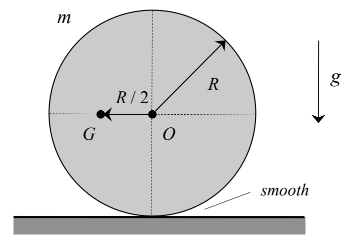
ME 274 – Spring 2025 Name SOLUTION
In-class practice problem

Given: An inhomogeneous disk (of mass m and outer radius R) has its geometric center at O and its center of mass at G (see figure below). The mass moment of inertia of the disk about G is known to be I_G. At the instant shown, the center of mass G is directly to the left of the disk geometric center O. The disk is placed on a smooth, horizontal surface.

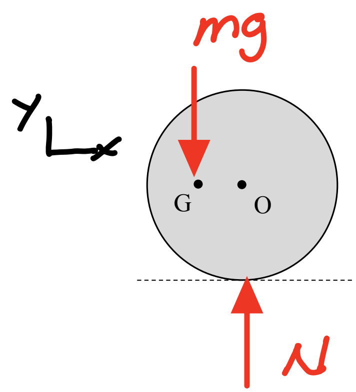


Find: If the disk is *released from rest*, determine the angular acceleration of the disk. Express your answer as a vector.

Leave your final answer in terms of, at most: *m, g, R* and I_G.

Solution:

STEP 1 – FBD



STEP 2 – Kinetics

(1) $\sum M_G = N\frac{R}{2} = I_G\alpha$

(2) $\sum F_y = N - mg = ma_{Gy}$

Combine (1) and (2):

$N = m(g + a_{Gy})$

$N = \frac{2}{R} I_G \alpha$

(3) $\frac{2}{R} I_G \alpha = m(g + a_{Gy})$

STEP 3 – Kinematics

$\vec{a}_G = \vec{a}_O + \vec{\alpha} \times \vec{r}_{G/O} - \omega^2 \vec{r}_{G/O}$

$= a_O\hat{i} + (\alpha\hat{k}) \times (-\frac{R}{2}\hat{i})$

$= a_O\hat{i} - \frac{\alpha R}{2}\hat{j}$

$\therefore$

(4) $a_{Gy} = -\frac{\alpha R}{2}$

STEP 4 - Solve

Substituting (3) into (4):

$\frac{2}{R} I_G \alpha = m(g - \frac{\alpha R}{2})$

$\hookrightarrow \vec{\alpha} = \left[\frac{mg}{\frac{2I_G}{R} + \frac{mR}{2}}\right]\hat{k}$