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]

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

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

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

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

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

$H = E + pV$ | $G = H - TS$

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

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

$K_a \cdot K_b = K_w = 1.0 \times 10^{-14}$ (at T = 25°C)

GENERAL CHEMISTRY 2
SECOND HOUR EXAM (Sample)

Name _____

Panthersoft ID _____

Signature _____

Part 1 _____ **(24 points)**

Part 2 _____ **(50 points)**

Part 3 _____ **(26 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) 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

2) Consider the following chemical reaction.

$$PCl_5(g) \leftrightarrows PCl_3(g) + Cl_2(g)$$

A system containing PCl_3, PCl_5, and Cl_2 at a fixed temperature is initially at equilibrium. Which of the following changes will lead to an increase in the number of moles of PCl_3 in the system?

a) Addition of 0.100 moles of Cl_2 into the system
b) Addition of 0.100 moles of PCl_5 into the system
c) Decreasing the volume of the system by 2.00 L
d) Both a and c
e) Both b and c

3) A Bronsted base is

a) a proton acceptor
b) a proton donor
c) an electron pair acceptor
d) an electron pair donor
e) any ionic compound that will dissolve in water

4) Ammonium perchlorate (NH_4ClO_4) is a soluble salt formed by the reaction of a strong acid with a weak base. The pH of a 0.100 M solution of ammonium perchlorate, measured at T = 25. °C, is expected to be

a) exactly equal to 7.0
b) approximately equal to 7.0
c) significantly larger than 7.0
d) significantly smaller than 7.0
e) undefined, because the concept of pH does not apply to solutions of salts

5) Hypoiodous acid (HOI) is a weak acid, with $K_a = 3.5 \times 10^{-8}$ (at T = 25. °C). OI^- ion is

a) a weak acid
b) a strong acid
c) a weak base
d) a strong base
e) None of the above, as ions have no acid or base properties

6) Which of the following is the strongest oxyacid?

a) HIO_2
b) HIO_3
c) HBrO
d) $HBrO_2$
e) $HBrO_3$

Part 2. Short answer.

1) 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. [8 points]

2) 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]

3) The pH of an aqueous solution is pH = 8.82 at T = 25 °C. Find $[H_3O^+]$, $[OH^-]$, and the pOH for the solution. [8 points]

4) Answer each of the following questions by filling in the blank. [4 points each]

a) The <u>conjugate base</u> of HCO_3^-. _____

b) The value for K_b for NO_2^-., at T = 25. °C _____
(Note $K_a = 4.5 \times 10^{-4}$ for HNO_2 at T = 25. °C)

c) The pH of pure water at T = 50.°C. _____
(Note $K_w = 5.5 \times 10^{-14}$ at T = 50.°C)

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

The weakest acid

HI HBr HCl HF

A strong soluble base

AgOH $Cu(OH)_2$ $Ba(OH)_2$ $Fe(OH)_3$

An example of a polyprotic acid

HBr HF HNO_2 H_2SO_4

Part 3. Problems.

1) 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]

2) A chemist prepares 500.0 mL of a 0.0200 M aqueous solution of hypochlorous acid (HOCl, $K_a = 3.5 \times 10^{-8}$). What is the pH of the above solution? [10 points]