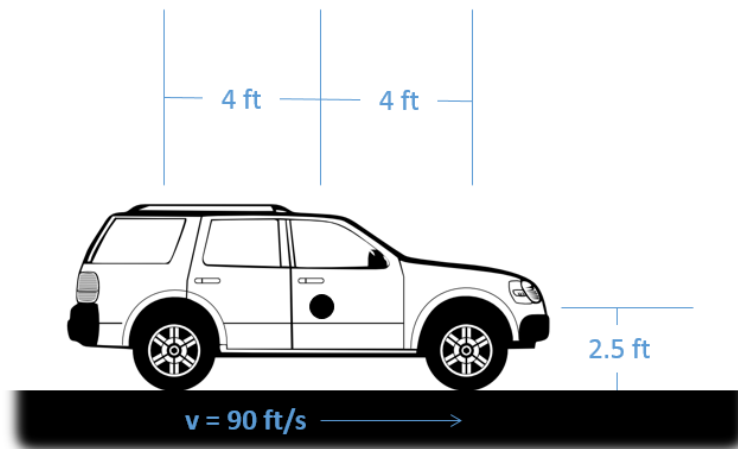


## Chapter 13 Homework Problems

### Problem 13.1

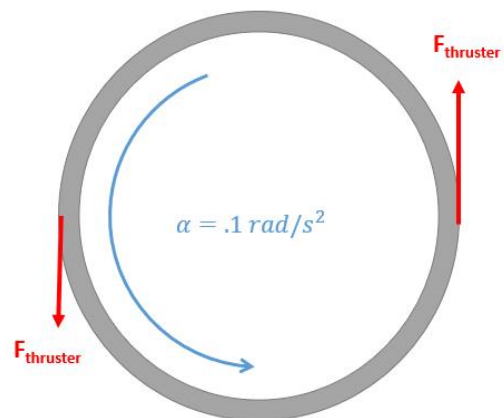
The SUV shown below has an initial velocity of 90 ft/s. It slams on its brakes, coming to a stop over a 300 ft distance. If the car has a weight of 3500 lbs and as center of mass as shown below, what are the normal forces at the front wheels? What are the normal forces at the back wheels?



(Solution:  $F_{NR} = 1291.4 \text{ lbs}$ ,  $F_{NF} = 2208.6 \text{ lbs}$ )

### Problem 13.2

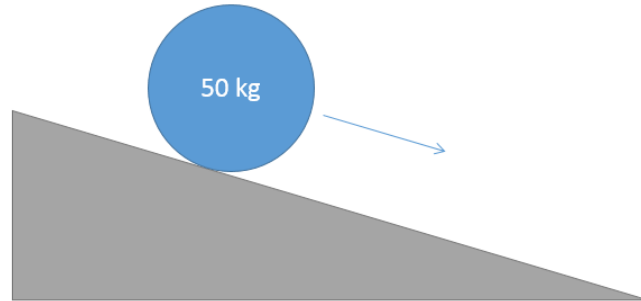
A ring-shaped space station can be approximated as a thin ring 60 meters in diameter with a mass of 500,000 kg. The space station has a set of thrusters able to exert equal and opposite forces as shown below. If we want to cause an angular acceleration of  $.1 \text{ rad/s}^2$  in the space station, what is the force required from each thruster?



(Solution:  $F_{\text{thruster}} = 750 \text{ kN}$ )

Problem 13.3

A 50 kg barrel with a diameter of .75 meters is placed on a 20° slope. Assuming the barrel rolls without slipping, what will the acceleration of the center of mass of the barrel be?

