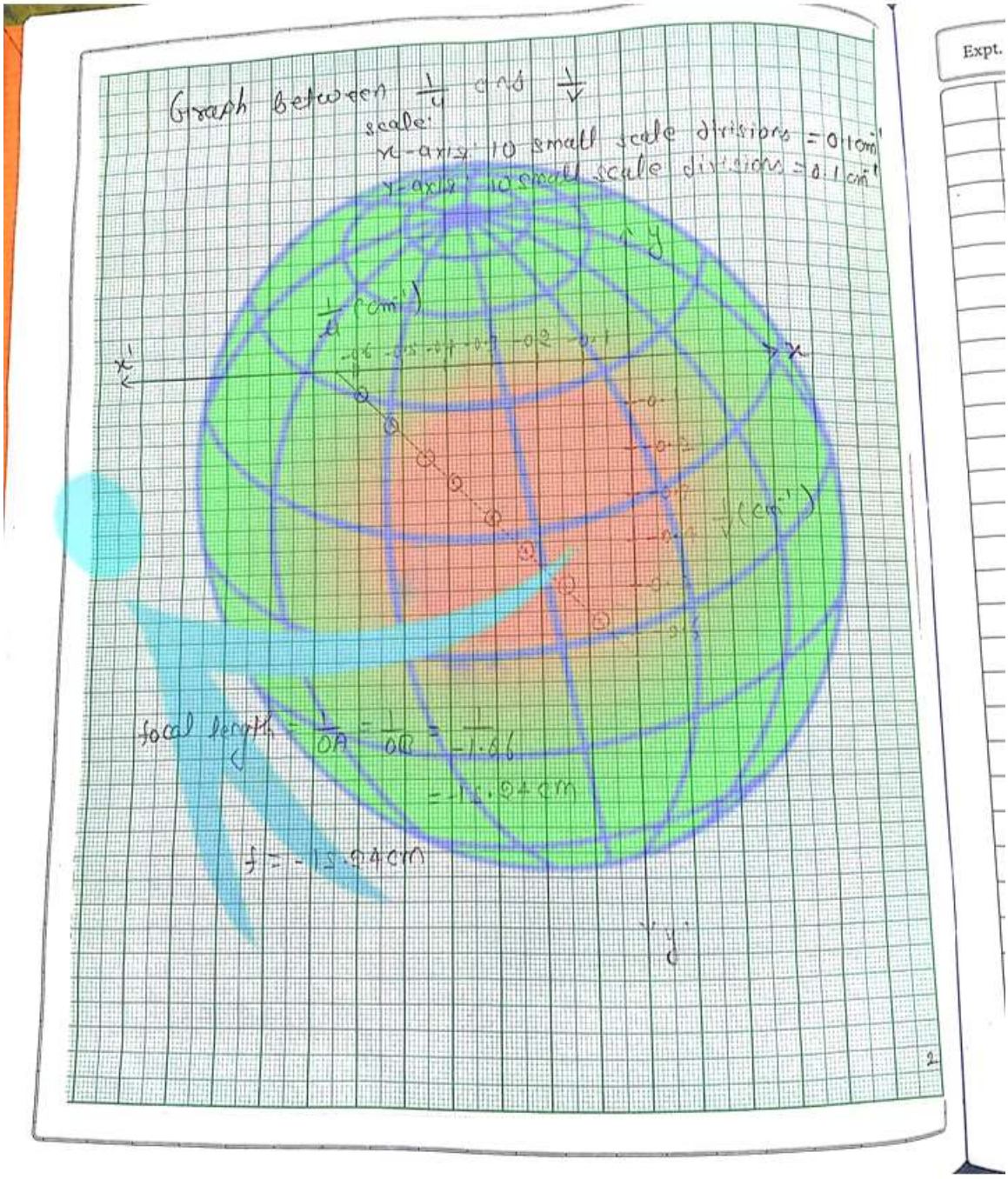
Graph between $\frac{1}{u}$ and $\frac{1}{v}$
scale:
x-axis: 10 small scale divisions = 0.1 cm^{-1}
y-axis: 10 small scale divisions = 0.1 cm^{-1}
$\frac{1}{u}$ (cm^{-1})
$\frac{1}{v}$ (cm^{-1})
x'
x
y
y'
focal length = $\frac{1}{OA} = \frac{1}{OB} = \frac{1}{-1.06}$
$= -1.04$ cm
$f = -1.04$ cm

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CALCULATIONS:

Calculation of focal length by graphical method

i) u-v graph

u is taken on x-axis and v on y-axis. The sign of both u and v is negative. The graph is in the shape of a rectangular hyperbola at $u = v = 2f = R$ line O makes angle 45°

EXPLANATION AND GRAPH(I)

mirror formula is

$$\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$$

as $u = v$, $\frac{1}{f} = \frac{2}{u}$ or $\frac{2}{u}$ $f = \frac{u}{2}$ or $\frac{v}{2}$

$$f = \frac{-AB}{2} = \frac{-30.48\,cm}{2} = 15.24\,cm$$

ii) $\frac{1}{u}$ and $\frac{1}{v}$ graph

By sign both $\frac{1}{v}$ and $\frac{1}{u}$ are negative

EXPLANATION AND GRAPH(II)

By mirror formula

$$\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$$

at $\frac{1}{v} = 0$, $\frac{1}{f} = \frac{1}{u}$

Thus $OA = \frac{1}{u} = \frac{1}{f}$ similarly at $\frac{1}{u} = 0$, $\frac{1}{f} = \frac{1}{v}$

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RESULT:

Focal length determined from

i) u-v graph = -15.24cm

ii) $\frac{1}{u}$ & $\frac{1}{v}$ graph = -15.24cm

PRECAUTIONS:

i) Principal axis of the mirror should be horizontal & parallel to the central line of optical bench.

