Spherometer

DETERMINE THE RADIUS OF CURVATURE OF VARIOUS WATCH GLASSES

- Measure the height of curvature *h* for two watch glasses for a given distance *s* between the tips of the spherometer legs
- Determine the radius of curvature *R* of both glasses
- Compare the method for both convex and concave surfaces

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BASIC PRINCIPLES

The spherometer consists of a tripod with three steel legs that taper into points forming the vertices of an equilateral triangle, each side of which measures 50 mm. A micrometer screw with a pointed tip passes through the centre of the tripod. A vertical scale shows the height *h* of the micrometer tip above or below the surface on which the legs of the spherometer rest. The displacement of the micrometer tip can be read to a precision of 1µm using a Vernier scale on a disc that rotates along with the micrometer screw.

The relation between the distance of the legs from the centre of the spherometer *r*, the unknown radius of curvature *R* and the height of curvature *h* is given by the equation:

$$R^2 = r^2 + (R-h)^2 \quad (1)$$

From the above equation, the value of *R* can be determined by transposition:

$$R = \frac{r^2 + h^2}{2 \cdot h} \quad (2)$$

The value for the distance *r* can be calculated from the length *s* which is the length of each side of the equilateral triangle formed by the legs of the spherometer:

$$r = \frac{s}{\sqrt{3}} \quad (3)$$

The equation for determining *R* is as follows:

$$R = \frac{s^2}{6 \cdot h} + \frac{h}{2} \quad (4)$$

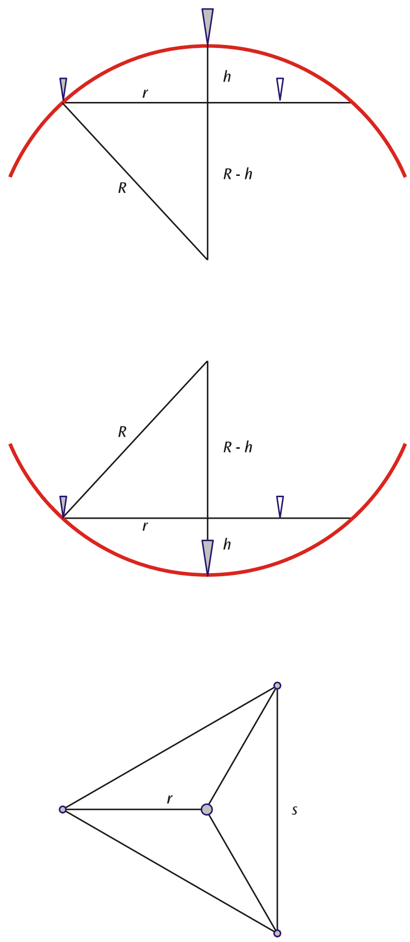

Fig. 1: Diagram showing how to measure radius of curvature using a spherometer
Top: Vertical section of an object with a convex surface
Middle: Vertical section of an object with a concave surface
Bottom: View from above

LIST OF APPARATUS

1	Precision spherometer	U15030
1	Plane mirror	U21885
1	Set of 10 watch glasses, 80mm	U14200
1	Set of 10 watch glasses, 125mm	U14201

SET-UP

Note: you should be able to tell when the tip of the spherometer's micrometer screw just touches the surface of the object to be measured by carefully turning the micrometer. When the tip can go no further, the tripod will start to turn along with the screw and a slight tilting movement can be felt. At this point, stop turning the screw.

- Clean the mirror and the watch glasses with a lint-free cloth, water and some washing-up liquid.
- Place the spherometer onto the plane mirror and verify the zero point of the scale.

EXPERIMENT PROCEDURE

- Place the large watch glass, with the curvature facing upwards, onto a flat surface.
- Adjust the spherometer such that the micrometer tip just touches the glass surface.
- Take the reading for the height of curvature h.
- Position the watch glass with the curvature facing downwards and repeat the measurement procedure.
- Repeat the measurements with the small watch glass.

Fig. 2: Measurement set-up

SAMPLE MEASUREMENTS AND EVALUATION

The distance s between the legs of the spherometer used in the experiment is 50mm. For small curvatures h, equation (4) can be simplified to:

$$R = \frac{s^2}{6 \cdot h} = \frac{2500\,\text{mm}^2}{6 \cdot h} \approx \frac{420\,\text{mm}^2}{h}$$

Table 1: Measured height/depth of curvature h and the calculated radius of curvature R of the watch glasses

∅ (mm)		h (mm)	R (mm)
125mm	convex	357	118
	concave	375	112
80mm	convex	536	78
	concave	565	74