PHYS 1443 – Section 003
Lecture #19

Wednesday, Nov. 10, 2004
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1. Moment of Inertia
2. Parallel Axis Theorem
3. Torque and Angular Acceleration
4. Rotational Kinetic Energy
5. Work, Power and Energy in Rotation
6. Angular Momentum & Its Conservation

Today's homework is HW #10, due 1pm next Wednesday!!

Moment of Inertia

Rotational Inertia: Measure of resistance of an object to changes in its rotational motion. Equivalent to mass in linear motion.

For a group of particles

$$I \equiv \sum_i m_i r_i^2$$

For a rigid body

$$I \equiv \int r^2 dm$$

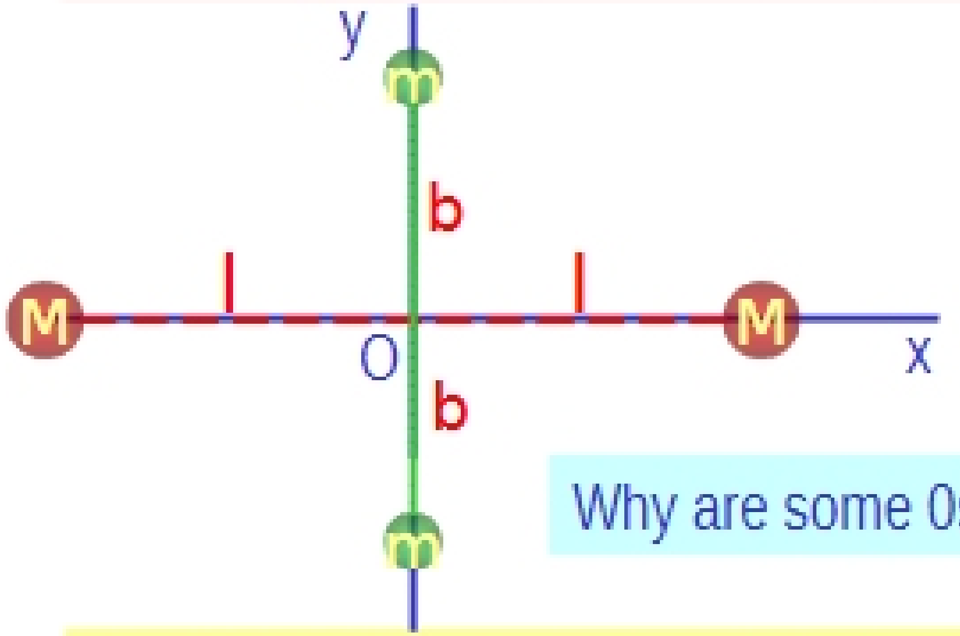
What are the dimension and unit of Moment of Inertia?

$$\left[ML^2\right] \quad kg \cdot m^2$$

Determining Moment of Inertia is extremely important for computing equilibrium of a rigid body, such as a building.

Example for Moment of Inertia

In a system of four small spheres as shown in the figure, assuming the radii are negligible and the rods connecting the particles are massless, compute the moment of inertia and the rotational kinetic energy when the system rotates about the y-axis at angular speed ω.



Since the rotation is about y axis, the moment of inertia about y axis, I_y, is

$$I = \sum_i m_i r_i^2 = Ml^2 + Ml^2 + m\cdot 0^2 + m\cdot 0^2 = 2Ml^2$$

Why are some 0s?

This is because the rotation is done about y axis, and the radii of the spheres are negligible.

Thus, the rotational kinetic energy is

$$K_R = \frac{1}{2} I\omega^2 = \frac{1}{2}\left(2Ml^2\right)\omega^2 = Ml^2\omega^2$$

Find the moment of inertia and rotational kinetic energy when the system rotates on the x-y plane about the z-axis that goes through the origin O.

$$I = \sum_i m_i r_i^2 = Ml^2 + Ml^2 + mb^2 + mb^2 = 2\left(Ml^2 + mb^2\right) \qquad K_R = \frac{1}{2} I\omega^2 = \frac{1}{2}\left(2Ml^2 + 2mb^2\right)\omega^2 = \left(Ml^2 + mb^2\right)\omega^2$$