W6.09

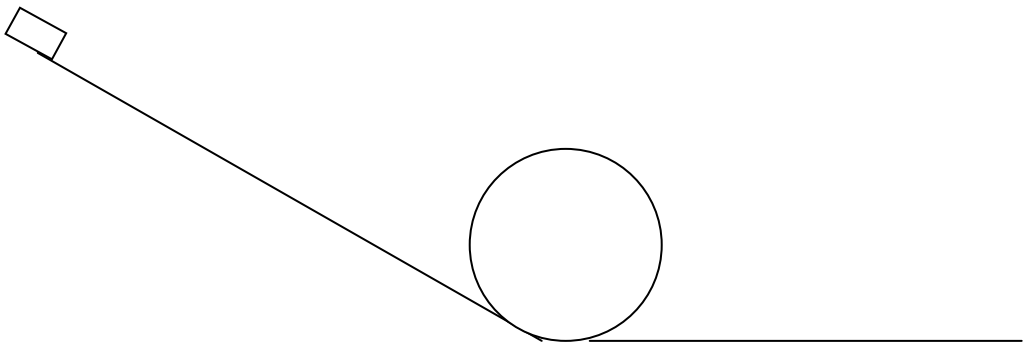
Vertical Circle Problems

1. A 5 kg ball is swung in a vertical circle at the end of a 4 meter rope under the influence of gravity.

   a. What is the critical speed at the top of the circle?
   b. If the ball is moving exactly at the critical speed at the top of the circle, what is its speed at the 3:00 position?
   c. What is the tension in the rope at the 3:00 position under the conditions in part (b)?
   d. What is the speed of the ball at the bottom of the circle if the ball is moving exactly at the critical speed at the top of the circle?
   e. What is the tension in the rope at under the conditions in part (d)?
   f. If the ball is moving at 10 m/s at the top of the circle, what is the required tension in the rope?

2. A block slides down a frictionless ramp and onto a loop as pictured below. The loop has a radius of 5 meters, and the block has a mass of 3 kg.

   a. Explain why the block will not complete the loop if it starts on the ramp even with the top of the loop with no initial velocity.
   b. If the block starts on the ramp even with the top of the loop with an initial speed of 8 m/s, will it complete the loop? Explain.
   c. If the block starts above the loop at a height of 12 meters off the ground with no initial velocity, will it complete the loop? Explain.
   d. Now lets assume the block starts at a height of 15 meters with no initial speed on the ramp. What will the normal force of the track on the block be at the 3:00 position on the loop?
   e. What will the speed of the block be at the top of the loop under the conditions in (d)?
   f. What will the normal force on the block be at the top of the loop under the conditions in (d)?



W6.09 Key

1.

a. **6.32 m/s**
b. **10.95 m/s**
c. **150 N**
d. **14.14 m/s**
e. **300 N**
f. **75 N**

2.

a. **The speed at the top of the loop would again be zero which is, of course, less than the critical speed.**
b. **Yes. The critical speed is 7.07 m/s which is less than 8 m/s. When the block returns to the same height as the initial position, it will have the same speed. So when it reaches the top of the loop its speed will be greater than the critical speed.**
c. **No. When reaching the top of the loop, it will have a speed of only 6.32 m/s which is less than the critical speed.**
d. **F_N provides the centripetal force. By energy, the speed at the 3 o'clock position is 14.14 m/s. The normal force will be 120 N.**
e. **10 m/s**
f. **30 N ($F_C = F_N + F_W$)**