Quiz 5

Solutions

Choose the best answer.

1. A student sits on a stool that can rotate freely about a vertical axis. She holds a rapidly spinning wheel with its axle vertical. Nothing is moving except the wheel, which has angular momentum **L**. She flips the axle 180° so it is vertical again but with the wheel spinning the other way. The angular momentum about the vertical axis of everything in the system *except* that of the wheel is:

   A. Zero.

   B. **L.**

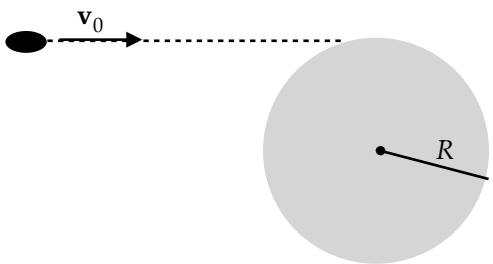
   C. –L.

   ☛D. 2**L.** [Wheel now has angular momentum –L; the total must remain +**L.]**

Choose T or F depending on whether the statement is true or false.

2. If a body has only two forces acting on it, of equal magnitude and opposite direction but not along the same line, then linear momentum is conserved but angular momentum is not conserved about any point. **T** [Torque is not zero about any point.]

3. A wooden disk of moment of inertia I is mounted on a vertical axle through its center, as seen from above. A bullet of mass m and speed v_0 strikes the disk as shown and sticks in it at the edge. The disk was originally at rest.



   a. Take the disk and bullet together as the system. What is conserved in the collision, and why?

   b. What is the final angular speed ω of the system?

   c. How much energy is lost in the collision?

a. Angular momentum about the axle is conserved because with no friction in the bearings there can be no external torque about the axle.

b. Initial angular momentum of bullet: $L_i = mRv_0$. Final angular momentum of system of disk plus bullet: $L_f = (I + mR^2)\omega$. Set $L_i = L_f$: $\omega = \dfrac{mRv_0}{I + mR^2}$.

c. Final kinetic energy: $K_f = \frac{1}{2}(I + mR^2)\omega^2 = \frac{1}{2}\dfrac{(mRv_0)^2}{I + mR^2} = \frac{1}{2}mv_0{}^2\dfrac{mR^2}{I + mR^2}$. Energy lost is $\frac{1}{2}mv_0{}^2 - K_f = \frac{1}{2}mv_0{}^2\dfrac{I}{I + mR^2}$.