Name: ________________________________ **"Alphabetic" Student No.:** [ ]

HOMEWORK #8: Rotation II (Phys 207, Fall 2005) **DUE on Monday, 11/14**

Problem #1: Convert Kinetic to Potential Energy

A **RING** rolls on a horizontal surface and then rolls up an incline without slipping. Assume that the ring has **mass *m***, **radius *R***, and initial **velocity *v***.

(a) Draw **pictures** of the ring both **before** and **after** it rolls up the incline. Draw and label any relevant variables (h, R, v).

(b) Find the total **initial kinetic K_i** energy of the ring.

(c) Using the Work-Energy Theorem #2, find the **height *h*** of the ring on the incline when it is moving with **one third** its initial velocity.

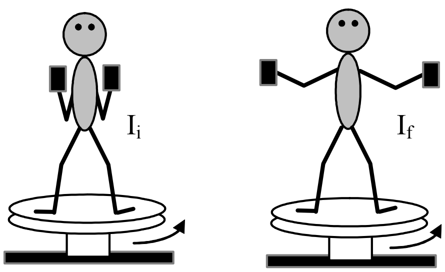
(d) If the rolling ring were replaced by a **disk** with the same initial velocity, would this height be greater, smaller, or the same? Explain why.

Problem #2: Changing Moment of Inertia *I*

A girls stands on a frictionless, rotating platform and holds weights **close** to her body. The platform rotates with initial angular velocity ω_i and the system's initial moment of inertia is I_i. She then **extends** her arms as shown in the picture below. The platform rotates **counterclockwise** from the **top view**.

(a) Draw the **vector directions** in the side-view boxes for the system's initial and final angular **velocities** (ω_i , ω_f) AND angular **momenta** (L_i , L_f). Check that the relative lengths of the vectors are consistent.

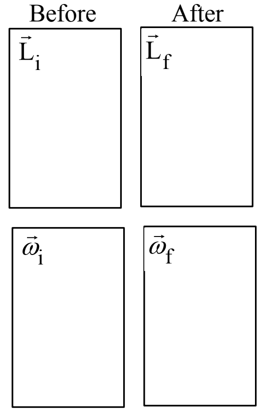
SIDE VIEW



Initial Final

SIDE VIEW

Before After



(b) The **moment of inertia** of the girl ______________________ (increases or decreases) when she extends her arms. Explain why.

(c) The **angular velocity** of the girl ______________________ (increases or decreases) when she extends her arms. Explain why.

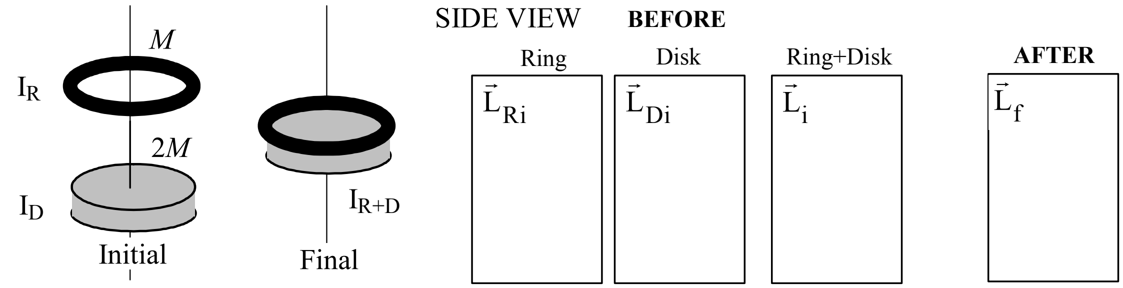
(d) Find an algebraic expression for the **change in kinetic energy ΔK** of the girl + platform system after the weights are extended outward (in terms of ω_i , ω_f , I_i , I_f).

(e) If the angular speed of the system is **halved** when the girl extends her arms, find **ΔK** in terms of $\boldsymbol{\omega_i}$ **and** $\boldsymbol{I_i}$.

<u>Problem #3</u>: Perfectly Inelastic "Collision" of Ring and Disk

A **ring** (mass *M*) and **disk** (mass 2*M*) with equal radii *R* are spinning on frictionless bearings in **<u>opposite</u>** directions. The **ring** is rotating counterclockwise with $+\omega$ and the **disk** clockwise with -2ω. They are then brought together and due to friction spin at the same final angular velocity ω_f.

