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Use_Of_ Vernier_Callipers

Theory :

By using ordinary scale; reading could be obtained correct up to 0.1 cm because it is graduated in cm and mm i.e. least count is 1mm. Hence a meter scale cannot be used for measurement of length if accuracy of a higher order than 0.1c rn is desired. A vernier calliper and micrometer screw gauge can be used in such cases. Vernier calliper is a device invented by P.Vernier (1580 - 1673). Vernier calliper consists of a short auxiliary scale, capable of sliding along the edge of the main scale, the zero line of vernier acting as the index. The scale which is divided into say 'n' equal divisions is generally equal in length to (a n - 1) divisions of the main scale where a = 1 or 2 enables the experimenter to read up to $\frac{1}{10}$ of the main scale division i.e. (1 x 10 - 1) = 9, 10 divisions of vernier = 9 divisions of main scale i.e. The least count would be equal to the ratio of the smallest divisions on the main scale to the number of divisions on the vernier scale.

Zero error

If the zero line of the vernier scale does not coincide with the zero line of the main scale when the jaws of the calipers are brought together, in contact with each other than the instrument is said to have a zero error. The zero error is said to be positive if the zero line of the vernier scale stands to the right of the zero' of the main scale [fig. (c)] and negative if to the left [fig (b)]

To determine zero error bring the jaws of the instrument together. Let us suppose that X^{th} division of the vernier scale coincides with some divisions on the main scale. In this case, the zero error is - (n - x) divisions on the vernier scale i.e. - (n - x) x L.C.

If the zero line of the vernier coincides with the zero line of the main scale, there is no zero error. [fig (a)]

Aim:

To find the volume of a sphere and a hollow cylinder by using Vernier calliper.

Apparatus:

Vernier calliper, spherical body, hollow cylinder, etc.

Formula:

(1) Volume of spherical body = $\frac{4}{3}\pi r^3$

(2) Volume of hollow cylinder = $\pi r^2 h$ (if thickness is negligible)

Diagram:

