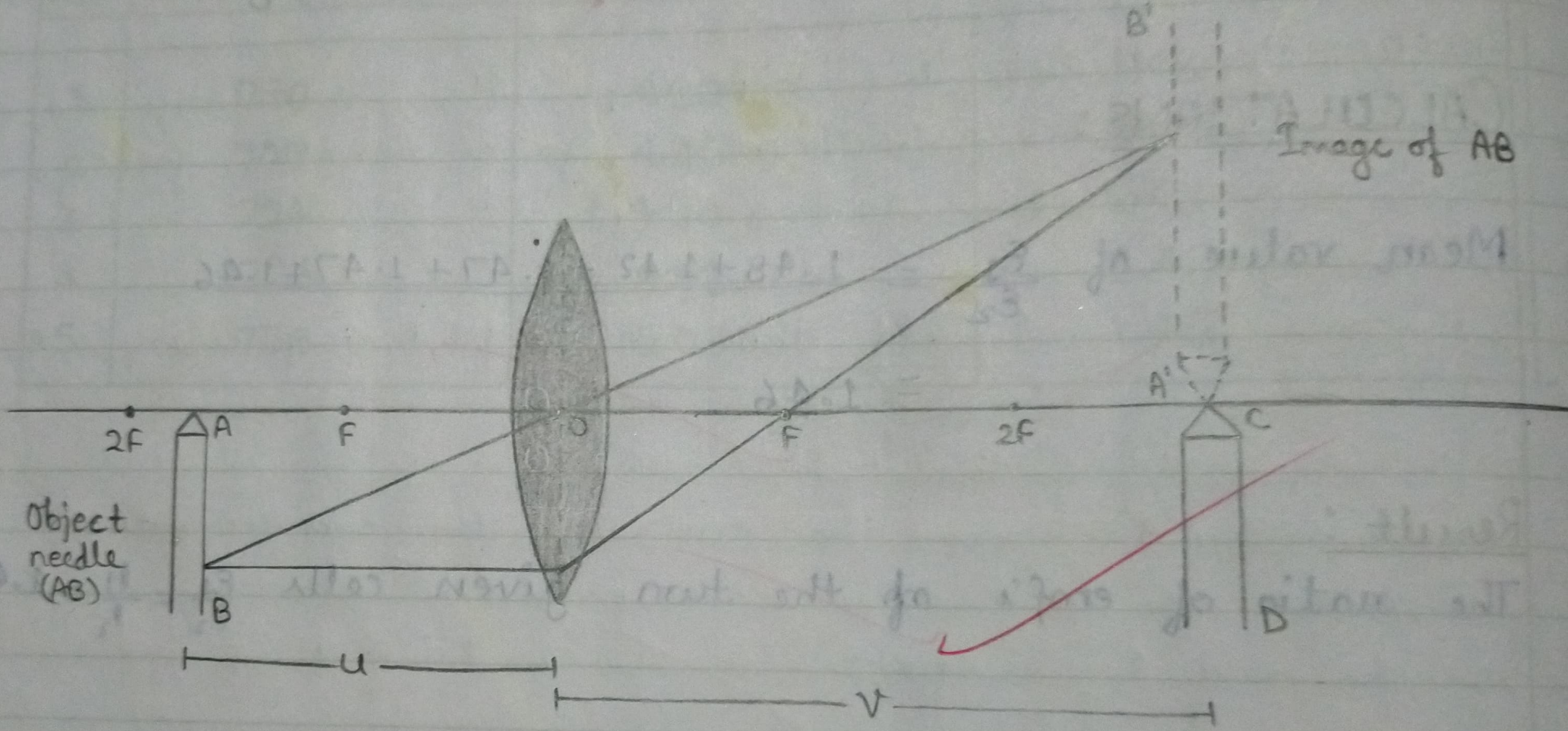
B'
Image of AB
A'
2F
A
F
O
F
2F
C
Object needle (AB)
B
D
u
v

EXPERIMENT - 1

AIM- To find the focal length of a convex lens by plotting graph between u and v.

APPARATUS REQUIRED- A convex lens of short focal length (say 15-20 cm), two needles, three uprights, one clamp, an optical bench, a half metre rod and knitting needle.

THEORY

The relation between u, v and f of a convex lens is

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

where, f = focal length of convex lens.
u = Distance of object needle from optical centre of the lens.
v = Distance of ~~lens~~ image needle from optical centre of the lens.

