

51326, Physics, Mechanics — Kinematics — Dynamics

Question A heavy solid sphere is thrown on a horizontal rough surface with initial velocity u without rolling. What will its speed be when it starts pure rolling motion?

Solution Let us use conservation of energy law here. We know, that when there is pure rolling motion linear velocity of sphere and its rotational velocity are of same amplitude. Hence, initial energy will transform into linear kinetic energy and rotational kinetic energy. So we have

$$\frac{mu^2}{2} = \frac{mv^2}{2} + \frac{Iw^2}{2}$$

where $I = \frac{2}{5}mr^2$ is moment of inertia of sphere and $w = \frac{v}{r}$ is angular velocity. Hence

$$\frac{mu^2}{2} = \frac{mv^2}{2} + \frac{\frac{2}{5}mv^2}{2} = \frac{7}{5} \frac{mv^2}{2}$$

From this we find the speed v :

$$v = \sqrt{\frac{5}{7}}u$$