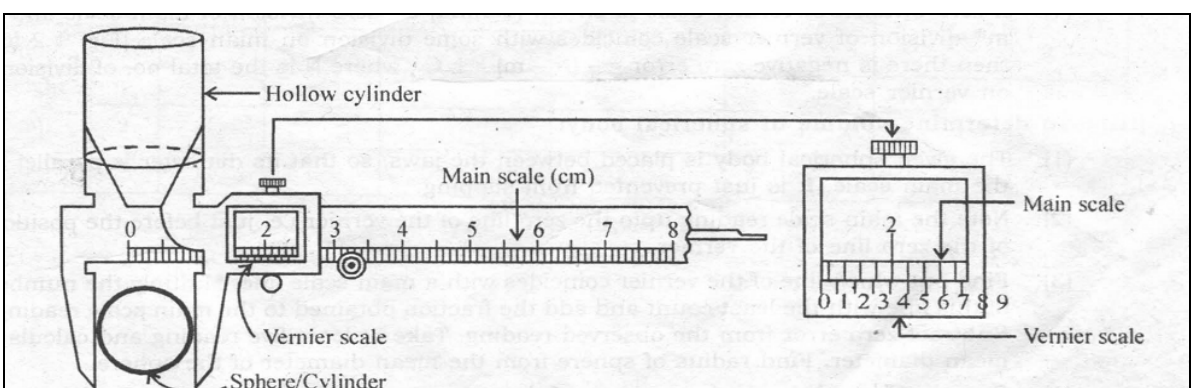


Fig. 1.1 Vernier Callipers

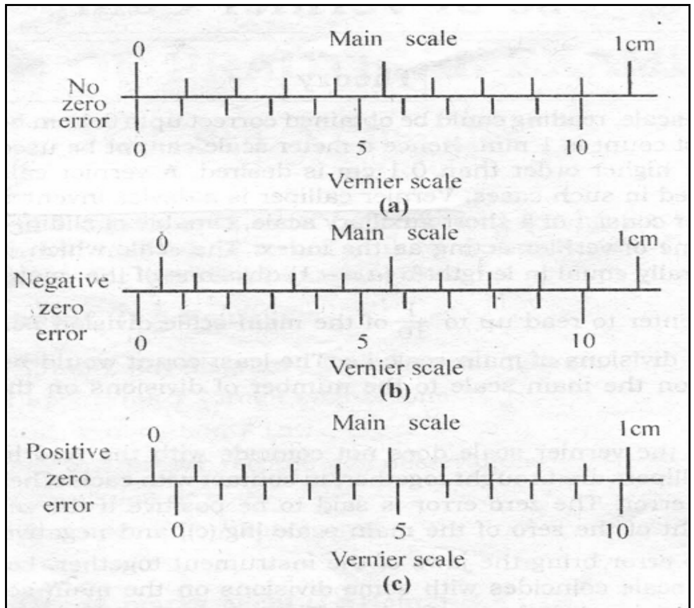


Fig. 1.2 To find zero error

<u>Procedure:</u>

(I) To find the least count :

(1) Note the smallest division on the main scale and the total number of divisions on vernier scale of vernier calipers.

(2) Hence find least count of the vernier calipers.

(II) To find the zero error:

(1) Bring the two jaws of vernier calipers in contact.

(2) If zero divisions of main scale coincide with zero division of vernier scale, then there is no zero error [Fig.1.2 (a)].

(3) If zero division of vernier scale is on right (ahead) of zero division of main scale, and if m''' division of vernier scale coincides with some division on main scale [Fig.1.2.(b)] then there is positive zero error = + m x L.C.

(4) If zero division of vernier scale is on left (behind) of zero division of main scale and if m= division of vernier scale coincides with some divis ion on main scale [Fig. 1.2 (c)] then there is negative zero error = - (N- m) x L.C, where N is the total no. of divisions on vernier scale

(III) To determine volume of spherical body:

(1) The given spherical body is placed between the jaws, so that its diameter is parallel to the main scale. It is just prevented from slipping.

(2) Note the main scale reading unto the zero line of the vernier i.e. just before the position of the zero line of the vernier.

(3) Find out which line of the vernier coincides with a main scale line. Multiply the number of this line with the least count and add the fraction obtained to the main scale reading. Subtract zero error from the observed reading. Take at least five reading and calculate mean diameter. Find radius of sphere from the mean diameter of the sphere.

(4) By using formulae calculate volume of the sphere.

(IV) Volume of hollow cylinder:

(i) By using vernier calliper radius and height of the cylinder is measured. For this repeat the above procedure.

(ii) By using formula calculate volume of a cylinder

<u>Precautions</u>

(1) Hold the object between jaws lightly otherwise there is deformation in size and shape of the object.

(2) Observation should be taken in different directions in the plane of object.

(3) Use magnifying lens to read the coinciding division.

Use_Of_Micrometer_Screw_Gauge

Theory :

By using Micrometer Screw Gauge, we will be able to read very accurately and correctly even upto 160 of a mm. The micrometer screw gauge is an instrument for measuring the linear dimensions of small objects. It consist of a U shaped metal frame with a small projecting cylindrical metal piece fixed at one and a nut fixed at the other end. A projecting metal piece has a flat face.

A screw with a flat end turns in the nut. The screw can be rotated with the help of thimble attached to the other end of the screw. It consist 0 two scales-a linear scale (main scale) and a circular scale. Micrometer screw is based on the principle of screw. When the head of the screw is turned through one complete turn, the tip of the screw moves through a distance between two consecutive threads in the direction at the axis of the screw. This is called pitch of the screw.

$$\text{Least count of micrometer screw} = \frac{pitch}{\text{Total no. of divisions on the head scale}}$$

To find the pitch of the screw, notice the distance through which the edge of the screw head moves along the main scale for ten complete rotations of the head. .pitch is equal to this distance divided by ten.

The screw head is rotated till the tip of the screw touches the nut on the jaw. If the zero marks on the circular scale (head scale) coincides with the reference line of the main scale it means that there is no zero error as 'shown in fig. (a). If the zero line on the head scale lies below the reference line on the head scale, the zero error is positive as shown in fig.(b) and if the zero line on the head scale lies above the reference line on the head scale, the zero error is negative as shown in fig. (c).

To calculate zero error when it is present notice which line on the head scale coincides with the reference line. Suppose it is x. Then if zero error is positive it is given by x×L.C. If the zero error is negative it is given by (n - x) x L.C., where n = total no. of divisions on the head scale. In either case the correct reading is obtained by subtracting the zero error from the observed reading.i.e.

(i) Correct reading = Total reading - x ×.L.C. in case of positive zero error

(ii) Correct reading = Total reading + (n - x) × L.C. in case of negative zero error.