2.) The uprights should be vertical

3) Tip to the needle should be removed between the needle & image of the needle.

4) To locate the position of the image the eye should be at least 10cm away from the needle.

5.) The tip of the object and mirror should lie at the same height as that of pole of concave mirror.

6.) Index correction should be applied.

SOURCES OF ERRORS:

1) The upright may not be vertical

2) Parallax removal may not be perfect.

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Ray diagram

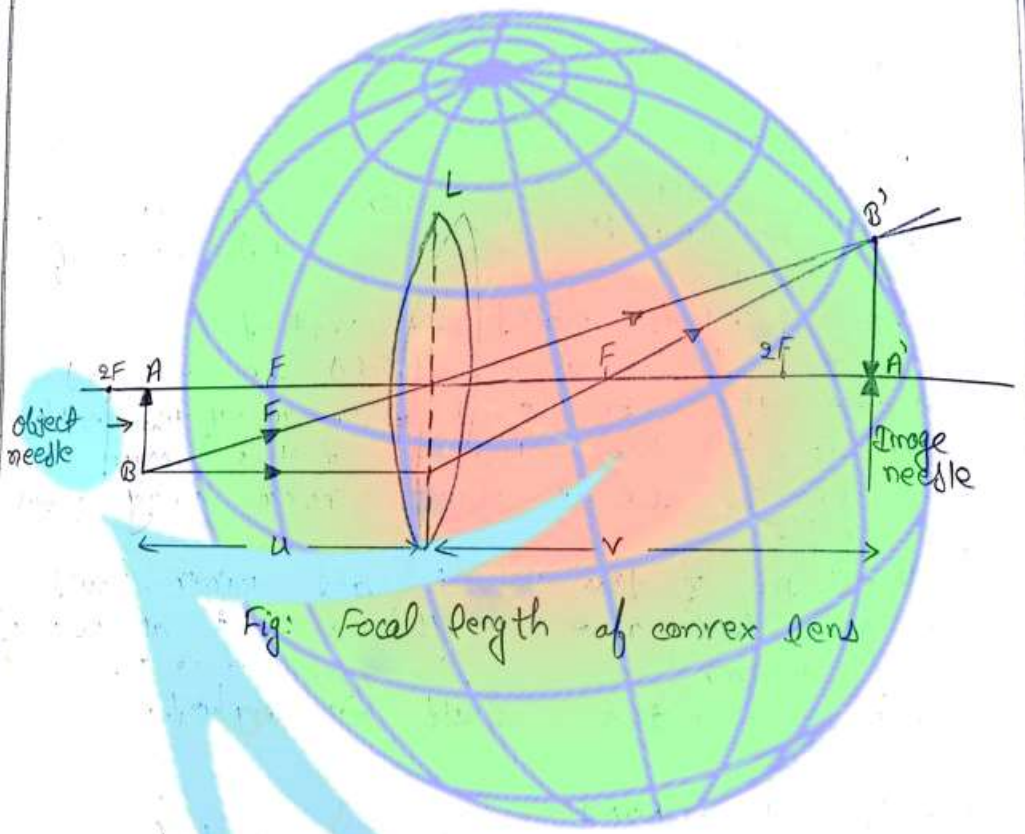


Fig: Focal length of convex lens

Ray diagram

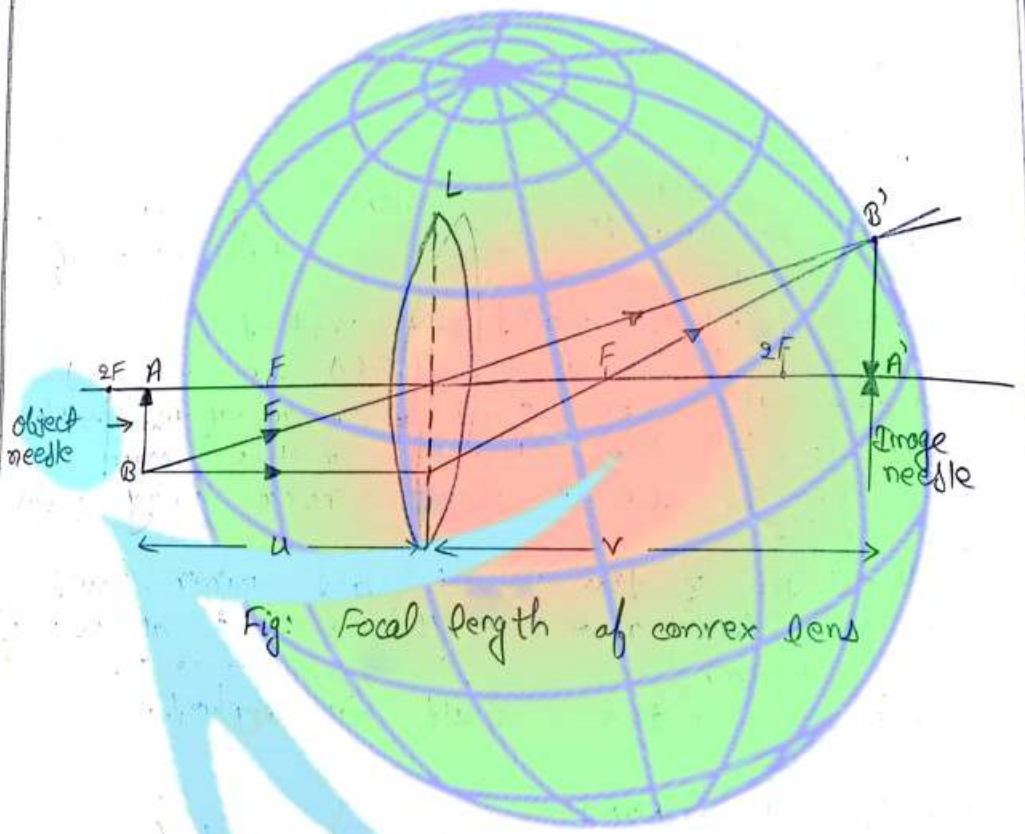
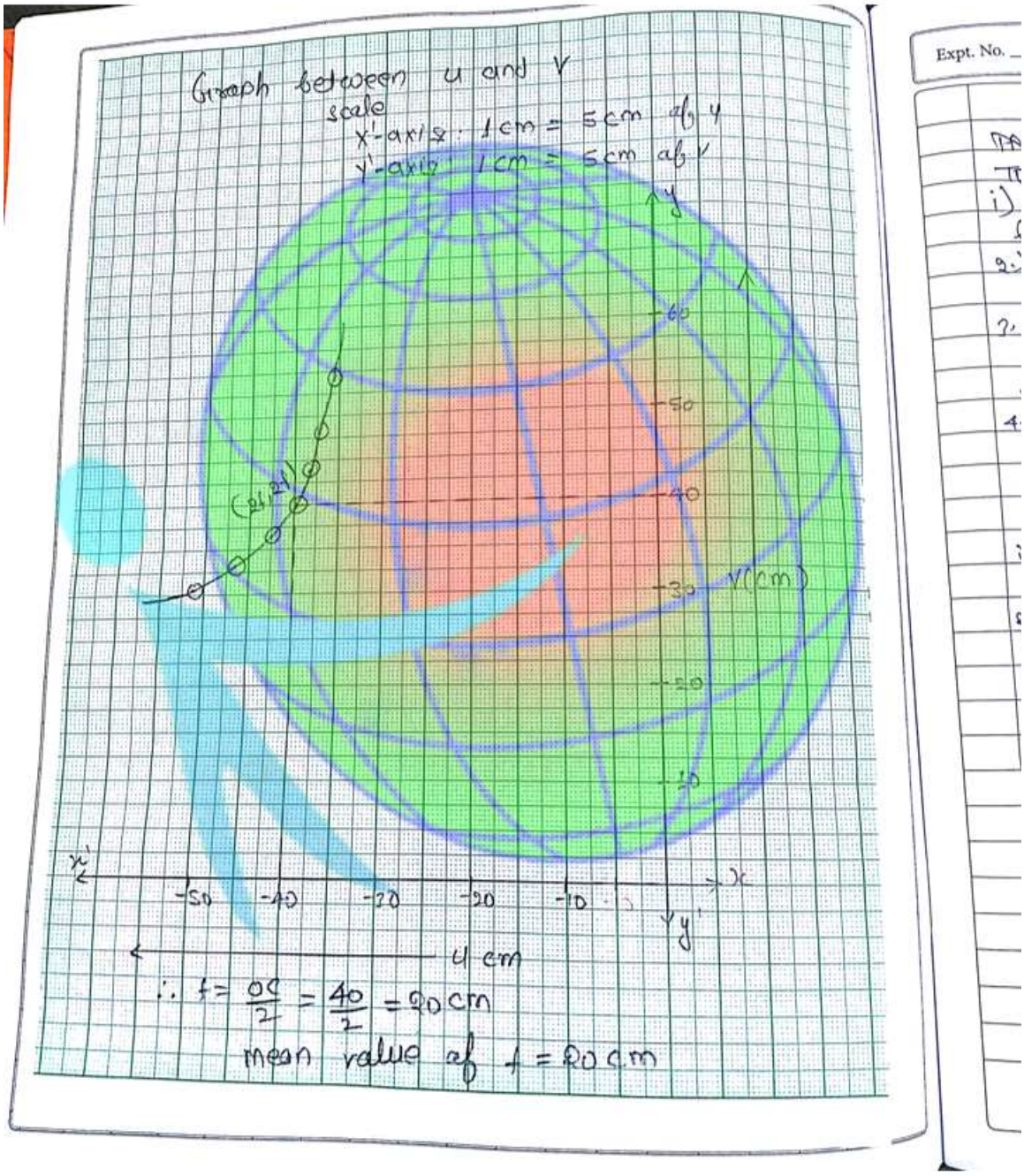


