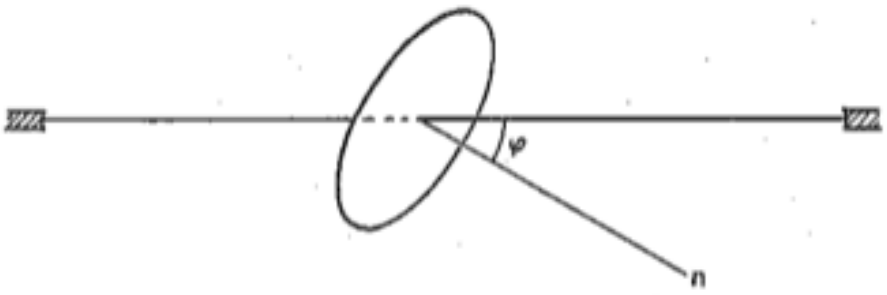
Homework 4: Rigid body motion

Due: Tuesday February 26th, 13:00

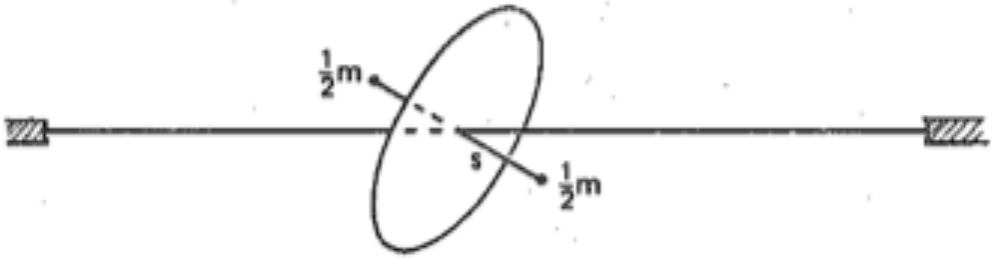
Policy: Collaboration is allowed, but every student is required to hand in his/her own version of the solutions. Please include your name and student number on the solutions.

Problem 1. A rigid body of spherical shape spinning rapidly about its axis of symmetry is placed on a flat table. Show by considering the moment of the force at the point of contact that its axis will precess in one direction if it is oblate, and in the opposite direction if it is prolate. Show also that if there is a small friction force, the axis will become more nearly vertical, so that if the body is oblate its center of mass will fall, but if it is prolate it will rise.

Problem 2. We consider a thin circle shaped disk (mass m, radius R). The moments of inertia of the disk are $I_n = \frac{1}{2}mR^2$ for rotation around the axis through the center of the disk and normal to the disk, and $I_p = \frac{1}{4}mR^2$ for rotation around an axis through the center of the disk and in the plane of the disk. The disk is mounted on an axle through its center. This axis makes an angle $\phi = \frac{\pi}{6}$ with the axis normal to the disk. The axis rotates together with the disk with a constant angular velocity ω.



1. Determine the angle between $\vec{L}$ and $\vec{\omega}$.
2. Determine the torque with respect to the center of the disk, which the axle needs to exert on the disk for the described motion.
3. One places two point masses (each with mass $\frac{1}{2}m$) on a massless rod oriented orthogonally through the center. The distance between the



point mass and the disk is s. Determine s such that the system is dynamically balanced, i.e. such that the $\vec{L}$ and $\vec{\omega}$ are parallel.