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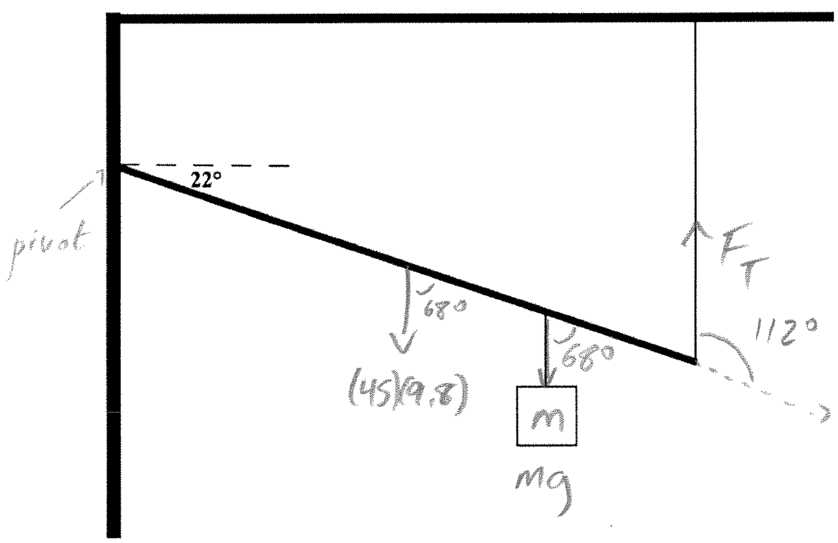
Physics 10154 - Exam #4b

Partial credit will be given provided you show all work and are solving parts of the problem correctly. Points will be deducted if you don't show your work (or if some parts are incorrect) even if you get the right answer. Clearly indicate your answer with a circle or box and remember to include correct units and significant figures.

1. (30 pts) A 45 kg uniform beam is welded to a vertical wall, and it projects from the wall at an angle of 22° below the horizontal as shown. A vertical rope attached to the end of the beam helps provides tension to maintain equilibrium, but the maximum tension it can withstand before breaking is 980 N. What is the maximum mass that can be hung from the beam at a location 3/4 of the way down the beam from the wall? Answer with 2 SF.



Assume $F_T = 980$, find m

$$\Sigma\tau = \tau_{45} + \tau_m + \tau_T = 0$$

$$-\frac{\ell}{2}(45)(9.8)\sin 68° - \frac{3\ell}{4} m(9.8)\sin 68° + \ell F_T \sin 112° = 0$$

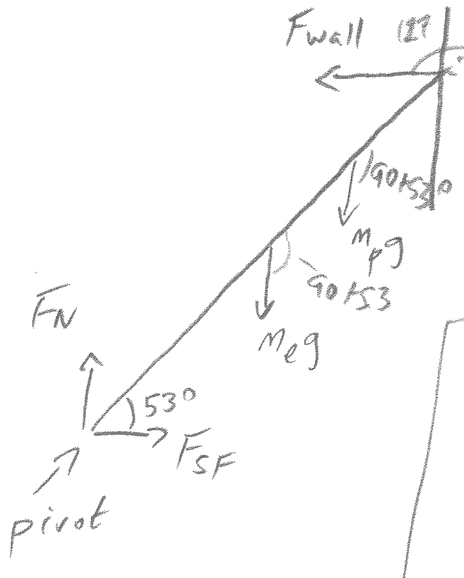
$$-204.4 - 6.8m + 908.6 = 0$$

$$6.8m = 704.2$$

$$\boxed{m = 100\ \text{kg}}$$

2. (35 pts) An 8.0 meter long uniform ladder rests against a frictionless, vertical wall. The ladder makes a 53° angle above the horizontal. The coefficient of static friction between the ladder and ground is 0.61. How far up the ladder can a 79 kg person climb before the ladder begins to slip?

25 kg



$\Sigma F_x : F_{SF} - F_{wall} = 0$

use $F_{SF} = \mu_s F_N$ since "about to slip"

$\mu_s F_N - F_{wall} = 0$

$\Sigma F_y : F_N - (25)(9.8) - (79)(9.8) = 0$

$F_N = 1019.2$

$\rightarrow (0.61)(1019.2) = F_{wall} = 621.7 N$

$$\Sigma \tau = \tau_{ladder} + \tau_{person} + \tau_{wall} = 0$$

$$-(4.0)(25)(9.8)\sin(143°) - x(79)(9.8)\sin(143°) + (8.0)(621.7)\sin(127°) = 0$$

$$-589.78 - 465.93x + 3972.09 = 0$$

$$465.93x = 3382.31$$

$$x = 7.3\ m$$

3. (35 pts) The weight of an object is 225 N, and when the object is placed in water, it floats with 73% of the object submerged. How much additional weight can be placed on top of the object before it sinks?

$$\rho_o V_o g = 225$$

Floating $\frac{V_f}{V_o} = 0.73$

$$\Sigma F_y = \rho_f V_f g - \rho_o V_o g = 0$$

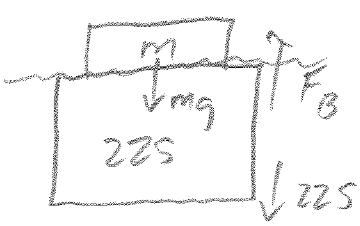
$$\rho_f V_f g = \rho_o V_o g$$

$$\frac{V_f}{V_o} = \frac{\rho_o}{\rho_f} = 0.73$$

so $\rho_o = 0.73 \rho_f = 730 \ kg/m^3$

$$V_o = \frac{225}{\rho_o g} = 0.03145 \ m^3$$

About to sink: completely submerged, so $V_f = V_o$



$$\Sigma F_y : \rho_f V_f g - 225 - mg = 0$$

$$(1000)(.03145)(9.8) - 225 = m(9.8)$$

$$308.2 - 225 = m(9.8)$$

$$m = 8.5 \ kg$$