Problem Set #4 due beginning of class, Thursday, Oct. 20.

#1 Please redo your midterm showing work, but not providing way too much information.

#2 From chapter 10.1 on rotational variables, start with the unnumbered exercise about the 777's engine: The GE90-110B1. Note that this turbo fan has a diameter of 3.25 m, but read more about it yourself at: https://en.wikipedia.org/wiki/General_Electric_GE90
Please answer a) and b) from the question itself. Then add to it:
c) What is the linear speed of the outer edge of the turbo fan? How does it compare to the top speed of the 777… Oh WOW. The top speed of the 777 is Mach 0.89 – 89% the speed of sound! The speed of sound at room temperature is about 340 m/s.
d) What is the average tangential linear acceleration of the outer edge of the turbo fan blade?
e) What is the acceleration of the 777 at a mass of 200,000 kg, with two of these engines?

#3) I take off northward from a light on my bicycle with 700 mm wheels (diameter) at constant acceleration. After 2 seconds, I'm traveling 10 m/s. Please find:

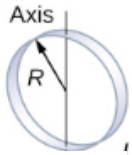
1) The rotational velocity of my wheel.
2) The angle I've rotated my wheel through.
3) The rotational acceleration of the wheel.
4) The direction of the rotational velocity of the wheel.

Angles should be radians

#4 Please do the first problem with the three rotating masses in chapter 10.4.

#5 The following objects have the same mass and same radius. Please put them in order of lowest moment of inertia to highest moment of inertia by thinking about the radial distribution of mass:

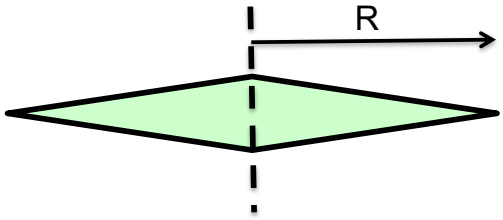
a) A solid sphere
b) A hollow sphere (remember these are the same size and same mass, so this one must have a very dense shell for just the shell to have the same mass as the solid sphere in a) above.
c) A ring spinning about a diameter as shown at right. The axis of rotation is the vertical line.



d) A flat disk of uniform thickness rotating about a diameter as shown above.
e) A ring spinning about the central cylindrical axis as shown at right (below).
f) A flat disk of uniform thickness rotating about the central cylindrical axis.

Check your answers in chapter 10.4 on moment of inertia.

#6 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.*

#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) How long does it take to spin the wheel up to 1000 rpm? What lens do you use?

b) 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?