Chemistry 236 -- Quiz 4

Lab Day ____

March 27, 2012 — 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. (4) Combustion of 1.473 g of substance A raises the temperature of 0.931 kg of water by 2.143 K. Therefore, combustion of 1.910 g of A will raise the T of 1.095 kg of water by how much?

2. (6) In experiments run at ~25°C, 1.038 g of BA and 47 mg of Fe fuse wire yield a temperature rise of 2.119 K. Then 1.272 g of unknown and 58 mg of fuse wire yield ΔT = 1.822 K. In each case the calorimeter pail is filled with the same volume of water. Calculate **(a)** the calorimeter constant, and **(b)** $q_{specific}$ for the unknown. [$q_{specific}$ (BA) = –26.413 kJ/g; $q_{specific}$ (Fe) = –6.68 kJ/g]

3. (3) If the masses just above are considered exact and the ΔT values are uncertain by 0.016 K, what are the % uncertainties in **(a)** the calorimeter constant, and **(b)** $q_{specific}$ for the unknown.

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. P. 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 $(\partial H/\partial T)_P = C_P$.]

   (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. [Hint: You may start here with the differential equation, $d \ln P/dT = \Delta H_{\mathrm{m,vap}}/(RT^2)$.]