

**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]

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

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

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

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

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

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

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

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

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

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

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

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

$$pV = nRT$$

$$p_A = X_A p_A^\circ$$

$$\Delta T_b = K_b m_B$$

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

$$H = E + pV$$

$$\Delta G_{\text{rxn}} = \Delta G^\circ_{\text{rxn}} + RT \ln Q$$

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

$$[B] = k p_B$$

$$\Delta T_f = K_f m_B$$

$$G = H - TS$$

$$\ln K = - \Delta G^\circ_{\text{rxn}}/RT$$

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

$$\Pi = [B]RT$$

**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)

**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) 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
- water is the solvent in the above solution
  - glucose is the solvent in the above solution
  - isopropyl alcohol is the solvent in the above solution
  - both glucose and isopropyl alcohol are solvents in the above solution
  - 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?
- The normal boiling point of the solution is higher than the normal boiling point of pure benzene
  - The normal boiling point of the solution is lower than the normal boiling point of pure benzene
  - The normal freezing point of the solution is higher than the normal freezing point of pure benzene
  - Both a and c
  - Both b and c
- 3) For a chemical reaction to be spontaneous which of the following must be true?
- $\Delta S_{\text{sys}} > 0$
  - $\Delta S_{\text{surr}} > 0$
  - $\Delta S_{\text{univ}} > 0$
  - Both a and b
  - Both a and b and c
- 4) For 1.000 mol of which of the following substances will  $S^\circ$ , the absolute entropy, be exactly zero at  $T = 25.^\circ\text{C}$ ?
- Cu(s)
  - O<sub>2</sub>(g)
  - O<sub>3</sub>(g)
  - Both a and b
  - None of the above
- 5) 1.000 mol of which of the following substances has the largest value for  $S^\circ$  at  $T = 25.^\circ\text{C}$ ?
- CH<sub>3</sub>OH(l)
  - CH<sub>3</sub>CH<sub>2</sub>CH<sub>2</sub>OH(l)
  - CH<sub>3</sub>OH(g)
  - CH<sub>3</sub>CH<sub>2</sub>CH<sub>2</sub>OH(g)
  - All of the above substances have the same value for  $S^\circ$  at  $T = 25.^\circ\text{C}$ .
- 6) The numerical value for the equilibrium constant for the reaction  $\text{A}_2(\text{g}) + 2 \text{B}(\text{g}) \rightleftharpoons 2 \text{AB}(\text{g})$  is  $K_C = 25$ . The numerical value for the equilibrium constant for the reaction  $\text{AB}(\text{g}) \rightleftharpoons \frac{1}{2} \text{A}_2(\text{g}) + \text{B}(\text{g})$ , measured at the same temperature, is
- $K_C = 0.040$
  - $K_C = 0.20$
  - $K_C = 5.0$
  - $K_C = 25$ .
  - 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 ( $\text{C}_6\text{H}_5\text{Cl}(\ell)$ ).

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 ( $\text{H}_2\text{O}$ , MW = 18.0 g/mol). What is the freezing point for the solution? Note that  $K_f = 1.86 \text{ kg}\cdot^\circ\text{C}/\text{mol}$ , and that the normal freezing point for pure water is  $T_f = 0.00 \text{ }^\circ\text{C}$ . [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  $\text{Cl}_2$ ,  $\text{NO}$ , and  $\text{NOCl}$  will achieve equilibrium. The process that takes place is



At  $T = 500. \text{ K}$ , the partial pressures of gas present at equilibrium are  $p(\text{Cl}_2) = 0.608 \text{ atm}$ ,  $p(\text{NO}) = 0.240 \text{ atm}$ , and  $p(\text{NOCl}) = 1.36 \text{ atm}$ .

a) What is the numerical value for  $K_p$  for the above reaction at  $T = 500. \text{ K}$ ? [5 points]

b) What is the numerical value for  $K_C$  for the above reaction at  $T = 500. \text{ K}$ ? [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  $\text{Cl}_2$  in the system. In all cases temperature is held constant at  $T = 500. \text{ K}$ . [4 points each]

Add 0.20 moles of  $\text{NOCl}$  to the system under conditions of constant volume

moles of  $\text{Cl}_2$   
will increase

moles of  $\text{Cl}_2$   
will remain constant

moles of  $\text{Cl}_2$   
will decrease

Double the volume of the system

moles of  $\text{Cl}_2$   
will increase

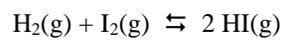
moles of  $\text{Cl}_2$   
will remain constant

moles of  $\text{Cl}_2$   
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<sub>2</sub>O, 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



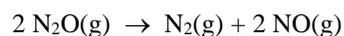
is  $K_C = 57.0$  at  $T = 700. \text{ K}$ .

The initial concentration of  $\text{H}_2$  and  $\text{I}_2$  in a system at  $T = 700. \text{ K}$  are  $[\text{H}_2] = 0.2000 \text{ mol/L}$  and  $[\text{I}_2] = 0.1000 \text{ mol/L}$ . No  $\text{HI}$  is initially present in the system. What are the concentrations of  $\text{H}_2$ ,  $\text{I}_2$ , and  $\text{HI}$  that are present when the system reaches equilibrium? [16 points]

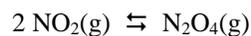
3) Thermodynamic data are given below and may be of use in doing some parts of this problem.

Substance	$\Delta H^\circ_f$ (kJ/mol)	$\Delta G^\circ_f$ (kJ/mol)	$S^\circ$ (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  $\Delta H^\circ_{rxn}$  and  $\Delta S^\circ_{rxn}$  for the process [8 points]



b) The free energy change for the reaction



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