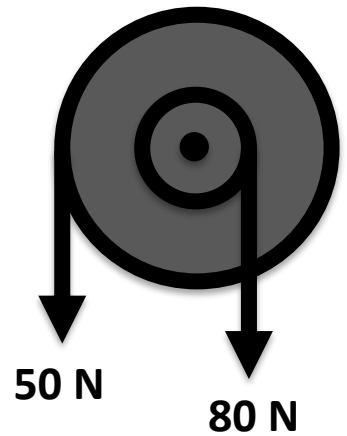Problem Set #6 due beginning of class, Tuesday, Feb. 19.

1) I have a 10 kg disc of radius 2 m, and uniform mass distribution that is free to
   spin on a low friction bearing. There is an inner pulley wheel of radius 80 cm.
   strings are wrapped around the outside of the wheel and inner pulley as shown. I
   pull on the string with the tensions indicated.
   a) Please describe the subsequent motion of the wheel.
   b) Quantify the resulting motion, and include the direction using the correct
      right-hand rule.
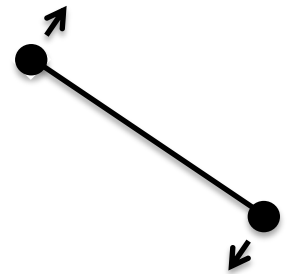
50 N

80 N

2) Section 4.7, Exercise 1. Dropping larger disk on rotating disk

3) This is a variation of Section 4.7, Exercise 2
   Two identical bodies are tied together with a string, are spinning in space about the center at angular
   speed, ω_i, when a motor at the center pulls them both inward such that the final
   diameter of their paths is 1/3 the original diameter, or, $d => 1/3\ d_i$. If this is in outer
   space, we can be sure there are no outside forces. We might consider conserving
   energy and/or angular momentum.
       a) Is it possible for the angular momentum to change? If so how?
       b) Is it possible for energy to change? if so, where did the energy go or come
          from?
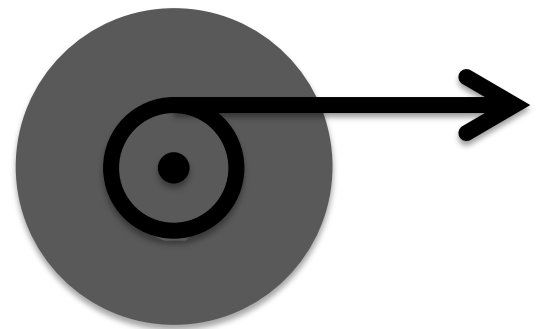   Is it possible to conserve both angular momentum **_and_** energy? Let's find out!
       c) What happens to the moment of inertia with this change? $I => \_\_\_ I_i$
       d) If we conserve angular momentum what should be the new angular velocity? $\omega => \_\_\_ \omega_i$,
       e) Would this change the kinetic energy? If so, by what factor: $KE => \_\_\_ KE_i$
       f) Can we conserve angular momentum **_and_** energy? If not, which one must have changed, and
          where did that extra energy (or momentum) come from?

4) You have an ax to grind, and you decide to grind it on the outer rim of a round 5 kg stone grinding wheel
   of uniform thickness and radius 30 cm. The coefficient of friction between steel and stone is 0.3. You spin
   the wheel up to 1000 rpm with a 100 W motor.
   a) What is the angular velocity of 1000 rpm?
   b) How long does it take to spin the wheel up to 1000 rpm? What lens do you use?
   c) Then I push the ax against the wheel with a force of 100 N and the sparks fly! But as soon as you start, the
      electricity goes out and the wheel is spinning freely without power. What is the angular acceleration of the
      wheel as you push against it with the ax?

5) A concrete flywheel of uniform thickness has a mass of 50 kg and
   a radius of 40 cm. If I pull on the string with a force of 100 N that
   is wound around a pulley of radius 16 cm.
   a) what will be the angular velocity, ω after 10 s? Remember, no
      credit without lens.
   b) What if instead of pulling for 10 s, I ask you to find the final
      angular velocity, ω after pulling 2 meters of string. Would this
      change the lens that you would look through? *Hint:* "yes, it
      changes the lens". Please find the final angular velocity, ω.
   c) Just as we did in linear problems, for problem (b) above,
      knowing the final ω, please find the average angular velocity, the time it took to pull the string and the
      average power that the wheel/ax produced in thermal energy as you slowed the wheel.

6) Chapter 5.0, Exercise 1, You see something moving in a circle.

7) Chapter 5.1 Exercise 1, Lunar period!

8) Chapter 5.2, Exercise 2, Lower Earth Orbit

9) Chapter 5.3, Do exercise 1 and 2, but don't hand it in. Does it stay in the bucket? Answers at end of chapter.

10) Chapter 5.3, Exercise 4, Loop the loop

11) Chapter 5.3, Exercise 6, Driving up and down hills in a car

12) Chapter 5.3, Exercise 7, Do you weigh the same at the equator?

13) Chapter 6.0, carefully consider Examples 1, 2, and 3. Then do the following:
   What if there is a coefficient of friction $(\mu_d = 0.1)$ on the 1 kg mass as is slides across the horizontal surface?
   a) How would this change the energy considerations in Example 1? Find the new speed of the system as it hits the ground 1 m below. Then find the time to fall and the acceleration.
   b) How would this change the dynamics considerations of the system (Exercise 2)? Find the new acceleration directly (is it the same as you found above?) and tension in the string. It will be helpful to first watch the systems/dynamics video for Monday's class.
   c) How would this consideration change the method of simultaneous equations (exercise 3)?