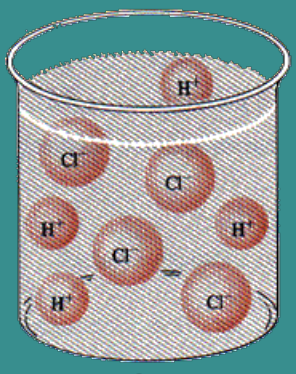
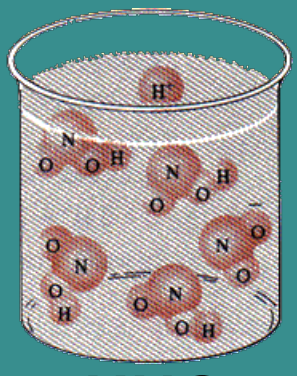
Acids and Bases

Strong vs. Weak

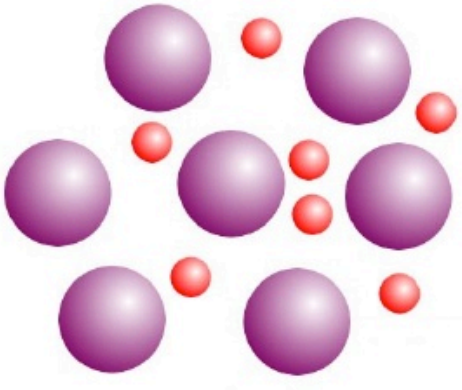


HCl

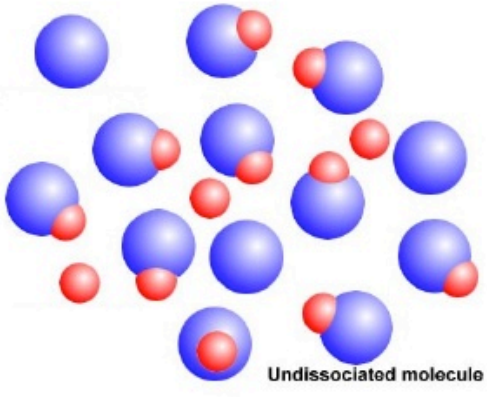


HNO_2

Strong Acids vs. Weak Acids



Strong acids are assumed to dissociate completely when in aqueous solution.



Weak acids dissociate only slightly in aqueous solution. The majority of molecules remain undissociated.

