Chapter 8: Angular Kinematics

1. A therapist examines the range of motion of an athlete's knee joint during rehabilitation from a knee injury. At full extension, the angle between the shank and thigh is 178°. At full flexion, the angle between the shank and thigh is 82°. During the test, the thigh was held in a fixed position and only the shank moved. What was the angular displacement of the shank from full extension to full flexion? Express your answer in degrees and radians.

$$178° - 82° = 96°$$

$$96°\left(\frac{\pi rad}{180°}\right) = 1.68 \text{ rad}$$

2. When discus thrower Anthony Washington begins his throwing motion, he spins with an angular velocity of 5 rad/s. Just before he releases the discus, Anthony's angular velocity is 25 rad/s. If the time from the beginning of the throw to just before release is 1 s, what is Anthony's average angular acceleration?

$$angacc = \frac{\Delta vel}{\Delta time} = \frac{25 rad/s - 5 rad/s}{1s} = 20 \text{ rad/s}^2$$

3. Lance Deal spins with an angular velocity of 540°/s. The distance from his axis of rotation to the center of gravity of the 7.26 kg hammer is 1.9 m.

    a) What is the linear velocity of the hammer head?

$$540°\left(\frac{\pi rad}{180°}\right) = 9.42 \text{ rad} \qquad v = \omega r = (9.42 rad/s)(1.9m) = 17.9 \text{ m/s}$$

    b) What is the centripetal acceleration of the hammer head?

$$\omega^2 r = (9.42 rad/s)^2 (1.9m) = 169 \text{ m/s}^2$$

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    c) What is the centripetal force created by the hammer head?

$$F = ma = 7.26kg(169m/s^2) = 1224 \text{ N}$$

4. What advantages does a longer-limbed individual have in throwing and striking activities?

    A longer limb means the radius will be larger. Considering that linear velocity equals the product of angular velocity and radius, an athlete should be able to obtain higher linear velocities. However, this will only be true if the athlete can generate similar angular velocities. As you consider Major League Baseball, it seems that the most effective pitchers are relatively tall.