Chemistry 236 -- Quiz 4

Lab Day ____

November 3, 2010 — Experiments 3 and 4

Pledge and signature:

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

A. (14) Bombs Away.

1. (8) Strangelove uses a bomb calorimeter to estimate the heat of combustion of an unknown. The calorimeter is calibrated with benzoic acid (BA, $q_{\text{specific}} = -26.413$ kJ/g); both the BA and the unknown are ignited with iron fuse wire ($q_{\text{specific}} = -6.68$ kJ/g).

   In experiments run at ~25°C, 1.038 g of BA and 57 mg of fuse wire yield a temperature rise of 1.119 K. Then 1.372 g of unknown and 48 mg of fuse wire produce a ΔT of 1.322 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.

2. (3) Give a balanced equation for the complete combustion of cyclohexane [$C_6H_{12}(\ell)$]. Then calculate the value of $\Delta H° - \Delta E°$ for this process at 40.0°C. [$R = 8.3145$ J mol^{-1} K^{-1}].

3. (3) What quantities do you measure when you run a single experiment with the bomb calorimeter? Give reasonable uncertainties (absolute) for each of these. Hence what is likely to be the dominant source of experimental uncertainty.

B. (12) Triple Trouble.

1. (6) I. B. Alwette and U. B. Water run the TP experiment and analyze their data to obtain ΔH_{vap} = 45.74±0.13 kJ/mol and ΔH_{sub} = 52.09±0.08 kJ/mol. Calculate from these results ΔH_{fus} and its uncertainty. State the results with the proper numbers of significant figures.

2. (2) Morely Smartt does very careful vapor pressure measurements on water near 25°C and obtains ΔH_{vap} = 44.001(3) kJ/mol, while Bud Wizer breezes through and gets 44.8(9) kJ/mol. The literature value is 44.012 kJ/mol. Which determination — Smartt's or Wizer's — is the greater cause for "concern"? Explain briefly.

3. (4) In the standard derivation of the integrated Clausius-Clapeyron (CC) Equation (which we employed), ΔH_m is assumed to be constant with respect to changes in T. Over an extended range of T, this becomes inadequate. Suppose we assume instead that ΔC_P is independent of T, whereupon we obtain $\Delta H_m(T) = \Delta H_0 + \Delta C_P\,(T - T_0)$, where T_0 is the triple point T. Use this expression for $\Delta H_m(T)$ in the differential form of the CC Equation, and integrate to obtain the more accurate expression for the integrated CC Equation.