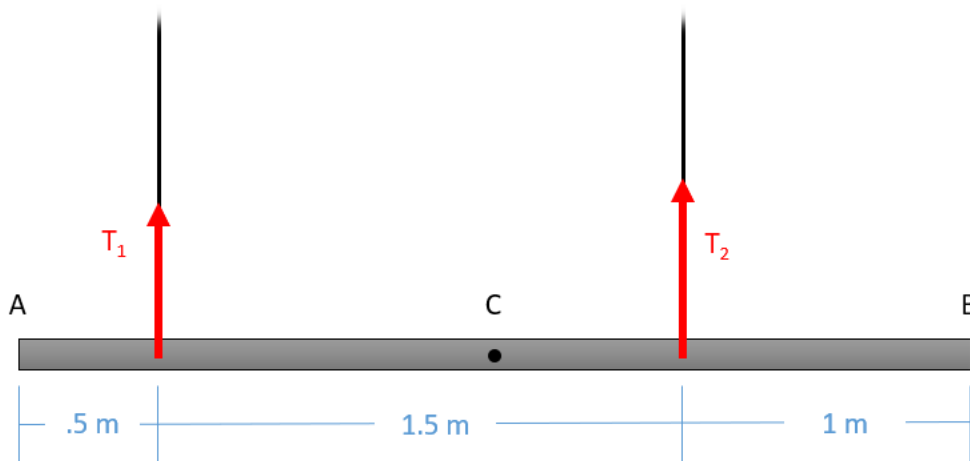


(Solution:  $a_x = 2.24 \text{ m/s}^2$ )

Problem 13.4

A 3-meter-long 25 kg beam is supported by two cables as shown below. You can treat the beam as a slender rod. Assume we want the left end of the beam at A to remain as a constant height while the right end of the beam at B to accelerate upwards at a rate of  $1 \text{ m/s}^2$ .

- a) What is the rate of acceleration of the center of the beam and the rate of angular acceleration for the beam?
- b) What will  $T_1$  and  $T_2$  need to be to achieve these accelerations?

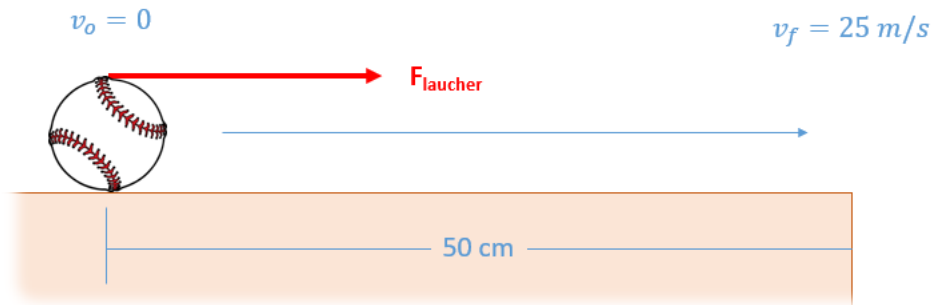


(Solution:  $a_{cy} = .5 \text{ m/s}^2$ ,  $\alpha = .333 \text{ rad/s}^2$ ,  $T_1 = 81.75 \text{ N}$ ,  $T_2 = 176 \text{ N}$ )

Problem 13.5

A baseball launcher rolls a ball along a 50 cm surface by applying a force to the top of the ball. Assume that there is sufficient friction along the bottom surface such that the ball rolls without slipping. Also assume the baseball is a sphere with a diameter of 7.5 cm and a mass of .15 kg. We wish to achieve a velocity of 25 m/s at the end of the 50 cm surface.

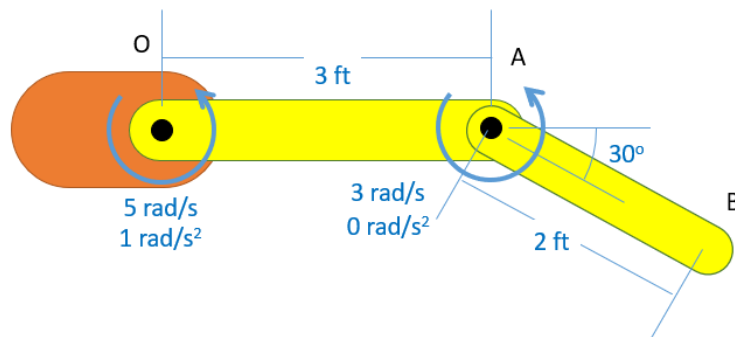
- What should the launching force on the top be?
- What will the friction force be with this launch force?



(Solution:  $F_{\text{launcher}} = 65.625 \text{ N}$ ,  $F_f = 28.125 \text{ N}$ )

Problem 13.6

You are modeling the robotic arm shown below. Treat each section of the arm as a slender rod. Section OA weighs 30 lbs and section AB weighs 18 lbs. If we want the relative angular velocities and accelerations shown below, what should the motor torques be at O and A? (This is a top down view of the robot arm)



(Solution:  $M_O = -3.9 \text{ ft lbs}$ ,  $M_A = -19.3 \text{ ft lbs}$ )