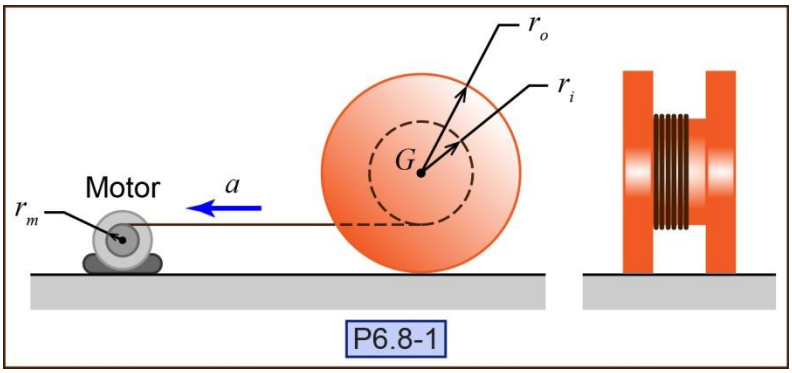
P6.8-1) A wood spool has a rope wrapped around its inner hub and rests on a cast iron track as shown in the figure. The spool has a radius of gyration about its mass center of 3.2 ft and a weight of 100 lb. The spool, starting from rest, has its rope pulled by a motor at 1 ft/s^2. Determine the tension in the rope and the frictional force between the spool and the track at this instant. Estimate the frictional characteristics as that between oak and cast iron and the kinetic coefficient is 80% of the static coefficient of friction. The physical parameters of the spool are as follows: r_o = 3 ft and r_i = 1.5 ft. The rope unwinds without slipping.



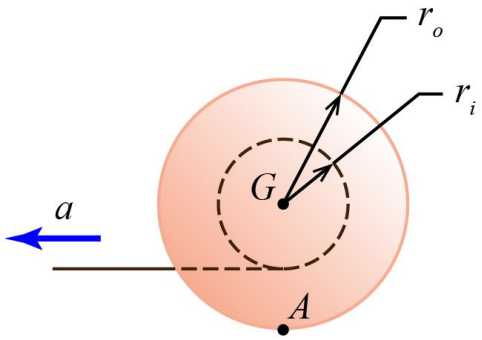
P6.8-1

Given:

Find:

Solution:

Free-body diagram



Friction

What are the coefficients of friction?

μ_s = _____

μ_k = _____

Mass moment

Calculate the mass moment of inertia with respect to the mass center.

I_G = _____

Angular Acceleration

Use kinematics to solve for the angular acceleration of the spool assuming no slip.

α = _____

Equation of motion – Method 1

Use Euler's second law to derive the spool's equations of motion, in variable form, using point A as a reference.

Reference point = A

Eq.M: _____

Tension

Use the equation of motion to solve for the tension.

T = _____

Equation of motion – Method 2

Use Euler's second law to derive the spool's equations of motion, in variable form, using point G as a reference.

Reference point = G

Eq.M: _____

Use Newton's second law to derive the spool's equations of motion.

Assume no slip.

Eq.M: _____

Friction Force

Use the equations of motion to solve for the static friction force.

F_{fs} = _____

Confirm that the spool does not slip.

$F_{fs,max}$ = _____

Tension

Solve for the tension in the rope and verify that you obtain the same value that you did using the first method.

T = _____