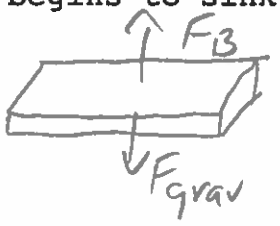
Physics 10154 - Exam #4A

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 wooden platform has a density of 722 kg/m^3. The square platform measures 3.50 meters on a side and is 11.0 cm tall.

a) How far above the water's surface is the top of the platform?
b) How many 65-kg people can stand on the platform before it begins to sink?

a)



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

$\rho_f V_f g = \rho_o V_o g$

$\frac{V_f}{V_o} = \frac{\rho_o}{\rho_f} = 0.722$

72.2% of platform is submerged, so 27.8% above water.

$(0.278)(11.0\text{ cm}) =$ **3.06 cm above water**

$(3.5 \times 3.5 \times .11)$

b) Assume platform submerged, so $V_f = V_o = 1.3475\ m^3$

$\Sigma F_y = \rho_f V_f g - \rho_o V_o g - N(65)(9.8) = 0$

$= (1000)(1.3475)(9.8) - (722)(1.3475)(9.8) - N(65)(9.8) = 0$

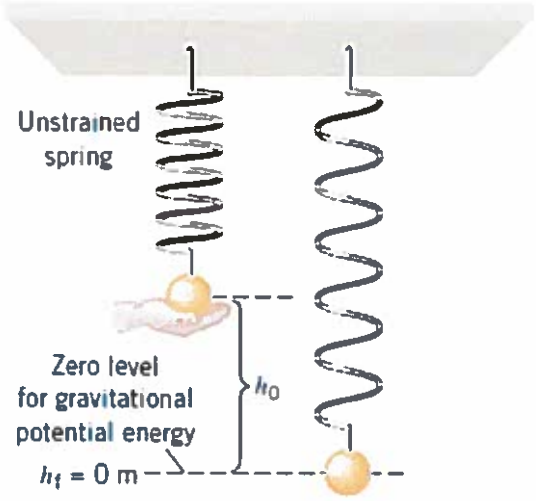
$= 3671 - N(637) = 0$

$N = 5.76$, so 6 = sinks

5 = max limit

2. (30 pts) A 345-gram ball is attached to a vertical spring with a spring constant k_s = 24.0 N/m. The ball, supported initially so that the spring is neither stretched nor compressed, is released from rest.

a) In the absence of frictional forces, how far does the ball fall before being brought to a stop by the spring?
b) What is the total mechanical energy of the system before the ball is released?
c) What is the total mechanical energy of the system when the ball is brought to a stop by the spring at h_f = 0m?



a) $\Sigma W_F = W_g + W_{spr} = \Delta K$

$= mgh - \frac{1}{2}kh^2 = 0 - 0$

$mg - \frac{1}{2}kh = 0$

$h = \frac{2mg}{k} = \boxed{0.282\,m}$

b) $U_{grav} + U_{spr} + K$

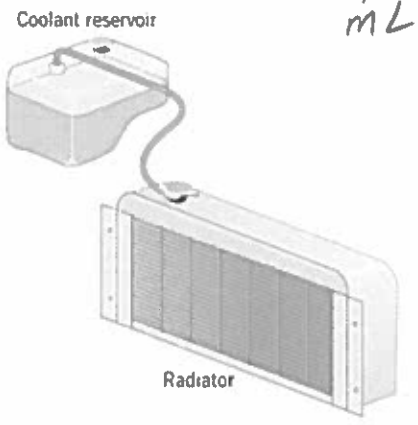
$= mgh + 0 + 0$

$= (.345)(9.8)(.282) = \boxed{0.953\,J}$

c) $U_{grav} + U_{spr} + K$

$= 0 + \frac{1}{2}(24)(.282)^2 + 0 = \boxed{0.953\,J}$

3. (35 pts) A small plastic container, called the coolant reservoir, catches the radiator fluid that overflows when the radiator becomes very hot. The radiator is made of copper (volume expansion coefficient 5.10 x 10^{-5} $(C°)^{-1}$), and the coolant has an expansion coefficient of 3.22 x 10-4 $(C°)^{-1}$. The radiator has a capacity of 4.00 gallons and is filled at T = 12.0 °C. How much overflow (in ~~gallons~~ mL) reaches the coolant reservoir when the temperature of the system rises to 93.0 °C, assuming both radiator and coolant expand?



$\Delta V_{rad} = (4.00)(5.1\times10^{-5})(81)$

$= .016524$ gal

$\Delta V_{coolant} = (4.00)(3.22\times10^{-4})(81)$

$= 0.10433$ gal

$0.10433 - 0.016524 = \boxed{.0878 \text{ gal}}$

$.0878 \text{ gal} \cdot \frac{3.786 \text{ mL}}{1 \text{ gal}} = \boxed{332 \text{ mL}}$