Fig: Focal length of convex lens


Graph between u and V
scale
X'-axis: 1 cm = 5 cm of u
Y'-axis: 1 cm = 5 cm of v
y
60
50
40
30
V(cm)
20
10
x'
x
-50
-40
-30
-20
-10
y'
u cm
∴ f = OC/2 = 40/2 = 20 cm
mean value of f = 20 cm

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PROCEDURE:

To determine rough focal length

1) The convex lens is mounted in the lens holder.
2) The lens is focal towards a distinct tree or building.
3) The image in obtained of the tree or building a white painted wall or screen. lens is adjusted by forward and backward motion
4) The measurement of the distance will give the rough focal length of the lens.

To set the lens.

1) The holder is clamped with the lens in a fixed upright and is kept at 50cm mark.
2) The lens is so adjusted that its surface is vertical and perpendicular to the length of the optical bench.
3) The upright is fixed in that position throughout.

To set the object needle

1) The thin optical needle is taken as object needle (O). It is mounted in outer laterally movable upright near zero end.
2) The needle (O) is moved upright and is clamped at a distance nearly 1.5 times the obtained focal length of lens

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3.) Height of the object needle is adjusted.
4.) The position of the index mark is noted on the base of the object needle upright.

To set the image needle:
1.) Thick optical needle(1) called image needle is moved in the fourth upright near the other end of the optical bench.
2.) Height of the needle is adjusted so that its tip is seen in line with the tip of the image when seen with right eye open.
3.) The parallax is checked by moving towards right. It occurs to be correct.
4.) The position of the index mark is noted on the base of the image needle upright.
5. The position of the index mark is recorded on the base of upright of the bench, the object needle and the image needle against the observation.

To set more observations.
1.) The object needle is moved again and again observation are taken.

OBSERVATION:
Rough focal length calculated (f) = +20cm
+1.5f = 1.5 * 20 = 30cm

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2f = 2×20 = 40cm

3.5f = 3.5×20 = 70cm

Sl. No.	OBJECT DISTANCE (u)	IMAGE DISTANCE (v)	u+v (cm)	uv	$f = \frac{uv}{u+v}$	AVERAGE f(cm)
1.	30	60	90	1800	20	
2.	32	57.6	85.6	1715.2	20.03	
3.	35	46.64	81.64	1632.4	20.00	
4.	38	42.22	80.22	1604.3	20	
5.	40	40	80	1600	20	20cm
6	44	36.67	80.67	1617.48	20	
7.	45	36	81	1620	20	
8	49	39.79	82.79	1655.86	20	
9.	50	39.33	89.33	1666.66	20	
10.	55	31.43	86.43	1708.57	20	

CALCULATIONS:

Calculation of focal length by graphical method

i) u-v graph

same scale is selected to represent and u and v on x and y axis. According to sign convention u is negative and v is positive. The graph obtained will be a rectangular hyperbola.

