KIN 335 - Biomechanics
Example Problems: Linear and Angular Kinetics

1) A 75 kg jumper lands stiff-legged on the floor and changes his velocity from –4.5 m/s to zero in 0.15 seconds. Compute the average ground reaction force under his feet during this time interval. If he increased the impact time to 0.2 s, what happens to the ground reaction force? (Caution: *net force* and *ground reaction force* is not the same thing! Be careful here!).

   GRF = 2,985 N. When time is increased to 0.2 s, the GRF decreases to 2,422.5 N

2) A football player pushed a 60 kg blocking sled with a constant horizontal force of 400 N. The coefficient of kinetic friction between the sled and ground is 0.5. How much horizontal force opposes the forward motion of the sled? What is the sled's horizontal acceleration? (assume that the playing surface is level).

   Friction force = 294 N (in the direction opposite to the direction of sliding); a = 1.77 m/s

3) Two ice skaters start out motionless in the center of the ice rink. They then push each other apart. The man (mass = 80 kg) moves to the right with a speed of 2.5 m/s. The woman moves to the left at some unknown speed.

   a) If her mass is 58 kg, calculate that speed. (assume frictionless ice) $V_{woman} = -3.45$ m/s
   b) What has happened to the total momentum of the system (woman + man) during the push-off? Why? Nothing…it has stayed exactly the same. The total momentum before the push equals the total momentum after the push. This is consistent with the conservation of momentum.

4) A child tries to swing an adult size baseball bat without choking up on it. She can manage only 200 deg/s of angular velocity with a radius of 80 cm. But then she chokes up on the bat thereby reducing the radius of rotation by 10 cm. She can now generate an angular velocity of 300 deg/s. Compute the linear velocity of the endpoint of the bat in each case in m/s (watch your units!).

   $V_{T\text{-}80\ cm} = 2.79$ m/s; $V_{T\text{-}70\ cm} = 3.665$ m/s

5) A golfer accelerates the club from the top of the backswing until impact with the ball with an average angular acceleration of 30 rad/s^2 for a period of 0.5 s. The radius of rotation is 1.1 m. Compute the angular velocity of the club at impact, the linear velocity of the clubhead at impact, and the radial acceleration of the clubhead at impact.

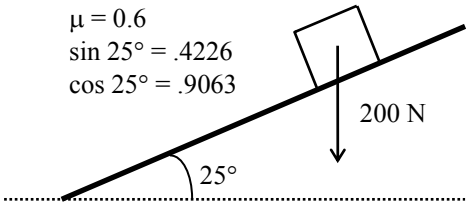
   $\omega = 15$ rad/s; $V_T = 16.5$ m/s; $a_R = 247.5$ m/s

6) A champion hammer thrower rotates at a rate of 3.2 rev/s just prior to releasing the hammer.

   a) If the hammer is located 1.6 m away from the axis of rotation, what is the radial acceleration experienced by the athlete? $a_R = 646.8$ m/s
   b) How much tension (i.e. force) is needed to produce this radial acceleration if the mass of the hammer is 7.3 kg? $F_{centripetal} = 4{,}721.7$ N

7) The 200 N box in the figure to the right will

   a) require an additional force of at least 24.3 N to initiate sliding
   b) have a friction force of 84.5 N opposing sliding
   c) have a limiting value of friction equal to 120 N
   d) both a and b



8) A 65 kg gymnast begins to prepare for his dismount from the high bar by increasing his angular velocity by a factor of 3. By what factor does the centripetal force change? (you may assume that *r* does not change)

   a) increases by a factor of 3
   b) increases by a factor of 6
   c) increases by a factor of 9
   d) increases by a factor of 12