# Physics 10154 - Exam #5c

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) Helium gas is kept in a container with a volume of 160 Liters and a pressure of 120 atm. The helium tank is emptied by filling many balloons, each a sphere with a radius of 18 cm at a pressure of 1.2 atm. The temperature inside the tank is 12° C and outside the tank is 22° C, and no Helium is lost in the transfer process. To the nearest whole number, how many balloons can be filled?

$N_1 = N_2$

$V_1 = 160\,L \qquad V_2 = ?$

$P_1 = 120\,atm \qquad P_2 = 1.2\,atm$

$T_1 = 285\,K \qquad T_2 = 295\,K$

$$\frac{V_2}{V_1} = \frac{\left(\frac{N_2}{N_1}\right)\left(\frac{k}{k}\right)\left(\frac{T_2}{T_1}\right)}{\left(P_2/P_1\right)} = \frac{(1)(1)\left(\frac{295}{285}\right)}{.01} = 103.5$$

$V_2 = 103.5\,V_1 = 16560.14\,L$ or $16.56014\,m^3$

$V_{bal} = \frac{4}{3}\pi r^3 = .02443\,m^3$

$N_{bal}\,V_{bal} = V_2$

$N_{bal} = \frac{16.56}{.02443} =$ 678 balloons

2. (30 pts) A 1.2-kg block is attached to a horizontal spring with a spring constant k = 92 N/m. The block oscillates on a frictionless surface and has a maximum speed of 6.5 m/s when it passes through the equilibrium point.

a) What is the amplitude of the oscillation?

b) What is the total mechanical energy of the system?

c) If x = 0 represents the equilibrium point, for what value of x is the kinetic energy equal to the potential energy?

b) $E = K_{max}$ or $U_{max}$

$= \frac{1}{2} m v_{max}^2 = \frac{1}{2}(1.2)(6.5)^2 = 25.35\,J$

or (25 J)

a) $25.35 = \frac{1}{2}(92)A^2$

$A = 0.74\,m$ or (74 cm)

c) When $\frac{1}{2}mv^2 = \frac{1}{2}kx^2$, each is $\frac{1}{2}E$

so $\frac{1}{2}kx^2 = \frac{1}{2}\left(\frac{1}{2}kA^2\right)$

$x = \sqrt{\frac{1}{2}}\,A = .707A$

$= (52\,cm)$

3. (40 pts) A 2.5 kg aluminum pot is heated to an initial temperature of 380° C. 210 grams of water is poured into the pot with an initial temperature of 33° C.

Determine the final temperature of the system. If the final temperature is 100° C, then determine how many grams of water are converted into steam.

$Q$ to cool pot to 100°C $= (2.5)(900)(-280) = -630{,}000$ J

$Q$ to heat water to 100°C $= (.210)(4186)(67) = 58{,}900$ J

$Q$ to boil water $= (.210)(2.26 \times 10^6) = 474{,}600$ J

$533{,}500$

So, all water boils, $T_F > 100°C$

$\Delta Q_{Al} + \Delta Q_W = 0$

$(2.5)(900)(T_F - 380) + 533{,}500 + (.210)(2010)(T_F - 100) = 0$

$2250 T_F - 855{,}000 + 533{,}500 + 422.1 T_F - 42210 = 0$

$2672 T_F - 363710 = 0$

$T_F = \frac{363710}{2672} = 136°C$