mean value of f = 20.0 cm

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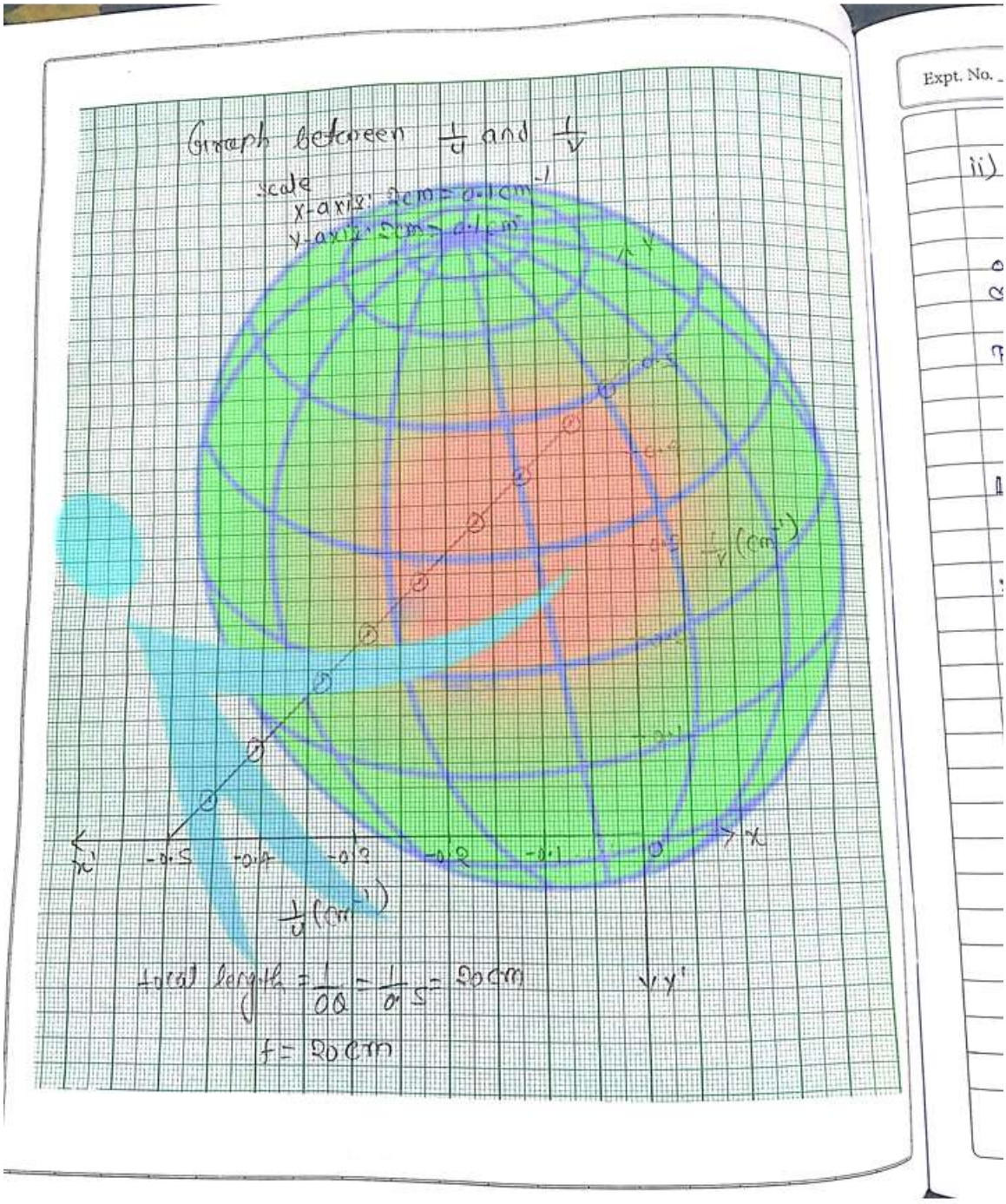
Graph between $\frac{1}{u}$ and $\frac{1}{v}$
scale
x-axis: 2cm = 0.1 cm^{-1}
y-axis: 2cm = 0.1 cm^{-1}
Y
X
$\frac{1}{v}$ (cm^{-1})
$\frac{1}{u}$ (cm^{-1})
-0.5
-0.4
-0.3
-0.2
-0.1
0
Y'
X'
Focal length = $\frac{1}{OQ} = \frac{1}{0.5} = 20$ cm
$f = 20$ cm

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ii)

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ii) $\frac{1}{u}$ and $\frac{1}{v}$ graph

since scale is chosen to represent $\frac{1}{u}$ and $\frac{1}{v}$ on X and Y axis respectively. By graph sign convention $\frac{1}{u}$ is negative & $\frac{1}{v}$ is positive.

RESULT:

$\frac{1}{f} = \frac{1}{OP} = 20\,cm.$

PRECAUTIONS:

1. The principal axis of the lens should be horizontal and parallel to the central line of the optical bench.
2. All the uprights should be vertical.
3. The tip of the needle, the centre of curvature and centre of lens should be at the same height.
4. While moving the paralax, the eye should be kept at the distance of minimum 30cm from the needle.
5. Tip to tip paralax should be removed.
6. Index correction should be applied between the image needle (I) and back surface of convex lens.
7. (O) should be placed such that only real, inverted image is formed.

SOURCE OF ERRORS:

1) The uprights may not be vertical.

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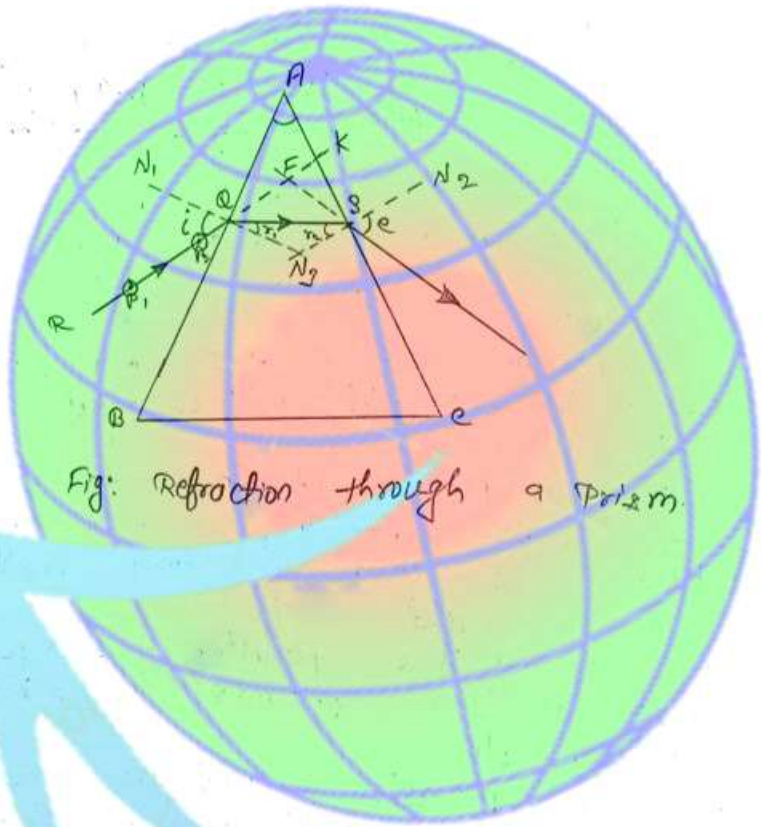

Fig: Refraction through a Prism.

