

Answer on Question #63825-Physics-Classical Mechanics

A thin hollow sphere of mass m is completely filled with non-viscous liquid of mass m . When the sphere rolls on horizontal ground such that the center moves with velocity v , kinetic energy of the system is equal to?

Solution

There are two components of the kinetic energy in this problem. The translational motion which both the hollow sphere and liquid contribute to and the rotational part which only the hollow sphere contributes since the liquid is presumably not rotating. The former is $\frac{1}{2} mv^2$ for both. The latter is $\frac{1}{2} I\omega^2$ for the sphere. Here, I , is the moment of inertia of the sphere and ω is the angular rotation speed, $\frac{v}{r}$.

$$E_{trans} = \frac{1}{2} mv^2 + \frac{1}{2} mv^2 = mv^2$$

$$E_{rot} = \frac{1}{2} I\omega^2 = \frac{1}{2} \left(\frac{2}{3} mr^2\right) \left(\frac{v}{r}\right)^2 = \frac{1}{3} mv^2$$

The kinetic energy of the system is

$$E = mv^2 + \frac{1}{3} mv^2 = \frac{4}{3} mv^2$$

Answer: $\frac{4}{3} mv^2$.

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