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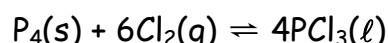
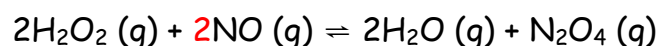
CHM 2046

Quiz 1A

Spring, 2017

Answer all questions. Give your final answer with correct units, if any, and to the correct sig. figs. Useful Information: $0\text{ }^{\circ}\text{C} \approx 273\text{ K}$, $R = 0.0820\text{ L}\cdot\text{atm}/\text{mol}\cdot\text{K}$

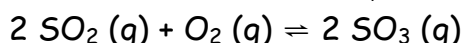
- 1) a) (3 points each) For the following equilibria, write down their mass-action expression, Q_c



$$Q_c = \frac{[\text{N}_2\text{O}_4][\text{H}_2\text{O}]^2}{[\text{NO}]^2[\text{H}_2\text{O}_2]^2}$$

$$Q_c = 1/[\text{Cl}_2]^6$$

- b) (5 points) At a particular temperature, $K_p = 313$ for the reaction



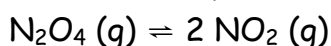
In a particular reaction carried out, the pressures of the gases at a particular time are 0.12 atm (atmospheres) of SO_2 , 1.2 atm of O_2 , and 2.2 atm of SO_3 . Has the reaction reached equilibrium yet? Explain.

$$Q_p = \frac{p(\text{SO}_3)^2}{p(\text{SO}_2)^2 p(\text{O}_2)} = \frac{(2.2)^2}{(0.12)^2 (1.2)} = 280 \quad \therefore Q_p \neq K_p \quad \therefore \text{not at equilibrium}$$

If not, in which direction is it proceeding? Explain.

$$Q_p < K_p \quad \therefore \text{reaction proceeding to the right.}$$

- c) (4 points) $\text{N}_2\text{O}_4(\text{g})$ was introduced into a 2.00 L flask and allowed to reach equilibrium at $80\text{ }^{\circ}\text{C}$. At equilibrium, the flask contained 0.48 mol

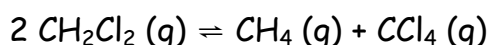


of N_2O_4 and 0.38 mol of NO_2 . What is K_c for this reaction at $80\text{ }^{\circ}\text{C}$?

$$K_c = \frac{[\text{NO}_2]^2}{[\text{N}_2\text{O}_4]} = \frac{(0.19)^2}{0.24} = 0.15$$

- 2). (6 points total)

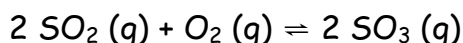
- a) At 350 K, the reaction below has $K_c = 1.05$. What is K_p at 350 K?



$$K_p = K_c$$

$$K_p = 1.05$$

- b) At 300 K, the reaction below has $K_c = 279$. What is K_p at 300 K?



$\Delta n = -1$ therefore

$$K_p = \frac{K_c}{RT} = \frac{279}{(0.082)(300)} = 11.3$$

$$K_p = 11.3$$

- c) At 300 K, what is K_c for the reaction below?



This is the reaction of part b) reversed and multiplied by 2

$$\therefore \text{new } K_c = \frac{1}{K_c^2} = \frac{1}{279^2} = 0.0000128 = 1.28 \times 10^{-5}$$



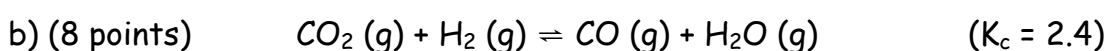
A 2.00 L flask is filled with 0.300 mol of HBr and allowed to reach equilibrium at a particular temperature. At equilibrium, $[\text{HBr}] = 0.104 \text{ M}$. Calculate K_c at this temperature.

	2HBr	\rightleftharpoons	H_2	$+$	Br_2	
I	0.150 M		0		0	
C	-2x		+x		+x	
E	(0.150-2x)		x		x	

$(0.150-2x) = 0.104$
 $\therefore x = 0.023$

$$K_c = \frac{[\text{H}_2][\text{Br}_2]}{[\text{HBr}]^2} = \frac{x^2}{(0.15-2x)^2} = \frac{(0.023)^2}{(0.104)^2}$$

$\therefore K_c = 4.89 \times 10^{-2}$



0.500 mol each of CO_2 and H_2 are placed in a 10.0 L flask and allowed to reach equilibrium at some temperature. Calculate the equilibrium concentrations of all species.

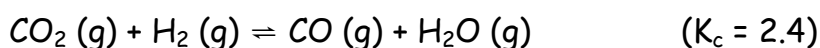
	CO_2	$+$	H_2	\rightleftharpoons	CO	$+$	H_2O
I	0.0500		0.0500		0		0
C	-x		-x		+x		+x
E	(0.0500-x)		(0.0500-x)		x		x

$$K_c = 2.4 = \frac{x^2}{(0.0500-x)^2} \quad \therefore \pm 1.549 = \frac{x}{0.0500-x} \quad \therefore x = 0.030$$

$$\pm 1.549x + 0.077 = x \quad \therefore [\text{CO}_2] = [\text{H}_2] = 0.020$$

$$\therefore 2.549x = 0.077 \quad [\text{CO}] = [\text{H}_2\text{O}] = 0.030$$

5. (14 points) Consider the reaction in Question 4b again.



This time 0.500 mol of CO_2 and 1.00 mol of H_2 are placed in a 10.0 L flask and allowed to reach equilibrium at some temperature. Calculate the equilibrium concentrations of all species.

	CO_2	$+$	H_2	\rightleftharpoons	CO	$+$	H_2O
I	0.0500		0.100		0		0
C	-x		-x		+x		+x
E	(0.0500-x)		(0.100-x)		x		x

$$K_c = 2.4 = \frac{x^2}{(0.0500-x)(0.100-x)} = \frac{x^2}{(0.005-0.15x+x^2)} = 2.4$$

$$\therefore 2.4x^2 - 0.36x + 0.012 = x^2$$

$$\therefore 1.4x^2 - 0.36x + 0.012 = 0$$

$$x = \frac{0.36 \pm \sqrt{0.1296 - 4(1.4)(0.012)}}{2.8} = \frac{0.36 \pm \sqrt{0.0624}}{2.8}$$

$$x = \frac{0.36 \pm 0.250}{2.8} = 0.039 \text{ or } 0.218$$

We choose $x = 0.039$

$\therefore [\text{CO}_2] = 0.011\text{M}$
 $[\text{H}_2] = 0.061\text{M}$
 $[\text{CO}] = [\text{H}_2\text{O}] = 0.039\text{M}$