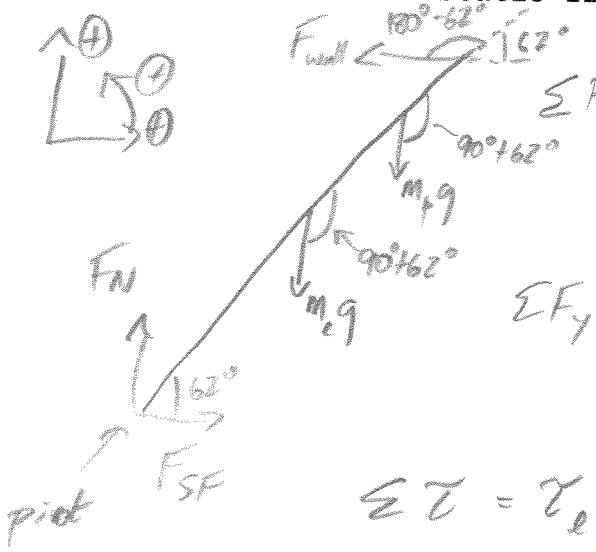
Physics 10154 - Exam #4a

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. (35 pts) A 12.0 meter long, 553 Newton uniform ladder rests against a frictionless wall, making an angle of 62.0° above the horizontal. When an 855 Newton firefighter is 9.5 meters from the bottom of the ladder, the ladder is just on the verge of slipping horizontally along the ground. What is the coefficient of static friction between the ladder and ground?



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

$$\mu_s F_N - F_{wall} = 0 \qquad F_{SF} = F_{SF,MAX}$$

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

$$F_N - 553 - 855 = 0 \qquad F_N = 1408\ N$$

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

$$-(6.0)(553)\sin 152° - (9.5)(855)\sin 152° + (12) F_{wall} \sin 118° = 0$$

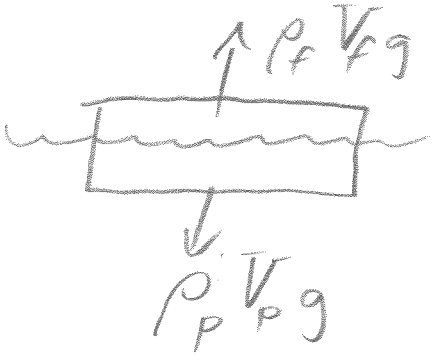
$$-1557.7 - 3813.3 + 10.60\, F_{wall} = 0$$

$$F_{wall} = 507\ N$$

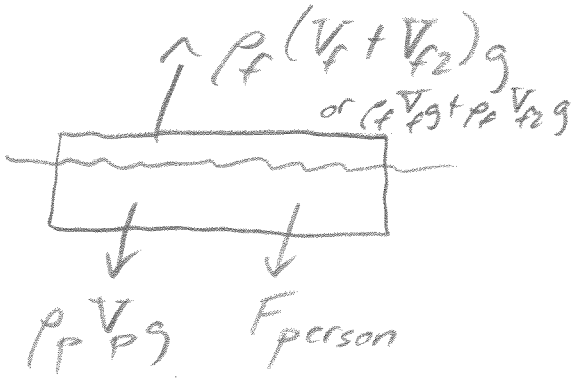
$$\mu_s (1408) - 507 = 0 \qquad \mu_s = 0.36$$

2. (35 pts) A wooden diving platform with a density of 750 kg/m^3 is floating on the surface of a lake. The platform has a cross-sectional area of 3.0 meters x 4.0 meters, and it is 75 cm thick. When a person climbs onto the platform, the platform is observed to sink 6.4 mm further into the water. What is the weight of the person?

Platform alone



Platform with person



$\Sigma F_y : \rho_f V_f g - \rho_p V_p g = 0$

V_f = original volume submerged

V_{f2} = extra volume submerged

buoyancy

$\Sigma F_y : \underbrace{\rho_f V_f g - \rho_p V_p g}_{0} + \rho_f V_{f2} g - F_p = 0$

so $\rho_f V_{f2} g = F_p$

In other words, the weight of the person is equal to the weight of the additional displaced water.

$V_{f2} = (3)(4)(.0064) = .0768 m^3$

$\rho_f V_{f2} g = \boxed{750 N}$

3. (30 pts) A merry-go-round is a solid 35-kg cylinder of radius 2.0 meters. It rotates at a rate of 0.20 rev/sec with an 85-kg man standing at a point 2.0 meters from the axis of rotation, moving with the merry-go-round.

a) If the man walks to a point 1.0 meters from the center, what is the new angular speed of the system?

b) How much work is done by the man in this interaction, assuming the man's applied force is the only force that does any work?

a) $(I_{1,i} + I_{2,i})\omega_i = (I_{1f} + I_{2f})\omega_f$

$I_{1,i} = I_{1f} = \frac{1}{2}MR^2 = \frac{1}{2}(35)(2)^2 = 70\ kg\cdot m^2$

$I_{2,i} = mR_1^2 = (85)(2)^2 = 340\ kg\cdot m^2$

$I_{2f} = mR_2^2 = (85)(1)^2 = 85\ kg\cdot m^2$

$\omega_i = 0.20\ rev/sec = 1.26\ rad/sec$

$(70+340)(1.26) = (70+85)\omega_f$

$\omega_f = 3.33\ rad/s$

b) $\Sigma W_F = W_{man} = \Delta K$

$K_f = \frac{1}{2}(70+85)(3.33)^2 = 859\ J$

$K_i = \frac{1}{2}(70+340)(1.26)^2 = 325\ J$

$\Delta K = 530\ J$