

KIN 335 Biomechanics
Practice Problems: Uniformly Accelerated Motion
($g = -9.8 \text{ m/s}^2$ or -32 ft/s^2)

1. If an athlete jumped 2 feet high and left the ground at an angle of 20 degrees with respect to the horizontal, how fast was the athlete going in the forward (positive horizontal) and upward (positive vertical) directions immediately after takeoff? If the height of takeoff was the same as the height of landing, how fast was the athlete going in the horizontal and vertical directions right before landing?

At takeoff: $V_H = 31.1 \text{ ft/s}$ At landing: $V_H = 31.1 \text{ ft/s}$
 $V_V = 11.3 \text{ ft/s}$ $V_V = -11.3 \text{ ft/s}$

2. An Olympic diver drops from the 10 meter platform with an initial vertical velocity of 0.0 m/s. What was the vertical velocity of the diver immediately before he/she hits the water? How long did it take the diver to reach the water?

At landing: $V_V = -14.0 \text{ m/s}$
 $t_{\text{down}} = 1.43 \text{ s}$

3. If the diver in problem 2 needed to clear the edge of the pool by 5 m, what was the horizontal velocity of the diver at the instant of takeoff? What was the horizontal velocity right before landing? (You may assume that the edge of the platform was directly above the edge of the pool.)

At takeoff *and* landing: $V_H = 3.5 \text{ m/s}$

4. A long jumper leaves the ground at an angle of 25 degrees with respect to the horizontal with a resultant velocity of 30 ft/s. What was the horizontal velocity of the jumper at takeoff? What was the vertical velocity at takeoff? How high did the CM rise above the point of takeoff?

At takeoff: $V_H = 27.2 \text{ ft/s}$
 $V_V = 12.7 \text{ ft/s}$
 $D_H = 2.51 \text{ ft above the point of takeoff}$

5. Two balls were thrown upward and were caught at the same height from which they were released. Ball A was thrown upward with a vertical velocity of 10 m/s. Ball B was thrown upward with a vertical velocity which was twice that of ball A. How far did each ball rise above the point of release? How long did each ball stay in the air (total time)? Considering that the velocity of ball B was 2× greater than that of ball A, describe how much higher ball B traveled and how much longer ball B stayed in the air.

Ball A: $D_V = 5.1 \text{ m}$ $t = 1.02 \text{ s}$
 Ball B: $D_V = 20.4 \text{ m}$ (*four times higher*) $t = 2.04 \text{ s}$ (*two times longer*)

6. If a shot is put an angle of 41 degrees relative to the horizontal with a velocity of 36 ft/s in the direction of the put, what will be the upward (vertical) velocity at the instant of release? What will be the forward (horizontal) velocity? How high (above the point of release) will the shot go? What is the time it takes the shot to reach its maximum height?

At release: $V_H = 27.2 \text{ ft/s}$
 $V_V = 23.6 \text{ ft/s}$
 $D_V = 8.72 \text{ ft above the point of release}$
 $T_{\text{up}} = 0.738 \text{ s}$

7. If the shot in problem 6 is released from a height of 6 ft and later lands on the ground (height = 0.0 ft), what was the total time of flight? How far did the shot travel horizontally?

$T_{\text{total}} = 1.697 \text{ s}$
 $D_H = 46.11 \text{ ft}$