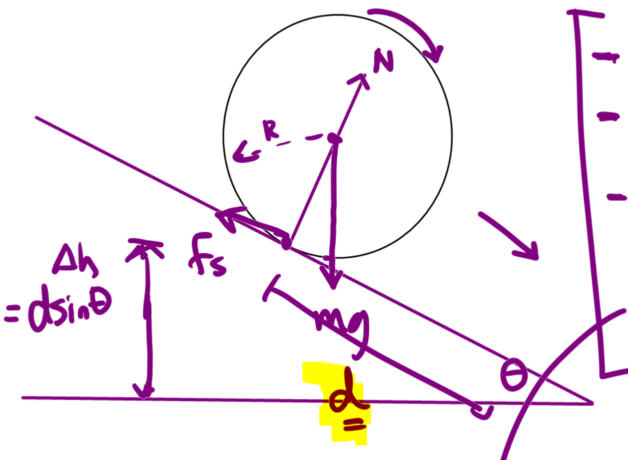
BALL ROLLING DOWN AN INCLING WITHOUT SLIPPING



- assume rigid body → no deformation
- normal force does not do work ($\perp$ to motion)
- gravity does positive work (conservative)
- static friction does $\underline{\underline{\text{positive}}}$ work ($\circlearrowright$ and τ is in the same direction with clockwise)

$W = \Delta K$

- increase of rotational kinetic energy as the ball rolls.
- K_{rot} comes from translational kinetic energy (can see from dynamics problem that the CM is translating more slowly when there is rotation compared ~~to~~ to sliding case)

still a closed system.
∴ energy is conserved.

$$\frac{1}{2}I\underline{\omega}^2 \quad I = \frac{2}{5}mR^2$$

$$= \frac{1}{2}\left(\frac{2}{5}mR^2\right)\left(\frac{v^2}{R^2}\right)$$

$$\underline{U} + \underline{K_{trans} + K_{rot}} = \text{constant}$$

$$mgh + \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2 = \text{constant}$$

$$+ \underbrace{\frac{1}{2}mv^2 + \frac{1}{5}mv^2} = \text{constant}$$

$$mgh + \frac{7}{10}mv^2 = \text{constant}$$

- after rolling for a distance d from rest $v_0 = 0$

$$\cancel{m}g\underbrace{d\sin\theta}_{\Delta h} = \frac{7}{10}\cancel{m}v^2 \longrightarrow v = \sqrt{\frac{10}{7}gd\sin\theta}$$

Same answer!!

-dynamics: $a = \frac{5}{7}g\sin\theta \longrightarrow$ kinematics

$$v^2 = \cancel{v_0^2} + 2ad$$

$$v = \sqrt{2a\underline{d}} = \sqrt{\frac{10}{7}gd\sin\theta}$$