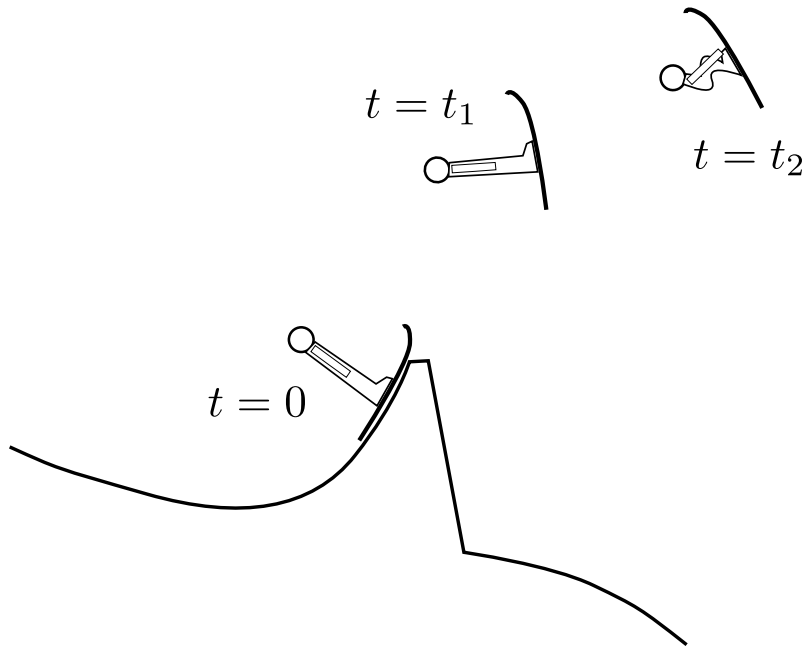
Classical Mechanics Problem - Freestyle skier flipping into a tuc position

January 4, 2012

An olympic aerial ski jumper takes off the lip of a jump at time $t = 0$. At a time t_1 later they rotate counter-clockwise by θ_1. Between time t_1 and time t_2, as they rotate counter-clockwise to an angle θ_2, they gradually(linearly) decrease their moment of inertia moving into a tuc position.



At what later time t_3 will the jumper have rotated a total of n times from their original orientation? Draw a plot of angle vs. time from $t = 0$ to $t = t_3$. Consider the original orientation to be 0 degrees.

Solution:

Find starting angular velocity with

$$\omega_{01} = \frac{\theta_f - \theta_i}{t_1 - t_0} = \frac{\theta_1}{t_1}$$

Find ω_{12} then α_{12} to get θ_2

$$\omega_{12} = \omega_{01} + \alpha_{12}(t_2 - t_1)$$

$$\alpha_{12} = \frac{\omega_{12} - \omega_{01}}{t_2 - t_1}$$

$$\theta_2 = \theta_1(t_2 - t_1) + \omega_{12}(t_2 - t_1) + \frac{1}{2}\alpha_{12}(t_2 - t_1)^2$$

with this final angle and final angular velocity at t_2 we can find the number of rotations.

$$n2\pi = \theta_2 + \omega_{12}t_3$$

$$t_3 = \frac{n2\pi - \theta_2}{\omega_{12}}$$

The plot looks like this