UNIT6-DAY5-LaB1230

Wednesday, February 20, 2013
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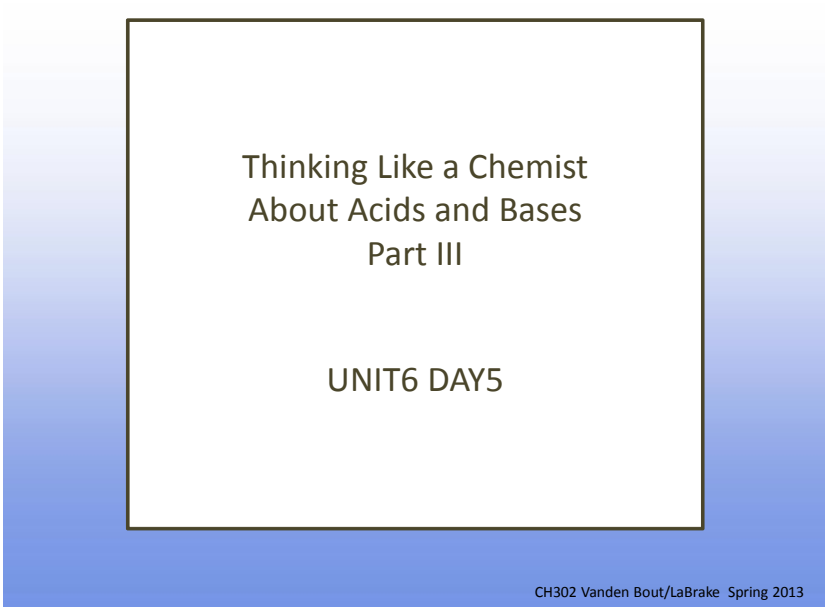

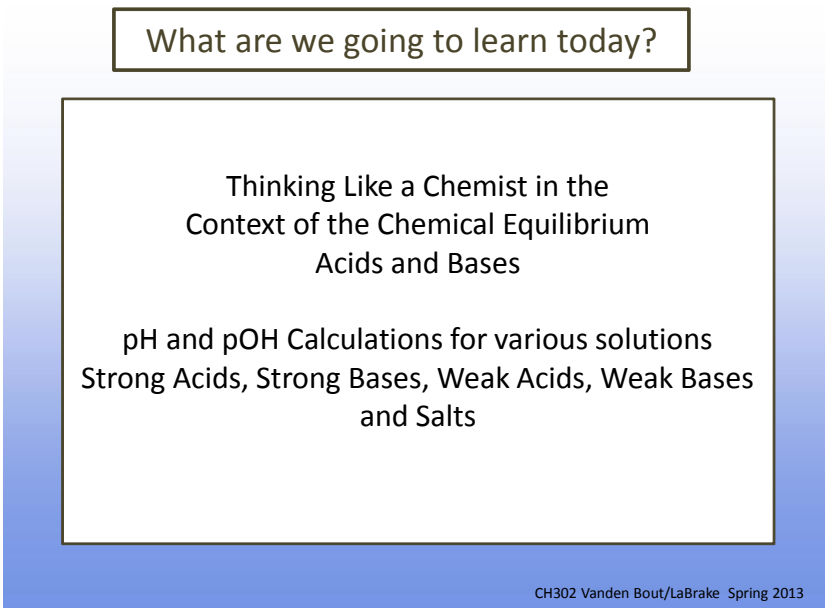

LM 19 & LM 20 Due 5pm Today

IMPORTANT INFORMATION

HW6 due ~~50~~ 45 questions Tue 9 AM

LM21 Neutralization & Salt due Tue 9AM

NGLM21 – "Neutralization Reactions" – highly recommended

or 19

Extra Practice Worksheets on Website

Exam wrapper available on Quest → more time

Friday 1-3 GSB 2.126 lots of people to help

POLL: Clicker Question 1

In the following list, select the answer that best describes your thoughts on the in class activity sheets:

A) Help me to gain a deeper understanding of the chemistry concepts being discussed
B) Help me develop problem solving strategies
C) Encourage me to figure out what I do and don't understand by talking with others around me
D) Frustrate me because they are too hard to do in the amount of time given
E) Find them to be a waste of time that could be better spent lecturing

STUDENT VOICE IN CLASS ACTIVITY

http://youtu.be/j8oVhzT4nuo

Quiz: Clicker Question 2

1. Which of the following is not a correctly matched set?

A) Potassium Hydroxide, KOH
B) Rubidium Hydroxide, RbOH
C) Cesium Hydroxide, CsOH
D) Barium Hydroxide, $Ba(OH)_2$
E) Lithium Hydroxide, LiOH

Quiz: Clicker Question 3

Which of the following is NOT correct?