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Experiment No. = 03

AIM OF THE EXPERIMENT:

i) To determine angle of minimum deviation for a given prism by plotting graphs between angle of incidence and angle of deviation.

ii) To determine the refractive index of the material (glass) of the prism.

APPARATUS REQUIRED:

Drawing board, a white sheet of paper, prism, drawing pins, pencil, half metre scale, office pins, graphs pins, a protractor.

THEORY

The refractive index (μ) of the material of the prism is given by

$$\mu = \frac{\sin\left(\frac{A + \delta_m}{2}\right)}{\sin\frac{A}{2}}$$

where,

δ_m = angle of minimum deviation

A = Angle of prism.

PROCEDURE:

i) A white sheet of paper is fixes on the

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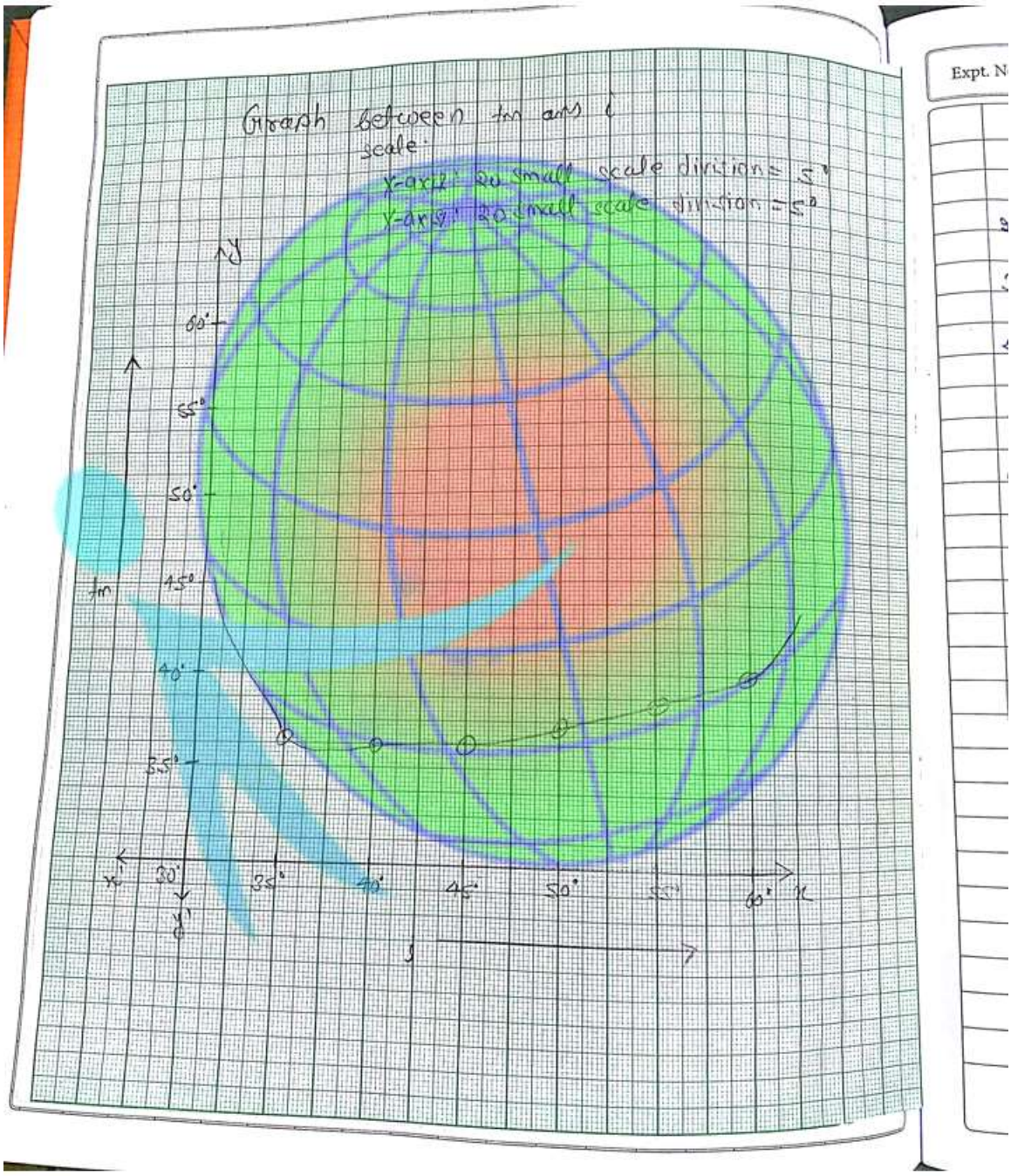
Graph between tan and
scale:
y-axis: 20 small scale division = 1
y-axis: 20 small scale division = 5°
tan
60°
55°
50°
45°
40°
35°
30°
35°
40°
45°
50°
55°
60°

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drawing board with the help of drawing pins.

