

CHEM 220 - Exam 2 - Spring 2011
Answer Section

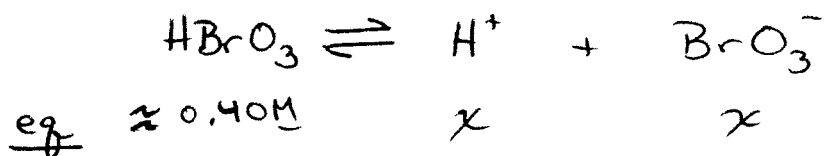
MULTIPLE CHOICE

- | | |
|-----------|--------|
| 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 |

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 $[\text{OH}^-]$ of a 0.40 M bromic acid (HBrO_3) solution.



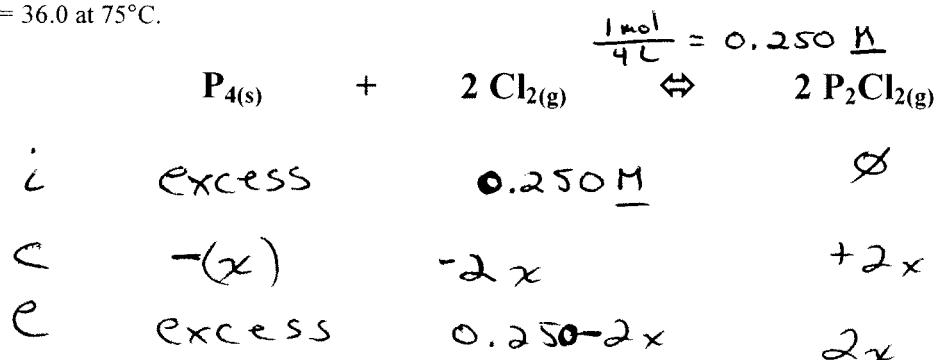
$$K_a = 3.4 \times 10^{-5} = \frac{x^2}{0.4}$$

$$x = 3.688 \times 10^{-3}$$

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

$$\text{pOH} = 11.567 \rightarrow [\text{OH}^-] = 10^{-11.567} = \boxed{2.7 \times 10^{-12} \text{ M}}$$

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.



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

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

$$1.5 - 12x = 2x$$

$$x = 0.107 \text{ M}$$

$$[\text{Cl}_2] = 0.036 \text{ M}$$

$$[\text{P}_2\text{Cl}_2] = 0.214 \text{ M}$$

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

Pressure of $P_2O_4 = 0.60 \text{ atm}$

Pressure of $O_2 = 0.50 \text{ atm}$

Pressure of $P_2O_5 = 0.40 \text{ atm}$

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

What are the equilibrium pressures of all species if $K_p = 2.0 \times 10^{-4}$.

	<u>LR</u>		<u>excess</u>		
	$2 P_2O_{4(g)}$	+	$O_{2(g)}$	\rightleftharpoons	$2 P_2O_{5(g)}$
Start	0.6		0.5		0.4
Assume 100% \rightarrow	<u>-0.6</u>		<u>-0.3</u>		<u>+0.6</u>
N.I.	\emptyset		0.2		1.00
C	$+2x$		$+x$		$-2x$
E	$2x$		$0.2+x$ ≈ 0.2		$1-2x$ ≈ 1

$$2.0 \times 10^4 = \frac{1^2}{(2x)^2(0.2)}$$

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

$$2x = 0.0158$$

$$P_{P_2O_4} = 0.016 \text{ atm}$$

$$P_{O_2} = 0.21 \text{ atm}$$

$$P_{P_2O_5} = 0.98 \text{ atm}$$

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.

	$2 N_2O_{4(g)}$	\rightleftharpoons	$2 N_2O_{(g)}$	+	$3 O_{2(g)}$
i	9 atm		\emptyset		\emptyset
c	$-2x$		$+2x$		$+3x$
e	$9-2x$ $= 4.00$		$2x$ $= 5.00$		$3x$ $= 7.50$

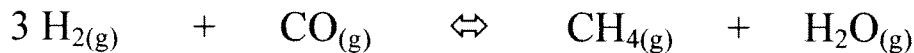
$$P_{TOTAL} = 16.5 = (9 - 2x) + (2x) + (3x)$$

$$16.5 = 9 + 3x$$

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

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

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?



i	<u>0.80 M</u>	<u>0.80 M</u>	0	0
c	-0.6	-0.2	+0.2	+0.2
e	<u>0.20 M</u>	<u>0.60 M</u>	<u>0.20 M</u>	<u>0.20 M</u>

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