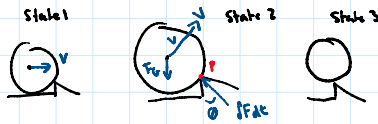
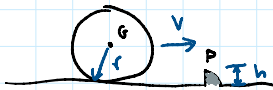


## Intermediate Conservation of Momentum

Inspiration: Hibbeler pg. 542 Example

500 - 1 kg  
4 - 8 cm

You are helping your mom with the groceries when you accidentally drop a can of beans. The 500 g can begins to roll on the ground and has a radius  $r = 4.25 \text{ cm}$ . Assuming the can does not slip nor rebound, determine the minimum initial velocity needed for it to roll over a pebble with height  $h = 0.7 \text{ cm}$ . The pebble does not move after the impact.



Angular momentum about P is essentially conserved

$$(\vec{H}_P)_1 = (\vec{H}_P)_2 \quad \hat{i} \times (\hat{i} + \hat{j}) \quad \hat{i} \times \hat{i} = 0 \quad \text{only } \hat{j} \text{ matters}$$

$$I_G \vec{\omega}_1 + \vec{r}_{GP} \times m \vec{v}_G = I_G \vec{\omega}_2 + \vec{r}_{GP} \times m \vec{v}_{G2}$$

$$+\vee \quad \frac{1}{2} m r^2 \omega_1 + (r-h) m v_{G1} = \frac{1}{2} m r^2 \omega_2 + r m v_{G2}$$

$$\frac{1}{2} (0.5) (0.0425)^2 \omega_1 + (0.0425 - 0.007) (0.5) v_{G1} = \frac{1}{2} (0.5) (0.0425)^2 \omega_2 + 0.0425 (0.5) v_{G2}$$

No slipping, essentially pinned  $v = r\omega$   $\omega = \frac{v_G}{0.0425}$ 

$$\frac{1}{2} (0.5) (0.0425)^2 \frac{v_{G1}}{0.0425} + (0.0425 - 0.007) (0.5) v_{G1} = \frac{1}{2} (0.5) (0.0425)^2 \frac{v_{G2}}{0.0425} + 0.0425 (0.5) v_{G2}$$

$$\frac{227}{8000} v_{G1} = \frac{51}{1600} v_{G2} \quad v_{G2} = \frac{227}{255} v_{G1}$$

Taking the center of gravity at state 2 as the datum

$$T_2 + V_2 = T_3 + V_3$$

$$\frac{1}{2} m v_{G1}^2 + \frac{1}{2} I_G \omega_1^2 + 0 = 0 + mgh$$

$$\frac{1}{2} (0.5) v_{G1}^2 + \frac{1}{2} (0.5) (0.0425)^2 \frac{v_{G1}^2}{0.0425^2} = (0.5) (9.81) (0.007)$$

$$0.5 v_{G1}^2 = 0.034375 \quad v_{G1} = 0.262 \text{ m/s}$$

$$v_{G1} = 0.29437 \text{ m/s}$$