

Thinking Like a Chemist
About Acids and Bases
Part III

UNIT 6 DAY 5

What are we going to learn today?

Thinking Like a Chemist in the
Context of the Chemical Equilibrium
Acids and Bases

pH and pOH Calculations for various solutions
Strong Acids, Strong Bases, Weak Acids, Weak Bases
and Salts

IMPORTANT INFORMATION

HW6 due

Tue 9 AM

LM20 Neutralization & Salt due Tue 9AM

First

Review naming of acids in the fundamentals section
of our eBook.

Extra Practice Worksheets on Website



POLL: Clicker Question

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

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, BaOH
- E. Lithium Hydroxide, LiOH



Quiz: Clicker Question

Which of the following is NOT correct?

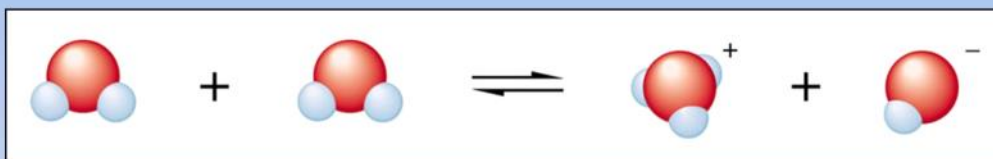
A. $K_w = [\text{H}_3\text{O}^+][\text{OH}^-] = 1 \times 10^{-14}$

B. $\text{pH} + \text{pOH} = 14$

C. If $[\text{H}_3\text{O}^+] > [\text{OH}^-]$; then $\text{pH} > 7$

D. $K_a \times K_b = 1 \times 10^{-14}$

Auto-ionization of Water



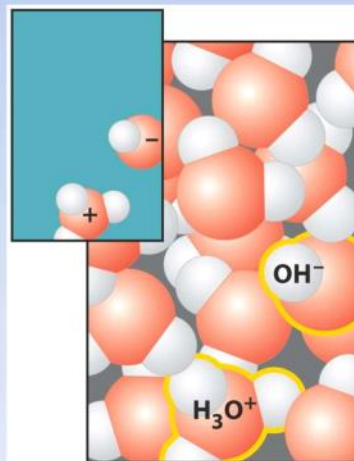
$$K_w = [\text{H}_3\text{O}^+][\text{OH}^-] = 1 \times 10^{-14}$$

Pure water always has some hydronium and hydroxide present.

- Equal amounts – neutral
- More hydronium – acidic
- More hydroxide – basic

$$\text{pH} = -\log[\text{H}_3\text{O}^+]$$

$$\text{pOH} = -\log[\text{OH}^-]$$

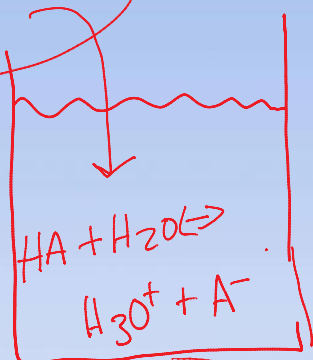


Work on Activity, Part I

(A) EASY

(B) HARD

0.2M HA



R	HA + H ₂ O	⇌	H ₃ O ⁺	+ A ⁻
I	.2		∅	∅
C	-x		+x	+x
E	.2-x		x	x

$\text{pH} = -2.69$
 $\text{pH} = -\log[\text{H}_3\text{O}^+]$
 $[\text{H}_3\text{O}^+] = .00204$
 10^x

$$K_a = \frac{[\text{H}_3\text{O}^+][\text{A}^-]}{[\text{HA}]}$$

Poll: Clicker Question

Calculate the K_a of a weak acid.

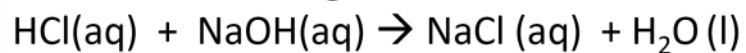
The pH of a 0.2 M aqueous solution of crotonic acid is 2.69.
What is the percent ionization of this acid?

- A. 5%
- B. 1%
- C. 100%
- D. 60%

Poll: Clicker Question

Acid-Base Reactions

Given the following:



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

- A) Neutral
- B) Basic
- C) Acidic

Do I have any
 OH^- or H_3O^+
at end?

1×10^{-7}

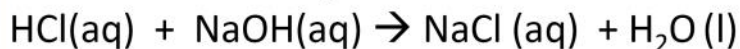
A) YES

B) NO

Poll: Clicker Question

Acid-Base Reactions

Given the following:



What is the pH of the resulting solution if 200 mL of 0.1 M HCl is mixed with 500 mL of 0.1 M NaOH?