PROCEDURE-

(i) Find the rough focal length of the given convex lens by focussing a sharp, clear image of a distant object on a white paper and measuring this distance between the lens and the white paper with a metre scale.

(ii) If the optical bench is provided with levelling screws, then level it by using a spirit level.

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OBSERVATIONS -

Sl. No.	Position of lens	Position of object	Position of image	u (cm)	v (cm)	f (cm
1	80 cm	40 cm	120 cm	-40	40	20
2	80 cm	35 cm	116.5 cm	-45	36.5	20.15
3	80 cm	30 cm	113.6 cm	-50	33.6	20.09
4	80 cm	30 cm	113.6 cm	-50	33.6	20.09
5	80 cm	25 cm	111.9 cm	-55	31.9	20.18
6	80 cm	20 cm	111.3 cm	-60	31.3	20.56
7	80 cm	40 cm	120 cm	-40	40	20

(iii) Mount the convex lens (held in its holder) on the central upright of the optical bench. Also mount the two needles on the remaining two uprights. Arrange the tips of the needles at the same vertical height as the centre of the lens.

(iv) Mark the object needle as AB and the image needle as CD. and put a distinguishing mark on one of them by rubbing its tip with piece of chalk.

(v) Find the index corrections for u and v using a knitting needle.

(vi) Shift the position of the object needle AB to a distance greater than 2f from the lens. Look from the other side of the lens along its principal axis near the end of the bench. If the setting is correct, an inverted, real image A'B' is seen. Now adjust the position of the second needle CD such that the parallax between the image of the object needle and the image needle is removed. The position of the second needle is adjusted so that the parallax is removed tip to tip. (shown in fig.)

(vii) Note the position of the lens, the object needle and the image needle on the bench scale and thus find the observed values of u and v. Apply the index corrections to get the corrected values of u and v.

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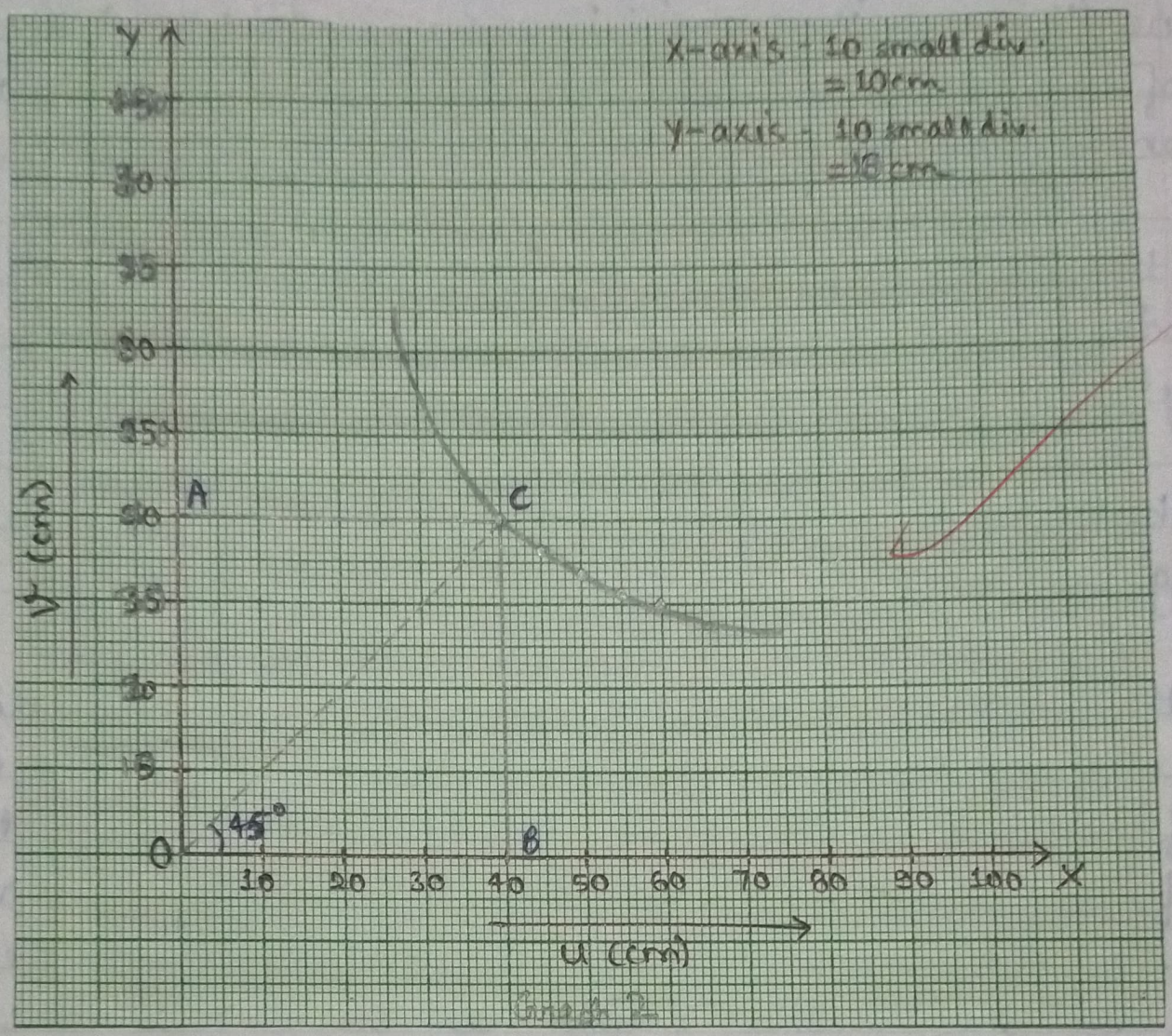


