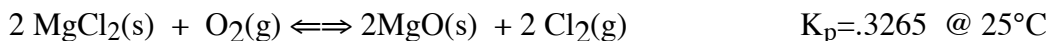


This is a sample Midterm #2 (longer than one midterm) that I (Rolf Unterleitner) have made up for Dr. Kelly's +Dr. Toup. sections of chem 2B. The answers are on the last page I'll go over the solutions on **Wedn. the 14th in 3216 Dutton 7:00-???(likely 2hours)**. Please do not ask your Prof. or the TA's for the solutions they do not have them thank you.

Part I

1) Calculate K_p for $\text{MgCl}_2(\text{s}) + \text{MgO}(\text{s}) \rightleftharpoons 2 \text{Mg}(\text{s}) + 1/2\text{O}_2(\text{g}) + \text{Cl}_2(\text{g}) @ 25^\circ\text{C}$

given the reactions below:

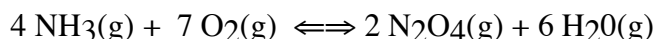


- a) 5.69×10^{89}
- b) .3265
- c) 1.00×10^{-90}
- d) -5.69×10^{89}
- e) 2.46×10^{-10}

2) Which of the following is false:

- a) At equilibrium the concentrations of all the solutions and gases remain constant.
- b) If the the temperature of an endothermic is increased the value of K would increase.
- c) If the amounts of the products are doubled the reaction will either not change or shift to the left.
- d) The pressure of the reactants is increased the value of K would also increase.
- e) If the moles of gas are the same for both the products and the reactants and there are no aqueous compounds then $K_p=K_c$.

3) Given the following reaction:



If the initial pressures for $\text{N}_2\text{O}_4(\text{g})$ and $\text{H}_2\text{O}(\text{g})$ are 1.00 atm and the equilibrium pressure of $\text{H}_2\text{O}(\text{g})$ is 0.125 atm then the value of K_p for the reaction is.

- a) 1.43×10^{-5}
- b) 3.11×10^{-9}
- c) 8.64×10^{-3}
- d) 5.89×10^{-10}
- e) 3.53×10^7

4) Which of the following would have the weakest conjugate weak base?

- a) HIO_2
- b) HIO_3
- c) HBrO_2
- d) HBrO_3
- e) H_2SO_3

- 5) Consider the following reaction:



If the equilibrium concentrations of $[\text{CO}_2]=0.086\text{M}$ and $[\text{H}_2\text{O}]=0.040\text{M}$ then what is the equilibrium concentration hydrogen gas is.

- a) 2.07
- b) 0.171
- c) 0.413
- d) 4.27
- e) 2.42

- 6) Which of the following is correct for the following reaction if the initial pressures are as follows $\text{CH}_4=2 \text{ atm}$, $\text{H}_2\text{O}=2 \text{ atm}$, $\text{CO}=2 \text{ atm}$ and $\text{H}_2=4 \text{ atm}$. (Q is the same ratio as k (products over reactants raised to the coef.) but using the initial values)



- a) The reaction favors the products and shifts to the products to get to equilibrium.
- b) The reaction favors the reactants and shifts to the products to get to equilibrium.
- c) The reaction favors the reactants and shifts to the reactants to get to equilibrium.
- d) The reaction favors the products and is at equilibrium.
- e) The reaction favors the products and shifts to the reactants to get to equilibrium.

- 7) Calculate the value of K_b and the pH if the percent protonation of the NH_2NH_2 in a 0.20 M solution is found to be 0.291 %.

- a) $K_b= .941$, $\text{pH}=13.70$
- b) $K_b=5.9 \times 10^{-5}$, $\text{pH}=10.76$
- c) $K_b= 1.7 \times 10^{-6}$, $\text{pH}=10.76$
- d) $K_b= 1.7 \times 10^{-5}$, $\text{pH}=3.24$
- e) $K_b= 5.75 \times 10^{-4}$, $\text{pH}=10.76$

- 8) Which of the following indicator(s) would most likely be suitable for the titration NH_3 with HCl.

- a) Bromothymol blue ($\text{p}K_{\text{in}}=7.1$)
- b) Thymol blue ($\text{p}K_{\text{in}}=1.7$)
- c) Bromophenol blue ($\text{p}K_{\text{in}}=3.9$)
- d) Alizarin yellow ($\text{p}K_{\text{in}}=11.2$)
- e) Methyl Orange ($\text{p}K_{\text{in}}=3.4$)

- 9) The pH of a $4.0 \times 10^{-8} \text{ M}$ HCl(aq) at 25°C is.

