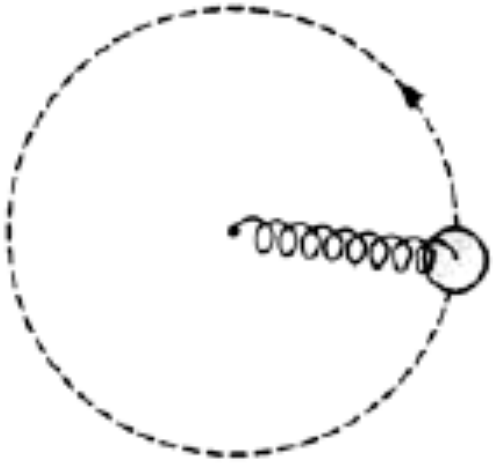
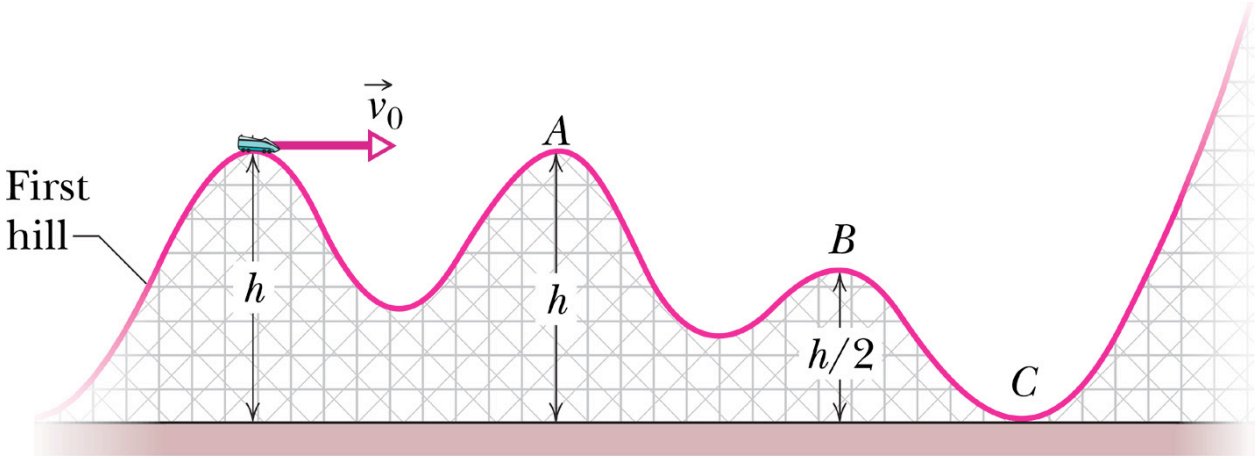
1. **The maximum mass that can be hung vertically from a string without breaking is 10 [kg]. A length of this string that is 2[m] long is used to rotate a 0.5 [kg] object in a circle on a frictionless table with the string horizontal. Calculate the maximum speed that the mass can attain under these conditions without the string breaking.**

2. **A ideal spring has a spring constant of 100 [N/m] and an unstretched length of 0.07 [m] . One end is attached to a post and is free to rotate in the center of a frictionless table, as shown below. The other end is attached to a 1 [kg] disc and is placed into motion and attains (and maintains) a constant speed of 3 [m/s]. What is the displacement of the spring (i.e., how much is it stretched) when the object is moving at 3 [m/s]?**

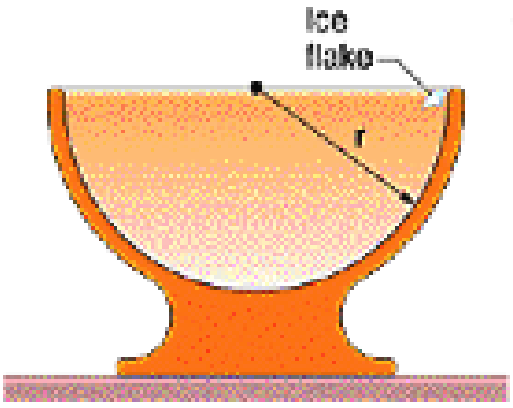


Top View

3. **A frictionless roller-coaster car of mass m = 825 [kg] tops the first hill with a speed v_0 = 17.0 [m/s] at height h = 42 [m].**
   a. **What is the speed of the car at point B?**
   b. **What is the speed of the car at point C?**

