Chemistry 116 - Fall 2021
Dr. Audrey Dell Hammerich
10 - Week of October 24
Chemical Equilibrium I

NOTE: Monday, October 25 is the second midterm exam covering everything since the first exam: Chapters 13, 5, 16.1-16.2, 16.10-16.11, and 17 (sections omitted appear on lecture slides).

NOTE: Since the end of this week is the last time that you are able to drop the course, we intend to grade the exam on Tuesday, and have grade estimates on Blackboard for Wednesday. All grades in the course, the curve, and what the grade estimates mean will be gone over on Wednesday during lecture.

NOTE: Remember that this week has no scheduled lab periods. Instead the normal lab periods are to be used to make-up any past lab.

LAB ASSIGNMENT: No scheduled labs. Lab period used for lab make-up.

LECTURE ASSIGNMENT: Online OWL assigned homework due on Monday, November 1 at noon except "W" problems are due Friday, October 29 at noon.

Monday, October 25

Exam II

Wednesday, October 27

Reading Assignment: Z Ch 6.1 - 6.5, H 8-2 [know how to write and calculate an **equilibrium constant** for a given reaction including **heterogeneous equilibria**; understand the **law of mass action**; know what happens to an equilibrium constant if you multiply the reaction by a factor n, write the reaction in reverse, add reactions together; be able to convert between K and K_P for a gas phase reaction]

Friday, October 29

Reading Assignment: Z Ch 6.4, 6.6 - 6-7, 6.9, H 8-2 [know what a reaction quotient is and how to use it; be able to solve equilibrium problems - when to use the **quadratic formula**, how to treat a system which has a small equilibrium constant; be able to properly write equilibrium constants using **activities**]

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Discussion Worksheet - Week 10

1. The reaction for the formation or breakdown of ammonia can be written

a) $N_2 + 3H_2$ <=> $2\ NH_3$ b) $1/2\ N_2 + 3/2\ H_2$ <=> NH_3

c) $1/3\ N_2 + H_2$ <=> $2/3\ NH_3$ d) NH_3 <=> $1/2\ N_2 + 3/2\ H_2$

e) Write the equilibrium constant expression for each of the above gas phase reactions.

f) Determine the numerical value of K for reaction a) if at 472°C and a total pressure of 10.0 atm the equilibrium mixture of gases consists of 24.58 mol percent N_2 and 73.76 mol percent H_2. [$K_P = 2.79 \times 10^{-5}$]

2. What is the value of K for the following reaction if an equilibrium mixture contains 1.0 mol Fe, 1.0×10^{-3} mol O_2, and 2.0 mol Fe_2O_3 in a 2.0-L container? [8.0×10^{9}]

$4\ Fe(s) + 3O_2(g)$ <=> $2\ Fe_2O_3(s)$

3. If the equilibrium mixture for the following reaction contains 0.500 atm CO, 0.500 atm H_2O, and 1.00 atm CO_2, what is the partial pressure of H_2 when $K_p = 1.845$? [0.461 atm]

$CO(g) + H_2O(g)$ <=> $CO_2(g) + H_2(g)$

4. Determine the equilibrium concentration of HI for the following reaction when the equilibrium concentrations of H_2 and I_2 are both 0.0010 mol/L and $K = 55.6$. [0.0075 mol/L]

$H_2(g) + I_2(g)$ <=> $2\ HI(g)$

5. Determine the equilibrium pressure of NO_2 if the equilibrium pressure of N_2O_4 is 2.71 atm at a temperature where $K_p = 0.133$ for: [0.600 atm]

$N_2O_4(g)$ <=> $2\ NO_2(g)$

6. From the following 427°C equilibrium constants

1) $Na_2O(s)$ <=> $2\ Na(l) + ½\ O_2(g)$ $K_1 = 2 \times 10^{-25}$
2) $NaO(g)$ <=> $Na(l) + ½\ O_2(g)$ $K_2 = 2 \times 10^{-5}$
3) $Na_2O_2(s)$ <=> $2\ Na(l) + O_2(g)$ $K_3 = 5 \times 10^{-29}$
4) $NaO_2(s)$ <=> $Na(l) + O_2(g)$ $K_4 = 3 \times 10^{-14}$

determine the values of the equilibrium constants (K_p) for the following:

a) $Na_2O(s) + ½\ O_2(g)$ <=> $Na_2O_2(s)$ [4000]
b) $NaO(g) + Na_2O(s)$ <=> $Na_2O_2(s) + Na(l)$ [0.08]
c) $2\ NaO(g)$ <=> $Na_2O_2(s)$ [8×10^{18}]

7. Complete the following table of changes.

	$4\ NH_3(g)$	+	$7\ O_2(g)$	<=>	$4\ NO_2(g)$	+	$6\ H_2O(g)$
Initial	0.30 atm		0.70 atm		0		0
Change							
Equilibrium							

8. Solid molybdenum is placed in contact with gaseous CH_4 at a pressure of 0.68 atm in a sealed empty reaction vessel at 300 K. After equilibrium is reached the total pressure in the container is 1.13 atm.

$$2\ Mo(s) \quad + \quad CH_4(g) \quad <=> \quad Mo_2C(s) \quad + \quad 2\ H_2(g)$$

a) What is the equilibrium pressure of H_2? [0.90 atm]

b) Write the expression for K_P.

c) Determine the numerical value of K_c. [0.14]

9. Determine K_p if the initial partial pressures are: $P_{NO} = 0.70$ and $P_{O_2} = 0.55$ atm and, when equilibrium has been reached, $P_{NO_2} = 0.20$ atm for: [0.36]

$$2\ NO(g) \ + \ O_2(g) \quad <=> \quad 2\ NO_2(g)$$

10. The following reaction was run in a 3.00 L vessel at a temperature where $K = 115$:

$$H_2(g) \ + \ F_2(g) \quad <=> \quad 2\ HF(g)$$

a) If 6.00 mol of all three components were initially added what are their equilibrium concentrations?
$[H_2] = [F_2] = 0.47$ M, $[HF] = 5.06$ M

b) If 3.00 mol of H_2 and 6.00 mol of F_2 were initially added what are all the equilibrium concentrations?
$[H_2] = 0.03$ M, $[F_2] = 1.03$ M, $[HF] = 1.94$ M