- a) 7.00
- b) 7.40
- c) 7.09
- d) 6.91
- e) 7.12

10) Calculate the pH after 75.0 mL of 0.400 M HBr(aq) is mixed with 75.0 mL of 0.400 M Ba(OH)₂(aq).

- a) 7.00 b) 13.30 c) 0.70 d) 14.00 e) 8.97

11) If you had a 0.10 M solution of each one of the following acids which one would be the most acidic? H₃PO₄ pK_{a1}=2.12 ,pK_{a2}=7.21 pK_{a3}=12.68, HCOOH pK_a=3.75, HClO pK_a=7.52, HClO₂ pK_a=2.00

- a) H₃PO₄ b) HCOOH c) HClO d) HClO₂
e) need more information to tell.

13) Calculate the pH at the equivalence point in the titration of 200mL of 0.500M HNO₂(aq) with 0.200 M Ca(OH)₂(aq) (K_a=4.47x10⁻⁴ for HNO₂(aq))

- a) 5.74
b) 8.25
c) 8.35
d) 7.00
e) 11.89

14) Calculate the pH of a solution that is made by mixing 100 mL of 0.50M HNO₂ with 200 mL of 0.250 M in KNO₂. (K_a=4.47x10⁻⁴ for HNO₂)

- a) 1.83
b) 7.00
c) 5.47
d) 10.6
e) 3.35

15) The pH of a 0.50 M CH₃NH₃CN(aq) would be:

Given K_a=4.79x10⁻¹⁰ for HCN(aq) and K_b=4.59x10⁻⁴ for CH₃NH₂(aq)

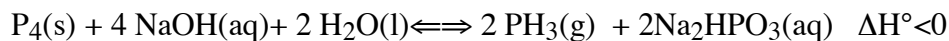
- a) greater than 7
b) less than 7
c) equal to 7
d) need more information to make any judgement about pH.

16) Calculate the ratio of the concentration of fluoride to hydrofluoric acid in a buffer solution with a pH of 4.00. K_a=6.76x10⁻⁴ for hydrofluoric acid HF.

- a) 6.76x10⁻⁴
b) 6.76
c) .148
d) 1.00
e) need more information

Part II

1) Consider the following reaction allowed to come to equilibrium:



If equilibrium is perturbed by the following changes, what will be the effect on the indicated quantity when equilibrium is reestablished.

- ___ 1. If $\text{PH}_3(\text{g})$ is added then K will?
a) increase b) decrease c) not change
- ___ 2. If water is added to the solution the pressure of $\text{PH}_3(\text{g})$ will?
a) increase b) decrease c) not change
- ___ 3. If $\text{HCl}(\text{l})$ is added to the solution the reaction will shift to_____.
a) left b) right c) will not shift
- ___ 4. If $\text{P}_4(\text{s})$ is added the reaction will shift to_____.
a) left b) right c) will not shift
- ___ 5. If $\text{NaOH}(\text{s})$ is added the reaction will shift to_____.
a) left b) right c) will not shift
- ___ 6. If the temperature is increased the rxn will shift to_____.
a) left b) right c) will not shift
- ___ 7. If the temperature is increased K will_____.
a) increase b) decrease c) not change
- ___ 8. If $\text{KOH}(\text{s})$ is added the reaction will shift to_____.
a) left b) right c) will not shift
- ___ 9. If the volume of the container is increased the rxn will shift to_____.
a) left b) right c) will not shift

2) Arrange the following in order of increasing acidity (with 1 be the most acidic), also put reason(s) why it is above the next closest.

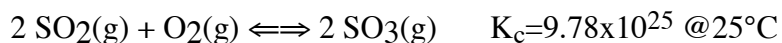


- 1) _____
- 2) _____
- 3) _____
- 4) _____
- 5) _____

3) For each of the following tell if the pH is > 7 , < 7 , $= 7$ or not enough information given (NEI), by putting the correct ($>7, <7, =7$ or NEI) sign in the space.

