Angular Momentum in Class Worksheet

Full Name, Period, AP/Honors:

0 Moments of Inertia

- $I_{sphere} = \frac{2}{5}MR^2$
- $I_{rod} = \frac{1}{12}ML^2$

1 Multiple Choice

1. A massless rod with length $4R$ is rotating with angular speed ω around its center. On each side of the rod, a distance of R from the center is a mass M. The masses slide to the ends of the rod. What will be the final angular speed of the rod?

2. An earth sized planet is orbiting a star. At the furthest point, a distance R_{max} from the star it has velocity $v\hat{\text{x}}$.

   (a) What will be its velocity when it reaches the closest point to the star, at a distance of R_{min}?

   (b) Would this method work for other points in the orbit? Why or why not?

3. Two identical uniform solid spherical objects with radius R and moment of inertia I are initially traveling with velocities of $-v\hat{\text{x}}$ and $3v\hat{\text{x}}$. One of the spheres is initially rotating with angular velocity ω cw. The second is not spinning. They collide and stick together, forming a new sphere. The final volume at the end is the same as the total volume at the beginning. What are the final velocity and angular velocity of the resulting object?

4. A rod with length ℓ and mass M is initially at rest with its center at the origin. 2 identical small clay balls (also with mass M) simultaneously impact the sides of the rod. One has velocity $v\hat{\text{x}}$ and impacts at $\frac{\ell}{2}\hat{\text{y}}$. The other has velocity $-v\hat{\text{x}}$ and impacts the rod at $-\frac{\ell}{2}\hat{\text{y}}$.

   (a) What are the final velocity of the center of mass, and angular velocity of the rod?

   (b) Will the velocity of center of mass of the rod be the same as the velocity of the center of mass of the system? Why or why not?

   (c) Challenge problem (very difficult): Find the final velocity of the ball that struck at the rod's end as a function of time. Use that $t = 0$ at the time of impact.