(a) Diagrams of the disk and ring both **before** and **after** the "collision" are shown below. After completing parts (c) and (d) below, draw the indicated **angular momentum** vectors before and after the collision in the boxes. **Check** that the relative **<u>lengths</u>** of the vectors are consistent.



(b) Find the **moments of inertia** I_R of the **ring,** I_D of the **disk,** and I_{RD} of the **ring+disk** system in terms of ***M* and *R*.**

$I_R =$

$I_D =$

$I_{RD} =$

(c) Find the **<u>initial</u> angular momenta** L_{Ri} of the **ring,** L_{Di} of the **disk,** and total Li of the **ring+disk** system in terms of ***M*, *R*, and** ω. Assume that **positive L** values point **upward** (counterclockwise rotation).

$L_{Ri} =$

$L_{Di} =$

$L_i =$

(d) Find the **<u>final</u> angular momentum** L_f of the ring + disk system in terms of ***M*, *R*, and ω_f.**

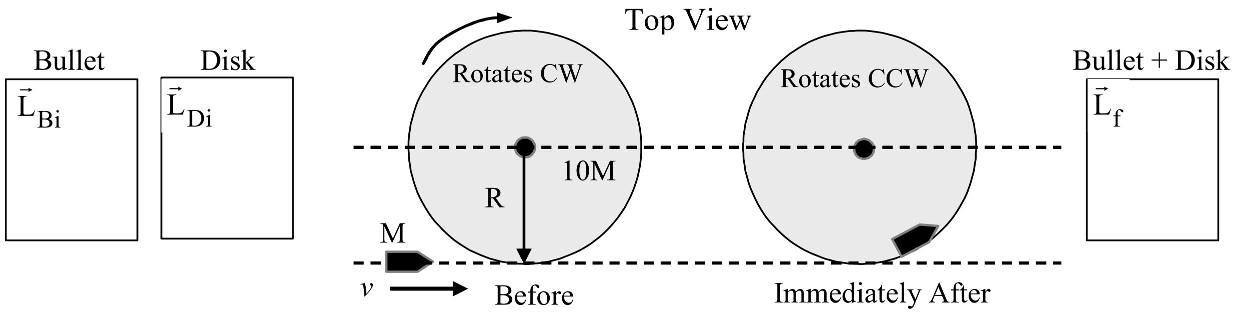
(e) Using conservation of angular momentum, find the **<u>final</u> angular velocity ω_f** of the ring + disk system in terms of any given variables (*M*, *R*, ω). State the **direction** of ω_f.

(f) In the above example, the ring and disk have a non-zero final ω_f. Find the **<u>ratio</u>** of the initial angular velocities of the **ring to the disk** ($\omega_{Ri} / \omega_{Di}$) so that they **<u>stop</u> rotating** when brought together, i.e. $L_f = 0$. Use back of page if necessary.

<u>Problem #4</u>: Perfectly Inelastic "Collision" of Bullet with Disk

A **disk** of mass **10M** and radius **R** is horizontally mounted with a pivot at the center, and it rotates clockwise with $-\omega$. A **bullet** of mass **M** and initial **speed** $\boldsymbol{v}$ is shot horizontally such that it collides with the disk at its radius R and then remains lodged.

(a) Top-view diagrams of the disk and bullet both **before** and **after** the collision are shown below. **<u>Assume</u>** that the disk reverses direction after the collision. Draw the **angular momentum** vector directions of the bullet and disk before the collision and of the bullet+disk system after the collision in the boxes.



(b) Find the **<u>initial</u> angular momentum** L_{Di} of the **disk** in terms of ***M*, *R*, and** ω. Assume that **positive L** values point **out of the page** (counterclockwise rotation).

(c) Find the **<u>initial</u> angular momentum** L_{Bi} of the **bullet** in terms of ***M*, *R*, and *v***.

(d) Find the **<u>final</u> angular momentum** L_f of the bullet + disk system in terms of ***M*, *R*, and** ω_f.

(e) Using conservation of angular momentum, find the **<u>final</u> angular velocity** ω_f of the bullet + disk system in terms of any given variables (M, R, ω, v). Simplify the expression and state the **direction** of ω_f.