A) $K_w = [H_3O^+][OH^-] = 1X10^{-14}$
B) pH + pOH = 14
C) If $[H_3O^+] > [OH^-]$; then ~~pH > 7~~ pH < 7
D) $K_a \times K_b = 1 \times 10^{-14}$

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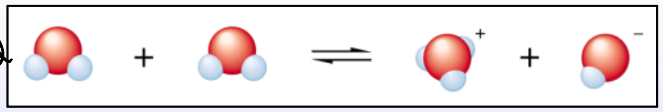
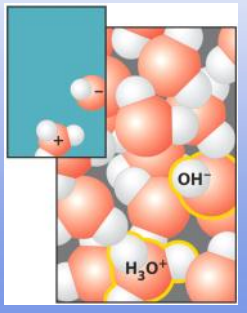
Memorize & Understand

Auto-ionization of Water



$K_w = [H_3O^+][OH^-] = 1X10^{-14}$

Pure water always has some hydronium and hydroxide present.
Equal amounts – neutral
More hydronium – acidic
More hydroxide – basic



pH = $- \log[H_3O^+]$

pOH = $-\log[OH^-]$

$K_a \cdot K_b = K_w$ for acid/base conj. partners

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REVIEW - APPLICATION

Calculate the K_a of a weak acid.

The pH of a .2 M aqueous solution of crotonic acid is 2.69.
What is the K_a of crotonic acid?

(1) Find $[H_3O^+]$

$pH = -\log[H_3O^+]$

$10^{-2.69} = [H_3O^+]$

$[H_3O^+] = 2.04 \times 10^{-3} M = x$

(2)

R	$HA + H_2O \rightleftharpoons A^- + H_3O^+$		
I	0.2	∅	∅
C	$-x$	$+x$	$+x$
E	$0.2-x$	x	x
	$0.2 - 2.04\times10^{-3}$	2.04×10^{-3}	2.04×10^{-3}

$[H_3O^+] = 2.04\times10^{-3} M = x$

E	0.2 - x	x	x
	$0.2 - 2.04\times10^{-3}$	2.04×10^{-3}	2.04×10^{-3}

$$K_a = \frac{[H_3O^+][A^-]}{[HA]} = \frac{(2.04\times10^{-3})(2.04\times10^{-3})}{(0.2 - 2.04\times10^{-3})} = 2.02\times10^{-5} \simeq 2.08\times10^{-5}$$

Poll: Clicker Question 4

Acid-Base Reactions

Given the following:
$HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$

What is the pH of the resulting solution if equal parts with equal concentration are mixed?
A)Neutral
B)Basic
C)Acidic

Strong Acid-Strong Base Reactions- Demo

Need exact amts

Given the following:
$HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$

What is the pH of 0.1 Molar HCl?
1.9
What is the pH of 0.1 Molar NaOH?
10.8
What is the pH of the resulting solution if equal parts mixed?
2.8

Strong Acid-Strong Base Reactions- Calculation

Given the following:
$HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$

What is the pH of 0.1 Molar HCl? $[H_2O^+] = 0.1$ $pH = -\log(0.1)$

What is the pH of 0.1 Molar NaOH?

Calculation

Given the following:

$HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$

What is the pH of 0.1 Molar HCl? $[H_3O^+] = 0.1$ $pH = -\log(0.1)$ $pH = 1$

What is the pH of 0.1 Molar NaOH? $[OH^-] = 0.1$ $pOH = -\log(0.1)$ $pH = 13$

What is the pH of the resulting solution if equal parts mixed of equal concentration are mixed?

$pH = 7$ 0.1 mol HCl + 0.1 mol NaOH → NaCl 0.1 mol

∅ ∅

Poll: Clicker Question 5

Acid-Base Reactions

$HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$

What is the pH of the resulting solution if 2 parts 0.1 M HCl are mixed with 1 part 0.1 M NaOH?

