# Recitation Exercises

April 22

## Question 1: on rotational dynamics

A flywheel (a large, spinning disc) of mass $m$ and radius $r$ is rotating at angular velocity $\omega$. The machine operator wishes to bring it to rest using a friction brake. When the brake is engaged, two brake pads on either side of the disc are pressed against it from either side, two-thirds of the way from the center to the outer edge; each brake pad exerts a normal force $F_N$.

If the coefficient of friction between the brake pads and the disc is $\mu_k$, how long does it take the brake to bring the flywheel to a stop?

# Question 2: on linked objects

A bucket of mass $m$ hangs from a string wound around a pulley (a solid cylinder) with mass $M$ and radius $r$. When the bucket is released, it falls, unwinding the string.

1. Draw force diagrams for the bucket and the pulley. Note that since the pulley rotates, you will need to draw an extended force diagram for it, drawing the object and labeling where each force acts.

2. In terms of the forces in your force diagrams, write an expression for the net torque on the pulley.

3. Write down Newton's laws of motion – $\sum \vec{F} = m\vec{a}$ for translation, and $\sum \tau = I\alpha$ – for each object. (One object moves, and the other turns...)

4. What is the relationship between the angular acceleration $\alpha$ of the pulley and the linear acceleration $a$ of the bucket? (The answer may be different depending on how you have drawn your pictures and your choice of coordinate system.)

5. Calculate the acceleration of the bucket in terms of $m$ and $M$.

6. Suppose that the pulley were a hollow cylinder with the same mass. How would this acceleration change?