- a) 5.0 M $C_6H_5CO_2H$ _____
- b) 0.01M $NaC_6H_5CO_2$ _____
- c) 0.2M $(CH_3CH_2)_2NH$ _____
- d) 0.2M $(CH_3CH_2)_2NH_2I$ _____
- e) $Ba(HSO_4)_2$ _____
- f) $Fe(ClO_3)_2$ _____
- g) $Fe(C_2H_3O_2)_2$ _____

4) Initially 6 moles of sulfur dioxide and 4 moles of oxygen gas and 10 moles of sulfur trioxide were placed in a 2.00 L container. Given the reaction and the K calculate all the equilibrium concentrations.



$[SO_2] =$ _____ $[O_2] =$ _____

$[SO_3] =$ _____

b) Calculate K_p and the total pressure at equilibrium.

$K_p =$ _____

$P_t =$ _____

5) Calculate the pH after the following volumes of 0.40M HCl(aq) has been added to 100.0 mL of 0.200M NH₃(aq). $k_b=1.75 \times 10^{-5}$ for NH₃(aq)

a) before any acid is added.

b) after 20.0 mL is added.

c) after 25.0 mL is added.

d) after 50.0 mL is added.

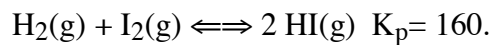
e) after 60.0 mL is added.

6) Calculate the pH and the concentrations of all the species in a 0.300 M solution of $\text{H}_3\text{PO}_4(\text{aq})$ given $\text{p}K_{\text{a}1}=2.12$, $\text{p}K_{\text{a}2}=7.21$, $\text{p}K_{\text{a}3}=12.68$ for $\text{H}_3\text{PO}_4(\text{aq})$.

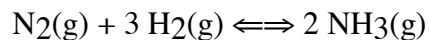
7) Calculate the pH of a 2.0 M solution of sulfuric acid (H_2SO_4). $K_{\text{a}2}=0.0120\text{M}$
(Hint: Don't forget H_2SO_4 is a diprotic acid for which the first proton is strong. This is an exception for most di and triprotic acids all the H^+ 's are weak.)

pH=_____

7) Calculate the equilibrium partial pressures and the total pressure if 10.0 grams of HI(g) is placed in a 5.0 L container at 500 K and allowed to go to equilibrium given the reaction and K below.



8) Only NH₃ is placed in a container at an initial pressure of 0.500 atm at 400K. At equilibrium the total pressure is found to be 0.6923 atm. Calculate the value of K_p for the following reaction.



K_p = _____

Warning: There may be mistakes by the end of the review all the mistakes should have been corrected, if you have to go early do not spend hours on one problem that could simply just be the wrong answer typed down here.

1) c 2) d 3) a 4) d 5) c 6) e 7) c 8) c, e 9) d 10) b 11) d 13) c 14) e 15) a 16) b

Page 4 1) 1) c 2) b 3) a 4) c 5) b 6) a 7) b 8) b 9) b 2) 1. HClO_4 resonance, 2. HClO_3 resonance, 3. HClO_2 inductive/electroneg of central atom, 4. H_3PO_4 inductive/electroneg of central atom, 5. H_2SiO_3

Page 5 3) a) < b) > c) > d) < e) < f) < g) NEI 4) $[\text{SO}_2]=1.14 \times 10^{-12} \text{ M}$, $[\text{O}_2]=0.50 \text{ M}$, $[\text{SO}_3]=8.0 \text{ M}$ $K_p=4.0 \times 10^{24}$, $P_t=208 \text{ atm}$

Page 6 a) 11.27 b) 9.42 c) 9.24 d) 5.06 e) 1.60

Page 7) $[\text{H}_3\text{PO}_4]=0.256 \text{ M}$, $[\text{H}_2\text{PO}_4^-]=4.41 \times 10^{-2} \text{ M}$, $[\text{H}_3\text{O}^+]=4.41 \times 10^{-2} \text{ M}$, $[\text{OH}^-]=2.27 \times 10^{-13} \text{ M}$, $[\text{HPO}_4^{2-}]=6.16 \times 10^{-8} \text{ M}$, $[\text{PO}_4^{3-}]=2.92 \times 10^{-19} \text{ M}$ 6) $\text{pH}=-0.304$

Page 8) 7) $P(\text{I}_2)=P(\text{H}_2)=x=4.38 \times 10^{-2} \text{ atm}$, $P(\text{HI})=0.554 \text{ atm}$ $P_t=0.642 \text{ atm}$ (same as the start because $\Delta n \text{ gases}=0$) 8) $K_p=41.0$