# Chemistry 236 -- Quiz 4

Lab Day ____

March 27, 2012 — Experiments 3 and 4

**Pledge and signature:**

**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?

   $\Delta T$ $m_A/m_{water}$ → $\Delta T$ = 2.363 K

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 $\Delta T$ = 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]

   (a) $C_K$ = 13.087 kJ/K (b) $q_{specific}$ = −18.441 kJ/g

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

   (a) 0.76 % (b) 1.16 % $[0.76^2 + 0.88^2]^{1/2}$ %

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

1. (6) The normal boiling point of water is 100.0°C, and $\Delta H_{m,vap}$ = 40.66 kJ/mol at that $T$. Taking $\Delta H_{m,vap}$ 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.

   358.57 K or 85.4 °C

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

   7.65(14) kJ/mol

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

   (a) Give an expression for $\Delta H_{m,vap}(T)$, in terms of $\Delta C_P$ and $\Delta H_{m,vap}$ 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 $\Delta C_P$ and $\Delta H_{m,vap}$ at $T_0$. [Hint: You may start here with the differential equation, $d \ln P/dT = \Delta H_{m,vap}/(RT^2)$.]

   [See Study Problem 9 for Experiment 4.]