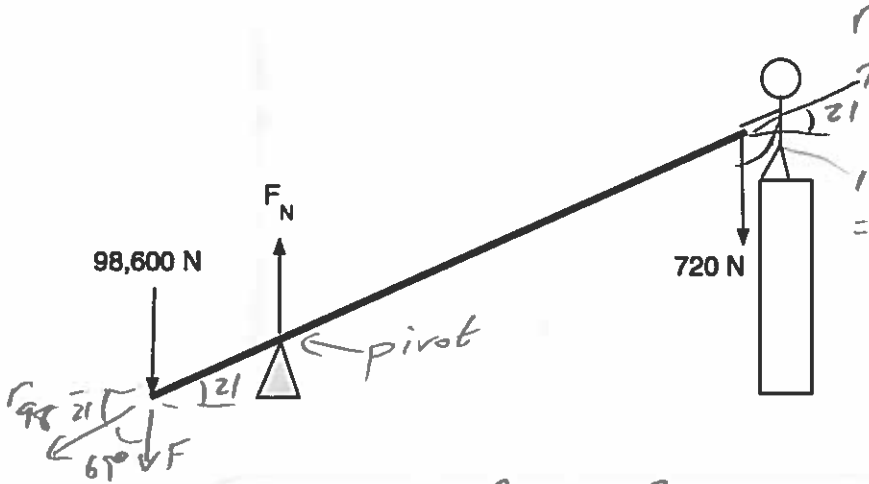
Physics 10154 - Quiz 8B

A quotation attributed to Archimedes, a famous Greek philosopher/mathematician: "Give me a lever long enough, a fulcrum, and a place to stand, and I can move the Earth!" (there are so many variants of this quotation, it is likely not legitimate, but it's still fun to think about).

In the figure below, a human is capable of exerting a vertically downward applied force of 720 Newtons on the end of the lever. At the other end of the lever is a mass of 98,600 N, the equivalent of a loaded concrete mixing truck. This mass pushes down vertically on the end of the lever.

The lever makes an angle of 21.0° with respect to the horizontal, and the distance from the 98,600 N mass and the fulcrum is 18.0 cm along the lever. The fulcrum shown exerts a vertical normal force on the lever, and we will assume for simplicity that the lever itself has negligible mass.

What must be **(a)** the distance from the fulcrum to the person in order for the person to lift the enormous mass with an applied force of 720 N as shown, and **(b)** the value of the normal force? The length of the lever in the drawing is not to scale! **Answer with 3 SF.**



$\tau_N = 0$ at pivot since $r_N = 0$

$$\Sigma \tau = \tau_{98} + \tau_N + \tau_{720} = 0$$

$$\tau_{98} = +(0.18)(98600)\sin 69° = 16569 \text{ N·m}$$

$$\tau_N = 0$$

$$\tau_{720} = -r_{720}(720)\sin 111° = -(672.2)r_{App} \text{ N·m}$$

$$16569 - 672.2\, r_{App} = 0 \Rightarrow \boxed{r_{App} = 24.6 \text{ m}}$$

$$\Sigma F_y: F_N - 98600 - 720 = 0 \Rightarrow \boxed{F_N = 99300 \text{ N}}$$