$u = 40\text{cm}, \quad v = 40\text{cm}$

$u = v = 2f$

$\therefore f = \frac{u}{2} = \frac{40}{2} = 20\text{cm}$

$\therefore \boxed{f = 20\text{cm}}$

(viii) Repeat the steps for 5 different positions.

OBSERVATION -

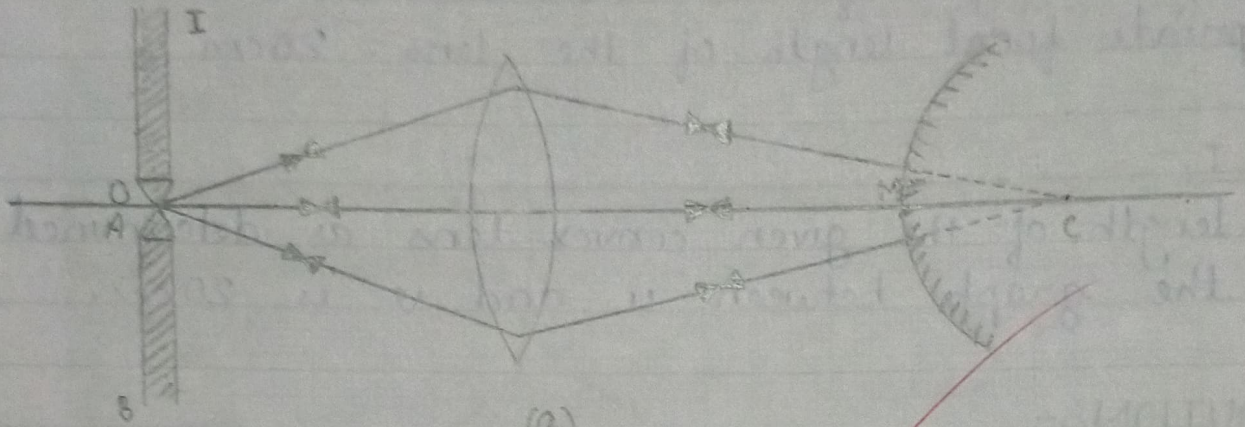
Rough focal length of the convex lens = 18cm
Appropriate focal length of the lens = 20cm

RESULT -

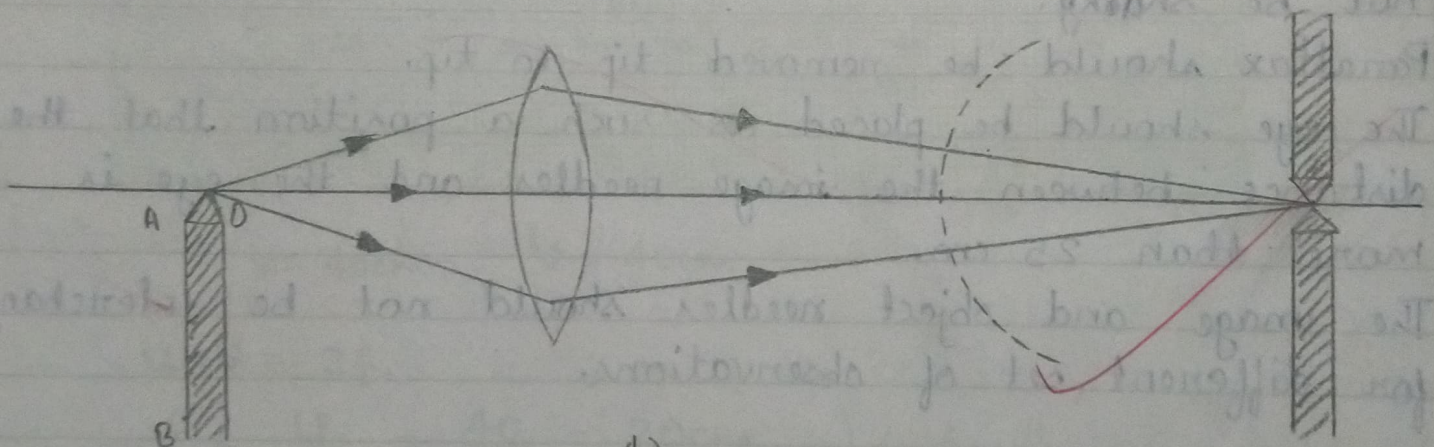
Focal length of the given convex lens as determined from the graph between u and v is 20 cm.

