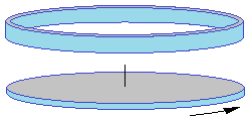
Physics I

Angular Momentum

Problem 1.- A uniform disk is rotating at a steady angular velocity of 0.87 rad/s (ignore friction in the axle). You then drop a hoop of the same mass and radius on top of the disk. What is the angular velocity now?

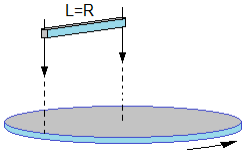
$I_{HOOP} = mR^2$

$I_{DISK} = \frac{1}{2}mR^2$



Problem 1a.- A uniform disk of mass 1.0kg and radius 1.0m is rotating freely (ignore friction in the axle) at a steady angular velocity of 1.44rad/s. You then drop on top of the disk a thin bar of mass 1.0kg and length 1.0m, as shown in the figure, and they rotate together. What is the angular velocity now?

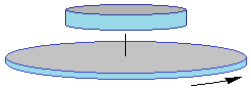
$I_{bar-rotated-at-one-end} = \frac{1}{3}mL^2$ $I_{disk} = \frac{1}{2}mR^2$



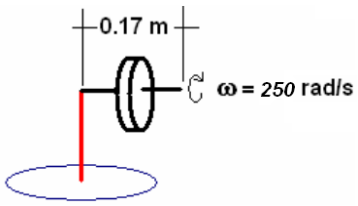
Problem 1b.- A uniform disk of radius 1m and mass 1kg is rotating at a steady angular velocity of 1.25 rad/s. You then drop another disk of mass 1kg too, but radius 0.5m on top of the rotating disk.

What is the angular velocity now?

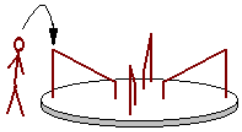
$I_{DISK} = \frac{1}{2}mR^2$



Problem 2.- Consider a gyroscope consisting of a disk of mass 0.25kg and radius 0.055m mounted at the center of an axle 0.17m long. The gyroscope spins at 250 radians/s. Calculate how long it takes for the gyroscope to precess once around.



Problem 3.- A 3.0m-radius merry-go-round is rotating freely at 1.2 rad/s. Its moment of inertia is 1500kgm^2. A person of mass 75kg suddenly steps on the edge of the merry-go-round. What is the angular velocity now?



Problem 3a.- A merry-go-round rotates at 30 rpm with a girl sitting on the edge. What would happen if the child walked to the center of the disk? Neglect friction and assume there is no other external torque.

Problem 4.- A springboard diver starts her motion rotating at a rate of four turns per second with her arms and body contracted, and then she stretches, doubling her moment of inertia. What is the new rotational speed?

Problem 5.- Two particles with mases $m_1 = 2$ kg and $m_2 = 3$ kg, move according to the trajectories

$r_1 = (t^2, t^3, 0)$

$r_2 = (5+2t^2, -t^3, 0)$

Here, t is in seconds and the distances are in meters. Calculate

(a) The external resultant force acting on the system.

(b) The total external torque acting on the system.

(c) The angular momentum of the system.

Problem 6.- If all the ice in the poles would melt and distribute in the oceans, would the days be longer, shorter or the same?