Homework #15

1) In unit-vector notation, what is the torque about the origin on a particle located at coordinates (0, −4.0 m, 3.0 m) if that torque is due to (a) force $\vec{F}_1$ with components $F_{1x} = 2.0$ N, $F_{1y} = F_{1z} = 0$, and (b) force $\vec{F}_2$ with components $F_{2x} = 0$, $F_{2y} = 2.0$ N, $F_{2z} = 4.0$ N?

2) At one instant, force $\vec{F} = 4.0\hat{\mathrm{j}}$ N acts on a 0.25 kg object that has position vector $\vec{r} = \left(2.0\hat{\mathrm{i}} - 2.0\hat{\mathrm{k}}\right)$ m and velocity vector $\vec{v} = \left(-5.0\hat{\mathrm{i}} + 5.0\hat{\mathrm{k}}\right)$ m/s . About the origin and in unit-vector notation, what are (a) the object's angular momentum and (b) the torque acting on the object?

3) At the instant the displacement of a 2.00 kg object relative to the origin is $\vec{d} = (2.00\text{ m})\hat{\mathrm{i}} + (4.00\text{ m})\hat{\mathrm{j}} - (3.00\text{ m})\hat{\mathrm{k}}$, its velocity is $\vec{v} = -(6.00\text{ m/s})\hat{\mathrm{i}} + (3.00\text{ m/s})\hat{\mathrm{j}} + (3.00\text{ m/s})\hat{\mathrm{k}}$ and it is subject to a force $\vec{F} = (6.00\text{ N})\hat{\mathrm{i}} - (8.00\text{ N})\hat{\mathrm{j}} + (4.00\text{ N})\hat{\mathrm{k}}$. Find (a) the acceleration of the object, (b) the angular momentum of the object about the origin, (c) the torque about the origin acting on the object, and (d) the angle between the velocity of the object and the force acting on the object (See HW 3, problem 4).

4) The angular momentum of a flywheel having a rotational inertia of 0.140 kg · m^2 about its central axis decreases from 3.00 to 0.800 kg · m^2/s in 1.50 s. (a) What is the magnitude of the average torque acting on the flywheel about its central axis during this period? (b) Assuming a constant angular acceleration, through what angle does the flywheel turn? (c) How much work is done on the wheel? (d) What is the average power of the flywheel?

5) Force $\vec{F} = (-8.00\text{ N})\hat{\mathrm{i}} + (6.00\text{ N})\hat{\mathrm{j}}$ acts on a particle with position vector $\vec{r} = (3.00\text{ m})\hat{\mathrm{i}} + (4.00\text{ m})\hat{\mathrm{j}}$. What are (a) the torque on the particle about the origin, in unit-vector notation, and (b) the angle between the directions of $\vec{r}$ and $\vec{F}$?

6)At time *t*, the vector $\vec{r} = 4.0t^2\hat{\mathrm{i}} - \left(2.0t + 6.0t^2\right)\hat{\mathrm{j}}$ gives the position of a 3.0 kg particle relative to the origin of an *xy* coordinate system ($\vec{r}$ is in meters and *t* is in seconds). (a) Find an expression for the torque acting on the particle relative to the origin. (b) Is the magnitude of the particle's angular momentum relative to the origin increasing, decreasing, or unchanging?

7) A rigid body rotates with constant angular velocity about a fixed axis. Show that its kinetic energy *K* and angular momentum *L* are related according to $K = \frac{L^2}{2I}$, where *I* is the rotational inertia.