Back lash error:

In some micrometers there is some space for the play of the screw. This space arises because of ill-fitting or wear and tear between the nut and the screw. As a result if the screw is rotated in one direction and then rotated in the opposite direction, the screw does not move along the axis for an appreciable rotation of the thimble. The corresponding error is called backlash error. It can be minimized by rotating the screw always in the same direction when final adjustment is made.

Aim :

To measure the diameter of a wire and the thickness of a metal / glass plate by using micrometer screw gauge.

Apparatus:

A micrometer screw gauge, a wire, a glass/ metal plate, etc.

Diagram:

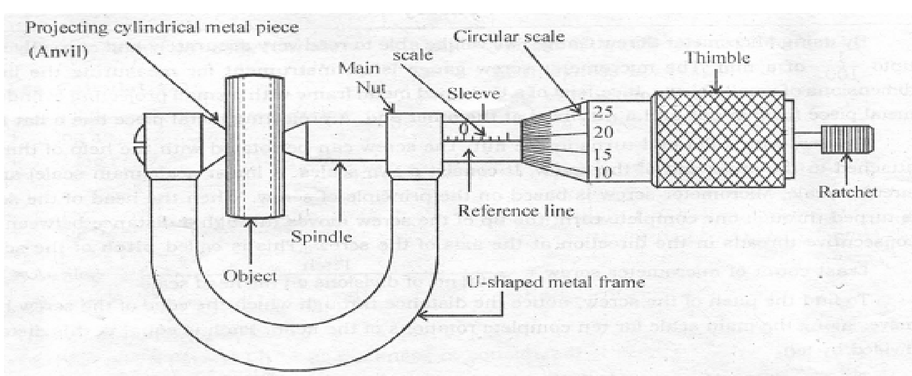


Fig. 2.1 Micrometer Screw Gauge

Procedure:

(A) To find pitch of the screw:

(1) Rotate the circular scale and let the zero mark coincides with the reference line .Note the reading of the main scale (M.S) and calculate the pitch by formula.

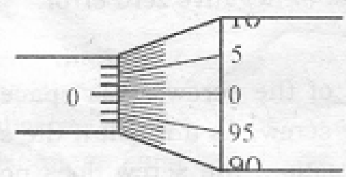
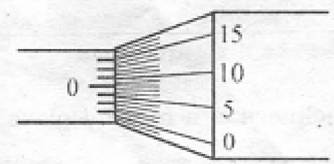
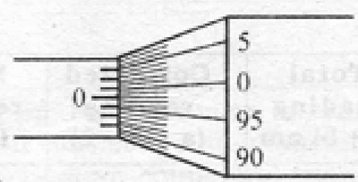
$$\text{Pitch (P)} = \frac{\text{Distance travelled by screw on the M.S. in no. of rotations}}{\text{Number of rotation given to C.S.}}$$

(2) Note the total number of division (N) on the C.S.

(3) Calculate the least count (L.C.) by using the formula

$$\text{L C} = \frac{\text{Pitch of the screw (P)}}{\text{Total number of divisions on C.S}}$$

(B) To find zero error of the micrometer screw gauge:

(1) Rotate the screw until the spindle just touches to Anvil (Ref. Fig.).If the zero mark of the circular scale coincides with the reference line of the M.S. the edge of C.S coincides with the zero of M.S. as shown in fig. 2.2 (a) then there is no zero error.	 *Fig. 2.2 (a)* *No zero error*
(2) When the circular scale stops before its zero reaches the zero of the M.S. the error is said to be positive zero error as shown in Fig.2.2 (b). If nth division of the C.S. coincides with the reference line the zero error = n x L.C.	 *Fig. 2.2 (b)* *Positive zero error*
(3) When 'the zero of the C.S. goes beyond the zero of the M.S. the error is said to be negative zero error as shown in Fig.2.2 (c). If nth division of the C.S. coincides with the reference line and N is the total number of divisions on the C.S, the zero error = - (N - n) x L.C. Whether the zero error is positive or negative zero error it has to be subtracted from the total reading.	 *Fig. 2.2 (c)* *Negative zero error*

(C) To determine diameter of wire and thickness of glass/ metallic plate:

(1) To measure the diameter of a wire, it is held between the screw and the jaw in such a way that it is just prevented from slipping.

(2) Note the main scale reading up to the edge of the circular scale i.e. the number of division of the main scale which are exposed.

