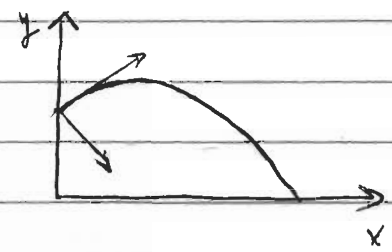


$$\begin{cases} x = v_0 \cos\alpha\, t \\ y = h + v_0 \sin\alpha\, t - \frac{1}{2} g t^2 \end{cases}$$

$$\vec{a} = -g\,\hat{e}_y$$

$$\vec{v} = v_0 \cos\alpha\,\hat{e}_x + (v_0 \sin\alpha - gt)\,\hat{e}_y$$

$$|\vec{v}| = \sqrt{v_0^2 + g^2t^2 - 2g v_0 \sin\alpha\, t} \qquad \vec{v} = v\hat{T}$$

$$\hat{T} = \frac{v_0 \cos\alpha}{v}\,\hat{e}_x + \frac{v_0 \sin\alpha - gt}{v}\,\hat{e}_y \qquad \hat{T}\cdot\hat{N} = 0 \qquad T_x N_x + T_y N_y = 0$$

$$\hat{N} = \frac{v_0 \sin\alpha - gt}{v}\,\hat{e}_x - \frac{v_0 \cos\alpha}{v}\,\hat{e}_y$$

guess $N_x = \pm T_y$
$N_y = \mp T_x$

$$\boxed{\vec{a} = \dot{v}\,\hat{T} + \frac{v^2}{\rho}\hat{N}} \qquad \dot{v} = \frac{1}{\cancel{2}v}(\cancel{2}g^2t - \cancel{2}g v_0 \sin\alpha) = \frac{g}{v}(gt - v_0\sin\alpha)$$

$$\vec{a} = -g\,\hat{e}_y = \frac{g}{v}(gt - v_0\sin\alpha)\frac{v_0\cos\alpha}{v}\hat{e}_x + \frac{g}{v}(gt - v_0\sin\alpha)\frac{v_0\sin\alpha - gt}{v}\hat{e}_y$$

$$+ \frac{\overbrace{(v_0^2 + g^2t^2 - 2g v_0 t \sin\alpha)}^{v^2}}{\rho}\,\frac{v_0\sin\alpha - gt}{\cancel{v}}\hat{e}_x - \frac{v^{\cancel{2}}}{\rho}\frac{v_0\cos\alpha}{\cancel{v}}\hat{e}_y$$

$$+ \frac{v_0\cos\alpha\, g}{v^2}\cancel{(v_0\sin\alpha - gt)} = \frac{v}{\rho}\cancel{(v_0\sin\alpha - gt)} = 0 \qquad \text{comp. } \hat{x}$$

$$\rho = \frac{v^3}{v_0\cos\alpha\, g} = \frac{\left[v_0^2 + g^2t^2 - 2g v_0 \sin\alpha\, t\right]^{3/2}}{v_0 g \cos\alpha} \quad //$$

comp. $\hat{y}$:

$$-g = -\frac{g}{v^2}(gt - v_0\sin\alpha)^2 - \frac{v}{\rho}v_0\cos\alpha \qquad -\frac{v}{\rho}v_0\cos\alpha = +g\left[\frac{(gt - v_0\sin\alpha)^2 - v^2}{v^2}\right]$$

$-v_0^2\cos^2\alpha$

$$\cancel{-}\frac{v}{\rho}\cancel{v_0}\cancel{\cos\alpha} = \cancel{-}g\frac{v_0^{\cancel{2}}\cos^{\cancel{2}}\alpha}{v^2} \qquad \rho = \frac{v^3}{g v_0\cos\alpha}$$