Chemistry 456A
Final Exam
March 20, 2002

Name _____

Constants and conversion factors that you *may* need

$R = 8.314\ J\ K^{-1}\ mol^{-1}$

$R = 8.21 \times 10^{-2}\ L\ atm\ K^{-1}\ mol^{-1}$

$R = 62.364\ L\ Torr\ K^{-1}\ mol^{-1}$

$1\ atm = 760\ Torr = 101.325 \times 10^{3}\ Pa$

$k = 1.381 \times 10^{-23}\ J\ K^{-1}$

$1\ L = 10^{-3}\ m^{3}$

NOTE: You must show your work to receive credit!

1) Consider the reaction $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$. At 1000 K, $\Delta H° = -123.77$ kJ mol^{-1}. Given the heat capacity data below, calculate ΔH_f^0 for $NH_3(g)$ at 300K.

Substance	N_2	H_2	NH_3
$C_{p,m}/R$	3.502	3.466	4.217

2) A sample of 4.0 mol of an ideal gas is originally confined to a volume of 20L at 270 K. It undergoes an adiabatic expansion against a constant pressure of 600 Torr until the volume has tripled. $C_{v,m} = 5/2$ R. Calculate q, w, ΔT, ΔU, ΔH, ΔS, ΔS_{surr}, and ΔS_{total}.

3) The density of diamond is 3.52 g/cm^3 and that of graphite is 2.25 g/cm^3. At 25° C, the Gibbs energy of formation of diamond from graphite is 2.900 kJ/mol. What pressure must be applied to bring diamond and graphite into equilibrium at 25° C?

4) At 25° C, $\Delta G^0 = 161.67$ kJ/mol for the reaction $Br_2(g) \leftrightarrow 2Br(g)$.
a) Calculate K_p at 25° C.

b) Assume that initially, 1.00 mol of $Br_2(g)$ is introduced into the reaction vessel and no Br(g) is present. Obtain an expression for ξ, the extent of reaction, in terms of the total pressure P, and K_P.

c) Using your result to part b), calculate ξ at 25° C and a total pressure of 10 atm.

5) The reaction between $CuSO_4$ and $ZnSO_4$ in the Daniell's cell is

$$Cu^{2+}(aq) + SO_4^{2-}(aq) + Zn(s) \leftrightarrow Cu(s) + SO_4^{2-}(aq) + Zn^{2+}(aq)$$

$\Delta_r G°$ = -212.7 kJ for this reaction at 25° C. The concentrations are given by $b(CuSO_4) = 1.0 \times 10^{-3}$ molal and $b(ZnSO_4) = 3.0 \times 10^{-3}$ molal. Note that the sulfate ion concentration in the two half-cells differs.

a) Calculate the ionic strength in each of the half-cell solutions.

b) Calculate the mean activity coefficient in each of the half-cell solutions using the Debye-Huckel limiting law.

c) Calculate the reaction quotient

d) Calculate the standard cell potential

e) Calculate the cell potential for the molalities given above

6) Give brief responses to the following questions or statements.

a) Explain why $C_{p,m}$- $C_{v,m}$ is much larger for a gas than for a liquid.