(3) Notice which line on the circular scale coincides with the reference line on the main scale. Multiply the number of this line with the least count and add the fraction obtained to the main scale reading so as to get the total Reading. Find the corrected reading using zero error.

(4) Take at least 5 reading and find the mean diameter of the wire.

(5) For thickness of glass /metal plate, replace wire by glass/ metal plate and repeat steps (1) to (4) and find the thickness of given plate.

Precautions

(1) Do not exert undue pressure while turning the screw.

(2) While taking each reading use ratchet arrangement. Adjust the screw head by turning it in one direction only to avoid backlash error.

(3) Select plane portion of wire for measuring diameter.

Use_Of_ Spherometer

Theory:

The spherometer is an instrument used for measuring the radius of curvature of a spherical surface. It consists of a small metal frame supported by three legs placed as nearly as possible on the corners of an equilateral triangle. Through the center of the metal frame passes a screw (S) of fine pitch, forming a fourth leg. There is a vertical main scale or pitch scale[p] and a circular Auxiliary scale (d) engraved on the disc. This instrument t also works on the circular. Scale is called pitch of the screw. The distance traversed on the vertical main scale by only one division of the scale is called, least count.

Aim:

To determine the radius of curvature of a given spherical surface by using Spherometer.

Apparatus:

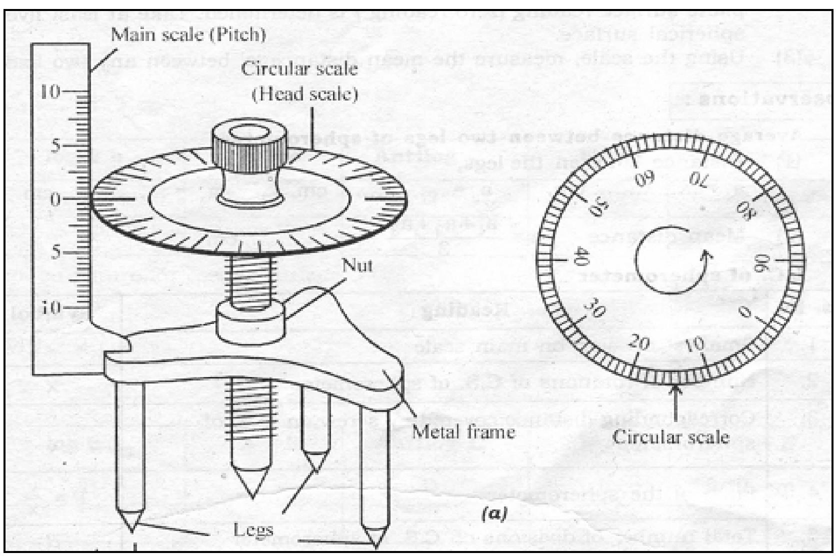
A spherometer, a spherical surface, plane glass plate, etc.

Formula :

$$R = \frac{a^2}{6h} + \frac{h}{2}$$

where, R = radius of curvature of spherical surface
a = average distance between two legs.
h = Sagitta of the spherical surface

Diagram :



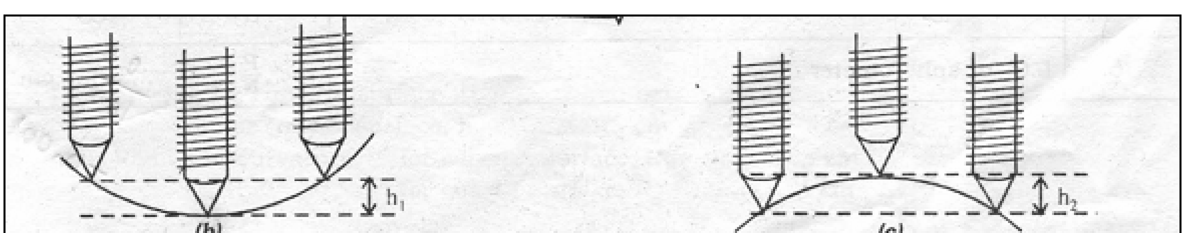


Fig. 3.1 (a) Spherometer, (b) Sagitta for convex surface, (c) Sagitta for concave surface

Procedure:

(A) To find least count of the spherometer :

(1) Bring the zero of the circular disc scale against a division mark on a main scale.

