FORMULA SHEET (tear off)

1A												3A	4A	5A	6A	7A	8A
1 H 1.01	2A																2 He 4.00
3 Li 6.94	4 Be 9.01											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.87	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.41	31 Ga 69.72	32 Ge 72.64	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc [98]	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	71 Lu 175.0	72 Hf 178.5	73 Ta 181.0	74 W 183.8	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po [209]	85 At [210]	86 Rn [222]
87 Fr [223]	88 Ra [226]	103 Lr [262]	104 Rf [261]	105 Db [262]	106 Sg [266]												

57 La 138.9	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm [145]	62 Sm 150.4	63 Eu 152.0	64 Gd 157.2	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0
89 Ac [227]	90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np [237]	94 Pu [244]	95 Am [243]	96 Cm [247]	97 Bk [247]	98 Cf [251]	99 Es [252]	100 Fm [257]	101 Md [258]	102 No [259]

$N_A = 6.022 \times 10^{23}$ $\quad$ $°C = (5/9)(°F - 32)$ $\quad$ $°F = (9/5)(°C) + 32$

1 amu = 1.661×10^{-27} kg $\quad$ $°C = K - 273.15$ $\quad$ $K = °C + 273.15$

1 atm = 760 torr = 760 mm Hg $\quad$ 1 atm = 1.013 bar $\quad$ $pV = nRT$

$R = 0.08206$ L·atm/mol·K $\quad$ 1 L·atm = 101.3 J

$R = 8.314$ J/mol·K $\quad$ 1 J= 1 kg·m^2/s^2

$$\ln(p) = -\frac{\Delta H°_{vap}}{T} + C \qquad \ln(p_2/p_1) = -(\Delta H°_{vap}/R)\{(1/T_2) - (1/T_1)\}$$

$p_A = X_A\, p_A°$ $\quad$ $[B] = k\, p_B$ $\quad$ $\Delta p_A = X_B p_A°$

$\Delta T_b = K_b\, m_B$ $\quad$ $\Delta T_f = K_f\, m_B$ $\quad$ $\Pi = [B]RT$

$H = U + pV$ $\quad$ $G = H - TS$

GENERAL CHEMISTRY 2
FIRST EXAM (Sample)

Name _____**KEY** _____

Panthersoft ID _____

Signature _____

Part 1 _____ **(24 points)**

Part 2 _____ **(44 points)**

Part 3 _____ **(32 points)**

TOTAL_____ **(100 points)**

Do all of the following problems. Show your work.

Part 1. Multiple choice. Circle the letter corresponding to the correct answer. There is one and only one correct answer per problem. [4 points each]

1) Which of the following states of matter is classified as a fluid?

a) The solid state
b) The liquid state
E c) The gas state
d) Both a and b
e) Both b and c

2) 10.0 grams of glucose (MW = 180.2 g/mol), 40.0 g of isopropyl alcohol (MW = 60.1 g/mol), and 400.0 g of water (MW = 18.0 g/mol) are mixed together to form a solution. We may say

a) water is the solvent in the above solution
b) glucose is the solvent in the above solution
A c) isopropyl alcohol is the solvent in the above solution
d) both glucose and isopropyl alcohol are solvents in the above solution
e) none of the components of the solution can be considered a solvent

3) A solution is prepared by dissolving 20.0 g of naphthalene (a non-volatile solute) in 150.0 g of benzene (a volatile solvent). Which of the following statements about this solution is correct?

a) The normal boiling point of the solution is higher than the normal boiling point of pure benzene
b) The normal boiling point of the solution is lower than the normal boiling point of pure benzene
A c) The normal freezing point of the solution is higher than the normal freezing point of pure benzene
d) Both a and c
e) Both b and c

4) For a chemical reaction to be spontaneous which of the following must be true?

a) $\Delta S_{syst} > 0$
b) $\Delta S_{surr} > 0$
C c) $\Delta S_{univ} > 0$
d) Both a and b
e) Both a and b and c

5) For 1.000 mol of which of the following substances will S°, the absolute entropy, be exactly zero at T = 25. °C?

a) Cu(s)
b) $O_2(g)$
E c) $O_3(g)$
d) Both a and b
e) None of the above

6) For a particular chemical reaction we find that $\Delta H°_{rxn} < 0$ and $\Delta S°_{rxn} < 0$. Based on this information, we expect that for standard conditions

a) the reaction will always be spontaneous
b) the raction will never be spontaneous
D c) the reaction will be spontaneous at high temperatures, but not at low temperatures
d) the reaction will be spontaneous at low temperatures, but not at high temperatures
e) cannot tell from the information given in the problem

Part 2. Short answer.

1) Define the following terms [4 points each]

colloid

A suspension of small particles within a solvent.

miscible

Refers to two (or more) liquids that will homogeneously mix to form a solution in any proportion.

state function

A function whose change in value depends only on the initial and final state of a system, and is independent of the pathway used.

sublimation

The phase transition solid $\rightarrow$ gas

2) Give the following [4 points each]

a) The formation reaction for chlorobenzene ($C_6H_5Cl(\ell)$).

$$6\ C(s) + {}^{5}/_{2}\ H_2(g) + {}^{1}/_{2}\ Cl_2(g) \rightarrow C_6H_5Cl(\ell)$$

b) The Third Law of thermodynamics

The absolute entropy of one mole of a pure substance in the form of a perfect crystal is 0.00 J/mol·K at absolute zero.