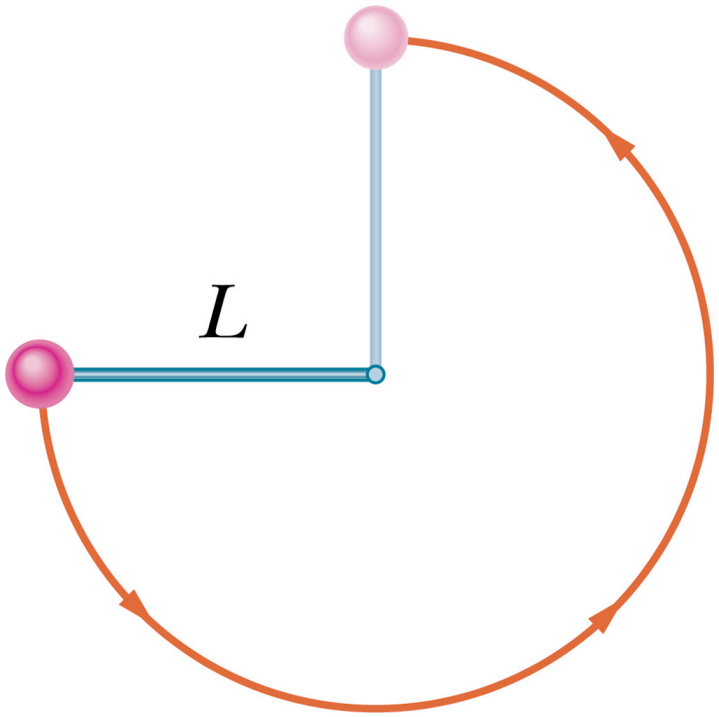


4. **In the figure below, a 2.50 [kg] ice flake is released from the edge of a hemispherical bowl whose radius r is 0.22 [m]. The flake-bowl contact is frictionless.**
   a. **What is the speed of the ice flake at the bottom of the bowl?**
   b. **What is the magnitude of the normal force acting on the ice flake at the bottom of the bowl?**



5. **A 4.8 [g] dart is fired vertically upward using a crossbow. The crossbow must be compressed 0.08 [m] if the marble is to just reach a target 12 [m] above the dart's position on the compressed crossbow.**
   a. **What is the change in the gravitational potential energy dart during the dart's 12 [m] ascent relative to position when the crossbow is fully stretched?**
   b. **What is the spring constant of the crossbow spring?**

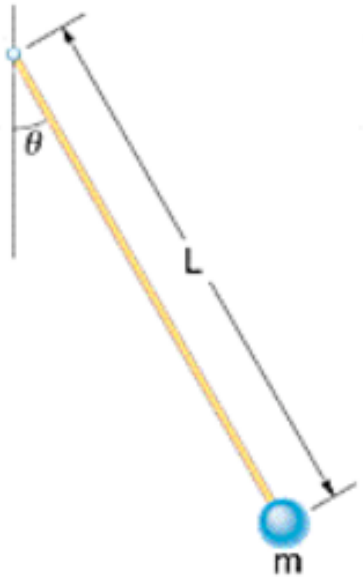
6. **The figure below shows a ball with mass m = 0.327 [kg] attached to the end of a thin rod with length L = 0.535 [m] and negligible mass. The other end of the rod is pivoted so that the ball can move in a vertical circle. The rod is held horizontally as shown and then given enough of a downward push to cause the ball to swing down and around and just reach the vertically up position, with zero velocity at that point.**
   a. **What initial speed must be given the ball so that it reaches the vertically upward position with zero velocity?**
   b. **What is the ball's velocity at the lowest point?**
   c. **The ball remains attached to the rod via static frictional force between the ball and the rod. What is the magnitude of static frictional force between the ball and the rod at the bottom of the swing if the ball is to remain attached to the rod (i.e., not fly off the rod)?**



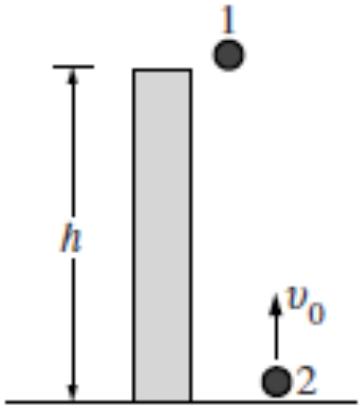
7. **The figure below shows a thin rod, of length L and negligible mass that can pivot about one end to rotate in a vertical circle. A heavy ball of mass m is attached to the other end. The rod is pulled aside through an angle θ and is released.**

   a. **What is the speed of the ball at the lowest point if L = 2.70 [m], θ = 24.0°, and m = 0.5 [kg]?**