(2) Give five complete rotations to the screw and find the distance moved by the disc of the circular scale on the main scale.

$$Pitch(P) = \frac{\text{Distance moves on the main scale}}{\text{number of rotations given (5)}} = \frac{l}{5}$$

(3) Count total number of division on circular scale (N)

(4) Least count = $\frac{P}{N}$ in cm.

(B) For sagitta of a spherical surface:

(1) To measure the radius of curvature of a spherical surface, first note the zero reading by placing the spherometer on a plane surface. The center leg is then moved up and down till its tip just touches the plane surface without rotating. The main scale reading is taken by noting the position on the edge of the disc on the main scale. The circular scale reading is determined by finding which division on the circular scale coincides with the vertical edge at the main scale. Hence the total reading is calculated. This reading is called the zero reading.

(2) The spherometer is then placed on the given spherical surface and the Centre leg is so adjusted that the instrument rests on the surface on all four legs, without rotating. This reading is noted. The difference between the spherical surface reading and the plane surface reading (zero reading) is determined. Take at least five readings for the spherical surface.

(3) Using the scale, measure the mean distance 'a' between any two fixed legs.

Precautions:

(1) To take reading with spherometer, consider the lowest division on the main scale as zero.

(2) The circular scale should be rotated in the same direction to avoid back lash error.

(3) While taking readings conform that tip of the screw and tip of three legs just touch the surface.

Coefficient_Of _Static_Friction

Theory :

When two bodies are in contact and an attempt is made to slide one over the other forces are brought into play which always acts so as to resist motion. These forces are known as the forces of Friction. It is found that up to a certain limit friction is a self-adjusting force, i.e. just enough force comes into play to prevent motion. As the pulling force is increased however a stage is reached where the body just beings to move. This limiting frictional force is directly proportional to the force pressing the two surfaces together and bears to it a constant ratio which is called the coefficient of friction. The force required just 'to start motion of one over another equal to the limiting static friction (F.)

The ratio of the force of static friction F. to the normal reaction (R) is the coefficient of static friction m_s

$$m_s = \frac{P}{W}$$

Aim:

To study the relationship between force of limiting friction and normal reaction and to determine coefficient of static friction between a block and a horizontal surface. .

Apparatus:

A horizontal plane surface with pulley at one end, a block of wood, pan, weight box, string, spirit level, rough balance, etc.

Formula:

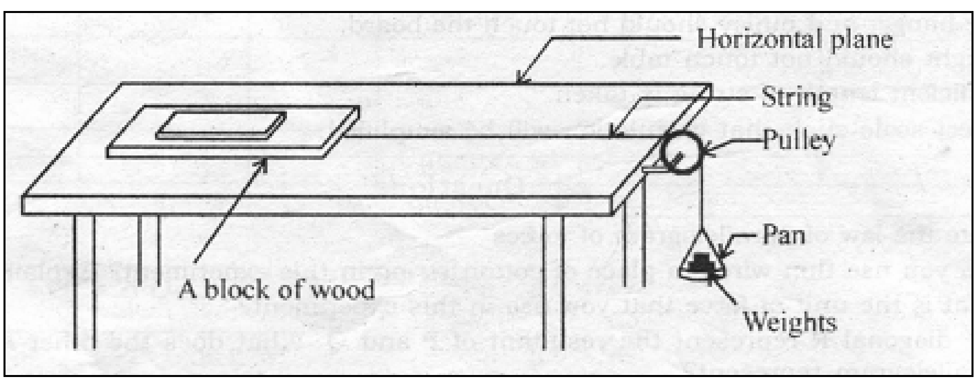
$$m_s = \frac{P}{W}$$

Where, m_s = Coefficient of static friction

W = Total weight of the block (Load)

P = Horizontal force required to move the block along the surface (Effort).

Diagram:



Procedure:

(1) Adjust the plane surface perfectly horizontal using spirit level, place the block of wood on the horizontal surface. Tie a string to one end of the block and pass the other end over a smooth pulley at the end of the plane. Take care to see that the length of the string between the block and the pulley is parallel to the plane. Suspend a pan from the free end of the string. Then pan should not touch the table.

(2) Add weights 'P' gradually to the pan so that the block just beings to slide on the plane. Note the weight added to the pan. Repeat the procedure two times for the same load. Find the mean value -of the weights added.

(3) Repeat the experiment by placing suitable weights on the block.

