First Name: _____

Student Number: _____

MIE 200F - Quiz number 5b – October 18, 2000
quiz duration = 20 minutes

(Based on homework problem 3/232)

The two spheres of equal mass m = 2 kg are able to slide *with zero friction* along the horizontal rotating rod. The are initially latched in position a distance r = 3 meters from the rotating axis., with the assembly rotating freely with an angular velocity ω = 10 *revolutions per second*. Neglect the small mass of the rod and shaft.

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(a) Find the initial angular momentum of the system with respect to the central axis.

(b) Find the initial linear momentum of the system with respect to the ground.

(c) Find the angular momentum of sphere "P" with respect to sphere "Q".

(d) At time t = 0, the latching mechanism releases the two masses, allowing them to slide out towards the ends o the rods. Find the *speed* of each of the two masses, just before they crash into the two ends of the rod

$\vec{a} = \dot{v}\,\hat{e}_t + v\dot{\theta}\,\hat{e}_n = \dot{v}\,\hat{e}_t + v^2/\rho\,\hat{e}_n$ $\quad \vec{v} = \dot{r}\,\hat{e}_r + r\dot{\theta}\,\hat{e}_\theta$ $\quad \vec{a} = (\ddot{r} - r\dot{\theta}^2)\,\hat{e}_r + (r\ddot{\theta} + 2\dot{r}\dot{\theta})\,\hat{e}_\theta$

$T_2 = T_1 + U_{1\to 2}$ $\quad \Sigma \vec{M}_o = \dot{\vec{H}}_o$ $\quad \vec{L} = m\vec{v}$ $\quad \vec{H}_o = \vec{r} \times m\vec{v}$ $\quad T = \tfrac{1}{2} mv^2$ $\quad \Delta\vec{H}_o = \int \vec{M}_o\, dt$

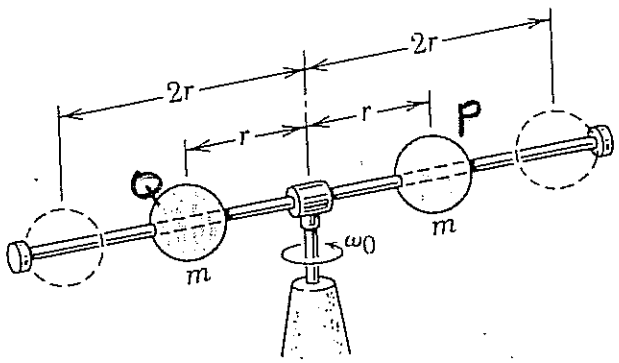
(a) $\vec{H}_o = 2\,\vec{r} \times m\vec{v}$

$= (2)(3)(2)(\omega r)$

but $\omega = 2\pi(10\,s^{-1}) = 62.8\,s^{-1}$

$\Rightarrow \vec{H}_o = (2)(3)(2)(62.8)(3)$

$= 2261\ kg\,m^2/s$



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(b) 2 masses have opposite velocities

$\Rightarrow \vec{L} = 0$

(c) $H_o = \vec{r} \times m\vec{v}$

$= (6)(2)(\omega r)$

$= (6)(2)(62.8)(6)$

$= 4522\ kg\,m^2/s$

(d) up to point of impact, there have been no forces acting on spheres during the sliding motion

$\Rightarrow$ no work is done

$\Rightarrow T, |\vec{v}|$ are unchanged $|\vec{v}| = \omega r|_{initial}$

$= (62.8)(3) = 188.4\ m/s$

(e) After impact ??