Enter your answer to one decimal place.

pH = ?

A) 12.6
B) dwh?

END

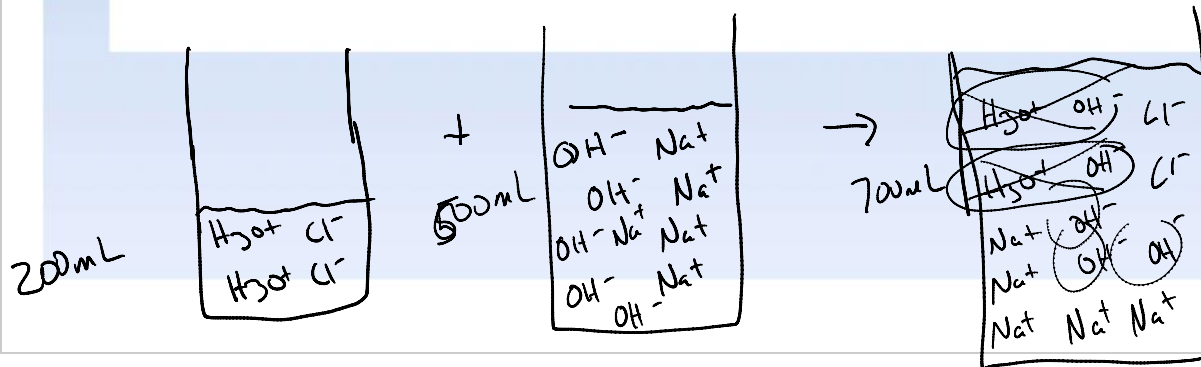


Figure out moles

	HCl	+	NaOH	→	NaCl	+	H ₂ O
Initial	.2 L (.1 M)		.5 L (.1 M)		∅		∅
	.02 moles		.05 moles				
Change	- .02 moles		- .02 mole		+ .02 mole		.02 moles
End	∅		.03 moles				.02 moles

$$[\text{OH}^-] = \frac{.03 \text{ moles}}{.7 \text{ L}} = .043 \text{ M} = [\text{OH}^-]$$

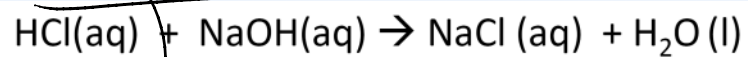
$$\text{pOH} = -\log [\text{OH}^-]$$

$$1.4 = \text{pOH} = -\log [.043]$$

$$\text{pH} = 14 - 1.4 = 12.6$$

Poll: Clicker Question

Acid-Base Reactions

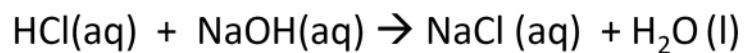


What is the pH of the resulting solution if 2 parts 0.1 M HCl are mixed with 1 part 0.1 M NaOH?

- A) Neutral
- B) Basic
- C) Acidic

Poll: Clicker Question

Strong Acid-Strong Base Reactions - Calculation

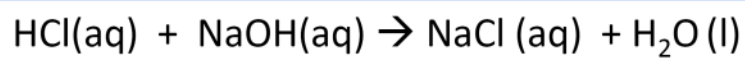


What is the pH of the resulting solution if 2 parts 0.1 M HCl are mixed with 1 part 0.1 M NaOH?

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

Poll: Clicker Question

Acid-Base Reactions



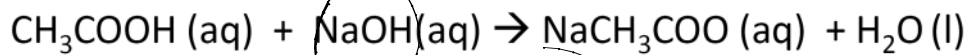
What is the pH of the resulting solution if 1 part 0.1 M HCl are mixed with 2 parts 0.1 M NaOH?

