Discussion 9a : Rotation

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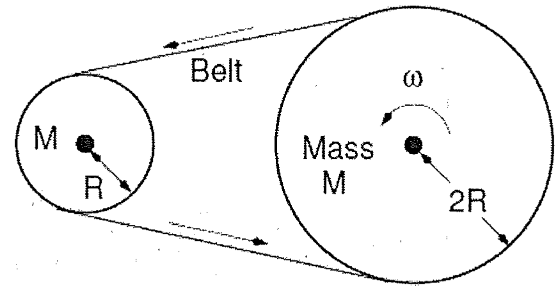
A) There are two uniform solid disks of equal mass. The larger disk has twice the radius of the smaller disk and is rotating at an angular velocity ω. There is a belt which connects the two disks as shown so that both rotate with the same tangential velocity at their respective rims (i.e., no slipping). What is the ratio of the rotational kinetic energy of the larger disk to that of the small disk?



talk about later!

$$I_s = \sum m r^2 = \frac{1}{2} M R^2$$

$$I_b = \frac{1}{2} M (2R)^2 = 4\left(\frac{1}{2} M R^2\right) = 4 I_s$$

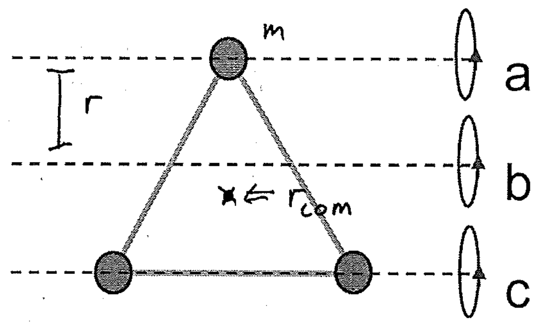
$V_s = V_b$ but $V = r\omega$ so $R\omega_s = 2R\omega_b$ so

$\omega_s = 2\omega_b$.

$$\frac{KE_b}{KE_s} = \frac{\frac{1}{2} I_b \omega_b^2}{\frac{1}{2} I_s \omega_s^2} = \frac{\frac{1}{2} 4 I_s (\omega_s/2)^2}{\frac{1}{2} I_s \omega_s^2} = \boxed{1}$$

Define r, m as so

B) A triangular shape is made from identical balls and identical rigid, massless rods as shown. The moment of inertia about the *a*, *b*, and *c* axes is I_a, I_b, and I_c respectively.



A. $I_a > I_b > I_c$

B. $I_a > I_c > I_b$

C. $I_b > I_a > I_c$

$$I_a = m(0)^2 + 2m(2r)^2 = 8mr^2$$

$$I_b = 3mr^2$$

$$I_c = 2m(0)^2 + m(2r)^2 = 4mr^2$$

Which of the statements above is correct? so B.

Or (slick way), I is smallest when rotating about the center of mass, so I_b is smallest. I is largest when rotating farthest from the center of mass, so I_a is the largest.

Name: ____________________________

C) Three small masses are located in the positions shown in the figure and connect by three light rigid rods.

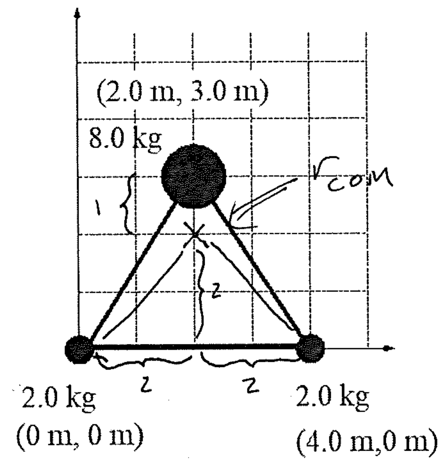
1) Where is the center of mass?

$$\vec{r}_{com} = \frac{\sum m_i \vec{r}_i}{m_{tot}} \quad \text{so}$$

$$\vec{r}_{com} = \frac{1}{2+2+8}\left[2\begin{pmatrix}0\\0\end{pmatrix} + 2\begin{pmatrix}4\\0\end{pmatrix} + 8\begin{pmatrix}2\\3\end{pmatrix}\right]$$

$$= \frac{1}{12}\left[\begin{pmatrix}8\\0\end{pmatrix} + \begin{pmatrix}16\\24\end{pmatrix}\right] = \frac{1}{12}\begin{pmatrix}24\\24\end{pmatrix}$$

$$\boxed{= \begin{pmatrix}2\\2\end{pmatrix} m}$$



2) If these objects are rotating with an angular velocity of 4.0 rad/s about an axis that is perpendicular to the plane of the paper and passes through the center of mass, then what is the rotational kinetic energy?

$KE = \frac{1}{2} I \omega^2$ but need I!

$I = \sum m_i r_i^2 \Rightarrow r$ is distance from rotation point!

so distance from COM, so

$$I = 2kg(2^2+2^2)m^2 + 2kg(2^2+2^2)m^2 + 8kg(1^2)$$

$$= 2\cdot 8 + 2\cdot 8 + 8 = 40\ kgm^2 \quad \text{so}$$

$$KE = \frac{1}{2}\, 40\, (4)^2 = 20\cdot 16 = \boxed{320\ J}$$