2.) A straight line xx' parallel to the length is drawn nearly in the middle of paper.

3.) Point's P_1, P_2, P_3 ---- are marked on the straight line xx' at suitable distance (about 1 inch)

4.) Normals P_1N_1, P_2N_2, ---- on points P_1, P_2, P_3--- are drawn.

5.) straight lines QP_1, QP_2--- making angles 30°, 34°, 38°, --- 54° respectively with normals are taken.

6.) The prism with its refracting face AB in the line xx', at points P_1, taking in the middle is placed.

To measure for a different case,

a.) A straight line P_3 and P_4 is drawn to obtaines emegent rays

2. The line is produces in the boundary of the prism to meet produces incident ray of at points F_1, F_2, F_3. ---

3.) Angles are measures which give the angle of deviation at different value of (i)

OBSERVATIONS:

Angles of prism = 60°

Sl.No.	Angle of Incidence(i)	Angle of deviation(+m)
1.)	90° - 30° = 60°	40.5°
2.)	90° - 34° = 56°	40°

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3.	$90^\circ - 28^\circ = 52^\circ$	39.5°
4.	$90^\circ - 42^\circ = 48^\circ$	39°
5.	$90^\circ - 46^\circ = 44^\circ$	38°
6.	$90^\circ - 50^\circ = 40^\circ$	39°
7.	$90^\circ - 54^\circ = 36$	40°

CALCULATION:

The graph is plotted against angle of deviation (δm) and angle of incidence (i). The angle of minimum deviation corresponds to the lowest point of the curve.

Let the value of angle of minimum deviation $\delta m = 38^\circ$

Then,

$$\mu = \frac{\sin\left(\frac{A + \delta m}{2}\right)}{\sin A/2}$$

$$\mu = \frac{\sin\left(\frac{60^\circ + 38^\circ}{2}\right)}{\sin 60^\circ/2}$$

$$\mu = \frac{\sin 49^\circ}{\sin 30^\circ} = \frac{7.5}{5}$$

$$\mu = 1.5$$

RESULT:

i) i - δm graph indicates that as the angles of

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incidence(i) increase, the angle of deviation fm first decreases, attains a minimum value fm and then again starts increasing for further increse in angle of incidence.

ii) Angle of minimum deviation fm $i = 38°$

iii) Refractive index of the material of prism $\mu = 1.5$

PRECAUTIONS:

1) A sharp pencil should be used for making boundary of pencil and for pin pricks.
2) The angle of incidence should be between 30-60°
3) The distance between the two pins should be not be less then 10cm.
4) The pins should be fixed vertically
5) The pins should be fixed vertically.
6) The same angle of (incidence) x prism should be used for all observation.

SOURCE OF ERRORS:

1) Pin prism may be thick.
2) Measurement of angles may be wrong.

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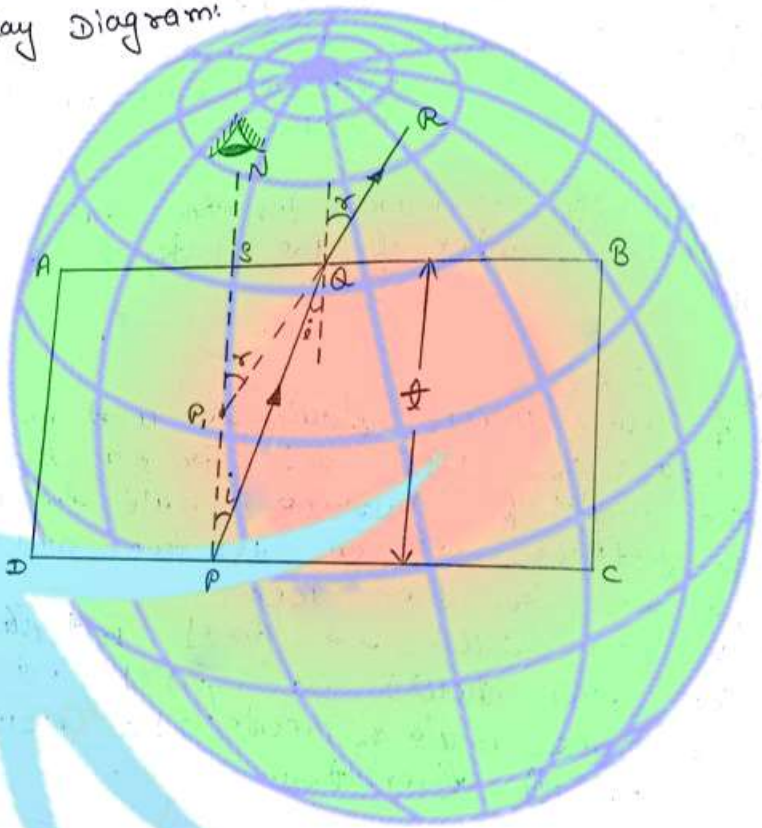
Ray Diagram:



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Experiment No = 04

AIM OF THE EXPERIMENT:
To determine the refractive index of a glass slab, using a travelling microscope.

APPARATUS REQUIRED.
Three glass slabs of different thickness but same material, a travelling microscope, lycopodium powder.

