PHYS 615 – Activity 3.3: Angular Motion

1. Circular Motion at constant speed

   A block is connected to a string of length r whose other end is attached to a table. Let's call the table surface the x-y plane with its origin where the string is attached to the table. Because the block is connected to the string, it is rotating around the origin at constant speed.

   (a) Draw a sketch of the situation with the block at two times t_1 and t_2. Between these two times it moved by, say, 1/8 of a revolution.

   (b) Add position vectors $\vec{r}_1$ and $\vec{r}_2$, as well as velocities $\vec{v}_1$ and $\vec{v}_2$ to your sketch (1, 2 refer to the two points in time you picked above).

   (c) Calculate angular momentum $\vec{l}_{1,2}$ for the block at times t_1 and t_2. State your result as a vector (you may have to specify your z direction.)

   (d) Is $\vec{r}(t)$ constant? Is $\vec{v}(t)$ constant? How about $\vec{l}(t) = \vec{r}(t) \times m\vec{v}(t)$? Is angular momentum conserved?

   (e) Draw a FBD, with all the forces acting on the block.

   (f) Using your FBD, find the net force and then the net torque $\vec{\Gamma}_{net}$.

   (g) Are your results consistent with the angular 2nd Law $\dot{\vec{l}} = \vec{\Gamma}_{net}$?

   (h) (Optional – if you have time you can come back here) Let's assume there is kinetic friction between the block and the table, with a coefficient of μ_k. Do it all again.

2. Angular Momentum of straight-line motion

   A particle is moving at constant velocity in the x-y plane.

   (a) Sketch the situation. The particle misses the origin. Let's call the minimum distance between the particle and the origin d.

   (b) What is the net force acting on the particle? (Hint: No FBD needed)

   (c) What is the net torque acting on the particle?

   (d) Should the particle's angular momentum be conserved?

   (e) Let's draw the particle into your sketch at 3 different times: (1) before (2) at (3) after its closest approach to the origin. Find its angular momentum $\vec{l}$ at these 3 times. Express it as a vector, in terms of the particles mass m, speed v, the distance d, and possibly some angle.

   (f) Are the three values you found for $\vec{l}$ consistent with your expectation on whether $\vec{l}$ should be conserved?