PRECAUTIONS-

(i) The tips of the needles should be as high as the optical centre of the lens.
(ii) The upright carrying the lens and the needles should not be shaaky.
(iii) Parallax should be removed tip to tip.
(iv) The eye should be placed as such a position that the distance between the image needles and the eye is more than 25 cm.
(v) The image and object needles should not be interchanged for different set of observations.



(a)



(b)

EXPERIMENT - 2

AIM - To find the focal length of a convex mirror using a convex lens.

APPARATUS REQUIRED - Optical bench, four uprights, convex mirror, convex lens, knitting needle, metre scale, pins, lensholder and mirror holder.

THEORY - Suppose a convex lens makes the image of an object AB at C on the other side of the lens. If the convex mirror is placed in the path of rays will fall on convex mirror as shown in fig.(b). This will cause refraction of rays and a real and inverted image is formed which coincides with the object AB at point O as shown in fig.(a). In this case, the distance between the pole of mirror P and C is equal to the radius of curvature R of the convex mirror. Using R we can calculate f for the given convex mirror by using relation

$$f = \frac{PC}{2} = \frac{R}{2}$$

PROCEDURE -

(i) Mount the convex mirror M and convex lens L and the object needle O on an optical bench as shown in fig (a) Look for the inverted image of O through the system of

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OBSERVATION TABLE -

Sl. No.	Position of convex mirror (M)	Position of image needle (I)	Radius of curvature, R = M − I	focus, $f = \frac{R}{2}$
1	42.8 cm	2 cm	40.8 cm	20.4 cm
2	47.7 cm	5.5 cm	42.2 cm	21.1 cm
3	45 cm	5 cm	40 cm	20 cm

the lens L and the mirror M by adjusting the position of O or L with respect to that of the mirror.

(ii) Remove the parallax between the object needle O and its inverted image and note the position of O, L and M on the bench scale.

(iii) Remove the mirror M and do not disturb the lens L and O at all. Take another needle I' and place it on the other side of the lens. (fig(b))

(iv) Take 3-5 sets of observations for different positions of O and L.

(v) Determine the index correction between the mirror M and the image needle I' if any.

OBSERVATION-

Approximate focal length of the convex lens = 18.5 cm
Least count of optical bench = 0.1 cm
Index correction, e = actual distance - observed distance, if any, should be corrected.

