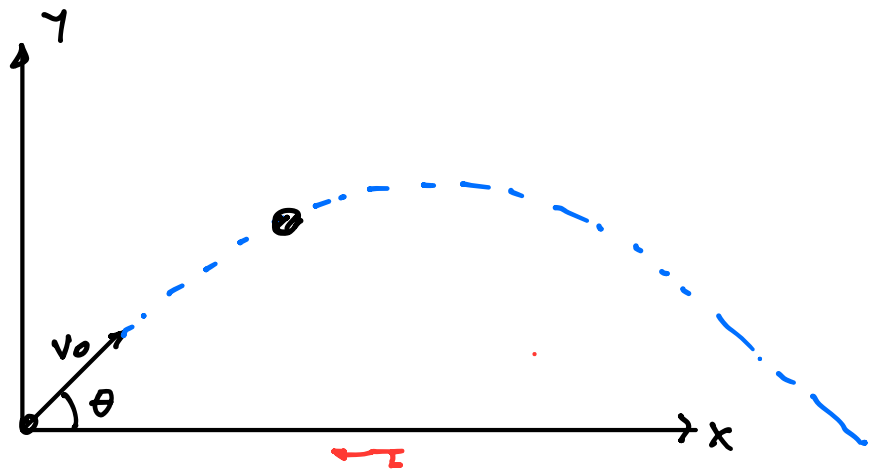


$$z = \begin{pmatrix} x \\ y \\ u \\ v \end{pmatrix} = \begin{pmatrix} z_0 \\ z_1 \\ z_2 \\ z_3 \end{pmatrix}$$

$$m\frac{d^2x}{dt^2} = 0 - r\frac{dx}{dt} \qquad \frac{dx}{dt} = u \qquad \frac{dx}{dt} = v \qquad \frac{dz_0}{dt} = z_2$$

$$m\frac{d^2y}{dt^2} = -mg - r\frac{dy}{dt} \qquad \frac{dy}{dt} = v \qquad \frac{dy}{dt} = v \qquad \frac{dz_1}{dt} = z_3$$

$t=0$ $\quad x(0)=0$, $\quad y(0)=0$

$$m\frac{du}{dt} = 0 - r\frac{dx}{dt} \qquad \frac{du}{dt} = 0 - \frac{r}{m}\frac{dx}{dt} \qquad \frac{dz_2}{dt} = 0 - \frac{r}{m}z_2$$

$x'(0) = V_0\cos\theta$

$y'(0) = V_0\sin\theta$

$$m\frac{dv}{dt} = -mg - r\frac{dy}{dt} \qquad \frac{dv}{dt} = -g - \frac{r}{m}\frac{dy}{dt} \qquad \frac{dz_3}{dt} = -g - \frac{r}{m}z_3$$

$$\begin{bmatrix} \frac{dz_0}{dt} \\ \frac{dz_1}{dt} \\ \frac{dz_2}{dt} \\ \frac{dz_3}{dt} \end{bmatrix} = \begin{bmatrix} z_2 \\ z_3 \\ 0 - \frac{r}{m}z_2 \\ -g - \frac{r}{m}z_3 \end{bmatrix}$$

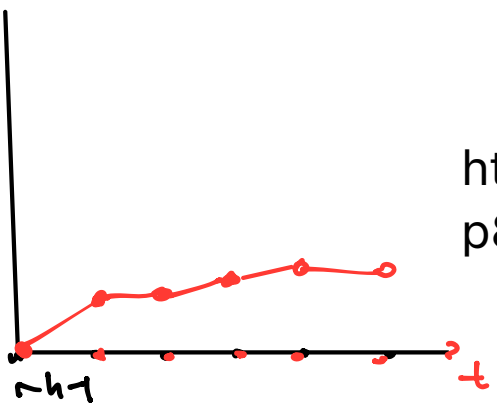
$x(0)=0$ $\quad z_0(0)=0$

$y(0)=0$ $\quad z_1(0)=0$

$u(0)=V_0\cos\theta$ $\quad z_2(0)=V_0\cos\theta$

$v(0)=V_0\sin\theta$ $\quad z_3(0)=V_0\sin\theta$

$$\frac{dz}{dt} = \vec{F}(\vec{z})$$



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