Physics 172 – Recitation 12 (Spring 2012)

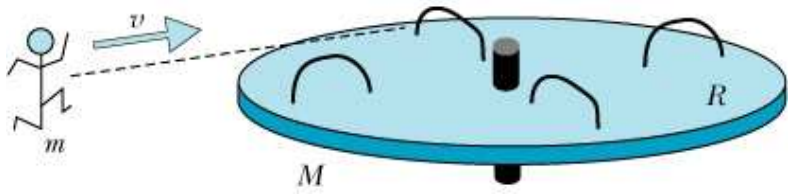
Purpose: The purpose of this recitation is to allow you to gain experience working with angular momentum.

Readings: 11.1-11.7

General Instructions:

- Identify your system
- State which objects are interacting with the system
- State the fundamental principle(s) you use to solve the problems
- Draw an appropriate diagram labeling key features of the problem
- State the approximations and simplifying assumptions you use.

Problem 1 : A playground ride consists of a disk of mass M and radius R mounted on a low-friction, vertical axle. The ride is initially at rest. A child of mass m runs in the positive x direction at speed v along a line tangent to the disk, jumps onto its outer edge and holds onto one of the railings shown. Recall that the moment of inertia of a uniform disk of mass M and radius R is $\frac{1}{2} MR^2$.



a) Consider the system consisting of the child and the disk, but not including the ride's axle. Estimate the vertical component of the system's angular momentum about the ride's center, i.e., its y component, just before the child jumps onto the disk.

b) Estimate the vertical component of the system's angular momentum just after the child has jumped onto the disk.

c) Estimate the angular speed of the ride just after the child has jumped onto it.

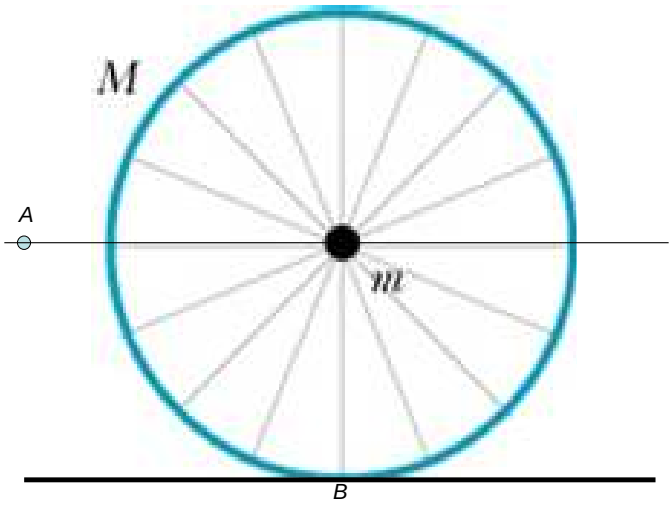
[Checkpoint 1]

d) Estimate the (linear) momentum of the child-disk system just before and just after the child jumps onto the ride. Explain clearly how your results are consistent with the momentum principle applied to the child-disk system.

e) If you used your preceding answers to estimate the total kinetic energy of the child-disk system just before and just after the child jumps onto the ride you would find that $K_f < K_i$. Explain clearly how this fact can be reconciled with what the energy principle applied to the child-disk system tells us.

[Checkpoint 2]

<u>Problem 2</u>: consider a bicycle wheel with an axle of mass *m* and a thin rim of mass *M* and radius *R*. The masses of the wheel's spokes are so small that we will neglect them.



It is rolling straight ahead to the right without slipping at constant speed *V*.

a) What is the rotational angular momentum of the wheel? What is the moment of inertia about its center of mass? What is its angular velocity?

b) What are the wheel's translational and total angular momenta about the point *A*?

c) What are the wheel's translational and total angular momenta about the point *B*, the point of contact between the wheel's rim and the ground at the instant shown in the figure?

d) What is the wheel's total kinetic energy? What are its translational and internal (in this case rotational) kinetic energies?

[Checkpoint 3]