Chemistry 236 -- Quiz 4

Lab Day ____

November 11, 2009 — Experiments 3 and 4

A. (17) Bomb Calorimetry — Concepts and Practice.

1. (2) If 1.0 gal of gasoline powers a car for 30 miles, then driving under the same conditions, how far should the same car go on 4.0 gal of gasoline?

   120 miles

2. (2) Now suppose there is a second fuel that has combustion energy content 50% greater than that of gasoline. How many gal of this "supergas" would be needed to power the same car 111 miles?

   2.47 gal

3. (2) Still comparing these same two fuels, if 1.00 g of gasoline raises the temperature of 1.00 kg of water by 1.95 K, by how much would 0.85 g of the second fuel raise the temperature of 1.55 kg of water?

   1.60_4 K

4. (3) Write a balanced reaction for the complete combustion of *n*-propanol [$C_3H_7OH(l)$] in a bomb calorimeter. Use this to compute the difference, $\Delta H° - \Delta E°$, at 25°C. [R = 8.31451 J mol^{-1} K^{-1}]

   $C_3H_7OH(l) + {}^9/_2\, O_2(g) \rightarrow 3\, CO_2(g) + 4\, H_2O(l)$

   $\Delta H° - \Delta E° = -{}^3/_2\, RT = -3.718$ kJ/mol

5. (4) The bomb calorimeter is calibrated using benzoic acid ($q_{specific}$ = –26.413 kJ/g at 25.0˚C) and Fe fuse wire ($q_{specific}$ = –6.68 kJ/g). In one run, combustion of 0.952 g of benzoic acid and 24 mg of Fe fuse wire yields a temperature rise of 2.584 K. Calculate (a) the total combustion heat, and (b) the calorimeter constant.

   (a) −25.31 kJ (b) 9.79_3 kJ/K

6. (4) If the masses are uncertain by 0.8 mg and ΔT is uncertain by 0.015 K, calculate (a) the uncertainty in the combustion heat, and (b) the uncertainty in the calorimeter constant.

   (a) s_{Fe} = 0.0008 (6.68 kJ) = 5.3 J; s_{BA} = 0.0008 (26.413) = 21.1 J; s_q = 21.8 J

   (b) $s_{C_K}/C_K = [(0.0218/25.31)^2 + (0.015/2.584)^2]^{1/2} \approx (0.015/2.584) \rightarrow s_{C_K} = 0.057$ kJ/K

B. (10) 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 temperature of water that is boiling in a pressure cooker in which P = 1.80 atm. [gas constant given in Problem A.4}

   Integrated CC eqn, w/ P_0 = 1.00 atm and T_0 = 373.15 K → T = 390.67 K = 117.5°C.

2. (2) Bob and Carol record sublimation and vapor P data for a substance near its triple point and obtain ΔH_{sub} = 35.1 kJ/mol and ΔH_{vap} = 29.1 kJ/mol. Ted and Alice do the same experiment on the same substance and obtain ΔH_{sub} = 31.5 kJ/mol and ΔH_{vap} = 36.2 kJ/mol. Which of these sets of results must certainly be wrong, at least in part; and how do you know this?

   Since ΔH_{fus} must be positive, and $\Delta H_{fus} = \Delta H_{sub} - \Delta H_{vap}$, T & A's results must be wrong.

3. (1) The voltmeter connected to the Baratron gauge in the TP setup reads 1.062 V. Assuming the meter is properly zeroed and that the gauge is performing according to specifications, what is the pressure?

   10.62 torr.

4. (1) Equal amounts (20 g) of isopropyl alcohol [$C_3H_7OH(l)$] are sealed in two flasks, one 250 mL, the other 1000 mL in volume. Both are maintained at 24.0°C until the liquid-vapor equilibrium is established. Then the vapor pressure in the smaller flask is found to be 40.0 torr. What will the vapor pressure be in the 1.0-L flask? 40.0 torr !