(4) Plot a graph of the effort versus the total load (W).Hence finds m_s .

Precautions:

(1) The two surfaces in contact should be dry and clean.

(2) The block should just start moving from its initial rest position.

(3) The pan and string should not touch the table.

(4) The string should be parallel to the horizontal surface.

Resistance_ per_cm_ Of _A_Wire

Theory :

Ohm's law: As long as physical conditions of the conductor remains constant the electric current flowing through a conductor is directly proportional to the potential difference across its ends.

$I \alpha V$ Where, I= Electric current

V= Potential difference across the ends of a conductor

It can be written as $V \alpha I$

V = RI .... (i)

Where, R is a resistance of conductor.

From equation (i) $R = \frac{V}{I}$

Let r be the resistance per unit length of wire of length I.

Then, R = rl

$$rl = \frac{V}{I}$$

$$r = \frac{V}{I.l}$$

Aim:

To determine resistance per cm of a given wire by plotting a graph of potential difference versus current.

Apparatus:

Voltmeter, an ammeter, one way key, uniform metal wire (1 meter long) of unknown resistance, meter scale, a jockey, rheostat, connecting wires, Battery eliminator (0 - 5 volt), etc.

Formula:

1) $R = \frac{V}{I}$

2) $r = \frac{R}{L}$

Where, R = Resistance of given wire

V = P.O. across the two ends of wire

I = Current flowing through wire

r = Resistance per unit length

L =Length of wire

Circuit diagram:

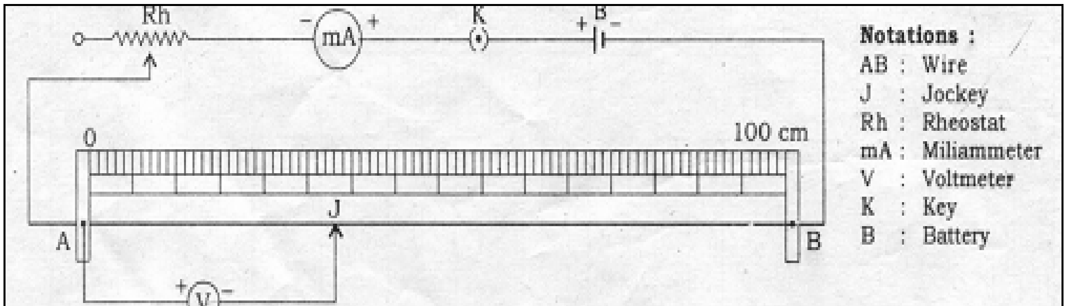


Fig. 6.1

Procedure:

(1) Make the connections as shown in circuit diagram.
(2) Note down the least count of the voltmeter and ammeter.
(3) Put the plug in the key K and adjust the rheostat so that ammeter reads current I amp.
(4) Connect the jockey to negative terminal of the voltmeter. Touch the jockey to resistance wire at the length 20 cm and note down the voltmeter reading.
(5) Slowly adjust the rheostat and note the voltmeter reading for different values of current.
(6) Repeat the procedure for 40 cm, 60 cm, 80 cm, 100 cm, for at least five different positions of the rheostat.
(7) Draw a graph between the potential difference (V) on Y-axis and the electric current (I) on X-axis for each length.
(8) Calculate resistance per unit length (p) of the wire in each case.

Precautions:

(1) Zero error of the meter (voltmeter and ammeter) should be adjusted.
(2) Key should be open when readings are not taken.
(3) The end connection should be tight so as no contact resistance developed.
(4) Length of the wire should be measured accurately.
(5) Heating effect of wire to be avoided hence doesn't pass very high current through wire.

R.I._Of_Material_Of_Prism

Theory:

In case of prism, refraction of light through prism, we have i + e = A + d

This shows that the angle of deviation ' d ' varies with the angle of incidence 'i' as shown in graph. For angle of minimum deviation, i = e. Refractive index of the material of the prism with respect to air is given by

$$m = \frac{\sin\left(\frac{A+d_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

We can find the R.I. of the material of the prism if A and d_m are determined experimentally.

Aim:

To determine the angle of minimum deviation for a given prism by plotting a graph between angle of incidence and angle of deviation and also to determine R.I. of material of prism.

Apparatus:

A prism, drawing paper, drawing pins, a drawing board, protractor, scale, etc.

