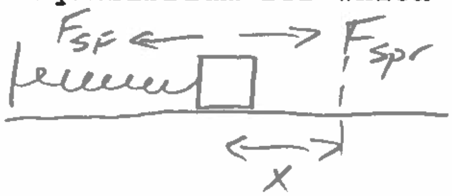
Physics 10154 - Exam #4B

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 spring (k_s = 47.0 N/m) lies on a horizontal table, and the left end of the spring is attached to a wall. The other end is connected to a 755-gram block. The coefficient of static friction between the block and the surface is 0.840.

a) If the spring is compressed by 9.11 cm, what is the magnitude and direction of the force of static friction on the block?
b) What is the maximum possible displacement of the spring from equilibrium for which the block will not move?



a)

$\Sigma F_x = +k_s x - F_{SF} = 0 \Rightarrow F_{SF} = k_s x = \boxed{4.28\ N}$

b) Need $F_{SF} = \mu_s F_N$ at threshold

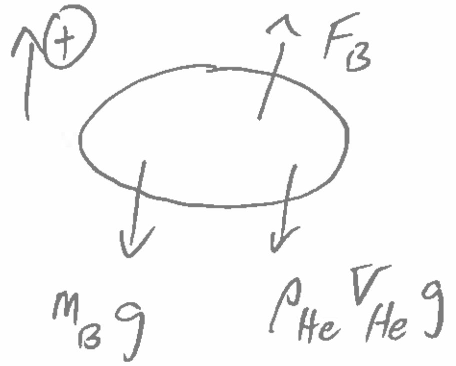
$F_N = mg$ since no other y-forces

$\Sigma F_x = k_s x - \mu_s mg = 0$

$$x = \frac{\mu_s mg}{k} = \frac{(.840)(.755)(9.8)}{47}$$

$$= \boxed{0.132\ m}$$

2. (35 pts) A blimp contains 4240 m³ of Helium with a density of 0.179 kg/m³. The raw materials that make up the blimp have a total mass (uninflated) of 355 kg. If the blimp is flying through air that has a density of 1.19 kg/m³ and carrying an additional 3890 kg of mass (a gondola full of people and equipment), what is the magnitude and direction of its acceleration?



$m_B = 355 + 3890 = 4245\ kg$

$m_{TOT} = m_B + \rho_{He} V_{He}$

$= 4245 + 759 = 5004\ kg$

$\Sigma F_y = F_B - m_B g - \rho_{He} V_{He} g = m_{TOT}\, a$

$= F_B - m_{TOT}\, g = m_{TOT}\, a$

$= \rho_{Air} V_{blimp}\, g - (5004)(9.8) = (5004)a$

$= (1.19)(4240)(9.8) - (5004)(9.8) = (5004)a$

$= 49447 - 49039 = 5004a$

$a = \frac{407.8}{5004} = \boxed{.0815\ m/s^2,\ up}$

3. (35 pts) 382 grams of ice with an initial temperature of -25.0 °C is placed in a styrofoam cup (ignore the mass of the cup for this problem) containing 275 mL of lemonade at an initial temperature of 22.0 °C. Assume the density of lemonade is the same as water (1000 kg/m3) and the specific heat is also the same as water (4186 J/kg · °C). What is the final temperature of the system? If the final temperature is zero, how much ice melts?

$$m_L = \rho_L V_L = (1000 \tfrac{kg}{m^3})(275 mL)(\tfrac{10^{-6} m^3}{mL})$$

$$= 0.275 \, kg$$

$$\Delta Q_L = (0.275)(4186)(-22) = -25325 \, J$$

to cool to 0°C

warm to 0°   melt

$$\Delta Q_{ice} = (.382)(2090)(25) + (.382)(333{,}000)$$

$$= 19{,}960 \quad + \quad 127206$$

There is enough heat in lemonade to bring ice to 0°C, (25325 > 19196)

but not enough to melt all ice. (25325 < 19960+127206)

$$T_F = 0°C$$

$$\Delta Q_L + \Delta Q_i = 0$$

how much ice melts

$$-25325 + 19960 + m_i(333{,}000) = 0$$

$$m_i(333{,}000) = 5366$$

$$m_i = .0161 \, kg$$