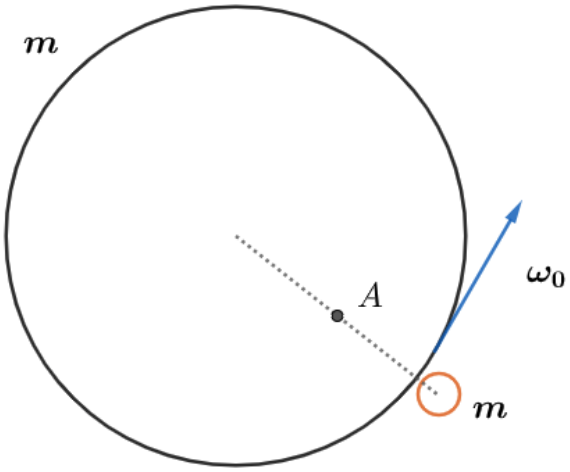
2021 F=ma Exam: Problem 10

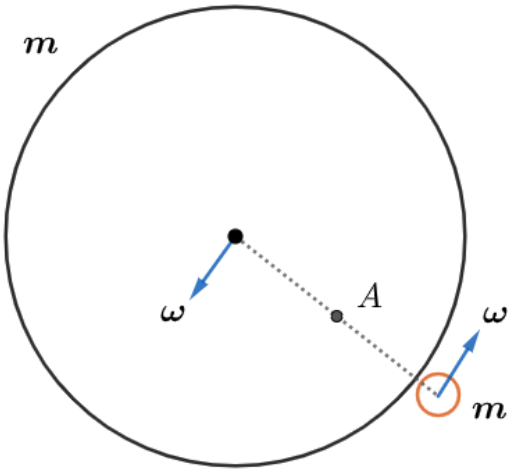
Kevin S. Huang



There is no net external force on the disk-stone system so their center of mass A does not move. Initially, the angular momentum about A only comes from the disk:

$$L_i = I_d\omega_0 = \frac{1}{2}mr^2\omega_0$$

When the stone stops sliding with respect to the disk, they rotate around A with angular velocity ω:



The angular momentum about A is now

$$L_f = I_{\text{tot}}\omega$$

where

$$I_{\text{tot}} = I_d + m(r/2)^2 + I_s = \frac{1}{2}mr^2 + \frac{1}{4}mr^2 + \frac{1}{4}mr^2 = mr^2$$

using parallel-axis theorem for the disk. Conserving angular momentum,

$$L_i = L_f$$
$$\frac{1}{2}mr^2\omega_0 = mr^2\omega$$
$$\omega = \frac{\omega_0}{2}$$

so the answer is $\boxed{\text{C}}$.