\[ v_0 = \frac{1000 \text{m}}{s} \quad x = 2000 \text{m} \quad y = 800 \text{m} \]

What is \( \theta_o \)?

**Method I**

Using

\[ y = x \tan \theta_o + \frac{g}{2 v_0^2 \cos \theta_o^2} x^2 \]

\[ 800 = 2000 \tan \theta_o - \frac{19.6}{\cos \theta_o^2} \]

\[ 800 = 2000 \frac{\sin (\theta_o)}{\cos (\theta_o)} - \frac{19.6}{(\cos (\theta_o))^2} \]

\[
\begin{pmatrix}
-2.7512469174935126092 \\
-1.5806356857788123621 \\
1.5609569678109808763 \\
.39034573609628062922
\end{pmatrix}
= \begin{pmatrix}
-157.635 \\
-90.564 \\
89.436 \\
22.365
\end{pmatrix}
\]

**Note:** A numerical solution (as mentioned in class) works nicely. Note that we would get rid of the first 2 solutions as they are negative values and would indicate an angle below the horizontal (which makes no sense). Thus the answers are 89.4° and 22.4°.

**Method II**

\[ 800 (\cos (\theta_o))^2 = 2000 \cos (\theta_o) \sin (\theta_o) - 19.6 \]

Using \( \sin \theta_o = \sqrt{1 - (\cos (\theta_o))^2} \)

\[ 800 (\cos (\theta_o))^2 = 2000 \cos (\theta_o) \sqrt{1 - (\cos (\theta_o))^2} - 19.6 \]
Simplifying

\[
\cos(\theta_o)^4 - .85531 \left( \cos(\theta_o) \right)^2 + .0000827586 = 0
\]

Using the Quadratic Equation:

\[
\left( \cos(\theta_o) \right)^2 = \frac{-85531 + \sqrt{(85531)^2 - 4 \cdot 1 \cdot (.0000827586)}}{2} = .85521323044937399500
\]

\[
\cos(\theta_o) = \sqrt{.85521323044937399500} \approx .925
\]

\[\theta_o = 22.4^\circ\]

\[
\left( \cos(\theta_o) \right)^2 = \frac{-85531 - \sqrt{(85531)^2 - 4 \cdot 1 \cdot (.0000827586)}}{2} = 9.676955062600502500010^{-5}
\]

\[
\cos(\theta_o) = \sqrt{9.676955062600502500010^{-5}} = .009837
\]

\[\theta_o = 89.4^\circ\]

Note again here we have left out the negative roots as they do not provide meaningful information. The answers again are as previously calculated, except without numerical integration.