Name: ______________________________ Test 2

140 points Chemistry 261

Dr. Jay H. Baltisberger April 3, 2000

Answer the following multiple choice questions for 10 points each.
Must show complete work for full credit to be given:

1. Calculate the change in entropy if an iron block with constant pressure heat capacity of 5.00 J/K is heated reversibly from 215 K to 425 K?

   A) 5.00 J/K **B)** 1050 J **C)** 3.28 J/K **D)** 3.41 J/K **E)** –2.47 J/K

2. Calculate the change in entropy if two moles of an ideal gas ($C_V = 3\ n\ R\ /\ 2$, $C_p = 5\ n\ R\ /\ 2$) is compressed to one-fourth its original volume and simultaneously heated to four times its initial temperature.

   A) 3 R ln 4 **B)** 5 R ln 4 **C)** R ln 4 **D)** 7 R ln 4 **E)** none of the above

3. A 3.5 L sample of 2.00 mol of an ideal gas at 330 K is subjected to isothermal compression and its entropy decreases by 25.0 J/K. Calculate ΔG for the compression.

   A) –8250 J **B)** 8250 J **C)** 2310 J **D)** –175 J **E)** none of the above

Choose one of the following two exercises for 20 points:

4. Calculate the change in the Gibbs energy of 1.00 mol of water ($\rho = 1.0\ g\ /\ cm^3$) if the pressure is increased from 100 kPa to 900 kPa.
5. Calculate the change in entropy if 50.0 g of ethanol (C_2H_5OH) at 300 K is poured into 70.0 g of ethanol at 350 K in an insulated cup. For ethanol, $C_{p,m} = 111.5$ J / mol K.

Choose two of the following four problems for 45 points each:

6. Suppose an internal combustion engine runs on octane, for which the enthalpy of combustion is –5512 kJ / mol and take the mass of one gallon of fuel as 3.0 kg. What is the maximum height, neglecting all forms of friction, to which a car of mass 1000 kg can be driven on 1.00 gallon of fuel given that the engine cylinder temperature is 2000˚C and the exit temperature is 800˚C.
7. At 25˚C the standard enthalpy of combustion of sucrose is –5645 kJ / mol and the standard Gibbs energy of combustion is –6333 kJ / mol. Calculate the additional non-expansion work that may be obtained by raising the temperature of the reaction to 37˚C.
8. The adiabatic compressibility, κ_S, is defined like $\kappa_T = (\partial V/\partial p)_T / V$ but at constant entropy. Show that for a perfect gas, $p\ \gamma\ \kappa_S = 1$. Recall that for an adiabatic expansion, $p\ V^\gamma$ = constant and $\gamma = C_p / C_V$.
9. The Joule coefficient, μ_J, is defined as $\mu_J = (\partial T/\partial V)_U$. Show that $\mu_J\ C_V = p - (\alpha\ T / \kappa_T)$.