CHEM 220 - Exam 2 - Spring 2011
Answer Section

MULTIPLE CHOICE

1.	ANS: C	PTS: 1
2.	ANS: E	PTS: 1
3.	ANS: D	PTS: 1
4.	ANS: B	PTS: 1
5.	ANS: E	PTS: 1
6.	ANS: F	PTS: 1
7.	ANS: E	PTS: 1
8.	ANS: C	PTS: 1
9.	ANS: C	PTS: 1

Chemistry 220 • Spring 2011 • Exam #2 Name: Key Section:______

FREE RESPONSE: (16 points each)

- ***Please answer 4 of the following 5 questions. Cross-out the one you DO NOT want graded, or the first 4 will be graded.***
- No answer requires a quadratic solution. You MAY NOT use your calculator to solve quadratic, cubic, or higher order equations – apply appropriate approximations when needed.
- Assume ideal gas behavior.
- Watch significant figures. You must show all work and units!

1. Determine the **pH** and the **[OH⁻]** of a 0.40 *M* bromic acid ($HBrO_3$) solution.

$$HBrO_3 \rightleftharpoons H^+ + BrO_3^-$$

eq: $\approx 0.40\,M$, x, x

$$K_a = 3.4\times10^{-5} = \frac{x^2}{0.4}$$

$$x = 3.\bar{6}88\times10^{-3}$$

$$\boxed{pH = 2.43} \quad (2.433)$$

$$pOH = 11.5\bar{6}7 \longrightarrow [OH^-] = 10^{-11.567} = \boxed{[OH^-] = 2.7\times10^{-12}\,M}$$

2. At 75°C, 50.0 g of solid phosphorus (excess) is placed in a 4.00-L container with 1.00 mol chlorine gas and no diphosphorus dichloride. The reaction below is allowed to reach equilibrium. Determine the equilibrium concentrations of all gas species. K_C = 36.0 at 75°C.

$$\frac{1\,mol}{4\,L} = 0.250\,M$$

	$P_{4(s)}$	+	$2\,Cl_{2(g)}$	⇔	$2\,P_2Cl_{2(g)}$
i	excess		0.250 M		∅
c	−(x)		−2x		+2x
e	excess		0.250−2x		2x

$$\sqrt{K_c = 36 = \frac{(2x)^2}{(0.25-2x)^2}}$$

$$6 = \frac{2x}{0.25-2x}$$

$$1.5 - 12x = 2x$$

$$x = 0.107\,M$$

$$\boxed{[Cl_2] = 0.036\,M \qquad [P_2Cl_2] = 0.214\,M}$$

3. A fixed container holds the gases below at the following initial pressures:

Pressure of P_2O_4 = 0.60 atm *Pressure of O_2 = 0.50 atm* *Pressure of P_2O_5 = 0.40 atm*

What are the equilibrium pressures of all species if $K_P = 2.0 \times 10^4$.

	LR		excess		
	$2\ P_2O_{4(g)}$	+	$O_{2(g)}$	⇔	$2\ P_2O_{5(g)}$
Start	0.6		0.5		0.4
ASSUME 100% →	−0.6		−0.3		+0.6
N.I.	∅		0.2		1.00
C	+2x		+x		−2x
E	2x		0.2+x ≈ 0.2		1−2x ≈ 1

$P_{P_2O_4}$ = 0.016 atm | P_{O_2} = 0.21 atm | $P_{P_2O_5}$ = 0.98 atm

$$2.0\times10^4 = \frac{1^2}{(2x)^2(0.2)}$$

$x = 7.91 \times 10^{-3}$

$2x = 0.0158$

4. The initial pressure of N_2O_4 in the system below is 9.00 atm with no products present. At equilibrium, the total pressure in the system is 16.5 atm. What is K_P for the reaction.

	$2\ N_2O_{4(g)}$	⇔	$2\ N_2O_{(g)}$	+	$3\ O_{2(g)}$
i	9 atm		∅		∅
c	−2x		+2x		+3x
e	9−2x = 4.00		2x = 5.00		3x = 7.50

$P_{TOTAL} = 16.5 = (9-2x) + (2x) + (3x)$

$16.5 = 9 + 3x$

$x = 2.50 \Rightarrow 2x = 5 \Rightarrow 3x = 7.5$

$$K_p = \frac{(7.50)^3(5.00)^2}{(4.00)^2} = \boxed{659}\ atm^3$$

5. The reaction below was studied at 350 K. A mixture of gases initially contained the reactants at the following concentrations: $[H_2] = [CO] = 0.80\ M$ with no products present. At equilibrium, $[CH_4]$ was found to be 0.20 M. What is the value of K_C for this reaction?

$$3\,H_{2(g)} + CO_{(g)} \Leftrightarrow CH_{4(g)} + H_2O_{(g)}$$

	$3\,H_{2(g)}$	$CO_{(g)}$	$CH_{4(g)}$	$H_2O_{(g)}$
i	0.80 M	0.80 M	Ø	Ø
c	−0.6	−0.2	+0.2	+0.2
e	0.20 M	0.60 M	0.20 M	0.20 M

$$K_c = \frac{(0.20)^2}{(0.20)^3(0.60)} = \boxed{8.3 = K_c}$$