11-Series Problem

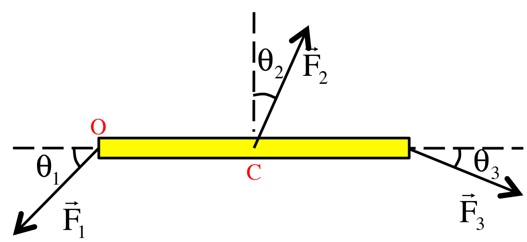
11.1) Given $\vec{M} = 2\hat{i} - 3\hat{j} + \hat{k}$ and $\vec{N} = 4\hat{i} + 5\hat{j} - 2\hat{k}$, determine $\vec{M} \times \vec{N}$.

11.3) Given $\vec{A} = \hat{i} + 2\hat{j}$ and $\vec{B} = -2\hat{i} + 3\hat{j}$:

a.) Determine $\vec{A} \times \vec{B}$.

b.) Using the polar approach to cross products, determine the angle between $\vec{A}$ and $\vec{B}$.

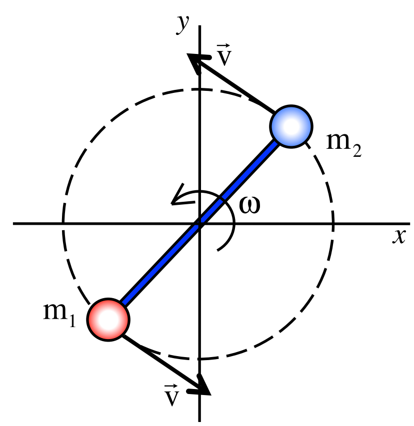
11.5) Consider the forces acting on the beam, as shown in the sketch to the right. Assuming $\vec{F}_1 = 30\text{ N}, \vec{F}_2 = 25\text{ N}, \vec{F}_3 = 10\text{ N}$, $\theta_1 = 45^\circ$, $\theta_2 = 30^\circ$ and $\theta_3 = 20^\circ$:



a.) Derive an expression for the net torque (magnitude and direction) on the beam about an axis through *Point O* and perpendicular to the page.

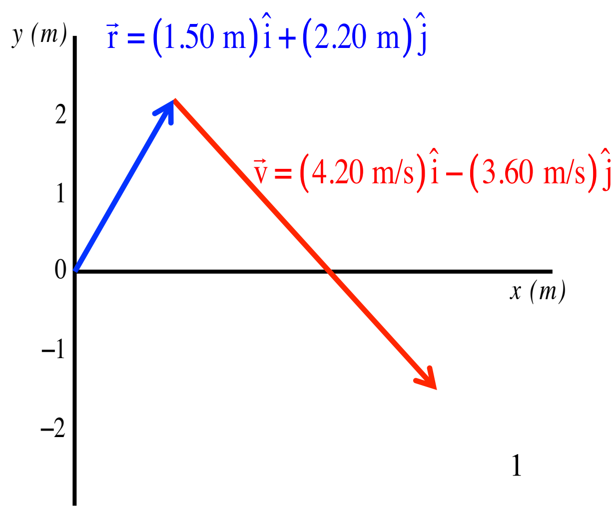
b.) Derive an expression for the net torque on the beam about an axis through *Point C* and perpendicular to the page.

11.7) If the magnitude of the cross product of two vectors equals the dot product of the two vectors, what must the angle be between the two vectors?



11.11) A mass $m_1 = 4.00\text{ kg}$ is attached to one end of a light rod of length $l = 1.00$ meters, and a second mass $m_2 = 3.00\text{ kg}$ is attached to the other end. The system rotates about its central axis as shown. What is its angular momentum when the masses are moving with velocity magnitude 5.00 m/s?

11.12) The position vector of a 1.50 kg mass, along with its mathematical representation, is shown in blue on the graph. Its velocity vector is shown in red. For the instance shown, determine the *angular momentum* of the body, relative to the origin.