Strong acids and bases completely ionize

$+H_2O$

$HCl \rightarrow H_3O^+ + Cl^-$

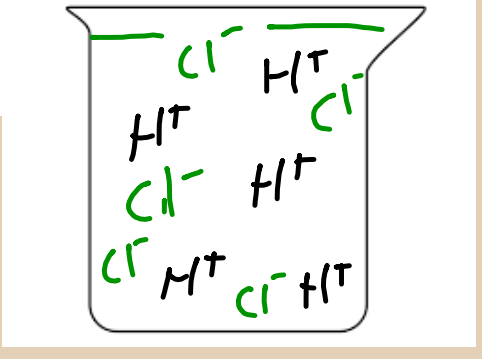
I 1 mol

S -1mol +1mol +1mol

E 0 1 mol

1M

$pH = -\log[1M] = 0$

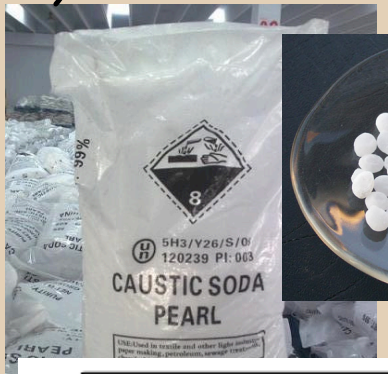


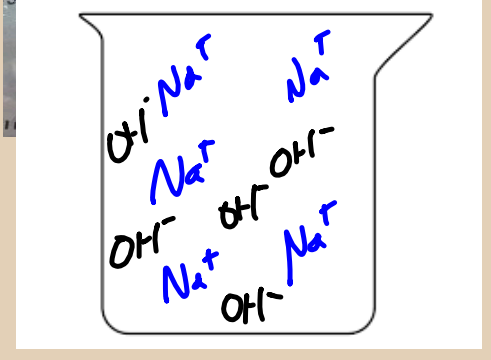
$NaOH \rightarrow Na^+ + OH^-$

1mol

-1mol +1mol +1mol

1 mol





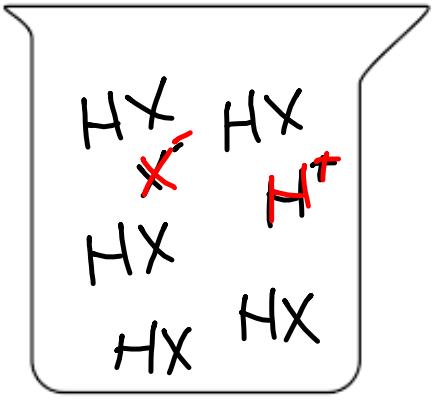
1 M HCl dissociates completely to give 1 M H_3O^+, or pH=0

1 M NaOH dissociates completely to give 1 M OH^-, or pOH=0, or pH=14

Weak acids and bases do not completely ionize

$$HC_2H_3O_2 + H_2O \rightarrow H_3O^+ + C_2H_3O_2^-$$

	$HC_2H_3O_2$	H_3O^+	$C_2H_3O_2^-$
I	1mol		
S	-0.0001mol	+ 0.0001mol	+0.0001mol
E	1 − 0.0001	0.0001 mol	0.0001 mol



$H_3O^+ = H^+$

$C_2H_3O_2^- = X^-$

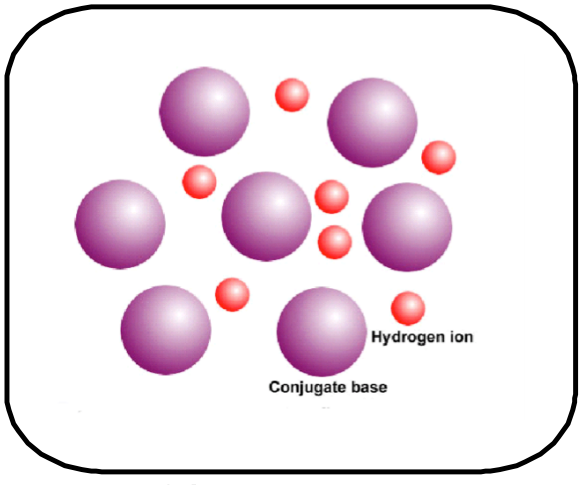
$$NH_3 + H_2O \rightarrow NH_4^{+1} + OH^{-1}$$

	NH_3	NH_4^+	OH^-
I	1mol		
S	-0.004 mol	+0.004 mol	+0.004 mol
E	1 − 0.004	0.004	0.004

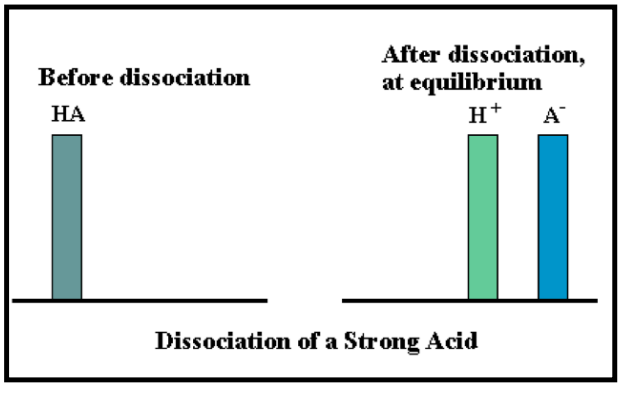
1 M $HC_2H_3O_2$ DOES NOT dissociate completely to give 1 M H_3O^+
pH > 0, (pH is about 3)

