PAL Problem Set 7 for Phys 5A (Ramps and Circular Motion)

Always explain your answers and show your work.

1. A ball is released from the top of a 3-m long ramp that makes an angle of 30^0 with the horizontal surface below.

   A. Sketch the situation. Choose your coordinate axis.

   B. What is the acceleration of the ball on its way down the ramp?

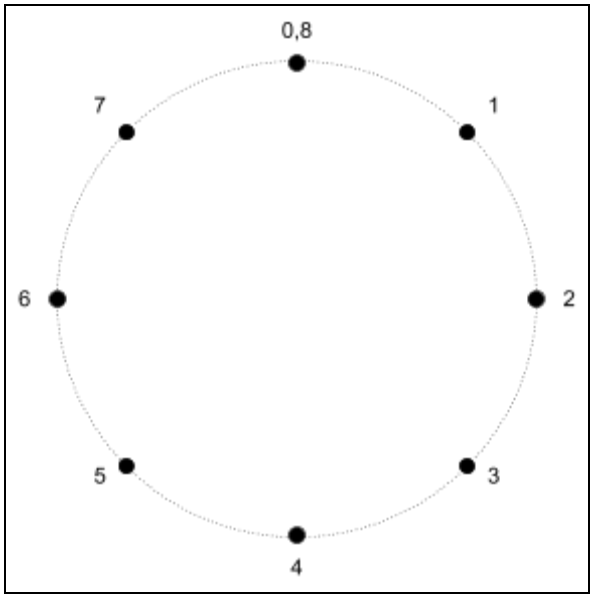
   C. How long does it take for the ball to reach the bottom of the ramp?

   D. What is the ball's speed at the bottom of the ramp?

   E. Assuming that the horizontal ground at the bottom of the ramp goes forever, how much further does the ball travel if it continues to move for another 3 minutes?

   F. Do you think you can build a ramp a get a ball to roll this far? Clearly explain your reasoning.

2. Here is the motion diagram of an object in uniform circular motion.



   A. What does the term "uniform" mean?

   B. Draw vectors representing the displacement vectors from $t = 0$ to $t = 1$, from $t = 1$ to $t = 2$, and so on.

   C. At $t = 0$ the velocity vector points perfectly to the right; at $t = 1$ the velocity vector points down and to the right; at $t = 2$ the velocity points straight down; and so on. The velocity vectors are tangent to the circle. But the *average* velocity between $t = 0$ and $t = 1$ points in the same direction as the displacement vectors you drew in part B. Convince yourselves of that.

D. Use the definition of acceleration ($\vec{a} = (\vec{v}_f - \vec{v}_i)/\Delta t$) to draw the acceleration vectors at each instant. *Hint 1: the acceleration vector points in the same direction as* $\Delta\vec{v}$. *Hint 2: we are only interested in relative sizes and the direction of the acceleration, so you may as well simply calculate* $\Delta\vec{v}$ and call it $\vec{a}$.

E. The acceleration vectors you found should all point to the center of the circle. They indicate the *centripetal acceleration* - responsible for changing the direction of the velocity but not having any effect on its magnitude (speed). The magnitude of the centripetal acceleration is $a = v^2/r$. If the radius of the circle above is 2 meters, and it takes 3 seconds for the object to complete one full revolution, what is the magnitude of the centripetal acceleration?