CTAngMom-1. A disk is spinning as shown with angular velocity \( \omega \). It begins to slow down.

While it is slowing, what is the direction of its vector angular acceleration \( \vec{\alpha} \)?

A) \( \uparrow \)  
B) \( \downarrow \)  
C) \( \leftarrow \)  
D) \( \rightarrow \)  
E) Some other direction, or zero.

Answer: up \( \uparrow \). Draw a \( \omega_1 - \omega_2 - \Delta \omega \) vector diagram. \( \omega_1 \) and \( \omega_2 \) are both down. \( \Delta \omega \) is up.

CTAngMom-2. What is \( \hat{j} \times \hat{i} + \hat{k} \)?

A) zero  
B) \( 2\hat{k} \)  
C) \( \hat{j} \)  
D) \( \hat{i} \)  
E) Question makes no sense

Answer: zero. \( \hat{j} \times \hat{i} = -\hat{k} \)
CTAngMom-3. A planet in elliptical orbit about the Sun is in the position shown.

With the origin located at the Sun, the vector torque on the planet.
A) is zero.    B) points along +z.    C) is in the x-y plane.    D) None of these.

Answer: The torque is zero. The angle between the force vector and the position vector is 180°.
CTAngMom-4. How does the magnitude of the angular momentum of the planet $L_{\text{planet}}$ (with the origin at the Sun) at positions A and B compare?

A) $L_A = L_B$
B) $L_A > L_B$
C) $L_A < L_B$

Answer: $L_A = L_B$  Angular momentum of the planet is conserved, since the torque on the planet is zero.

CTAngMom-5. Three identical wheels, all with momentum of inertia $I$, are all spinning with the same angular velocity $\omega$. The total angular momentum of the 3-wheel system has magnitude $3I\omega$.

One of the three wheels is flipped upside-down, while the magnitude of its angular velocity remains constant.

The new angular momentum of the 3-wheel system has magnitude.

A) $3I\omega$ (the same as before)  B) $2I\omega$  C) $I\omega$  D) some other value.

Answer: $I\omega$  Angular momentum is a vector.
CTAngMom-6. Consider a solid disk with an axis of rotation through the center (perpendicular to the diagram). The disk has mass $M$ and radius $R$. A small mass $m$ is placed on the rim of the disk. What is the moment of inertia of this system?

A) $(M+m)R^2$  
B) less than $(M+m)R^2$  
C) greater than $(M+m)R^2$

Suppose that mass-disk system is rotating and the axle is frictionless. Atom-Ant carries the mass $m$ toward the center of the rotating disk. As Atom-Ant moves inward, the magnitude of the angular momentum $L$ of the system.

A) increases  
B) decreases  
C) remains constant

As Atom-Ant moves inward, the kinetic energy of the system.

A) increases  
B) decreases  
C) remains constant

Hint: did Atom-Ant do work?

Suppose the disk was on a phonograph player, so that it always turned at 33 rpm. As Atom-Ant moves inward, the speed $v$ of the mass $m$

A) increases  
B) decreases  
C) remains constant

Answers:
The moment of inertia of the system is less than $(M+m)R^2$.
As Atom-ant moves inward, the angular momentum $(L = I\omega)$ of the system remains constant, by Conservation of Angular Momentum
As Atom-ant moves inward, the $KE_{rot} = (1/2)I\omega^2 = (1/2)L^2/I$ of the system increases.
When the rotation rate is fixed at 33 rpm, the speed of Atom-Ant decreases as he moves inward, since $v_{tan} = \omega r$.

CTAngMom-7. A star is rotating with a period $T$. Over a period of a million years, its radius decreases by a factor of 2. What is the new period of the star? (Hint:

$I_{sphere} = \frac{2}{5}M R^2$ )

A)T/2  
B) 2T  
C) 4T  
D) T/4  
E) None of these.

Answer: T/4  (Use Conservation of Angular Momentum $L = I\omega = \text{constant}$ )
While holding a frictionless spinning wheel, a person is sitting on a frictionless stool that can spin. The axis of the wheel is vertical, and the magnitude of the angular momentum of the wheel is $L_W$. The person then flips the axis of the wheel, rotating it $180^\circ$. The wheel continues to spin at the same rate. After the wheel is flipped, the magnitude of the angular momentum of the person+stool (just the person/stool, not the person/stool+wheel) is..

A) Zero  
B) $L_W$  
C) $2L_W$  
D) $(1/2)L_W$  
E) None of these.

Answer: $2L_W$. By conservation of angular momentum, the total angular momentum of person+stool+wheel must remain constant.