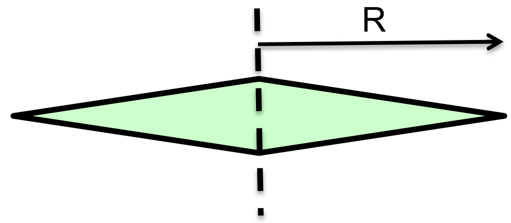
Problem Set #6 due beginning of class, Monday, Oct. 28

1) Section 4.5 Exercise 1, Ranking Several Objects
2) Section 4.5 Exercise 2, Rolling Objects up a hill
3) Read Section 4.5, exercise 3 and do the following:

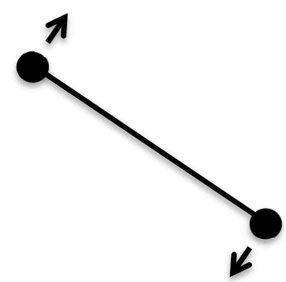


Before attempting this, it may be a very good idea to watch the last ~ 5minutes of the moment of inertia video again. I think you can skip ahead the second time you watch it. If not, right click on the video and copy the youtube video link.

You invent a new kind of round discus that spins about a vertical axis (dotted line) as shown at right. The object has a thickness of t_o at the axis (at $r=0$) that tapers evenly to a sharp edge at $r=R$, or $t = t_o(1-r/R)$. The mass of the discus is M,

a) Judging from moments of inertia of other objects (above question), please guess as best you can what should be the moment of inertia about the axis in terms of the variables given, and support your estimate with reasons. For starters, you might consider if this moment of inertia is greater or less than a rim of mass M, a disk of mass M, a hollow or solid sphere of mass M.
b) Calculate exactly what the moment of inertia is by integrating over the mass. *Hint: You'll have to do two integrations for this: one to find the volume, and the next to find the moment of inertia. A similar problem was done in the moment of inertia video, and is found as exercise 3 in section 4.5.*

4) Section 4.6 Exercise 2, Diving Board Problem.
5) Section 4.7, Exercise 1. Dropping larger disk on rotating disk
6) 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, $d \Rightarrow$ <u>1/3</u> 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?

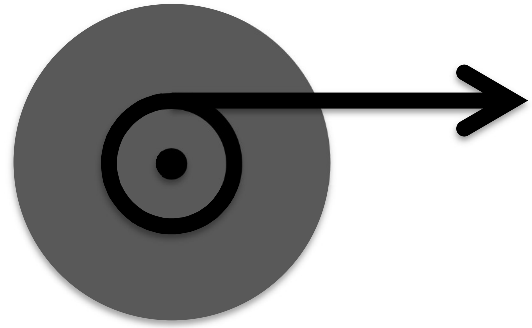
Is it possible to conserve both angular momentum ***<u>and</u>*** energy? Let's find out!

  c) What happens to the moment of inertia with this change? $I \Rightarrow$ ___ I_i
  d) If we conserve angular momentum what should be the new angular velocity? $\omega \Rightarrow$ ___ ω_i,
  e) Would this change the kinetic energy? If so, by what factor: $KE \Rightarrow$___ KE_i
  f) Can we conserve angular momentum ***<u>and</u>*** energy? If not, which one must have changed, and where did that change come from?

7) 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?

8) 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, knowing the final ω, please find the average angular velocity, the time it took to pull the string and the average power output.

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

10) Chapter 5.1 Exercise 1, Lunar period!

11) Chapter 5.2, Exercise 2, Lower Earth Orbit

12) 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.

13) Chapter 5.3, Exercise 4, Loop the loop

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

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