Formula:

$$m = \frac{\sin\left(\frac{A+d_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

Where; d_m = Angle of minimum deviation

A= Angle of prism

m = R.I. of prism

Ray diagram:

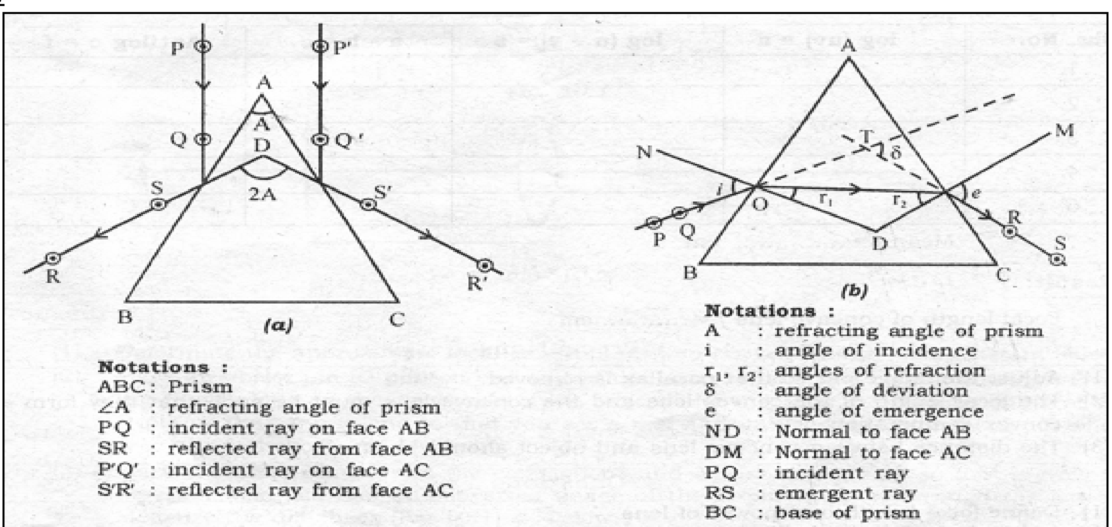


Fig. 11.1 (a) For angle of prism (A)
(b) For angle of deviation (δ)

Procedure:

(A) Angle of prism:

(1) Fix a drawing paper on the drawing board, place the prism on the paper and mark its outline ABC as shown in fig 11.1 (a).

(2) Remove the prism. Draw two parallel lines PQ and P'Q' to represent incident rays on the two refracting faces AB and AC of the prism.

(3) Replace the prism, (at its position ABC).Fix two pins P and Q on the line PQ at a distance of 4 to 5 cm from each other, Observe the bases of the images of the pins obtained due to reflection at the face of the prism and fix the pins Rand S such that bases of the pins (R and S) and images of the pins P and Q are in the same straight line. Remove pins; mark their positions by dots with small circles round them.

(4) In the same way, fix two pins P' and Q' on the other line. Fix the pins R' and S' such that bases of the pins (R' and S') and images of the pins P' and Q' are in the same straight line. Remove all the pins and mark their positions by dots with small circles round them.

(5) Remove the prism. Join SR and S'R'. Produce these lines such that the lines intersect at the point D. Measure the LRDR'. LRDR' = 2A where A is the refracting angle of the prism. Hence find A.

(B) Variation of angle of deviation with the angle of incidence:

(1) Place the prism on the paper and draw its outline ABC.

(2) Take a point 0 on AB almost midway between A and B and draw the normal ON to AB at the point O. draw another line OP making an angle of 30' with the normal at O. This makes the direction of the incident ray.

(3) Fix two pins P and Q on OP at a distance of 4 cm from each other.

(4) Now see through face AC and fix two more pins Rand S, in such a way that the refracted images of P and Q and the pins Rand S appear to be in the same straight line.

(5) Remove the prism and pins. Produce PQ forwards and RS backwards and left them intersect Each other in the point T. Then LXTR= I) is the angle of deviation. [Fig. 11.1 (b)]

(6) Repeat the procedure for angles of incidence equal to 30°, 35°, 40°, 45°, 50°, 55°, and 60°.

(7) Plot a graph of the angle of division (8) against the angle of incidence (i) and determine the d_m of d .

Precautions:

(1) To adjust the pins in the same straight line see at the base of pins.

(2) Pin should be fixed exactly vertical.

(3) Measure angles accurately.

(4) Prism should be placed exactly in its original position before fixing pins.