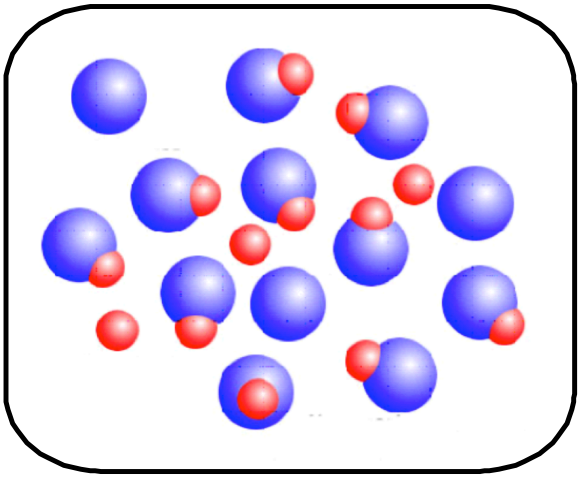
1 M NH_3 DOES NOT dissociates completely to give 1 M OH^-,
pOH > 0, or pH < 14 (pH is about 11)

Strong vs. Weak

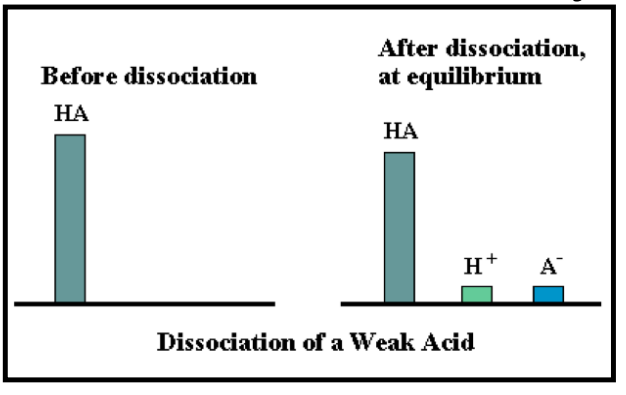


100% dissociates





dissociates minimally



6 Strong Acids

- $HCl_{(aq)}$ → Hydrochloric acid
- $HBr_{(aq)}$ → Hydrobromic acid
- $HI_{(aq)}$ → Hydroiodic acid
- $HNO_{3(aq)}$ → Nitric acid
- $H_2SO_{4(aq)}$ → sulfuric acid
- $HClO_{4(aq)}$ → Perchloric acid

Weak acids

All other acids are **weak**

examples:

HF

$HC_2H_3O_2$ } edible

H_3PO_4

Strong Bases

X-OH where X is any metal from the 1st or 2nd family (except Be)

Weak Bases

All other hydroxides are nearly insoluble

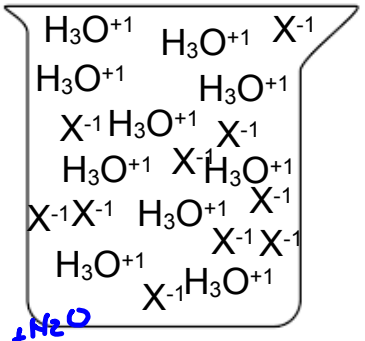
NH_3

Strong vs. Weak, Concetrated. vs. Dilute

Strong Acid:

Conc.

10 particles



$+H_2O$

$HX \longrightarrow H_3O^{+1} + X^{-1}$

I 10 — +10 — +10

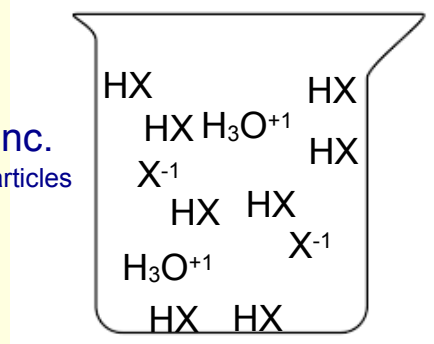
S -10

E ∅ — 10 — 10

Weak Acid

Conc.

