Name: _____

TAM 210/211 Written Assignment 3 (due on October 12th)

The board is used to hold the end of a four-way lug wrench in position. A torque $\mathbf{T} = -25\,\mathbf{i}$ N.m is required to tighten the nut (note that the system of coordinates has the origin placed in the center of the wrench and the nut is located at position <-100,0,0> mm). You decided to step at the end of the wrench in order to turn it. Assume that the force provided by your foot can be modeled as a concentrated force at point A with magnitude F. We also assume that the force vector $\mathbf{F}$ lies in the vertical plane y-z and makes an angle θ with the y-axis.

a) Determine the moment $\mathbf{M}_o$ of the force $\mathbf{F}$ about a point located at the nut. Write your answer as a function of F (force magnitude) and θ.

b) Does all of $\mathbf{M}_o$ act to turn the nut? Explain.

c) Determine the magnitude of the force required to tighten the nut if $\theta = 30^o$.

d) Which angle would require the least amount of force? What would be the corresponding magnitude of the force?

e) What is/are the benefit(s) from using a board to hold the end of a four-way lug wrench?

f) Suppose the goal was to now loosen one of the other nuts with a torque of $\mathbf{T} = \mathcal{T}\,\mathbf{i}$ N.m while the max achieved by stepping on the wrench is $\pi\,\mathbf{i}$ N.m. What might you do in order to achieve the desired torque? Is there a term for the strategy you came up with? (Note: $\mathcal{T} = 2\pi$)