

Expression for velocity of a ring,  
solid cylinder, solid sphere & hollow sphere having same radii rolling down the smooth inclined plane without slipping.

The General expression for the velocity of the rolling body is,

$$V = \sqrt{\frac{2gh}{\left(1 + \frac{k^2}{R^2}\right)}} \quad \text{----- (1)}$$

1] Velocity of Ring :-

$$\boxed{k = R}$$

Putting value in eq<sup>n</sup> (1),

$$V = \sqrt{\frac{2gh}{\left(1 + \frac{R^2}{R^2}\right)}}$$

$$V = \sqrt{\frac{2gh}{2}}$$

$$\boxed{V = \sqrt{gh}}$$

## 2] Velocity of solid cylinder (or disc)

$$k = \frac{R}{\sqrt{2}}$$

Putting value in eq<sup>n</sup> (1),

$$V = \sqrt{\frac{2gh}{1 + \left[ \frac{\left(\frac{R}{\sqrt{2}}\right)^2}{R^2} \right]}}$$

$$V = \sqrt{\frac{2gh}{1 + \left[ \frac{\frac{R^2}{2}}{R^2} \right]}}$$

$$V = \sqrt{\frac{2gh}{\frac{3}{2}}}$$

$$V = \sqrt{\frac{4gh}{3}}$$

3] Velocity of solid sphere,

$$k = \sqrt{\frac{2}{5}} R$$

Putting value in eqn (1),

$$V = \sqrt{\frac{2gh}{1 + \frac{\left[\sqrt{\frac{2}{5}} R\right]^2}{R^2}}}$$

$$V = \sqrt{\frac{2gh}{1 + \frac{\left(\frac{2}{5}\right) R^{\cancel{2}}}{R^{\cancel{2}}}}}$$

$$V = \sqrt{\frac{2gh}{1 + \frac{2}{5}}}$$

$$V = \sqrt{\frac{2gh}{\frac{7}{5}}} \rightarrow \boxed{V = \sqrt{\frac{10gh}{7}}}$$

4] velocity of hollow sphere,

$$k = \sqrt{\frac{2}{3}} R$$

Putting value in eq<sup>n</sup> (1),

$$V = \sqrt{\frac{2gh}{1 + \frac{\left[\sqrt{\frac{2}{3}} R\right]^2}{R^2}}}$$

$$V = \sqrt{\frac{2gh}{1 + \frac{\left[\frac{2}{3} R^2\right]}{R^2}}}$$

$$V = \sqrt{\frac{2gh}{\frac{5}{3}}}$$

$$V = \sqrt{\frac{6gh}{5}}$$