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 spring (k_s = 57.0 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 355-gram block. The block is given an initial velocity of 1.40 m/s, and it is initially at a point where the spring is unstrained.

a) How far does the block move from its initial position before coming briefly to rest?
b) What is the velocity of the block when it is halfway to the rest position found in part (a)?
c) How much time does it take for the block to reach the rest position found in part (a)?

a) Energy conservation, at $x = 0$

$$\cancel{\tfrac{1}{2}kx^2} + \tfrac{1}{2}mv^2 = \tfrac{1}{2}kA^2$$
$$\quad 0$$

$$v = \sqrt{\frac{k}{m}}\,A \quad \Rightarrow \quad A = \sqrt{\frac{.355}{57}}\,(1.40)$$

$$= \boxed{0.110 \text{ m}}$$

b) At $x = \frac{1}{2}A = .0552$

$$v^2 = \frac{k}{m}A^2 - \frac{k}{m}x^2 = \frac{k}{m}(A^2 - x^2)$$

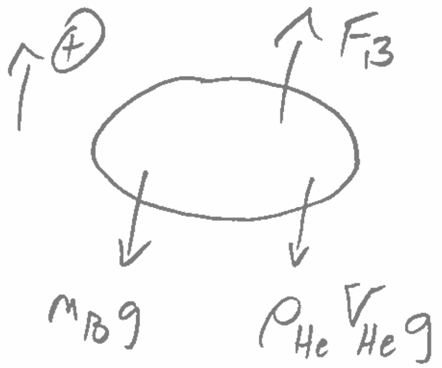
$$= \frac{57}{.355}(.110^2 - .0552^2)$$

$$= 1.453 \text{ m}^2/\text{s}^2 \Rightarrow \boxed{v = 1.21 \text{ m/s}}$$

c) $t = \frac{1}{4}T \quad T = 2\pi\sqrt{\frac{m}{k}} = 0.496 \text{ s}$

$$\boxed{t = 0.124 \text{ s}}$$

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?



$$m_B = 355 + 3890 = 4245\ kg$$

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

$$= 4245 + 759 = 5004\ kg$$

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

$$= \rho_{Air} V_{blimp} g - m_{TOT} g = m_{TOT} a$$

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

$$= 49447 - 49039 = 5004 a$$

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

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 and specific heat of lemonade are the same as liquid water. What is the final temperature of the system? If the final temperature is zero, how much ice melts?

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

$$= 0.275\ kg$$

cool to 0°C

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

warm to 0°C, melt

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

$$= 19960 + 127206$$

Since 25325 > 19960, there is enough heat to bring all ice to 0°C.

Since 25325 < (19960+127206), not all ice melts

$$\Rightarrow \boxed{T_F = 0°C}$$

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

amount of ice that melts is unknown

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

$$m_{ice}(333{,}000) = 5365$$

$$\boxed{m_{ice} = 0.0161\ kg}$$