Phys.115 Exam III
21 November 2007

Please do not turn the page until you are told to do so. Make sure that you have all three problems on your copy of the test. In order to get credit on a problem, you must show your work. If you only write down an answer without the work leading up to it, you will get no credit for it, even if it is the right answer.
1) You are designing a machine for a space exploration vehicle. It contains an enclosed column of oil that is 1.50 m tall, and you need the pressure difference between the top and the bottom of this column to be 0.125 atm.

   a) (7 points) What must be the density of the oil?

b) (6 points) If the vehicle is taken to Mars, where the acceleration due to gravity is 0.379g, what will be the pressure difference (in earth atmospheres) between the top and bottom of the oil column? (Use a density for oil of 800 kg/m$^3$ if you did not get an answer for part a.)

c) (7 points) What is the ratio of the forces at the bottom of the columns in parts a and b ($F_a/F_b$) assuming that the pressure at the top of the column is kept at 1 atm in both situations?
2) A hollow plastic sphere is held below the surface of a freshwater lake by a cord anchored to the bottom of the lake. The sphere has a volume of 0.650 m$^3$ and the tension in the cord is 900 N.

a) (6 points) Calculate the buoyant force exerted by the water on the sphere.

b) (7 points) What is the mass of the sphere?

c) (7 points) The cord breaks and the sphere rises to the surface. When the sphere comes to rest, what fraction of its volume will be submerged?
3) What is the amount of heat entering your skin when it receives the heat released

a) (6 points) by 25.0 g of steam initially at 100.0°C that cools to 34.0°C?

b) (6 points) by 25.0 g of water initially at 100.0°C that cools to 34.0°C?

c) (2 points) What do these results tell you about the relative severity of steam and hot-water burns?

d) (6 points) Plot a curve for parts a) and b) showing the temperature as a function of the time elapsed.
\[ P = \frac{F}{A} \]
\[ \rho = \frac{m}{V} \]
\[ P_2 = P_1 + \rho gh \]
\[ F_B = W_{\text{fluid displaced}} \]
\[ \rho A v = \text{const} \]
\[ P + \frac{1}{2} \rho v^2 + \rho g y = \text{const} \]
\[ T = T_C + 273.15 \]
\[ \Delta L = \alpha v \Delta T \]
\[ \Delta V = \beta V_0 \Delta T \]
\[ \beta = 3 \alpha \]
\[ Q = mc\Delta T \]
\[ Q = Lm \]
\[ Q = \frac{(k\Delta T)h}{L} \]
\[ Q = e\sigma T^4 A t \]
\[ PV = nRT = NkT \]
\[ k = \frac{R}{N_A} \]
\[ n = \frac{m_{\text{sample}}}{\text{Mass per mole}} \]
\[ \overline{KE} = \frac{3}{2} kT \]
\[ U = \frac{3}{2} nRT \]

...constants...
\[ g = 9.8 \text{ m/s}^2 \]
\[ 1 \text{ atm} = 1.013 \times 10^5 \text{ Pa} \]
\[ R = 8.314 \text{ J/(mol} \cdot \text{K)} \]
\[ k = 1.38 \times 10^{-23} \text{ J/K} \]
\[ c_{Al} = 9 \times 10^2 \text{ J/kg} \cdot \text{C}^\circ \]
\[ c_{Cu} = 387 \text{ J/kg} \cdot \text{C}^\circ \]
\[ c_{glass} = 840 \text{ J/kg} \cdot \text{C}^\circ \]
\[ c_{water} = 4186 \text{ J/kg} \cdot \text{C}^\circ \]
\[ c_{ice} = 2000 \text{ J/kg} \cdot \text{C}^\circ \]
\[ L_{f_{\text{water}}} = 33.5 \times 10^4 \text{ J/kg} \]
\[ L_{v_{\text{water}}} = 22.6 \times 10^5 \text{ J/kg} \]
\[ \rho_{\text{water}} = 1000 \text{ kg/m}^3 \]

.......other........
\[ Ax^2 + Bx + C = 0 \]
\[ x = \frac{-B \pm \sqrt{B^2 - 4AC}}{2A} \]
\[ V_{sphere} = \frac{4}{3} \pi r^3 \]