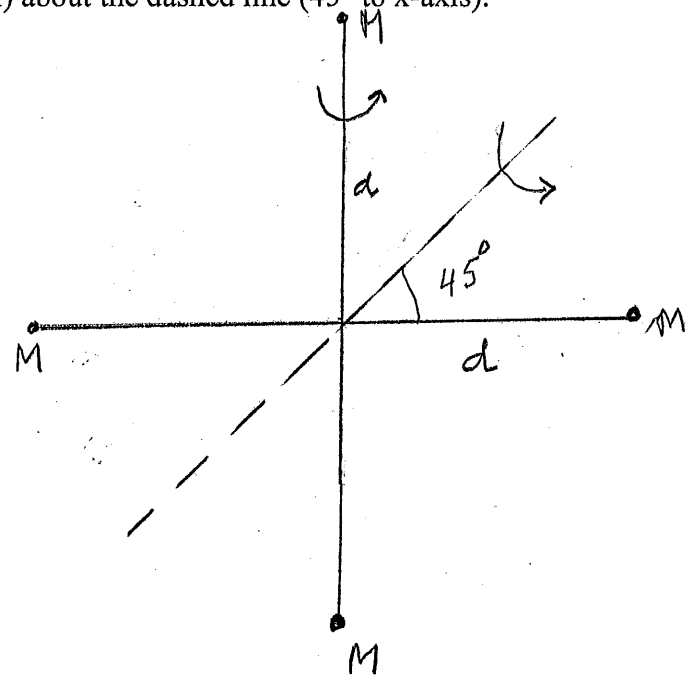
Week 11- Problems

11-1 What is a rigid body?

11-2 What is the difference between force and torque?

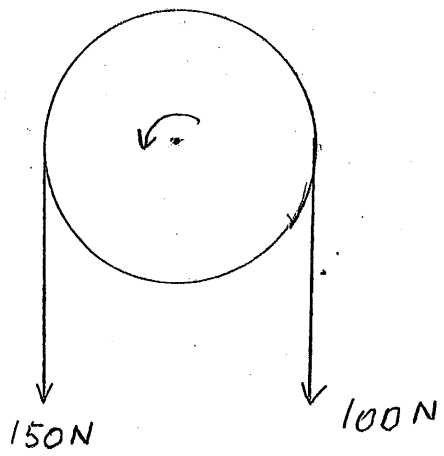
11-3 Four particles of equal masses M are connected by thin (massless) rods. Calculate the moment of inertia (i) about the y-axis, (ii) about the dashed line (45° to x-axis).



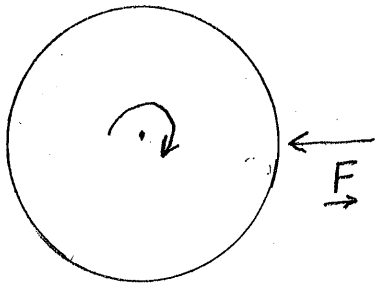
11-4 For a rigid body, in translation the linear momentum $\underset{\rightarrow}{P} = M\underset{\rightarrow}{V}$ and the kinetic energy is $K = \frac{P^2}{2M}$. Show that in rotation about a fixed axis, the kinetic energy is $K = \frac{L^2}{2I}$, the angular momentum is $\underset{\rightarrow}{L} = I\underset{\rightarrow}{\omega}$ where I is the moment of Inertia.

11-5 What is the kinetic energy of the Earth due to its daily rotation? Assume that the moment of Inertia is $I = \frac{1}{3} M_E R_E^2$.

11-6 For a disk rotating on an axis perpendicular to its center $I = \frac{Mr^2}{2}$. The disk shown has M = 5kg and r = 0.5m. For the forces indicated (i) what is the total torque in the disk? (ii) What is the angular acceleration of the disk?

