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

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

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

$K_p = K_C (RT)^{\Delta n}$

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

$\Delta G_{rxn} = \Delta G°_{rxn} + RT \ln Q$ $\quad$ $\ln K = - \Delta G°_{rxn}/RT$

If $ax^2 + bx + c = 0$, then $x = \left(\frac{- b \pm [b^2 - 4ac]^{1/2}}{2a} \right)$

GENERAL CHEMISTRY 2
FIRST EXAM (Sample)

Name _____

Panthersoft ID _____

Signature _____

Part 1 _____ **(24 points)**

Part 2 _____ **(50 points)**

Part 3 _____ **(46 points)**

TOTAL_____ **(120 points)**

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Do all of the following problems. <u>Show your work.</u>

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) 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
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

2) 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
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

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

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

5) 1.000 mol of which of the following substances has the largest value for S° at T = 25. °C?

a) $CH_3OH(\ell)$
b) $CH_3CH_2CH_2OH(\ell)$
c) $CH_3OH(g)$
d) $CH_3CH_2CH_2OH(g)$
e) All of the above substances have the same value for S° at T = 25. °C.

6) The numerical value for the equilibrium constant for the reaction $A_2(g) + 2\ B(g) \leftrightarrows 2\ AB(g)$ is $K_C = 25$. The numerical value for the equilibrium constant for the reaction $AB(g) \leftrightarrows {}^1/_2\ A_2(g) + B(g)$, measured at the same temperature, is

a) $K_C = 0.040$
b) $K_C = 0.20$
c) $K_C = 5.0$
d) $K_C = 25.$
e) Cannot tell from the information given

Part 2. Short answer.

1) Define the following terms [4 points each]

colloid

miscible

2) Give the following [4 points each]

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

b) The Third Law of thermodynamics

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]

4) As discussed in class, there are two factors that make it likely that two liquids will homogeneously mix to form a solution. What are they? [6 points]

5) A system containing the gases Cl_2, NO, and NOCl will achieve equilibrium. The process that takes place is

$$2\ NOCl(g) \leftrightarrows 2\ NO(g) + Cl_2(g)$$

At T = 500. K, the partial pressures of gas present at equilibrium are $p(Cl_2) = 0.608$ atm, $p(NO) = 0.240$ atm, and $p(NOCl) = 1.36$ atm.

a) What is the numerical value for K_p for the above reaction at T 500. K? [5 points]

b) What is the numerical value for K_C for the above reaction at T = 500. K? [5 points]

c) For each of the changes given below, indicate (by circling the correct answer) whether the change will lead to an increase, decrease, or no change in the number of moles of Cl_2 in the system. In all cases temperature is held constant at T = 500. K. [4 points each]

Add 0.20 moles of of NOCl to the system under conditions of constant volume

moles of Cl_2 will increase	moles of Cl_2 will remain constant	moles of Cl_2 will decrease

Double the volume of the system

moles of Cl_2 will increase	moles of Cl_2 will remain constant	moles of Cl_2 will decrease

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]

2) The numerical value for the equilibrium constant for the reaction

$$H_2(g) + I_2(g) \leftrightarrows 2\ HI(g)$$

is $K_C = 57.0$ at T = 700. K.

The initial concentration of H_2 and I_2 in a system at T = 700. K are $[H_2] = 0.2000$ mol/L and $[I_2] = 0.1000$ mol/L. No HI is initially present in the system. What are the concentrations of H_2, I_2, and HI that are present when the system reaches equilibrium? [16 points]

3) Thermodynamic data are given below and may be of use in doing some parts of 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]

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

b) The free energy change for the reaction

$$2\ NO_2(g) \leftrightarrows N_2O_4(g)$$

is $\Delta G°_{rxn}$ = - 5.3 kJ/mol at T = 25. °C. Based on this information, find the numerical value for K, the equilibrium constant, for this reaction. [6 points]