

**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]						

$$N_A = 6.022 \times 10^{23}$$

$$1 \text{ amu} = 1.661 \times 10^{-27} \text{ kg}$$

$$1 \text{ atm} = 760 \text{ torr} = 760 \text{ mm Hg}$$

$$R = 0.08206 \text{ L}\cdot\text{atm}/\text{mol}\cdot\text{K}$$

$$R = 8.314 \text{ J}/\text{mol}\cdot\text{K}$$

$$^\circ\text{C} = (5/9) (^\circ\text{F} - 32)$$

$$^\circ\text{C} = \text{K} - 273.15$$

$$1 \text{ atm} = 1.013 \text{ bar}$$

$$1 \text{ L}\cdot\text{atm} = 101.3 \text{ J}$$

$$1 \text{ J} = 1 \text{ kg}\cdot\text{m}^2/\text{s}^2$$

$$^\circ\text{F} = (9/5)(^\circ\text{C}) + 32$$

$$\text{K} = ^\circ\text{C} + 273.15$$

$$pV = nRT$$

$$p_A = X_A p_A^\circ$$

$$\Delta T_b = K_b m_B$$

$$H = U + pV$$

$$[B] = k p_B$$

$$\Delta T_f = K_f m_B$$

$$G = H - TS$$

$$\Delta p_A = X_B p_A^\circ$$

$$\Pi = [B]RT$$

**GENERAL CHEMISTRY 2  
FIRST EXAM**

**Name** \_\_\_\_\_

**Panthersoft ID** \_\_\_\_\_

**Signature** \_\_\_\_\_

**Part 1** \_\_\_\_\_ (20 points)

**Part 2** \_\_\_\_\_ (30 points)

**Part 3** \_\_\_\_\_ (30 points)

**TOTAL** \_\_\_\_\_ (80 points)

**Do all of the following problems. Show your work.**

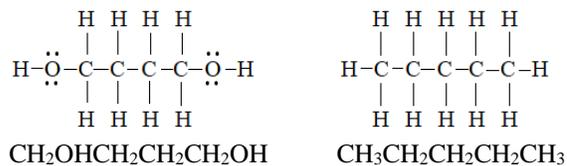
**Part 1. Multiple choice.** Circle the letter corresponding to the correct answer. There is one and only one correct answer per problem. [4 points each]

- 1) Which of the following statements concerning the thermodynamics of solution formation is correct?
  - a)  $\Delta S_{\text{soln}}$  is usually much less than zero
  - b)  $\Delta S_{\text{soln}}$  is usually much greater than zero
  - c)  $\Delta S_{\text{soln}}$  is usually about equal to zero
  - d) Both a and c
  - e) Both b and c
  
- 2) Which of the following aqueous solutions of strong electrolytes is expected to have the highest boiling point?
  - a) A 0.0100 mole/kg solution of potassium nitrate ( $\text{KNO}_3$ )
  - b) A 0.0100 mole/kg solution of iron(III) chloride ( $\text{FeCl}_3$ )
  - c) A 0.0100 mole/kg solution of sodium sulfate ( $\text{Na}_2\text{SO}_4$ )
  - d) A 0.0200 mole/kg solution of calcium bromide ( $\text{CaBr}_2$ )
  - e) A 0.0200 mole/kg solution of sodium bromate ( $\text{NaBrO}_3$ )
  
- 3) A perfect crystal of which of the following pure substances will have  $S^\circ = 0.0 \text{ J/mol}\cdot\text{K}$  at  $T = 0. \text{ K}$ ?
  - a) Fe (iron)
  - b)  $\text{I}_2$  (iodine)
  - c) ZnO (zinc II oxide)
  - d) Both a and b
  - e) Both a and b and c
  
- 4) For which of the following chemical reactions would you expect  $\Delta S^\circ_{\text{rxn}}$  to be positive at  $T = 25. \text{ }^\circ\text{C}$ ?
  - a)  $3 \text{ O}_2(\text{g}) \rightarrow 2 \text{ O}_3(\text{g})$
  - b)  $\text{C}_3\text{H}_8(\text{g}) + 5 \text{ O}_2(\text{g}) \rightarrow 3 \text{ CO}_2(\text{g}) + 4 \text{ H}_2\text{O}(\ell)$
  - c)  $\text{CaCO}_3(\text{s}) \rightarrow \text{CaO}(\text{s}) + \text{CO}_2(\text{g})$
  - d) Both b and c
  - e) None of the above
  
- 5) Which of the following substances should have the largest value for  $S^\circ$  (standard molar entropy) at  $T = 25. \text{ }^\circ\text{C}$ ?
  - a)  $\text{N}_2(\text{g})$
  - b)  $\text{O}_2(\text{g})$
  - c)  $\text{NO}(\text{g})$
  - d)  $\text{Zn}(\text{s})$
  - e)  $\text{ZnO}(\text{s})$

**Part 2. Short answer questions.**

- 1) A solution is prepared by dissolving 4.183 g of copper II chloride ( $\text{CuCl}_2$ ,  $\text{MW} = 134.45 \text{ g/mole}$ ) in water. The final volume of the solution is  $V = 250.0 \text{ mL}$ . What is the molarity of copper II chloride in the solution? [6 points]

2) 1,4-butanediol ( $\text{CH}_2\text{OHCH}_2\text{CH}_2\text{CH}_2\text{OH}$ ) and n-pentane ( $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$ ) are both liquids at room temperature and pressure. Which of these molecules would you expect to be miscible with water? Why? Note that the Lewis structures of both molecules are shown below. [6 points]



3) A solution is formed by dissolving a 2.482 g of a nonvolatile solid in liquid benzene ( $\text{C}_6\text{H}_6$ , MW = 78.11 g/mol). The volume of the solution is  $V = 50.0$  mL. The osmotic pressure of the solution relative to pure benzene, measured at  $T = 25.0$  °C, was  $\Pi = 483$ . torr. What is the molecular weight of the nonvolatile solid? [10 points]

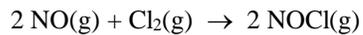
4) Give the formation reaction for sodium nitrate ( $\text{NaNO}_3(\text{s})$ ). [4 points]

5) What is the difference, if any, between a solution and a colloid? [4 points]

### Part 3. Problems

1) A solution of potassium chloride (KCl, MW = 74.55 g/mol) and water (H<sub>2</sub>O, MW = 18.02 g/mol) has a density  $D = 1.078$  g/mL. The mole fraction of potassium chloride in the solution is  $X_{\text{KCl}} = 0.0317$ . What is the molarity of potassium chloride in the solution? [14 points]

2) Consider the following chemical reaction



a) Find the numerical values for  $\Delta G^\circ_{\text{rxn}}$  and  $\Delta S^\circ_{\text{rxn}}$  for the reaction at  $T = 298. \text{ K}$ . Thermochemical data at this temperature are given below and may be of use in doing this problem. [12 points]

Substance	$\Delta H^\circ_f(\text{kJ/mol})$	$\Delta G^\circ_f(\text{kJ/mol})$	$S^\circ(\text{J/mol}\cdot\text{K})$
$\text{Cl}_2(\text{g})$	0.00	0.00	222.96
$\text{NO}(\text{g})$	90.25	86.57	210.65
$\text{NOCl}(\text{g})$	51.71	66.07	261.6

b) Is the above reaction spontaneous for standard conditions and  $T = 298. \text{ K}$  (yes/no/cannot tell)? Briefly justify your answer. [4 points]