Wentworth Institute of Technology Engineering Physics I, Fall 2015
Instructor: Dr. Marissa Vogt
Problem Set #9
Due: before 4:30 p.m. in my mailbox in Ira Allen 316 *or* turned in after class, Tuesday, November 17, 2015
Remember to write down the names of any classmates you worked with.

Problem 1 (8 points)

The MAVEN spacecraft, a NASA mission that is studying the Martian atmosphere, launched from Cape Canaveral in November 2013 on an Atlas V rocket. The rocket burns about 280,000 kg of fuel over 4 minutes (you can assume dm/dt is constant over that interval) and ejects the fuel at speeds of 4000 m/s. How much thrust does the rocket provide?

Problem 2 (12 points)

(Based on Y&F 9.14) A circular saw blade of radius 5 cm starts from rest. After 10 seconds ω = 200 rad/s.

a) What is the angular acceleration? (You can assume α is constant.)
b) How far has a point on the edge of the saw blade moved over the 10 seconds?

Problem 3 (15 points)

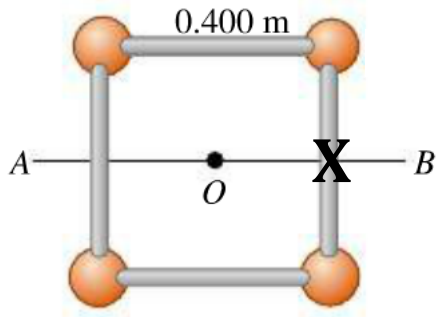
(Based on Y&F 9.20) A CD stores music in a coded pattern of tiny pits, arranged in a track that spirals outward toward the rim of the disc. The inner radius of this spiral is ~20 mm and the outer radius is ~60 mm. As the disc spins inside a CD player, the track is scanned with a constant linear speed of ~1.3 m/s.

a) What is the angular speed of the CD when the innermost part of the track is scanned?
b) What is the angular speed of the CD when the outermost part of the track is scanned?
c) If the maximum playing time of a CD is 78 minutes, what is the length of track if it were stretched out in a straight line.

Problem 4 (15 points)

(Based on Y&F 9.28) Four small spheres (treat as point masses) with mass 1.5 kg are arranged as shown in the figure, with a separation of 0.4 m. You can neglect the mass of the rods attaching the spheres.

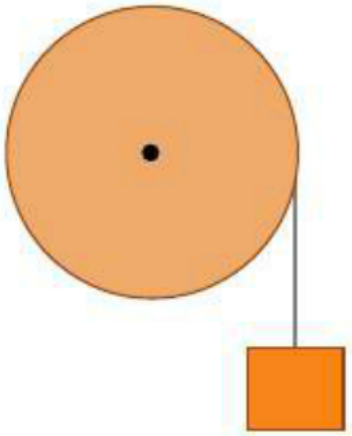
Figure **E9.28**



a) What is the moment of inertia of the system if it is rotating around an axis at point O (an axis coming out of the page)?
b) What is the moment of inertia if the system is rotating around the line AB?
c) Use the parallel axis theorem and your answer to part a to find the moment of inertia of the system if it is rotating around an axis coming out of the page at point X.

Problem 5 (10 points)

Figure **E9.45**

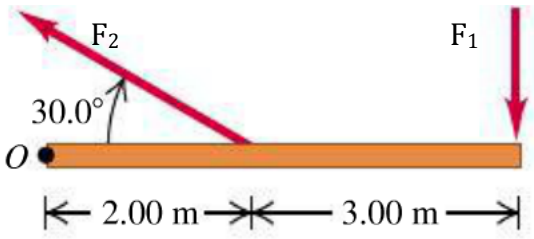


(Based on Y&F 9.45) A block is on the end of a massless cable that is tied to a frictionless wheel (uniform disk) as shown in the figure at right. The wheel has a radius of 0.4 m. The system is initially at rest. If the block moves downward, with a constant acceleration, a distance of 2 m in 3 s, what is the mass of the wheel?

Problem 6 (10 points)

(Based on Y&F 9.44) Instead of the frictionless wheel in problem 7, imagine that the rope is tied to a frictionless pulley with radius *R* but an unknown moment of inertia. If the pulley always has half as much kinetic energy as the block, what must be its moment of inertia? The block has a mass *m*.

Problem 7 (10 points)



(Based on Y&F 10.2) Calculate the torque from both force 1 and force 2 as shown in the figure below, and the net torque, about point O. Let $|F_1|$ = 5 N and $|F_2|$ = 8 N. Don't forget that your answer should be in the form of a vector!

Problem 8 (10 points)

(Based on Y&F 10.19) For each of the following objects, what is the total kinetic energy and rotational kinetic energy, and what fraction of the total kinetic energy is rotational? Assume for each that the linear velocity v = 2 m/s and m = 5 kg.

a) A uniform circular cylinder
b) A uniform sphere
c) A thin-walled, hollow sphere

Problem 9 (10 points)

(Based on Y&F 10.21) A solid ball is released from rest and slides down a ramp that makes an angle of 50 degrees with respect to the horizontal.

a) What is the minimum coefficient of static friction between the ramp and the ball for no slipping to occur?
b) Would this coefficient of static friction be sufficient to stop a hollow ball (like a basketball or soccer ball) from slipping? Why or why not?
c) Why does part a ask about the coefficient of static, not kinetic, friction?