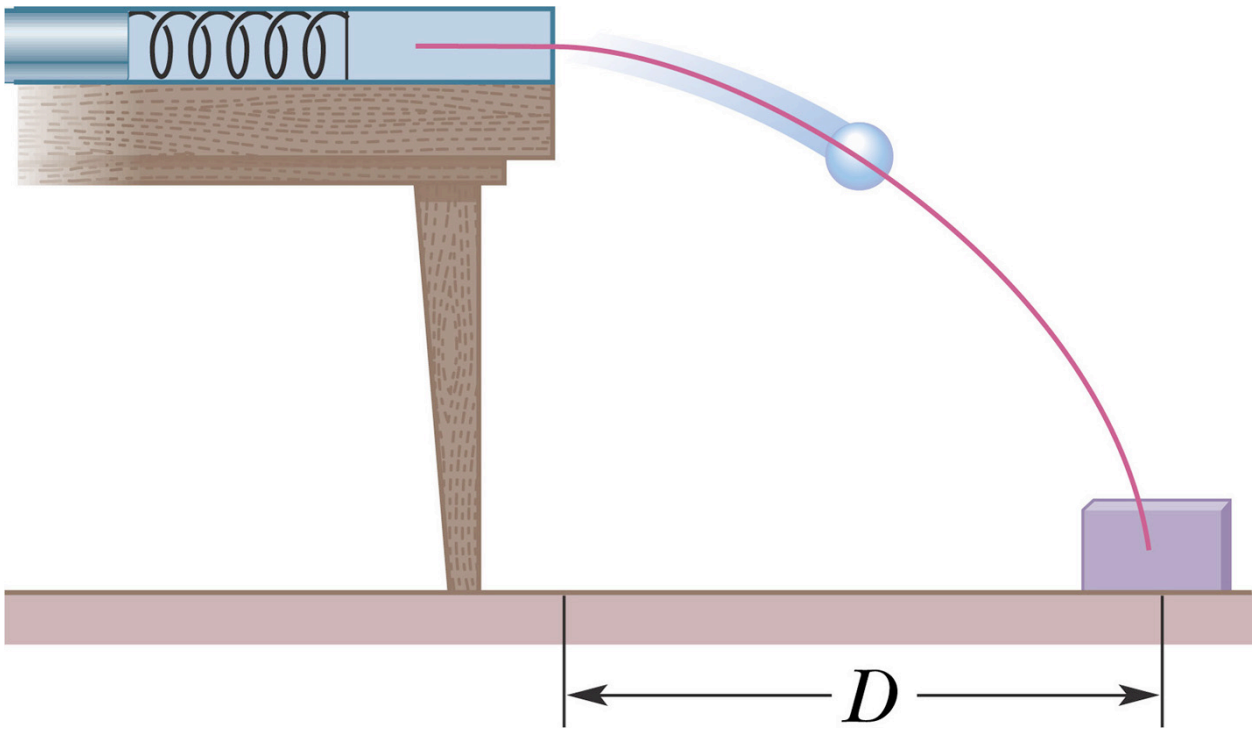
   b. **As in the previous problem, a frictional force between the ball and the rod holds the ball in place. What is the magnitude and direction of the static frictional force acting on the ball when the ball is at the location to the LEFT of the vertical at the same angle θ = 24.0°.**



8. **Ball 1 is dropped from rest at time t = 0 from a tower of height h = 20 [m] as shown below. At the same instant, ball 2 is launched upward from the ground with initial speed of 5 [m/s]. If air resistance is negligible, at what time will the two balls pass each other? (hint: at the time the balls pass each other, the displacement of ball 1 + displacement of ball 2 = h)**



9. **The spring of a projectile launcher (k = 500 [N/m]) is compressed by 0.25 [m] and shoots a ball of mass m = 3.4 [kg] off of a table. The launcher is 1.5 [m] above the ground level.**
   a. **What is the velocity of the ball just as it leaves the table?**
   b. **The ball hits a box a distance D from the base of the table. What is the distance D?**



10. **The position of a particle moving along the x-axis is given as a function of time by the expression x(t) = 3cos(4t+3) where x is in meters and t is in seconds. Use degree mode for this calculation.**
   a. **What is the velocity of the particle at 3 [s]?**
   b. **What is the acceleration of the particle at 3 [s]?**

11. **AP FBD's**
   a. **2010 #2 a only**
   b. **2008 #2 a only**
   c. **2000 #2 a only**
   d. **1997 #3 b only**

HW Set 6 Answers

1. 19.79 [m/s]

2. 0.267 [m]

3a. 26.46 [m/s]
3b. 33.35 [m/s]

4a. 2.08 [m/s]
4b. 73.7 [N]

5a. 0.564 [J]
5b. 176 [N/m]

6a. 3.24 [m/s]
6b. 4.58 [m/s]
6c. 16 [N]

7a. 2.14 [m/s]
7b. 4.48 [N]

8. 4 [s]

9a. 3.03 [m/s]
9b. 1.68 [m]

10a. -3.11 [m/s]
10b. -46.36 [m/s^2]

11. FBD's will be discussed in class