A person whirls a stone in a horizontal circle of radius of 2m and at a height of 1.5m above the ground in a perfect circle. At some point, the string breaks. The stone flies off horizontally and lands on the ground after traveling a horizontal distance of 15 m.

What is the magnitude of the velocity and the radial acceleration during the circular motion?

Let’s treat this problem backwards.

1. We need $V_0$.

Between A&B: Projectile motion $\Rightarrow$ on $V_0$.

$y_0 = 1.5 \, \text{m}$
$x_0 = 0 \, \text{m}$

$\vec{V}_0 = V_0 \hat{\mathbf{e}}_x$ only

We need $y(x)$

From:

\[
\begin{align*}
    y &= y_0 + V_0 \sin \theta \cdot t - \frac{1}{2} g t^2 \\
    x &= x_0 + V_0 \cos \theta \cdot t
\end{align*}
\]

So:

\[
y - y_0 = -\frac{1}{2} g \left( \frac{x - x_0}{V_0 \cos \theta} \right)^2
\]

or:

\[
2 V_0 \cos \theta = \sqrt{\frac{g}{\frac{1}{2} \left( y - y_0 \right)^2}} \left( \frac{x - x_0}{\cos \theta} \right)
\]

\[
V_0 = \sqrt{\frac{g}{2 \left( y - y_0 \right) \cos \theta}} \left( \frac{x - x_0}{\cos \theta} \right)
\]
\[ V_0 = \sqrt{\frac{9.8}{2 \times 1.5}} \frac{15}{1} = 2.71 \text{ m/s} \]

During the circular motion:

\[ V_0 = V \implies a_c = \frac{V^2}{R} \]

So \[ a = \frac{(2.71)^2}{2} = 36.7.5 \text{ m/s}^2 \]