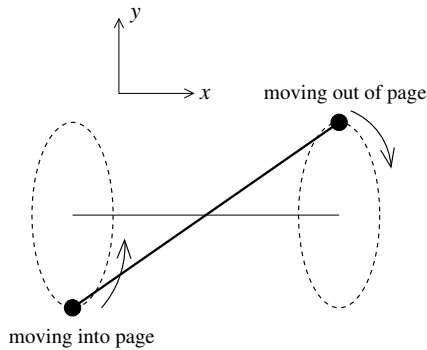


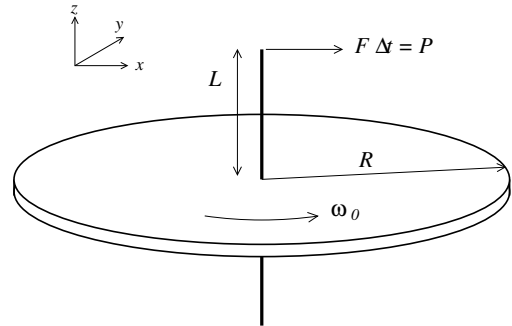
**PHY509: HOMEWORK 8. (due 11/07/05)**



**P1.** (a) Two point particles of identical mass  $m$  are connected by an infinitesimally thin rod. The center of mass is fixed in space and the object is *constrained* to rotate in the manner as shown at an angular frequency  $\omega_0$ . Draw the directions of angular velocity and angular momentum in the inertial frame with the center of mass at origin.

(b) Suddenly at  $t = 0$ , the external constraint force is removed and the object undergoes a force-free motion. The snapshot of the object's orientation at  $t = 0$  is as shown here. What are the angular velocity and angular momentum afterwards?

**P2.** A massive disc of radius  $R$  and mass  $M$  rotating with an angular velocity  $\boldsymbol{\omega} = \omega_0 \hat{\mathbf{z}}$  as shown. Suddenly a finite impact of  $P = F\Delta t$  is given to a massless axis penetrating the center of mass of the disc normal to the plane, at a distance  $R$  from the center.  $\Delta t$  is infinitesimal. After the impulse, there is no force. Assume that the center of mass is not moving.



(a) With the origin at the CM, what are the moments of inertia for the body axes  $(x, y, z)$ ?

(b) Before the impulse, what are the angular velocity and angular momentum?

(c) Right after the impulse, what are the angular velocity and angular momentum in the body frame?

(d) After the impulse, what is the kinetic energy?

(e) Write down the Euler equations of rigid body for the angular velocity  $\boldsymbol{\omega}$  in the body frame.

(f) What are the precession frequency of  $\boldsymbol{\omega}$  in the body frame and the precession direction?

(g) What is the initial direction of the movement of the axis?