To Determine Radius of Curvature of a Given Spherical surface by a Spherometer

Aim
To determine radius of curvature of a given spherical surface by a spherometer.

Apparatus
Spherometer, convex surface (it may be unpolished convex mirror), a big size plane glass slab or plane mirror.

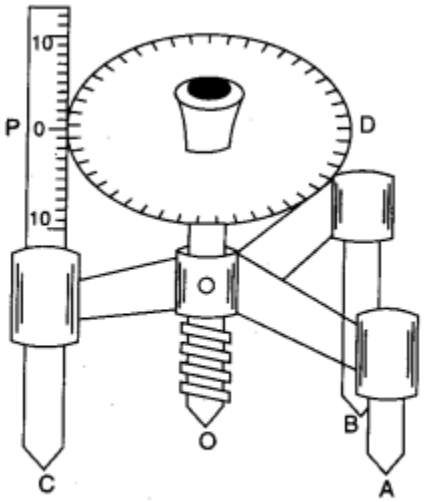
Diagram


Fig. 2.14. Spherometer.

Theory
It works on the principle of micrometre screw (Section 2.09) It is used to measure either very small thickness or the radius of curvature of a spherical surface that is why it is called a spherometer.

Procedure

1. Raise the central screw of the spherometer and press the spherometer gently on the practical note-book so as to get pricks of the three legs. Mark these pricks as A, B and C.
2. Measure the distance between the pricks (points) by joining the points as to form a triangle ABC.
3. Note these distances (AB, BC, AC) on notebook and take their mean.
4. Find the value of one vertical {pitch) scale division.

5. Determine the pitch and the least count of the spherometer [Art. 2.13(c)] and record it step wise.
6. Raise the screw sufficiently upwards.
7. Place the spherometer on the convex surface so that its three legs rest on it.
8. Gently, turn the screw downwards till the screw tip just touches the convex surface. (The tip of the screw will just touch its image in the convex glass surface).
9. Note the reading of the circular (disc) scale which is in line with the vertical (pitch) scale. Let it be a (It will act as reference).
10. Remove the spherometer from over the convex surface and place over a large size plane glass slab.
11. Turn the screw downwards and count the number of complete rotations (n_1) made by the disc (one rotation becomes complete when the reference reading crosses past the pitch scale).
12. Continue till the tip of the screw just touches the plane surface of the glass slab.
13. Note the reading of the circular scale which is finally in line with the vertical (pitch) scale. Let it be b.
14. Find the number of circular (disc) scale division in last incomplete rotation.
15. Repeat steps 6 to 14, three times. Record the observation in tabular form.

Observations

1. Distance between two legs of the spherometer

In ΔABC marked by legs of the spherometer

AB = ... cm

BC = ... cm

AC = ... cm

Mean value of $l = \dfrac{AB + BC + CA}{3}$ = ... cm

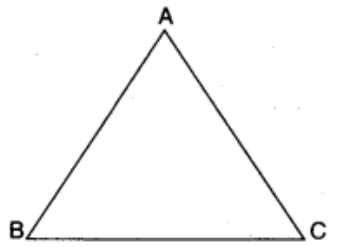


Fig. Distance between the two legs of the spherometer.

2. Least count of spherometer

1 Pitch scale division = 1 mm

Number of full rotations given to screw = 5

Distance moved by the screw = 5 mm

Hence, pitch, $p = \dfrac{5\text{ mm}}{5} = 1$ mm

Number of divisions on circular (disc) scale = 100

Hence, least count $= \dfrac{1\text{ mm}}{100}$

$= 0.01$ mm

$= 0.001$ cm.

3. Table for Sagitta (h)

Serial No. of Observations	Circular (Disc) Scale Reading		Number of complete rotations on plane (n_1) glass sheet	No. of Disc scale divisions in incomplete rotation $x = (a - b)$ or $(100 + a) - b$	Total Reading $h = n_1 \times p + x \times (L.C.)$ (mm)
	On convex surface Initial (a)	On plane glass sheet Final (b)			
1.					$h_1 =$
2.					$h_2 =$
3.					$h_3 =$

Calculations

1. Find value of h in each observation and record it in column 5.
2. Find mean of value of h recorded in column 5

$$\text{Mean value of } h = \frac{h_1 + h_2 + h_3}{3} \text{ mm}$$

$$= \ldots\ldots \text{ mm} = \ldots\ldots \text{ cm.}$$

3. Calculate $$R = \frac{l^2}{6h} + \frac{h}{2} \text{ cm}$$

$$= \ldots\ldots \text{ cm.}$$

Result

The radius of curvature of the given convex surface is cm.

Precautions

1. The screw should move freely without friction.
2. The screw should be moved in same direction to avoid back-lash error of the screw.
3. Excess rotation should be avoided.

Sources of error

1. The screw may have friction.
2. The spherometer may have back-lash error.
3. Circular (disc) scale divisions may not be of equal size.

Viva Voce

Question.1. Describe principle of a spherometer.
Answer. It works on the principle of micrometre screw. ‘

Question.2. Why is a spherometer so called ?
Answer. It measures radius of curvature of spherical surfaces, hence it is called a spherometer.

Question.3. Give formula for the determination of radius of curvature by spherometer.
Answer.

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

Question.4. What are values of P and R? for a plane surface ?
Answer. For a plane surface,
P = 0 and R = infinite.

Question.5. What is meant by pitch of spherometer ?
Answer. The pitch is the distance between two consecutive threads of the screw taken parallel to the axis of rotation or the distance moved by the screw in one complete rotation of the circular scale.

Question.6. How can the accuracy of a spherometer be increased ?
Answer. The smaller is the least count, the more is the accuracy of an instrument and vice versa. The accuracy of the spherometer can be increased by decreasing the pitch or by increasing the number of divisions of circular scale.

Question.7. The least count of screw gauge and spherometer is same. Which will you prefer to measure the radius of curvature of lens or mirror ?
Answer. The spherometer.

Question.8. Write the Len’s maker formula.
Answer. The focal length of a lens

$$\frac{1}{f} = \left(\frac{n_2}{n_1} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

Question.9. Can you measure the focal length of a lens ?
Answer. Yes, by measuring R_1 and R_2 by spherometer $n_1 = 1$ and n_2 is known refractive index of material of lens.

Question.10. Why are the good spherometer made of gun metal ?
Answer. To minimise wear and tear.