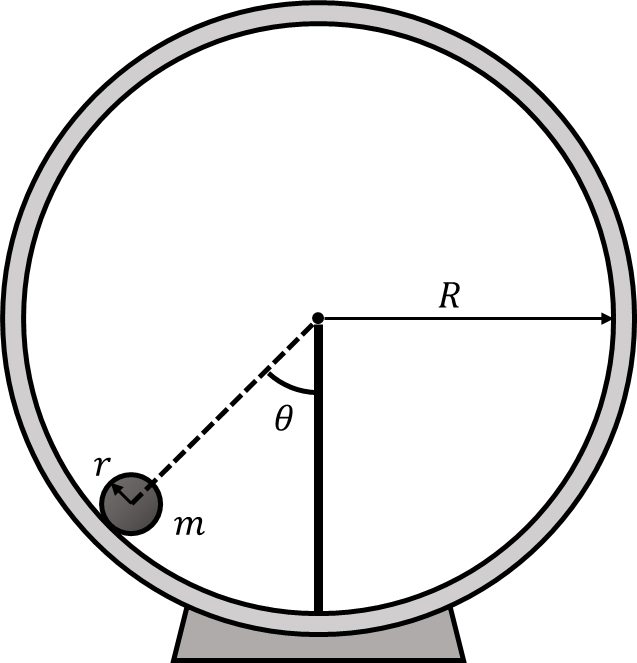
**1. INTRODUCTION**

In this problem, we are going to visualize the motion of a spherical bead rolling back and forth in a stationary circular hoop. To do so, we will animate the motion in Matplotlib with the help of our recently-learned techniques.

**2. PROBLEM STATEMENT**

A solid bead with radius and mass is released at one side of a circular hoop with radius . The bead rolls without slipping down and back up the ramp, making an angle with the vertical as shown in the figure on the right.

In the assumption that is small and , the equation of motion for the hoop is as written below:

Using Matplotlib, animate the motion of the bead on the hoop and create a plot of with respect to time.

**3. CHECKING YOUR RESULTS**

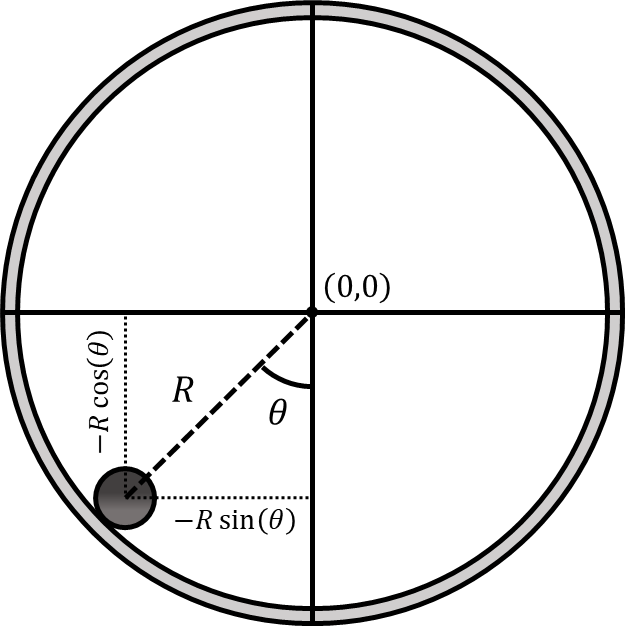
To check your results, compare your solution with the provided solution files in the GitHub repository. Not all solutions will be identical – the provided solution is meant to be used as a guide if you get stuck.

**4. TABLE OF CONSTANTS**

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**5. APPENDIX**

This problem involves converting from polar to rectangular coordinates. The angle of the particle on the hoop with respect to the vertical must be expressed in terms of x and y coordinates to be plotted. As shown below, assuming and placing the center of the hoop at the origin, the x and y positions of the bead are and respectively.



When animating the motion, we must offset the bead by a distance from the hoop so that the edge of the bead, not the center, is in line with the hoop. In rectangular coordinates, this involves adding and to the x and y positions respectively as depicted below.