3) A solution is prepared by dissolving 1.200 g of potassium iodide (KI, MW = 166.0 g/mol) in 25.00 g water (H_2O, MW = 18.0 g/mol). What is the freezing point for the solution? Note that K_f = 1.86 kg•°C/mol, and that the normal freezing point for pure water is T_f = 0.00 °C. [10 points]

moles KI = 1.200 g $\frac{1 \text{ mol}}{166.0 \text{ g}}$ = 0.007229 mol KI Since KI(s) $\rightarrow$ $K^+(aq) + I^-(aq)$

molality of particles = $\frac{0.007229 \text{ mol KI}}{0.02500 \text{ g water}} \frac{2 \text{ mol particles}}{1 \text{ mol KI}}$ = 0.5783 mol/kg

$\Delta T_f = K_f m_B$ = (1.86 kg•°C/mol) (0.5783 mol/kg) = 1.08 °C

Since freezing point is lower for a solution than for a pure liquid, the freezing point for the solution is

T_f = 0.00 °C - 1.08 °C = - 1.08 °C

4) The vapor pressure of a particular pure liquid is p = 48.2 torr at T = 20.0 °C, and p = 247. torr at T = 50.0 °C. What is the numerical value for $\Delta H°_{vap}$, the enthalpy of vaporization, for the liquid? [10 points]

$\ln(p_2/p_1) = - (\Delta H°_{vap}/R) \{ (1/T_2) - (1/T_1) \}$

So $\Delta H°_{vap} = - \frac{R \ln(p_2/p_1)}{\{ (1/T_2) - (1/T_1) \}}$

$= - \frac{(8.314 \text{ J/mol•K}) \ln(247./48.2)}{\{ (1/323.2 \text{ K}) - (1/293.2 \text{ K})\}}$ = 42900. J/mol = 42.9 kJ/mol

Part 3. Problems.

1) A solution is prepared by dissolving 48.43 g of potassium bromide (KBr, MW = 119.01 g/mol) in water (H_2O, MW = 18.02 g/mol) to form a solution with final volume and density V = 500.0 mL and D = 1.068 g/mL. What are the molarity of KBr in the solution and the mole fraction of KBr in the solution? [16 points]

grams KBr = 48.43 g mol KBr = 48.43 g $\frac{1\ \text{mol}}{119.01\ \text{g}}$ = 0.407 mol

grams solution = 500.0 mL $\frac{1.068\ \text{g}}{\text{mL}}$ = 534. g soln

grams H_2O = 534. g soln - 48.43 g KBr = 485.6 g H_2O mol H_2O = 485.6 g $\frac{1\ \text{mol}}{18.02\ \text{g}}$ = 26.95 mol

molarity = $\frac{\text{mol solute}}{\text{L soln}} = \frac{0.407\ \text{mol}}{0.5000\ \text{L}}$ = 0.814 mol/L

mole fraction KBr = $\frac{\text{mol KBr}}{\text{mol KBr + mol } H_2O} = \frac{0.407\ \text{mol}}{(0.407 + 26.95)\ \text{mol}}$ = 0.0149

2) Thermodynamic data are given below (at T = 25.0 °C and p = 1.00 atm) and may be of use in doing this problem.

Substance	$\Delta H°_f$ (kJ/mol)	$\Delta G°_f$ (kJ/mol)	$S°$ (J/mol·K)
$N_2(g)$	0.0	0.0	191.5
NO(g)	90.4	86.7	210.6
$N_2O(g)$	81.6	103.6	220.0

a) What are the numerical values for $\Delta H°_{rxn}$ and $\Delta S°_{rxn}$ for the process [8 points]

$$2\ N_2O(g) \rightarrow N_2(g) + 2\ NO(g)$$

$\Delta H°_{rxn} = [\ \Delta H°_f(N_2(g)) + 2\ \Delta H°_f(NO(g))\ ] - [\ 2\ \Delta H°_f(N_2O(g))\ ]$

$= [\ 0.00 + 2\ (90.4)\ ] - [\ 2\ (81.6)\ ] = +\ 17.6$ kJ/mol

$\Delta S°_{rxn} = [\ S°(N_2(g)) + 2\ S°(NO(g))\ ] - [\ 2\ S°(N_2O(g))\ ]$

$= [\ 191.5 + 2\ (210.6)\ ] - [\ 2\ (220.0)\ ] = +\ 172.7$ J/mol·K

b) What is the numerical value for $\Delta S°_{univ}$ for the above process? [8 points]

$\Delta S°_{syst} = \Delta S°_{rxn} = +\ 172.7$ J/mol·K

$\Delta S°_{surr} = -\ \dfrac{\Delta H°_{rxn}}{T} = -\ \dfrac{17600.\ J/mol}{298.\ K} = -\ 59.1$ J/mol·K

$\Delta S°_{univ} = \Delta S°_{syst} + \Delta S°_{surr} = +\ 172.7$ J/mol·K + (- 59.1 J/mol·K) = + 113.6 J/mol·K