THEORY:
When an object in the dense medium is viewed from the rarer medium it appears to be situated nearly at refractive index of the denser medium with respect to rarer medium be 'u' then,

$$u = \frac{\text{Real depth}}{\text{Apparent depth}}$$

∵ 50 M.S.D = 1 cm
∴ 1 M.S.D = 1/50 = 0.05 cm
∴ 50 V.S.D = 49 M.S.D
1 V.S.D = $\frac{49}{50}$ = 0.98 × 0.05
= 0.049 cm

∴ least count = 1 M.S.D − 1 V.S.D = 0.05 − 0.049 = 0.001 cm

PROCEDURE:
ADJUSTMENT OF MICROSCOPE.
1. The travelling microscope (m) is placed on the

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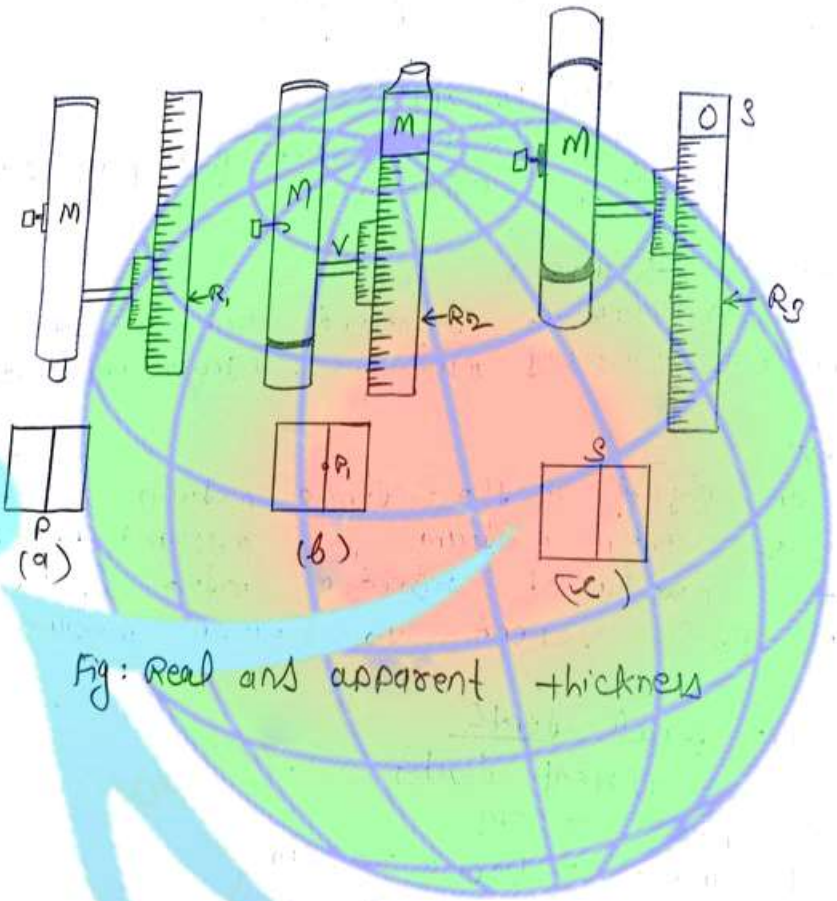

Fig: Real and apparent thickness

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table near a window so that sufficient ν falls on it.

2. The levelling screws are adjusted so that the base of the microscope becomes horizontal.

3. microscope is made horizontal. The position of eye piece is adjusted so that sufficient light falls on it.

4. The screw constants of the vernier scale of the microscope is determined.

Other steps:

5.) A black-ink cross-mark is made on the base of the microscope. The mark will serve as point

6.) The microscope is made vertical and focuses on the cross at P, so that there is no parallax between the cross-wires and the image of mark P.

7.) The main scale and vernier scale readings are noted on the vertical scale.

8. The glass slab of least thickness is placed over the mark B.

OBSERVATIONS AND CALCULATIONS:

No. of OBS	MAIN SCALE (x)	VERNIER SCALE	VERNIER SCALE (y)	Total (x+y)	C-A	C-B	$\mu = \frac{C-A}{C-B}$
1. A	4.3	7	0.007	4.307			
B	4.9	2	0.002	4.902	2.085	1.440	1.41

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C	6.3	42	0.007	6.342	2.085	1.440	1.41
R.A	4.1	5	0.002	4.105			
B	4.8	80	0.042	4.880			
C	6.2	40	0.005	6.240	2.135	1.360	1.56
S.A	4.1	10	0.080	4.110			
B	4.8	35	0.040	4.835			
C	6.1	45	0.025	6.145	2.025	1.910	1.55

So, the mean of μ is

$$\mu = \frac{\mu_1 + \mu_2 + \mu_3}{3} = \frac{1.41 + 1.56 + 1.55}{3} = 1.5$$

RESULT:

The ratio $\frac{\sin i}{\sin r}$ is constant. It gives the refractive index of the material of the glass slab. The refractive index of glass slab is 1.5

PRECAUTIONS:

1. In microscope, the parallax should be properly removed.
2. The microscope should be moved in upper direction only to avoid backlash error.

SOURCES OF ERRORS:

1. The microscope scale may not be properly calibrated.

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