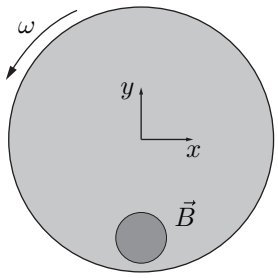
J08E.2 - Rotating Disk in a Magnet

Problem



(Top view)

An aluminum disk of radius R, thickness d, conductivity σ, and mass density ρ is mounted on a frictionless vertical axis. It passes between the poles of a magnet near its rim which produces a $\vec{B}$-field perpendicular to the plane of the disk over a small area A of the disk. The initial speed of the disk is $\omega(t = 0) = \omega_0$.

a) An observer on the disk, moving between the pole pieces of the magnet would feel an electric field. Give the direction and magnitude of this field in terms of R, ω_0, and $\vec{B}$ (assume the angular speed ω is small enough so that $\gamma \sim 1$). This results in a current density.

b) Calculate the torque due to the Lorentz force produced on this current density by the $vecB$-field of the magnet.

c) Given the moment of inertia of the disk around its axis ($I = \frac{1}{2}MR^2$), write out the equation of motion of the disk and calculate the number of revolutions of the disk before it comes to rest.