CALCULATION-

Mean focal length of the convex mirror

$$f_{mean} = \frac{f_1 + f_2 + f_3}{3} = 20.5 \text{ cm}$$

RESULT-

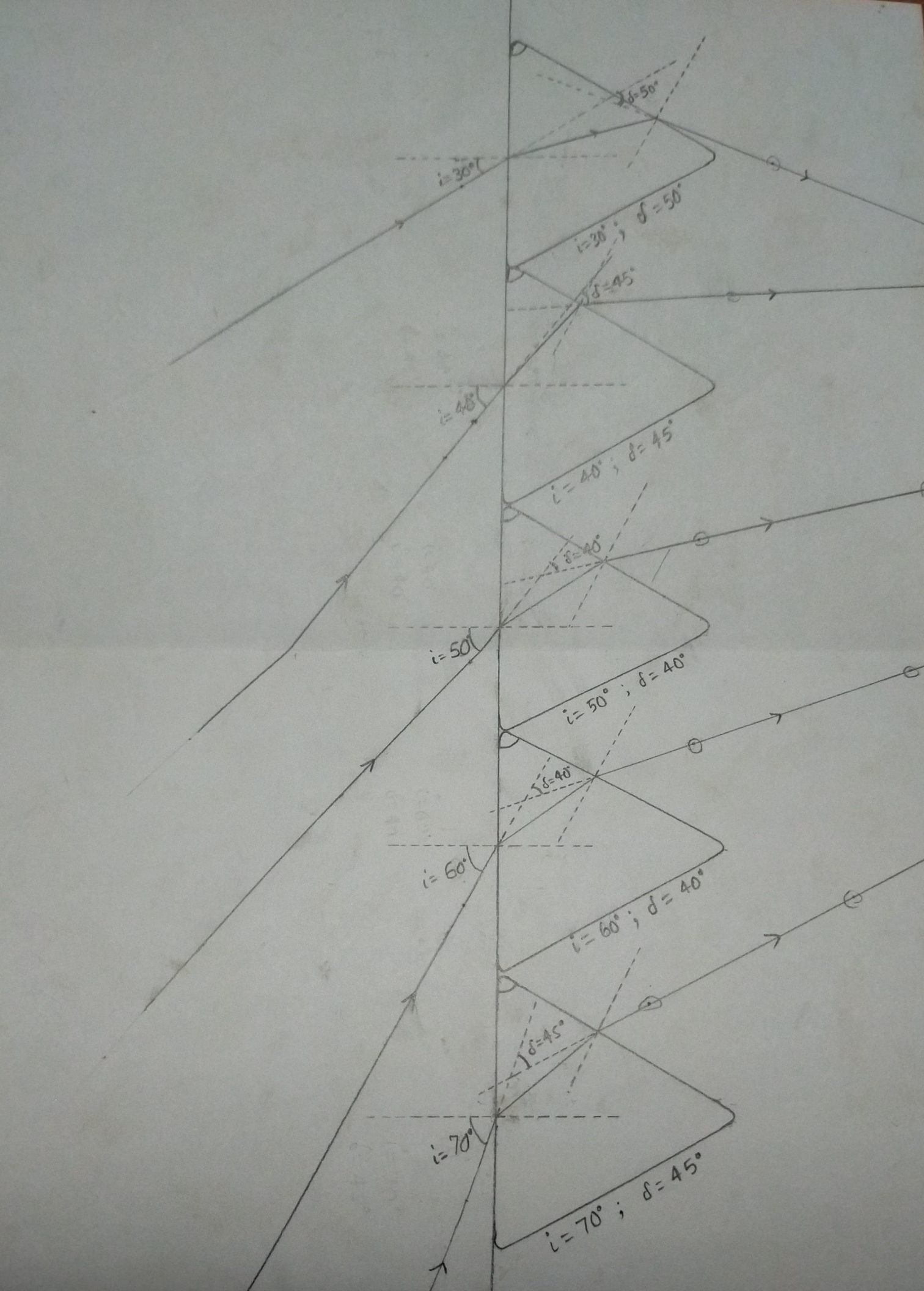
The focal length of the convex mirror is = 20.5 cm.

PRECAUTIONS-

(i) The aperture of the mirror should be small.

(ii) The convex lens should be kept close to the convex mirror.

(iii) The tip of image should not overlap with the tip of ~~gen~~ image needle.


δ=50°
i=30°
i=30° ; δ=50°
δ=45°
i=40°
i=40° ; δ=45°
δ=40°
i=50°
i=50° ; δ=40°
δ=40°
i=60°
i=60° ; δ=40°
δ=45°
i=70°
i=70° ; δ=45°

EXPERIMENT - 3

AIM - To determine the angle of minimum deviation for a given glass prism by plotting a graph between the angle of incidence and angle of deviation.

APPARATUS REQUIRED - Glass prism, drawing board, pins, drawing pins, white paper sheet, pencil meter scale, protractor, etc.

Theory:

When a light ray passes through a glass prism it undergoes refraction, the way bends towards the base of the prism through an angle δ, called the angle of deviation. For a prism, δ depends on i and varies as for small angle of incidence i, angle of deviation δ is large. As i increases, δ first decreases to δ_m and then after it increases.

PROCEDURE -

(i) Fix a white sheet of paper on the drawing board with the help of fixing pins.

(ii) Draw the outline of the prism. Mark A, B and C near the vertices of the triangle.

(iii) Take a point P on the boundary and draw a normal at that point to the side AB. Draw a line PQ at an angle 30° with the normal.

