Chapter 9: Angular Kinetics

1. At the instant of takeoff, a 60-kg diver's angular momentum about his transverse axis is 20 kg·m^2/s. His radius of gyration about the transverse axis is 1.0 m at this instant. During the dive, the diver tucks and reduces his radius of gyration about the transverse axis to 0.5 m.

a) At takeoff, what is the diver's angular velocity about the transverse axis?

$$H = I\omega \qquad I = mk^2 = 60(1^2) = 60kgm^2 \qquad \omega = \frac{H}{I} = \frac{20}{60} = 0.33 \text{ rad/s}$$

b) After the diver tucks, what is his angular velocity about the transverse axis?

$$H = I\omega \qquad I = mk^2 = 60(0.5^2) = 15kgm^2 \qquad \omega = \frac{H}{I} = \frac{20}{15} = 1.33 \text{ rad/s}$$

Notice how decreasing the radius of gyration by half, the angular velocity increased by four times.

2. A volleyball player jumps into the air to spike the ball. She leaves the ground without any angular momentum. As she swings her arm forward to spike the ball, what happens to her legs if her trunk and non-hitting arm do not rotate?

Her legs, trunk, and non-hitting arm will rotate in the opposite direction. So, if we think of the hitting arm rotating clockwise, the rest will rotate counter-clockwise since angular momentum will be conserved (at least until the ball is contacted.

3. The mass of a discus is 2 kg, and its radius of gyration is 12 cm. The average net torque exerted on a discus about its axis of spin is 100 Nm during a throw. If the discus is not spinning at the start of the throwing action, and the throwing action lasts for 0.20 s, how fast is the discus spinning when it is released?

$$T\Delta t = I\Delta\omega \qquad I = mk^2 = 2(0.12^2) = 0.0288kgm^2$$

$$\omega = \frac{T\Delta t}{I} = \frac{100(0.20)}{0.0288} = 694 \text{ rad/s}$$