- A) Neutral
- B) Basic
- C) Acidic

Practice

Poll: Clicker Question

Acid-Base Reactions



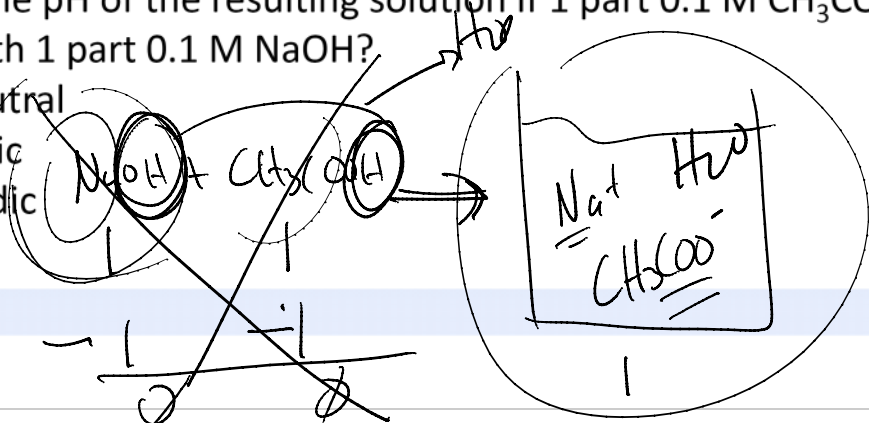
What is the pH of the 0.1 M CH_3COOH solution?

- A) Neutral
- B) Basic
- C) Acidic



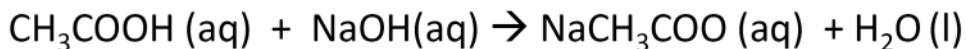
What is the pH of the resulting solution if 1 part 0.1 M CH_3COOH is mixed with 1 part 0.1 M NaOH ?

- A) Neutral
- B) Basic
- C) Acidic



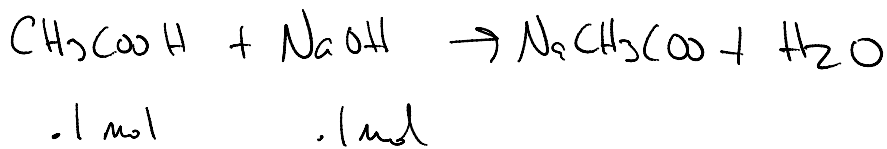
Poll: Clicker Question

Weak Acid-Strong Base Reactions - Calculation



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) 8.7
- E) 11.1



11.1
E) 11.1 I .1 mol .1 mol

C - .1 mol - .1 mol + .1 mol + .1 mol

END \emptyset \emptyset .1 mol

? Volume \rightarrow 2L \rightarrow $\frac{.1 \text{ mol CH}_3\text{COO}^-}{2 \text{ L}} = .05 \text{ M}$

NOW YOU NEED TO THINK ABOUT EQUILIBRIUM!



I .05

\emptyset

\emptyset

C -x

+x

+x

E .05-x

x

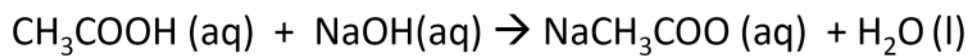
x

$$K_b \cdot K_a = K_w = 1 \times 10^{-14}$$

$$K_b = 5.6 \times 10^{-10}$$

Poll: Clicker Question

Acid-Base Reactions

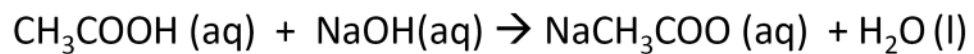


What is the pH of the resulting solution if 1 part 0.1 M CH_3COOH is mixed with 2 parts 0.1 M NaOH?

- A) Neutral
- B) Basic
- C) Acidic

Poll: Clicker Question

Weak Acid-Strong Base Reactions



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

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

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

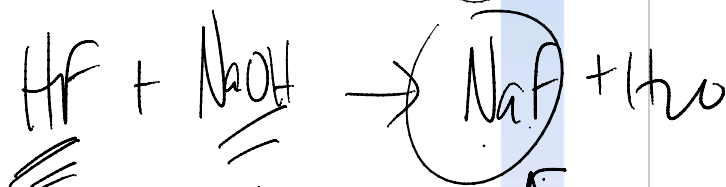
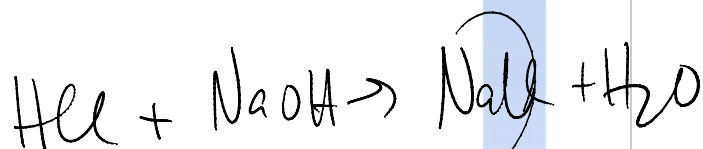
Poll: Clicker Question

Acid or Base Game!

- For each of these salts dissolved in water, is the solution acidic, basic, or neutral:

NaCl, NaF, NH₄Cl?

- A. Acidic, basic, neutral
- B. Neutral, acidic, basic
- C. Neutral, basic, acidic
- D. Basic, acidic, neutral
- E. Basic, basic, acidic



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

NH₄⁺
K_a

B) Basic

C) Acidic

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.