(iv) Fix two pins on the line PQ vertically to the plane of the

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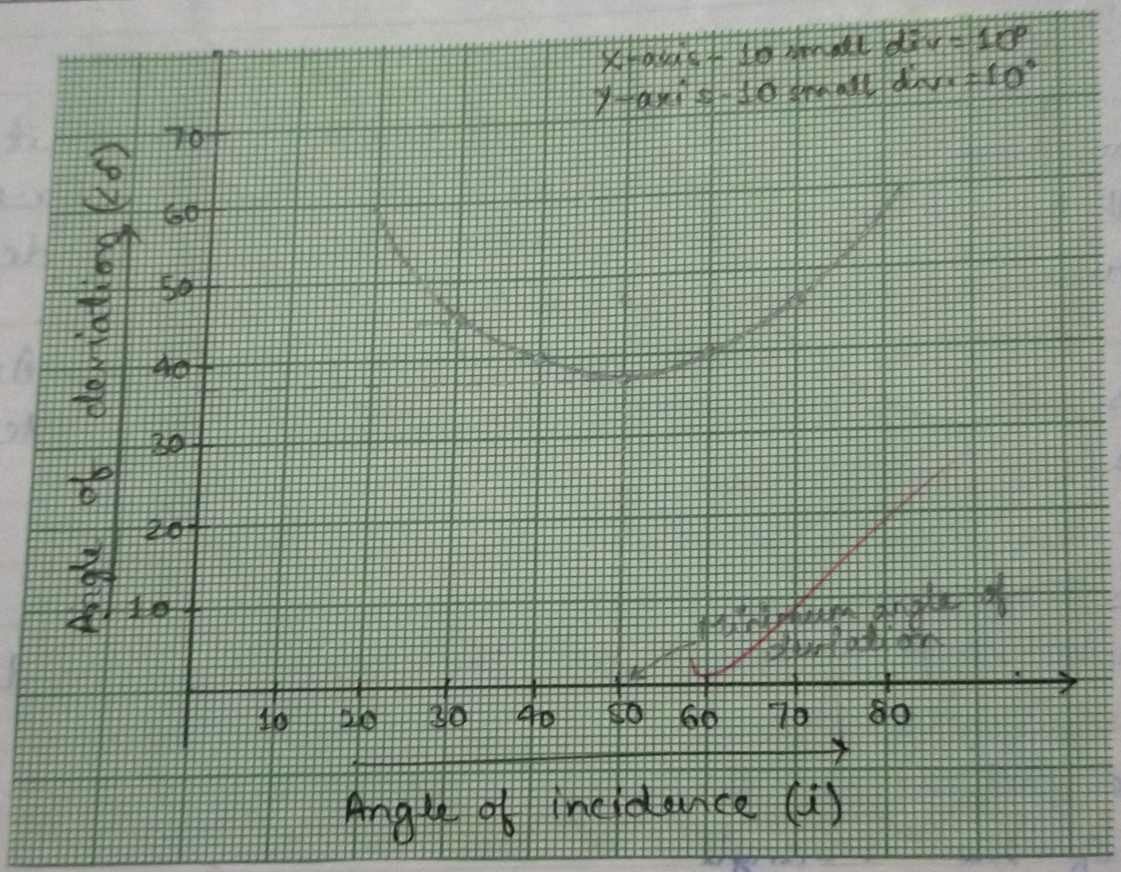
OBSERVATION - TABLES

S. No.	Angle of incidence	Angle of deviation
1	30°	45°
2	40°	40°
3	50°	37°
4	60°	40°
5	70°	45°



paper such that the distance between the pins is not so short. The line joining P_1 and P_2 acts as incident ray.

(v) Position the prism on boundary again.

(vi) Observe the two pins in a straight line from the side BC and keep two more pins such that all the 4 pins appear to be in a straight line.

(vii) Remove the prism. Mark the positions of all pins. Line joining the P_3 and P_4 acts as emergent rays.

(viii) The angle between the extended incident ray and emergent ray gives the angle of deviation.

(ix) Repeat the same process for other angle of incidence.

RESULT-

The angle of minimum deviation from i vs d graph is 37°.

