

# KIN 3309: Biomechanics

## Problem Set #2

*Spring 2017, Section 3, T/R 1:00-2:30pm*

1. During an elbow flexion exercise, the relative angle at the elbow is  $110^\circ$  at 0.67 seconds and  $82^\circ$  at 0.75 seconds. What is the average angular velocity of the elbow in  $[\text{°}/\text{s}]$ ?
2. If a skater is rotating during a spin at a constant angular velocity of  $3.6 \text{ rad/s}$  for 5 seconds, what is his angular acceleration in  $[\text{rad/s}^2]$ ?
3. A top is spinning at  $5.6 \text{ rev/s}$  and starts decelerating at  $0.61 \text{ rev/s}^2$ . How long will it take the object to stop in  $[\text{s}]$ ?
4. An object is spinning at a constant velocity of  $1000^\circ/\text{s}$ . If it spins for 2.0 seconds, what is the angular distance traveled in  $[\text{rad}]$ ?
5. A hammer thrower releases the hammer after reaching an angular velocity of  $17.2 \text{ rad/s}$ . If the hammer is 180 cm from the axis of rotation, what is the linear velocity of the hammer at release in  $[\text{m/s}]$ ?
6. The final angular velocity of a golf swing was  $330^\circ/\text{s}$  with a constant angular acceleration of  $500^\circ/\text{s}^2$ . Assume the initial angular velocity was  $0^\circ/\text{s}$ . How far did the club rotate in  $[\text{°}]$ ?
7. A ball of mass  $0.5\text{kg}$  is thrown towards a wall at  $20\text{m/s}$ . The ball's collision with the wall lasted  $0.15\text{s}$ . The ball rebounded off of the wall with a velocity of  $-10\text{m/s}$ . What was the force produced during the collision (in  $\text{N}$ )?
8. A person wants to push a  $110\text{-kg}$  box across the floor. The coefficient of friction between the box and the floor is  $0.3$ .
  - a. What is the normal force experienced by the box at rest in  $[\text{N}]$ ?
  - b. If the person pushes horizontally on the box, how much force must be applied to move the box in  $[\text{N}]$ ?

- c. If the person pushes against the box with 500N of force but at an angle of  $20^\circ$  relative to the horizontal, what is the normal force experienced by the box in [N]?
- d. What is the horizontal acceleration of the box when the 500N of force at an angle of  $20^\circ$  relative to the horizontal is applied, in  $[m/s^2]$ ?
9. Quentin is lifting a 10 kg dumbbell by pulling upward on it with a 120 N force. What is the acceleration of the dumbbell as a result of this force, in  $[m/s^2]$ ?
10. How much power is generated in the horizontal direction by a force of 1150 N applied to an object at angle of  $0^\circ$  (relative to the horizontal), causing the object to move horizontally 4m in 1.6 seconds in [W]?
11. A 608 N woman dives from a 10m platform.
- What is her potential energy 7 m into the dive in [J]? Assume no external forces are applied during the dive.
  - What is her kinetic energy 7 m into the dive in [J]? Assume no external forces are applied during the dive.
  - What is the diver's velocity 7 m into the dive in  $[m/s]$ ? Assume no external forces are applied during the dive.
12. Tonya crashes into Nancy while they are practicing their figure skating routines. Tonya's mass is 60 kg and Nancy's mass is 50 kg. Just before the collision occurs, Tonya's velocity is 5 m/s and Nancy's velocity is 6 m/s in the opposite direction. During the collision, Tonya exerts an average force of 1000 N against Nancy.
- What is the magnitude of the average force Nancy exerts against Tonya during the collision in [N]?
  - In what direction is the reaction force of Nancy generated?
13. A 200 kg football player is running toward another player at 8 m/s. How much force needs to be applied over 1.9 seconds to bring him to stop in [N]?
14. The moment of inertia of an object is  $2.5 \text{ kgm}^2$ . It is moving at an initial angular velocity of 10 rad/s. If the object's velocity increases to 150 rad/s, what is the angular impulse exerted on the system in  $[\text{kgm}^2/\text{s}]$ ?
15. A box of 10kg is pushed by a force of 30N over a distance of 6m in 8 seconds. Assume that the angle between the horizontal and the applied force is  $\theta = 60^\circ$ .

- a. Calculate the work done on the box in [J].
- b. Calculate the power of this action in [W].