Unit-02　Basic Measurement II

Objective：

Use spherometer to measure the curvature radius of a spherical surface.

Apparatus：

Spherometer, traditional spherometer, plate glass, convex glass

Principle：

A. The Construction

The structure of a spherometer is shown as Fig.1. **A** is a tripod with three arms **B**, **C**, and **D**, and that also with equivalent length. The included angle of each two arms is 120°. **E** is the main-meter, one tick is 1 mm. And there are 100 ticks on the periphery of sub-meter **F**. Probe **H** shifts 1 mm when sub-meter is screwed one round, which means the length per tick is 0.01 mm. We can get the height of probe from the main-meter and sub-meter.

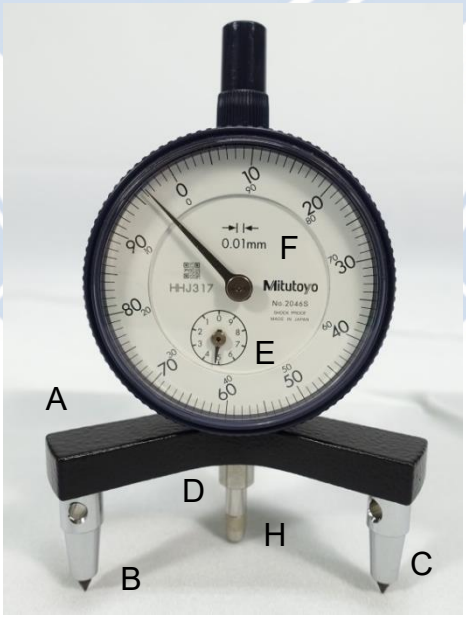

Figure 1. The structure of a spherometer

B. Measurement

(a) Main-ruler reading

Sub-ruler's pointer between N and N+1 mm, the readings record N mm.

(b) Sub-ruler reading

Find out the ticks on sub-meter. It should include estimate value.

C. Curvature Radius

As shown in Fig.2, the distance between each arm of the tripod is *S*, hence **B**, **C** and **D** form an equilateral triangle. We can make a circumscribed circle of radius *r*.

The extended line of probe **H** is sure to pass the center of the sphere **O'**. We assume that the line **O'H** intersects place **BCD** at **O**. Let curvature radius is *R*, if we measure the height is *a* by probe **H**, and then we could calculate curvature radius *R* by Pythagorean proposition.

$$r = \frac{S}{\sqrt{3}}$$

$$R^2 = (R-a)^2 + r^2$$

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

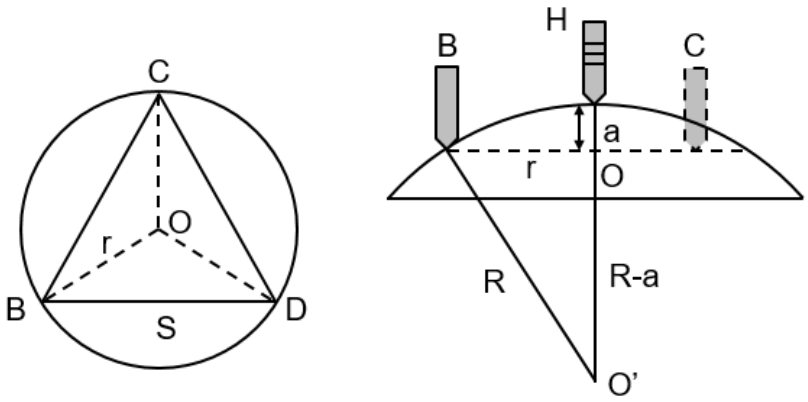

Figure 2. Vertical view and Side view of a spherometer

Remarks：

1. When you put spherometer on the glossy grass plate, please gently lay down.

Procedure：

1. Adjust the fixed tips to make it into triangle.
2. Push down 3 tips B, C, D on the paper.
3. Remove the spherometer and and draw a triangle.
4. Use vernier caliper to measure the length between two fixed tips.
5. Put the spherometer on the plate glass, and making the tips of **BCDH** contact the plate glass. Recording the value a_0.
6. Put the spherometer on the convex glass, and making the tips of **BCDH** contact the convex glass. Recording the value a_1.

7. The difference between a_0 and a_1 is a, that is the height of **H** from plane **BCD**.

$$a = |a_1 - a_0|$$

8. Get the average value and standard deviation of the mean.
9. Calculate the curvature radius R. (should consider the error transfer)

   [Note] Curvature Radius $R = \overline{R} \pm \sigma_R$

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

$$\sigma_R = \sqrt{\sigma_S^2 \left(\frac{\overline{S}}{3\overline{a}} \right)^2 + \sigma_a^2 \left(-\frac{\overline{S}^2}{6\overline{a}^2} + \frac{1}{2} \right)^2}$$

10. Used traditional spherometer to do this experiment.

Questions：

1. The construction of traditional spherometer and spherometer are the same? Please explain.
2. Can we use spherometer to measure the radius of convex len? Please explain.