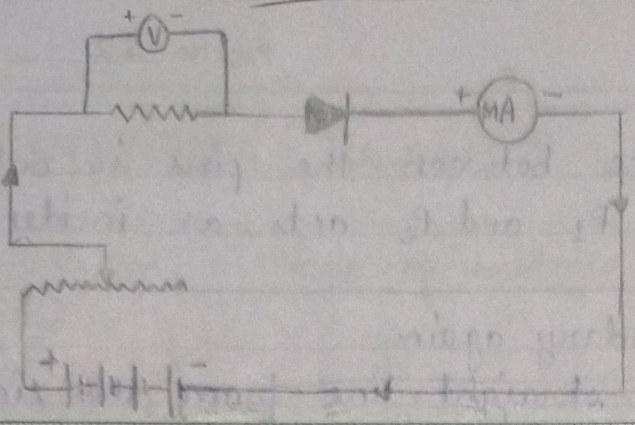
PRECAUTIONS-

(i) All the pins should be vertical.

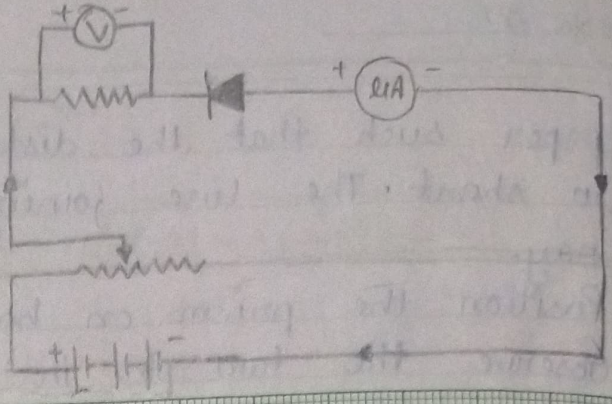
(ii) The surface of the glass prism should be clean.

(iii) While plotting i vs d graph a smooth freehand curve should be drawn to ensure that a maximum number of points lie on the curve.

