FORMULA SHEET (tear off)

1A																	8A
1 H 1.01	2A											3A	4A	5A	6A	7A	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]

$N_A = 6.022 \times 10^{23}$ $°C = (^5/_9)(°F - 32)$ $°F = (^9/_5)(°C) + 32$

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

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

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

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

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

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

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

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

GENERAL CHEMISTRY 2
FIRST EXAM (Sample)

Name _____

Panthersoft ID _____

Signature _____

Part 1 _____ **(20 points)**

Part 2 _____ **(48 points)**

Part 3 _____ **(32 points)**

TOTAL _____ **(100 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) Consider the following three pure chemical substances: hydrogen (H_2), chlorine (Cl_2), and methyl alcohol (CH_3OH). Of these three substances, we would expect
        a) H_2 has the highest normal boiling point and Cl_2 has the lowest normal boiling point
        b) H_2 has the highest normal boiling point and CH_3OH has the lowest normal boiling point
        c) CH_3OH has the highest normal boiling point and H_2 has the lowest normal boiling point
        d) CH_3OH has the highest normal boiling point and Cl_2 has the lowest normal boiling point
        e) Cl_2 has the highest normal boiling point and H_2 has the lowest normal boiling point

2) Which of the following pairs of liquids are likely to be <u>immiscible</u>?
        a) A polar liquid and a nonpolar liquid
        b) Two polar liquids
        c) Two nonpolar liquids
        d) Both a and b
        e) Both b and c

3) A solution forms from a volatile solvent and a nonvolatile solute. Which of the following statements about the solution is correct?
        a) The vapor pressure of the solution is higher than the vapor pressure of the pure solvent
        b) The boiling point of the solution is higher than the boiling point of the pure solvent
        c) The freezing point of the solution is higher than the freezing point of the pure solvent
        d) Both b and c
        e) Both a and b and c

4) The Second Law of Thermodynamics says which of the following must be true for a process to occur?
        a) $\Delta S_{syst} > 0$
        b) $\Delta S_{surr} > 0$
        c) $\Delta S_{univ} > 0$
        d) Both b and c
        e) Both a and b and c

5) For a chemical reaction to be spontaneous for standard conditions, which of the following must be true?
        a) $\Delta H°_{rxn} < 0$
        b) $\Delta G°_{rxn} < 0$
        c) $\Delta S°_{rxn} < 0$
        d) $\Delta S°_{rxn} > 0$
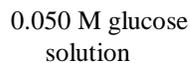   e) Both b and d

Part 2. Short answer.

1) What is the difference (if any) between an amorphous solid and a crystalline solid? [6 points]

2) For each of the following circle the correct answer. There is one and only one correct answer per problem.
[4 points each]

   a) The substance where hydrogen bonding between molecules can occur

   $CH_3CH_2CH_3$ H_2 HCN NH_3

   b) The aqueous solution with the largest value for osmotic pressure (relative to pure water)

   0.050 M $CaCl_2$ 0.050 M $Fe(NO_3)_3$ 0.050 M glucose   0.050 M NaBr
      solution   solution   solution   solution

   c) The substance with the highest value for S° (at T = 25. °C)

   $CH_3COOH(\ell)$ $CH_3COOH(g)$ $CH_3CH_2CH_2COOH(\ell)$ $CH_3CH_2CH_2COOH(g)$

   d) A reaction that is never expected to be spontaneous for standard conditions (assuming the values for both
$\Delta H°_{rxn}$ and $\Delta S°_{rxn}$ are independent of temperature)

   $\Delta H°_{rxn} > 0$ and $\Delta H°_{rxn} > 0$ and $\Delta H°_{rxn} < 0$ and $\Delta H°_{rxn} < 0$ and
      $\Delta S°_{rxn} > 0$ $\Delta S°_{rxn} < 0$ $\Delta S°_{rxn} > 0$ $\Delta S°_{rxn} < 0$

3) Information about benzene (C_6H_6, MW = 78.11 g/mol) is given below

   Freezing point depression constant (K_f) = 5.12 kg ·°C/mol
   Boiling point elevation constant (K_b) = 2.53 kg ·°C/mol
   Normal boiling point for benzene (T_b) = 80.08 °C

A solution is formed by dissolving an unknown amount of naphthalene ($C_{10}H_8$, MW = 128.2 g/mol), a nonvolatile solute, in benzene. The normal freezing point of the solution is found to be 1.15 °C lower than the normal freezing point of pure benzene. What will be the value for the normal boiling point of the solution? [6 points]

4) State the Third Law of Thermodynamics. [4 points]

5) Give the correctly balanced formation reaction for methylamine ($CH_3NH_2(\ell)$). [4 points]

6) It takes 31400. J of heat to convert 1.000 moles of a particular unknown liquid into vapor at its normal boiling point, $T°_{vap} = 68.5 °C$. What are $\Delta G°_{vap}$, $\Delta H°_{vap}$, and $\Delta S°_{vap}$ for the substance at this temperature? [12 points]

Part 3. Problems.

1) A solution is prepared by dissolving 25.628 g of hexamethylbenzene (HMB = $C_{12}H_{18}$, MW = 162.3 g/mol) in carbon tetrachloride (CCl_4, MW = 153.8 g/mol). The density and final volume of the solution are D = 1.556 g/mL and V = 200.0 mL. What are the molarity, molality, and percent by mass HMB in the solution? [16 points]

2) Thermodynamic data are given below (at T = 25. °C) and may be of use in doing this problem.

Substance	$\Delta H°_f$ (kJ/mol)	$\Delta G°_f$ (kJ/mol)	$S°$ (J/mol·K)
$Br_2(g)$	30.907	3.110	245.46
$Cl_2(g)$	0.00	0.00	223.07
$CH_3Br(g)$	- 35.4	- 26.3	246.4
$CH_3Cl(g)$	- 81.9	- 58.4	234.6

a) What are $\Delta G°_{rxn}$ and $\Delta S°_{rxn}$ for the following reaction, at T = 25. °C [12 points]

2 $CH_3Cl(g)$ + $Br_2(g)$ ⇋ 2 $CH_3Br(g)$ + $Cl_2(g)$
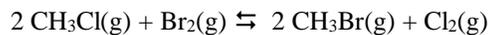
b) Is the above reaction spontaneous for standard conditions and T = 25. °C (yes or no)? <u>Justify your answer</u>. [4 points]