A)Neutral
B)Basic
C)Acidic

Strong Acid-Strong Base Reactions - DEMO

$HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$

What is the pH of the resulting solution if 2 parts 0.1 M HCl are mixed with 1 part 0.1 M NaOH?

Poll: Clicker Question 6

Strong Acid-Strong Base Reactions - Calculation

$HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$

What is the pH of the resulting solution if 2 parts 0.1 M HCl are mixed with 1 part 0.1 M NaOH?

A)1.5
B)3.0
C)7.0
D)8.5
E)13

$HCl + NaOH \xrightarrow{100\%} NaCl + H_2O$

	HCl	NaOH	
	0.1 M	0.1 M	
	200 mL	100 mL	
I	0.02 mol	0.01 mol	
C	−0.01	−0.01	+0.01
E	0.01 mol	∅	0.01

HCl NaOH
0.1M 0.1M
200mL 100mL

H^+ Na^+ H_2O Cl^- 300mL

$\frac{0.01 \text{ moles}}{0.3 L} = 0.033 M$

$0.033 = [H_3O^+]$

Why subtract 0.01?
Reaction goes to completion: What is the limiting reagent?

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Poll: Clicker Question 7

Acid-Base Reactions

$HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$

What is the pH of the resulting solution if 1 part 0.1 M HCl are mixed with 2 parts 0.1 M NaOH?

A)Neutral
B)Basic
C)Acidic

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Strong Acid-Strong Base Reactions - DEMO

$HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$

What is the pH of the resulting solution if 1 part 0.1 M HCl are mixed with 2 parts 0.1 M NaOH?

Strong Acid-Strong Base Reactions - Calculation

$HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$ pH = 12.5

What is the pH of the resulting solution if 1 part 0.1 M HCl are mixed with 2 parts 0.1 M NaOH?

$HCl + NaOH \rightarrow NaCl + H_2O$

	100 mL	200 mL
	0.1 M	0.1 M
I	0.01	0.02
C	−0.01	−0.01
E	0	0.01

$\frac{0.01\ mol}{0.3} = 0.033 M$

$pOH = -\log(0.033)$

$pOH = 1.5$

$pH = 12.5$

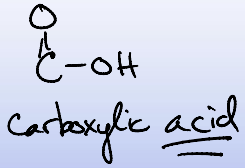
Poll: Clicker Question 8

Acid-Base Reactions

$CH_3COOH\ (aq) + NaOH(aq) \rightarrow NaCH_3COO\ (aq) + H_2O\ (l)$

1. What is the pH of the 0.1 M CH_3COOH solution?
   A) Neutral
   B) Basic
   C) Acidic

weak acid
"acetic acid"



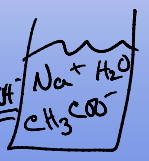
Carboxylic acid

2. What is the pH of the resulting solution if 1 part 0.1 M CH_3COOH is mixed with 1 part 0.1 M NaOH?
   A) Neutral
   B) Basic
   C) Acidic

WHY?

$CH_3COO^- + H_2O \leftrightarrow CH_3COOH + OH^-$

salt is a weak base



Weak Acid-Strong Base Reactions - DEMO

$CH_3COOH\ (aq) + NaOH(aq) \rightarrow NaCH_3COO\ (aq) + H_2O\ (l)$

What is the pH of the 0.1 M CH_3COOH solution?

What is the pH of the resulting solution if 1 part 0.1 M CH_3COOH is mixed with 1 part 0.1 M NaOH?

Poll: Clicker Question 9

Weak Acid-Strong Base Reactions - Calculation

$CH_3COOH\ (aq) + NaOH(aq) \rightarrow NaCH_3COO\ (aq) + H_2O\ (l)$

What is the pH of the 0.1 M CH_3COOH solution? $K_a = 1.8 \times 10^{-5}$

$[H_3O]^+ = 1.3 \times 10^{-3}$ pH = 2.9 ⇒ Should be simple & ready

$K_b = \frac{K_w}{K_a} = \frac{1 \times 10^{-14}}{1.8 \times 10^{-5}} = 5.56 \times 10^{-10}$

$Na^+ + CH_3COO^- + H_2O \leftrightarrow CH_3COOH + OH^-$

	CH_3COO^-	CH_3COOH	OH^-
I	0.05 M	Ø	Ø
C	$-x$	$+x$	$+x$
E	$0.05 - x$	x	x

$K_b = \frac{[CH_3COOH][OH^-]}{[CH_3COO^-]}$

What is the pH of the resulting solution if 1 part 0.1 M CH_3COOH is mixed with 1 part 0.1 M NaOH?