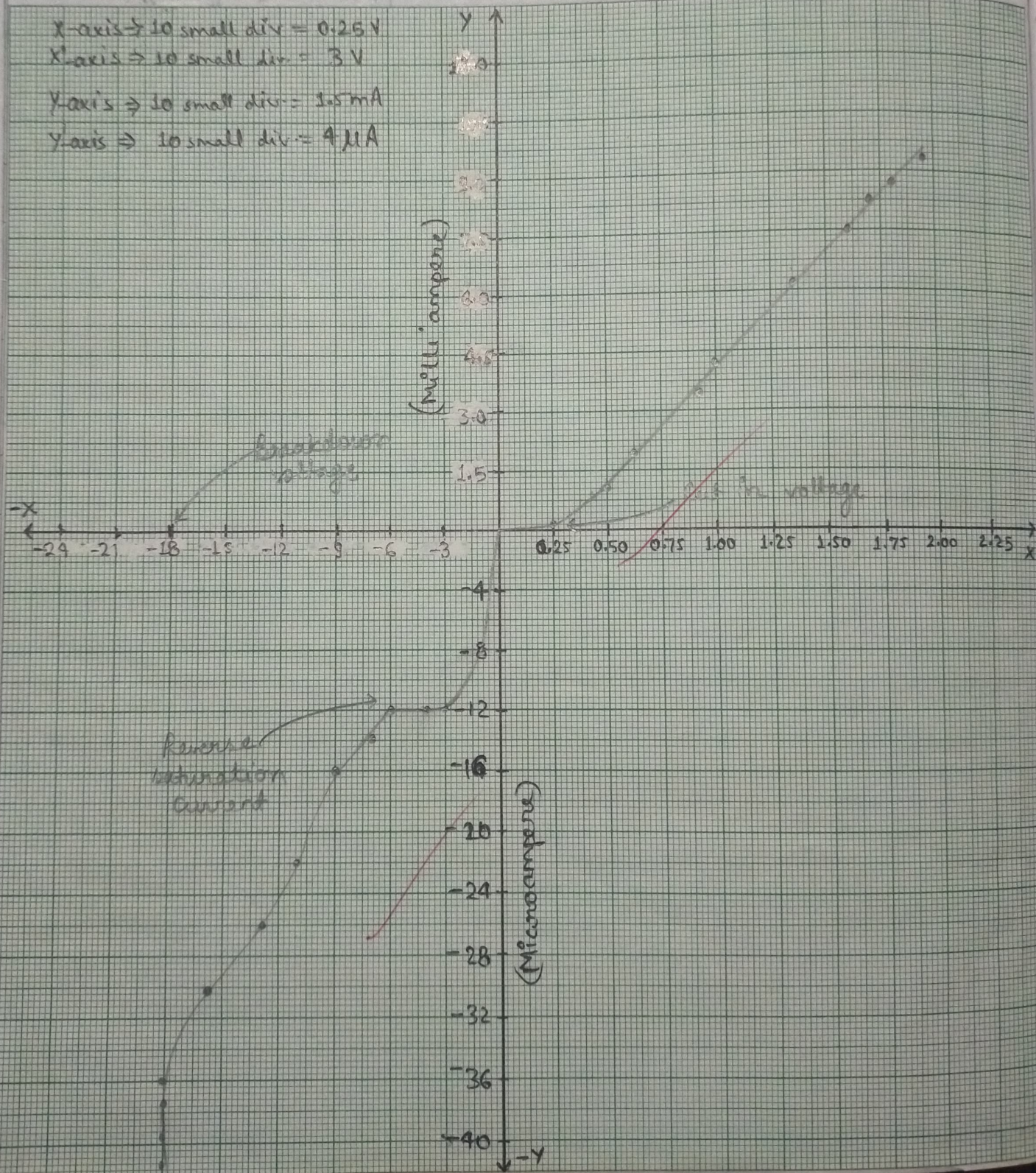
Forward bias



Reverse bias



X-axis → 10 small div = 0.25 V
X'-axis ⇒ 10 small div = 3 V
Y-axis ⇒ 10 small div = 1.5 mA
Y'-axis ⇒ 10 small div = 4 μA



EXPERIMENT-4

AIM - To draw I-V characteristic curve of a p-n junction in forward bias and reverse bias.

APPARATUS REQUIRED p-n junction diode, battery, rheostat, resistance, millimeter, microammeter, voltmeter and connecting wires.

THEORY -

Forward bias diode. - A diode is said to be forward bias if p-end of the junction is at higher potential with respect to n-end of the junction.

Reverse bias diode - A diode is said to be reverse bias if p-end of the junction is at lower potential with respect to n-end of the junction.

PROCEDURE -

(a) **Forward bias** -

(i) Make the connections as shown in figure.

(ii) Adjust the rheostat of the potential divider arrangement to a minimum value and slowly increase the potential difference across the diode by varying the rheostat.

(iii) Note the reading in the voltmeter and corresponding reading in the ~~volt~~ ammeter.

(iv) Vary the potential difference so as to have 10-12 observations

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OBSERVATION -

Forward bias :

S.No.	Voltmeter reading	Milliammeter reading	Corrected reading of V (volt)	Corrected reading of A (milliampere)
1	0.40	0.4	0.25	0.2
2	0.65	1.4	0.50	1.2
3	0.75	2.0	0.60	1.8
4	1.00	3.4	0.85	3.2
5	1.15	4.4	1.00	4.2
6	1.50	6.4	1.35	6.2
7	1.75	7.8	1.60	7.6
8	1.85	8.4	1.70	8.2
9	1.95	9.0	1.80	8.8
10	2.10	9.6	1.95	9.4

Reverse bias :

S.No.	Voltmeter reading	Microammeter reading	Corrected reading of V (volt)	Corrected reading of A (microampere)
1	2.5	6	1.0	8
2	5.0	10	3.5	12
3	6.0	10	4.5	12
4	7.5	10	6.0	12
5	9.0	12	7.5	14
6	10.5	14	9.0	16
7	12.5	20	11.0	22
8	15.0	24	13.5	26
9	17.5	28	16.0	30
10	20.0	34	18.5	36
11	21.5	∞	20.0	∞
12	22.0	∞	20.5	∞
13	22.5	∞	21.0	∞

(b) Reverse bias

Make the connections as shown in fig. 2.

Repeat the (ii), (iii) and (iv) steps of forward bias.

OBSERVATIONS -

Forward Bias

Least count of voltmeter = 0.05V

Least count of milliammeter = 0.2 mA

Zero error of voltmeter = 0.15V (+ve)

Zero error of milliammeter = 0.2mA (+ve)

Reverse Bias

L.C. of voltmeter = 0.5V

L.C. of microammeter = 2 μA

Zero error (voltmeter) = 1.5V (+ve)

Zero error (microammeter) = 2 μA (+ve)

PRECAUTIONS -

(i) All the connections should be neat and tight.

(ii) Voltmeter, ammeter should be of appropriate range and least count should be used.

(iii) The battery connections of p-n junction diode should be checked and in forward biasing it should be ensured that p is connected to positive and n to the (-ve) of battery.

(iv) Never cross the limits specified by the manufacturer otherwise the diode will get damaged.

RESULT -

The value of threshold voltage for given diode = 0.25V

The value of reverse saturation current for the given diode = ~~-1 μA~~ -12 μA