

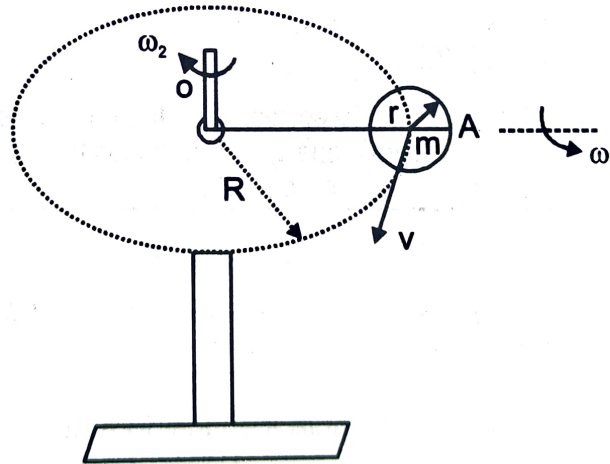
A uniform sphere of mass  $m$  and radius  $r$  rolls without sliding over a horizontal plane, rotating about a horizontal axle  $OA$ . In the process, the centre of the sphere moves with a velocity  $v$  along a circle of radius  $R$ . Find the kinetic energy of the sphere.

**Solution.**

Here the motion of the body is orbital and spin combined. The sphere is spinning about a horizontal axis and orbiting about a vertical axis.

We write total kinetic energy of the sphere, i.e.,

$$KE = K_{\text{orbital}} + K_{\text{spin}}$$



The kinetic energy of the sphere due to its rotation about its own axis and its motion along circular path with velocity  $v$ .

$$KE = \frac{1}{2}I_1\omega_1^2 + \frac{1}{2}I_2\omega_2^2$$

where  $I_1 = \frac{2}{5}mr^2$  and  $I_2 = \left(\frac{2}{5}mr^2 + mR^2\right)$

$$\omega_1 = \frac{v}{r} \text{ and } \omega_2 = \frac{v}{R}$$

Substituting these values in the above equation, we get

$$KE = \frac{7m}{10}v^2 \left[1 + \frac{2r^2}{7R^2}\right]$$