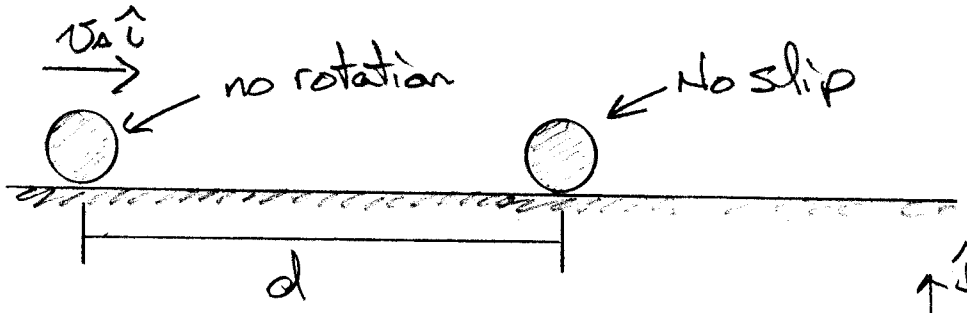
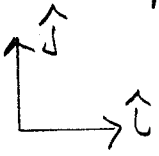
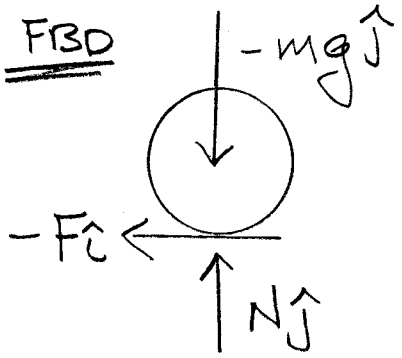


Given: m, R, v_A, μ_k, μ_s

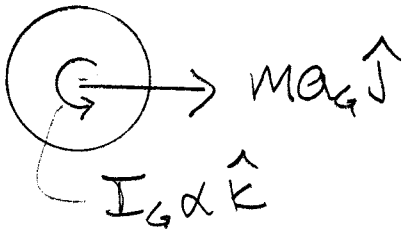
Find: d



FBD



MAD



expect $a_G < 0$, $\alpha < 0$

Euler $\quad \Sigma \underset{\sim}{F} = m\underset{\sim}{a}_G \; ; \; \Sigma \underset{\sim}{M}_G = \underset{\sim}{r}_{P/G} \times m\underset{\sim}{a}_G + I_G\alpha\hat{k}$

$\hat{j}: \; N - mg = 0 \Rightarrow N = mg \; ; \Rightarrow F = \mu_k mg$

$\hat{i}: \; -\mu_k mg = ma_G \Rightarrow a_G = -\mu_k g$

$\hat{k}_G: \; -\mu_k mgR = I_G\alpha = \frac{2}{5}mR^2\alpha$

$$\Rightarrow \alpha = \frac{-5\mu_k g}{2R}$$

Integrate

$$v_G = \int a_G\,dt = a_G t + C_0$$

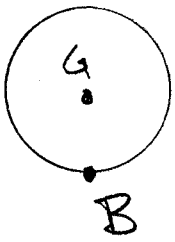
I.C. $\quad v_G(0) = 0 + C_0 = v_A \Rightarrow C_0 = v_A$

$$v_G = -\mu_k g t + v_A$$

$$\omega = \int \alpha\,dt = \alpha t + C_1$$

I.C. $\quad \omega(0) = 0 + C_1 = 0 \Rightarrow C_1 = 0$

$$\omega = \frac{-5\mu_k g}{2R} t$$



$$\underset{\sim}{v}_B = \underset{\sim}{v}_G + \underset{\sim}{\omega} \times \underset{\sim}{r}_{B/G} = v_G \hat{i} + \underbrace{\omega \hat{k} \times -R\hat{j}}_{\omega R \hat{i}}$$

$$= \left(v_A - \mu_k g t - \frac{5}{2}\mu_k g t \right) \hat{i}$$

$$= \left(v_A - \frac{7}{2}\mu_k g t \right) \hat{i}$$

Stops slipping when $\underset{\sim}{v}_B = 0$

$$\Rightarrow v_A - \frac{7}{2}\mu_k g t_s = 0$$

$$\Rightarrow t_s = \frac{2v_A}{7\mu_k g}$$

$$x_G = \int v_G \, dt = -\frac{1}{2}\mu_k g t^2 + v_A t + C_2$$

IC: $x_G(0) = 0 + 0 + C_2 = 0 \Rightarrow C_2 = 0$

$$x_G(t_s) = d = -\frac{1}{2}\mu_k g \left(\frac{2v_A}{7\mu_k g} \right)^2 + v_A \frac{2v_A}{7\mu_k g}$$

$$\boxed{d = \frac{12 v_A^2}{49 \mu_k g}}$$

units $\dfrac{L^2/T^2}{L/T^2} = L$