A) 2.9
B) 4.5
C) 7.2
D) 8.1
E) 11.1

$NaOH + CH_3COOH \rightarrow NaCH_3COO + H_2O$

	0.1 M, 100 mL	0.1 M, 100 mL	
I	0.01 mol	0.01 mol	Ø
C	−0.01	−0.01	+0.01

What is the pH of the resulting solution if 1 part 0.1 M CH_3COOH is mixed with 1 part 0.1 M NaOH?

A) 2.9
B) 4.5
C) 7.2
D) 8.1
E) 11.1

	100mL	100mL	
I	0.01 mol	0.01 mol	Ø
C	-0.01	-0.01	+0.01
E	Ø	Ø	0.01 mol in 200 mL

CH_3COO^-

200mL

0.05M

$K_b = \frac{[CH_3COOH][OH^-]}{[CH_3COO^-]}$

$5.56 \times 10^{-10} = \frac{x^2}{0.05}$

$x = 5 \times 10^{-6}$

pOH = 5.9

pH = 8.1

Poll: Clicker Question 9

Acid-Base Reactions

$CH_3COOH\ (aq) + NaOH(aq) \rightarrow NaCH_3COO\ (aq) + H_2O\ (l)$

What is the pH of the resulting solution if 1 part 0.1 M CH_3COOH is mixed with 2 parts 0.1 M NaOH?

A)Neutral
B)Basic
C)Acidic

Weak Acid-Strong Base Reactions - DEMO

$CH_3COOH\ (aq) + NaOH(aq) \rightarrow NaCH_3COO\ (aq) + H_2O\ (l)$

What is the pH of the resulting solution if 1 part 0.1 M CH_3COOH is mixed with 2 parts 0.1 M NaOH?

Weak Acid-Strong Base Reactions - Calculation

$CH_3COOH\ (aq)\ +\ NaOH(aq) \rightarrow NaCH_3COO\ (aq)\ +\ H_2O\ (l)$

What is the pH of the resulting solution if 1 part 0.1 M CH_3COOH is mixed with 2 parts 0.1 M NaOH?

Poll: Clicker Question 10

pH of salt in water

The pH of a solution of a soluble salt will be:

A) Neutral
B) Basic
C) Acidic
D) Any of the above, depends on the salt

Poll: Clicker Question 11

pH of salt in water

The pH of a 0.1 M aqueous solution of $NaCH_3COO$ will be:

A)Neutral
B)Basic
C)Acidic

↳ from previous example

pH of salt in water CALCULATION

The pH of a 0.1 M aqueous solution of $NaCH_3COO$ will be:

Acid or Base Game!

$NaCH_3OO$ from strong base + weak acid acetic acid → neutralize to get salt

↳ basic

NaOH gets 100%

NH_4Cl

↳ acidic

weak base + strong acid

$NH_3 + HCl \rightarrow NH_4Cl + H_2O$

↳ 100%

NaCl

↳ neutral

strong acid + strong base

$HCl + NaOH \rightarrow Na^+ + Cl^- + H_2O$

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Game!

NH_4Cl

↳ acidic

NaOH Base

Na_2SO_4 neutral

Citric Acid acid

THIS IS WHAT WE EXPECT YOU CAN DO NOW!

Fully describe: Weak Base + Strong Acid reaction with resulting salt solution

Write the chemical reaction and calculate the pH when a 0.1 M Solution of ammonia is mixed with a 0.1 M solution of hydrochloric acid.
Before you do the calculation you should be able to predict if the resulting solution would be:

A) Neutral
B) Basic
C) Acidic

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Work it OUT!

What did we learn today?

Determine the pH of solutions of:

- strong acid
- strong base
- weak acid
- weak base
- salts formed as the result of acid-base neutralization reactions.

Learning Outcomes

Show mastery of neutralization reactions including predicting products, determining molar concentrations of all species in solution and predicting and calculating pH of resulting solution

Predict whether a salt is expected to produce an acidic, basic or neutral solution when dissolved in water.

Calculate the pH (and/or pOH) of the solution of a soluble salt.