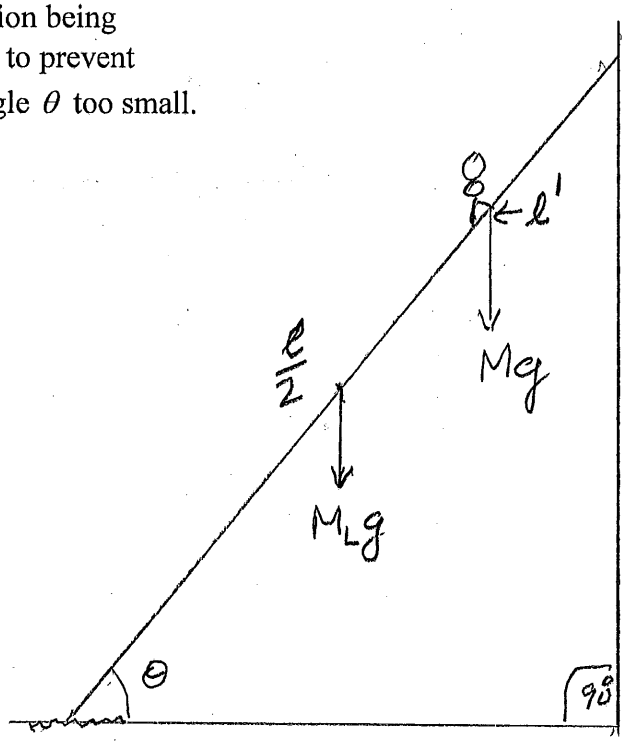


11-7 A disk of radius 20cm and mass 0.05kg is rotating about the z-axis with angular velocity $\underset{\rightarrow}{\omega} = -2 rad/s\,\hat{z}$. If you wish to stop it in 5 secs, what force must be applied on the rim?

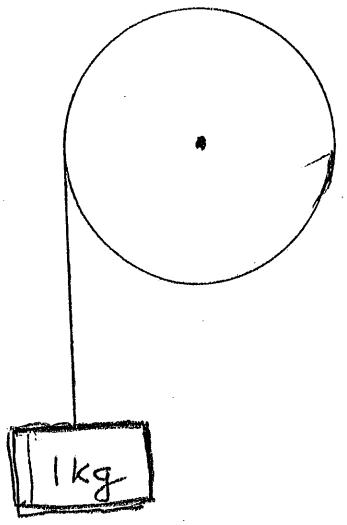


11-8 In the loop-the-loop of problem 10-8 suppose the object is a sphere of radius r which rolls without slipping as it goes around the track. What is the minimum value of h necessary so it can go completely around the loop? ($I = \frac{2}{5} M r^2$).

11-9 A ladder of mass M and length L is leaning against a smooth vertical wall. The floor is rough, the coefficient of static friction being μ_s. Explain why it is essential that to prevent slipping you must not make the angle θ too small.

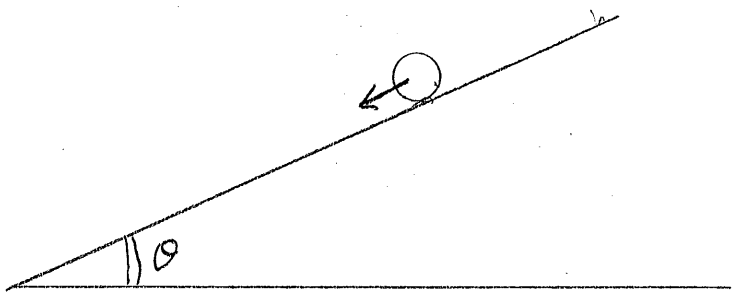


11-10 A 4kg cylinder is mounted so it can rotate freely about its horizontal (z) axis. A string is wound around the cylinder and has a 1 kg mass hanging. If you release the 1 kg mass, how far will it drop in 2 secs? Why?



11-11 On an inclined plane you release (i) a ring and (ii) a sphere. Which will reach the bottom first if there is no slip in either case? Why?

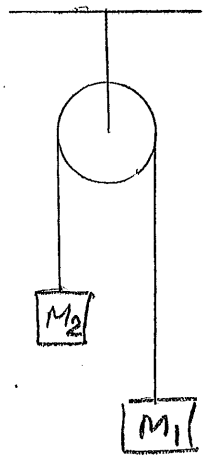
$$\left[I_{ring} = M r^2, I_{sphere} = \frac{2}{5} M r^2 \right]$$



11-12 In the Atwood machine [Prob 4 – 14] the pulley has a mass Mp. Show that the magnitude of the accelerations of M_1, M_2 is

$$a = \frac{(M_1 - M_2)g}{M_1 + M_2 + \frac{Mp}{2}}$$

if the string does not slip on the pulley.



11-13 Calculate the pressure increase in the fluid in a syringe if the nurse applies a force of 42 N to the syringe's piston of diameter 0.5 ″.

11-14 The pressure at the center of a tornado is 0.1 atm. What is the net force on a window pane of dimension 1.4m x 1.4m? Assume that the house is airtight and the pressure inside is 1 atm.