# 8.01 Sports Problem 1.1 "Solutions"

Part 1)

I "presume" that the average height of the nose is some fixed proportion of the person's height.

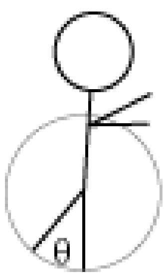
$$Y_{0\mathrm{NOSE}} = Ph$$

The proportion (*P*) is unitless, a ratio of two lengths. For me, $P \approx 12/13$.

I "presume" that the amount of up/down bobbing of the nose is depends on length of the legs and the angle the legs extend to. (see figure). Thus, the up/down bob of the nose is something like:

$$Y_{nosemovement} = \tfrac{1}{2} l_{leg} (1 - \cos\theta)$$

$l$ and $Y$ have dimensions of length; ½, 1, and $\cos\theta$ have no units. (Using this information on nose movement distance, I could better dial in the P in the first part.)




I presume that people walk as if their legs are the spokes onose a bicycle wheel. One bobbing cycle corresponds to movement between when one leg is straight under the center of mass and when the other leg comes under the center of mass.

If one knows the person's velocity, leg length, and maximum leg angle, then rate × time = distance produces an equation like:

$$t_{cycle} = \frac{l_{leg}\theta}{v_{person}}$$

The number of cycles/time is $1/t_{cycle}$; thus, the nose bob equation looks something like:

$$Y_{nose} = Ph + \left( \tfrac{1}{2} l_{leg} \left(1 - \cos\theta\right) \cos\left( \frac{v_{person}}{l_{leg}\theta} t \right) \right)$$

Are you happy about the units? I expect some trouble justifying the units of:

$$\frac{v_{person}}{l_{leg}\theta} t$$

Part 2)

A simple estimate is to presume walking is falling and if gravity is 10 times that of earth, then 2 meter tall bi-peds will walk about 10 times faster than earthlings.

Another way of looking at the problem would be to take the 2nd derivative with time of the bobbing nose and "presume" that the acceleration of the nose is on the order of that of the planet's gravitational field. This estimate has the non-earthlings walking about $\sqrt{10}$ times faster than earthlings.