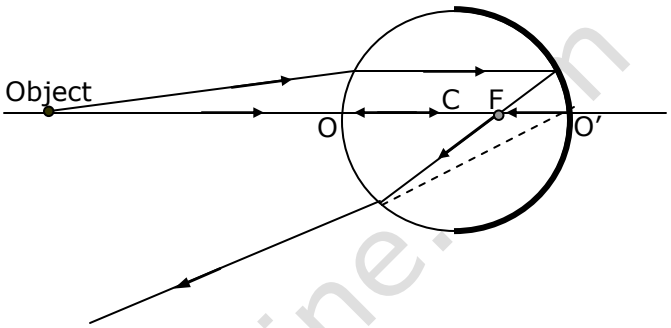
Q- A solid glass sphere of radius R and index 1.50 is silvered over one hemisphere. A small object is located on the axis of the sphere at a distance 2R from the pole of the un-silvered hemisphere. Find the position of the final image formed by the refracting and reflecting surfaces.

(1) The rays first refracted from the curved convex surface of the sphere and the distance of the image v_1 is given by the formula of refraction through curved surfaces as

$$\frac{\mu_2}{v_1} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$$



here μ_2 = 1.50 is the refractive index of glass, μ_1 = 1.00 is the refractive index of air, u = - 2R the object distance and R = + R is the radius of the surface.

Hence substituting in the equation we get

$$\frac{1.50}{v_1} - \frac{1}{-2R} = \frac{1.50 - 1.00}{R}$$

Gives v_1 = infinite, means that the rays becomes parallel to the principal axis after refraction.

(2) These parallel rays will get reflected from the concave mirror on the opposite hemispherical surface and forms a real point image at focus point F at a distance R/2 from the pole of the mirror O'.

(3) This image will behave as an object (at F) for the returning rays and the image formed by the refraction from the curved surface (O) again to give final image at distance v_2 from the pole O of the curved un-silvered surface, and hence again using the same formula (for the rays from right to left which is +ve now and light is going from glass to air) we get

$$[\frac{\mu_1}{v_2} - \frac{\mu_2}{u_2} = \frac{\mu_1 - \mu_2}{R}]$$

or $$\frac{1}{v_2} - \frac{1.5}{-(3R/2)} = \frac{1 - 1.50}{-R}$$

gives v_2 = - 2R

This means that the image is on the same side as that of object (real image by the reflection and at a distance 2R from the pole O, i.e. at the pole O' of the silvered hemisphere.