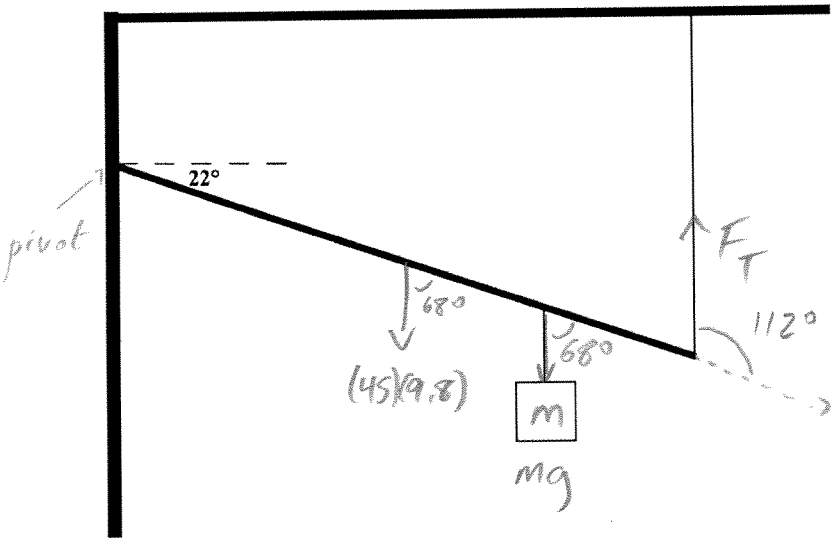
Physics 10154 - Exam #4b

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

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

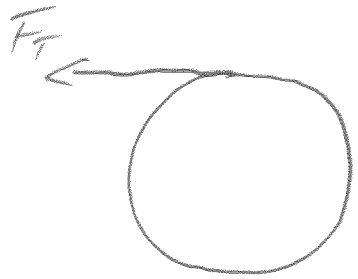
$$-\frac{\ell}{2}(45)(9.8)\sin 68° - \frac{3\ell}{4}m(9.8)\sin 68° + \ell F_T \sin 112° = 0$$

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

$$6.8m = 704.2$$

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

2. (35 pts) A thin string is wrapped around a cylindrical spool with a radius of 85 cm and a moment of inertia of 3.1 kg-m^2. An applied force pulls tangentially on the string. 21 meters of string unwinds in 8.0 seconds. The spool has a frictional torque opposing this motion of 2.4 N-m. What is the tension force pulling on the string?



$\Delta s = 21\,m \Rightarrow \Delta\theta = 24.7\,rad$

$\omega_0 = 0$

$\omega = ?$

$\alpha = ?$

$t = 8.0\,s$

$\Sigma\tau = \tau_T + \tau_{Fric} = I\alpha$

$\Delta\theta = \omega_0 t + \frac{1}{2}\alpha t^2$

$24.7 = 0 + \frac{1}{2}\alpha(64)$

$24.7 = 32\alpha$

$\alpha = 0.772$

$\tau_T = +RF_T \sin 90$

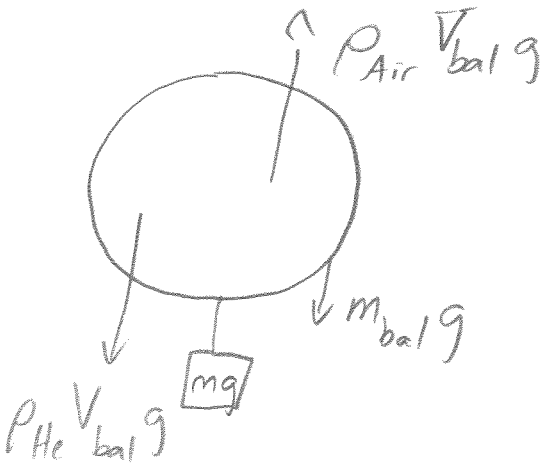
$.85F_T - 2.4 = (3.1)(.772)$

$0.85F_T = 4.8$

$\boxed{F_T = 5.6\,N}$

3. (35 pts) A spherical balloon has a mass of 45 grams (the material of the ballon only) and, when filled with Helium, a radius of 52 cm. The density of Helium in the balloon is 0.181 kg/m^3. The density of air surrounding the balloon is 1.29 kg/m^3. How much additional weight can the balloon support without moving toward the ground if it is initially at rest?

The volume of a sphere is $\frac{4}{3}\pi R^3$



$$V_{bal} = \frac{4}{3}\pi (.52)^3$$

$$= 0.589\ m^3$$

$$\Sigma F_y : \rho_{Air} V_{bal} g - \rho_{He} V_{bal} g - m_{bal} g - mg = 0$$

$$(1.29)(.589)(9.8) - (.181)(.589)(9.8) - (.045)(9.8) - m(9.8) = 0$$

$$7.446 - 1.045 - 0.441 - 9.8m = 0$$

$$9.8m = 5.96$$

$$m = 0.61\ kg$$