Problem 1

A small object of mass $M$ is launched with a velocity $v_0$ at the top of the frictionless track shown. Calculate the normal force on the object at point A. The curved portion of the track has a radius of curvature $R$. A is the exact bottom of the curve.

\[
\left( P.E + K.E. \right)_{\text{top}} = \left( P.E. + K.E. \right)_{\text{bottom}}
\]

\[
\frac{1}{2} m v_0^2 + 3 m g R = \frac{1}{2} m v^2
\]

Free Body Diagram at A:

- $N + mg = - \frac{m v^2}{R}$ \[\Sigma F = ma\]

\[
N = mg + \frac{m v^2}{R} \left[ \sqrt{v_0^2 + 6 g R} \right]
\]

\[
N = m \left( g + \frac{v_0^2}{R} + 6 g \right) = m \left( \frac{v_0^2}{R} + 7 g \right)
\]

\[
N = m \left( \frac{v_0^2}{R} + 7 g \right) \uparrow \text{ directed towards the center of the "circle".}
\]