Chemistry 236 -- Quiz 4

Lab Day ____

November 5, 2008 — Experiments 3 and 4

Pledge and signature:

Note: If you want your paper returned folded (*i.e.*, score concealed), please print your name on the back.

A. (13) Bomb Calorimetry.

1. (3) Combustion of 1.270 g of substance A raises the temperature of 0.931 kg of water by 2.44 K. Therefore, combustion of 1.710 g of A will raise the *T* of 1.190 kg of water by how much?

2. (3) Taking the first two masses and the first ΔT given above as exact, and the 3rd and 4th masses as uncertain by 0.006 g and 0.003 kg, respectively, calculate (a) the % uncertainty, and (b) the absolute uncertainty in your computed ΔT. (c) Use the latter to state your result correctly.

3. (4) Calculate the value of $\Delta H° - \Delta E°$ at 25°C for the combustion of 1.00 mol of heptane (C_7H_{16}) to produce $CO_2(g)$ and $H_2O(g)$. (R = 8.3145 J mol^{-1} K^{-1}.)

4. (3) List the three most significant quantities you measure in conjunction with running a single bomb calorimetry experiment, and give reasonable values and uncertainties for each.

B. (14) Phase Equilibria and the Triple Point.

1. (6) The normal boiling point of water is 100.0°C, and $\Delta H_{\mathrm{m,vap}}$ = 40.66 kJ/mol at that T. Taking $\Delta H_{\mathrm{m,vap}}$ to be constant, calculate the boiling point of water at the top of Pike's Peak on a day when the atmospheric pressure is its average value of 446 torr.

2. (3) I. B. Alwette and U. B. Water run the TP experiment and analyze their data to obtain $\Delta H_{\mathrm{m,vap}}$ = 44.74±0.12 kJ/mol and $\Delta H_{\mathrm{m,sub}}$ = 52.39±0.07 kJ/mol. Calculate from these results ΔH_{fus} and its uncertainty. State the results with the proper numbers of significant figures.

3. (5) In analyzing our vapor pressure data for water, we assumed that $\Delta H_{\mathrm{m,vap}}$ was independent of temperature. Over an extended T range, this becomes a poor approximation. Suppose we include the T-dependence in $\Delta H_{\mathrm{m,vap}}$ by treating ΔC_P (= $C_{P,\mathrm{m},g} - C_{P,\mathrm{m},l}$) as independent of T.

   (a) Give an expression for $\Delta H_{\mathrm{m,vap}}(T)$, in terms of ΔC_P and $\Delta H_{\mathrm{m,vap}}$ at the triple point (T_0). [If need be, you can derive this using $(\partial H/\partial T)_{\mathrm{P}} = C_P$.]

   (b) Use this expression to obtain a version of the integrated Claussius-Clapeyron equation that could be used to analyze vapor pressure data to obtain ΔC_P and $\Delta H_{\mathrm{m,vap}}$ at T_0.