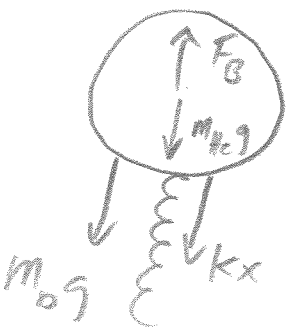
Physics 10154 - Exam #4c

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 large party balloon weighs 18 N when empty. If the balloon is filled with 3.5 m^3 of Helium with a density 0.171 kg/m^3 and held down by a vertically oriented spring with spring constant k = 110 N/m, what is the elongation of the spring? Assume the balloon is surrounded by air of density 1.29 kg/m^3.



$$\Sigma F_y = F_B - F_{g,He} - F_{g,bal} - kx = 0$$

$$F_B = \rho_{Air} g V_{Air}$$

$$= (1.29)(9.8)(3.5) = 44.25\ N$$

$$F_{g,He} = \rho_{He} g V_{He}$$

$$= (.171)(9.8)(3.5) = 5.87\ N$$

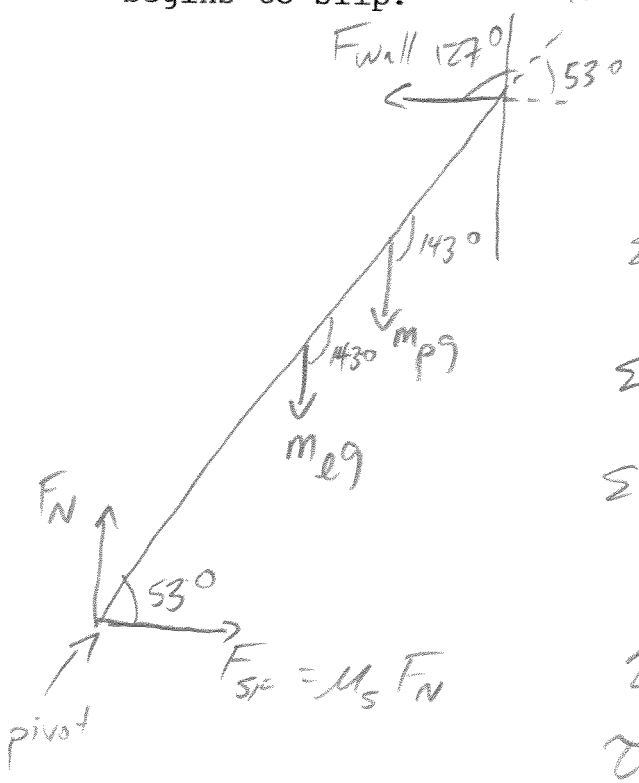
$$F_{g,bal} = 18\ N$$

$$44.25 - 5.87 - 18 - 110x = 0$$

$$20.38 = 110x$$

$$x = 0.19\ m$$

2. (40 pts) A 22-kg ladder is 8.0 meters long. The ladder leans up against a frictionless verticall wall, making an angle of 53° above the horizontal. The coefficient of static friction between the ladder and the ground is 0.61. How far along the ladder can a [redacted] 92 kg person climb before the ladder begins to slip?



$F_{SF} = \mu_s F_N$ because ladder is about to slip

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

$$\Sigma F_y = F_N - m_l g - m_p g = 0$$

$$\Sigma \tau = \tau_l + \tau_p + \tau_{wall} = 0$$

$$\tau_l = -(4)(22)(9.8)\sin 143°$$

$$\tau_p = -x(92)(9.8)\sin 143°$$

$$\tau_{wall} = +(8) F_{wall} \sin 127°$$

$$\Sigma F_y = F_N - (22)(9.8) - (92)(9.8) = 0$$

$$F_N = 1117.2\ N$$

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

$$F_{wall} = (.61)(1117.2) = 681.5\ N$$

$$\Sigma \tau = -519.0 - 542.6x + 6.39 F_{wall} = 0$$

$$-519.0 - 542.6x + 4354.2 = 0$$

$$3835.2 = 542.6x$$

$$x = 7.1\ m$$

3. (30 pts) A merry-go-round has a mass of 250 kg and a radius of 1.7 meters. Assume it has the moment of inertia of a cylinder. A 95 kg person stands on the rim of the merry-go-round and moves with the merry-go-round. Initially, both are moving at an angular rate of 12 rev/min. If the person walks inward to a radius of 75 cm, (a) what is the new angular speed of the system and (b) if the person is the only force doing work in the problem, how much work does the person do when walking inward?

$I_{mgr} = \frac{1}{2}(250)(1.7)^2 = 361.25 = I_{mgr,f}$

$I_p = MR^2 = (95)(1.7)^2 = 274.55$

ω_i for both $= 12 \frac{rev}{min} = 1.26 \ rad/s$

$I_{p,f} = (95)(.75)^2 = 53.44$

a) $I_{1i}\omega_{1i} + I_{2i}\omega_{2i} = I_{1f}\omega_{1f} + I_{2f}\omega_{2f}$

$(361.25 + 274.55)(1.26) = (361.25 + 53.44)\omega_f$

$801.1 = 414.7\,\omega_f$

$\omega_f = 1.9 \ rad/s$

b) $K_i = \frac{1}{2}(361.25 + 274.55)(1.26)^2 = 504.7$

$K_f = \frac{1}{2}(361.25 + 53.44)(1.9)^2 = 748.5$

$W = K_f - K_i = 240 \ J$