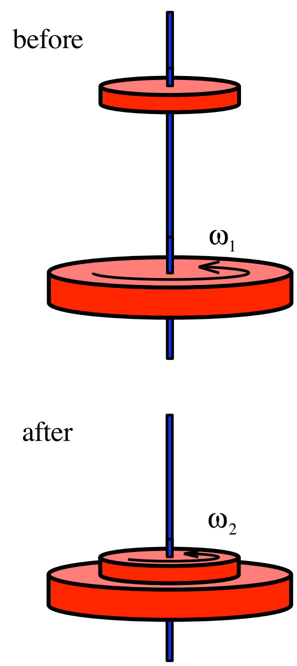
11.15) A 2.00 kg mass has a position vector of $\vec{r} = \left(6.00\hat{i} + 5.00t\,\hat{j}\right)$ meters, where *t* is in seconds. What is the particle's *angular momentum* (as a function of time) relative to the origin?

11.22) Write out the kinetic energy of an object rotating about a fixed axis in terms of its angular momentum *L* and its moment of inertia *I*.

11.25) A solid, homogeneous, 3.00 kg disk of radius 0.200 meters rotates at 6.00 rad/sec about an axis perpendicular to the disk's face.

a.) Determine the disk's angular momentum if the axis of rotation passes through the center of the disk.

b.) Determine the disk's angular momentum if the axis of rotation passes through a point R/2 units from the center of the disk.



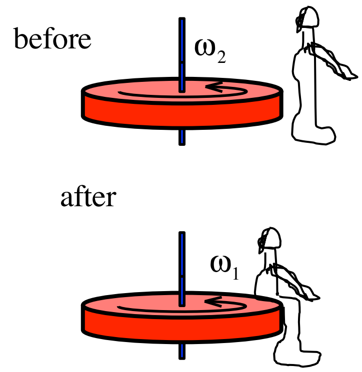
11.30) Two disks are oriented coaxially, one under the other. The bottom disk (moment of inertia I_1) is rotating with angular velocity ω_1 with the top disk (moment of inertia I_2) initially stationary. At some point, the top disk drops onto the bottom disk. Although there is initially slippage between the two disks, frictions bring them finally motivates the two to move with a common angular velocity ω_2.

a.) Derive an expression for ω_2.

b.) What is the ratio of the system's rotational energy, final to initial.

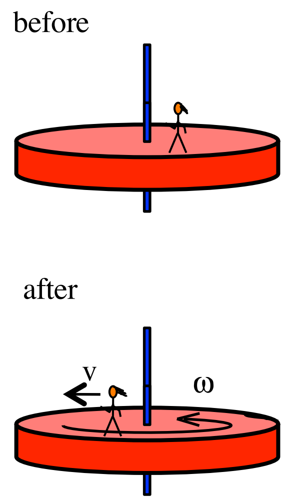
(there's more . . .)

11.31) A merry-go-round rotates about its axis frictionlessly, moving at 10 rev/min. Its moment of inertia is $I = 250\ kg \bullet m^2$ and its radius is R = 2.00 meters. A kid who is initially stationary next to the m-g-r sits down on its edge while it is in motion. If the kid's mass is m = 25.0 kg, what is the m-g-r's new angular speed once the kid is seated and moving with the m-g-r?



11.35) A woman standing on the edge of a frictionless, mini-merry-go-round (without restraining bars) begins to walk from rest, topping out at a constant 1.50 m/s. If the m-g-r's particulars are $I_{mgr} = 500 kg \bullet m^2$ with a radius of 2.00 meters, and if the woman's mass is $m = 60\ kg$:

- a.) Is the mechanical energy wrapped up in the woman/m-g-r system conserved? Justify.
- b.) Is the momentum of the system conserved? Justify.
- c.) Is the angular momentum of the system conserved? Justify.
- d.) As a vector, what is the "final" angular velocity of the m-g-r?
- e.) For the woman to make this happen, how much chemical energy does her body have to convert into mechanical energy in the process?



11.37) Situated on a frictionless tabletop is a wooden block of mass *M* attached to a massless rod of length *l* that is, itself, attached to a pivot at its other end (it would be more satisfying to use *L* for the length, but *L* is the symbol we are using for angular momentum, and that's going to get confusing). A bullet of mass *m* moving with velocity magnitude *v* strikes the block square (that is, in the horizontal, parallel to the table) and embeds itself into the block.

- a.) Determine the block/bullet system's initial angular momentum, relative to the pivot.
- b.) What percentage of mechanical energy is "lost" to heat and deformation and sound (i.e., to "internal" energy) through the collision?