10 particles



$HX \longrightarrow H_3O^{+1} + X^{-1}$

I 10 — +2 — +2

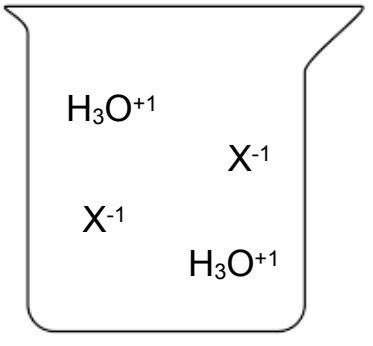
S -2

E 8 — 2 — 2

Strong Acid:

Dilute

2 particles



$HX \longrightarrow H_3O^{+1} + X^{-1}$

I 2 — +2 — +2

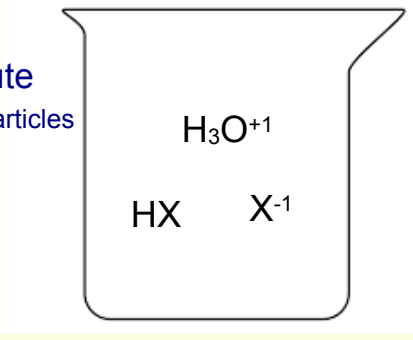
S -2

E ∅ — 2 — 2

Weak Acid

Dilute

2 particles



$HX \longrightarrow H_3O^{+1} + X^{-1}$

I 2 — +1 — +1

S -1

E 1 — 1 — 1

p. 47

pH of Strong Acids

1. 0.5M HBr

   a. Write the hydrolysis reaction and create an ISE table.

	HBr	+	H_2O		H_3O^+	+	Br^{-1}
I	0.5						
S	-0.5				+0.5		+0.5
E	0				0.5		0.5

   b. What is the concentration of H_3O^{+1} ions at the end?

0.5M H_3O^+

   c. What is the pH of the solution?

pH = -log[0.5] = 0.301

2. 0.1M HCl

   a. Write the hydrolysis reaction and create an ISE table.

	HCl	+	H_2O	$\longrightarrow$	H_3O^+	+	Cl^{-1}
I	0.1						
S	-0.1				+0.1		+0.1
E	0				0.1		0.1

   b. What is the concentration of H_3O^{+1} ions at the end?

0.1M

   c. What is the pH of the solution?

pH=1

3. 0.001M HX (strong acid)

   a. Write the hydrolysis reaction and create an ISE table.

$HX + H_2O \rightarrow H_3O^+ + X^-$

I	0.001						
S	-0.001				+0.001		+0.001
E					0.001		0.001

   b. What is the concentration of H_3O^{+1} ions at the end?

0.001 M

   c. What is the pH of the solution?

$pH = -\log[0.001] = 3$

Determine the pH of a 0.5 M HF solution.

Weak

$$HF + H_2O \longrightarrow H_3O^+ + F^{-1}$$

	HF	H_2O	H_3O^+	F^{-1}
I	0.5			
S	-x		-x	-x
E	0.5-X		x	x
			0.018	0.018

Ionization Constant, $K = \frac{\text{products}}{\text{reactants}}$

$$K_a = \frac{[H_3O^+]\,[F^-]}{[HF]} = \frac{x \cdot x}{0.5 - X} = 6.6\text{ E-4}$$

acid

negligible, disregard this"x"

$$(0.5)\,(6.6\text{ E-4}) = x^2$$

$$x^2 = 0.00033$$

plug in

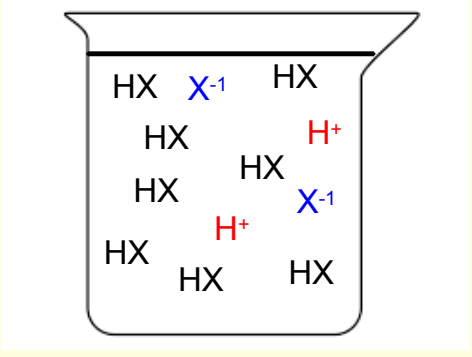
$$X = 0.018\text{ M}$$

$$[H_3O^+] = 0.018\text{M}$$

$$pH = -\log(0.018) = 1.74$$

concentrated weak

10 particles partial ionization

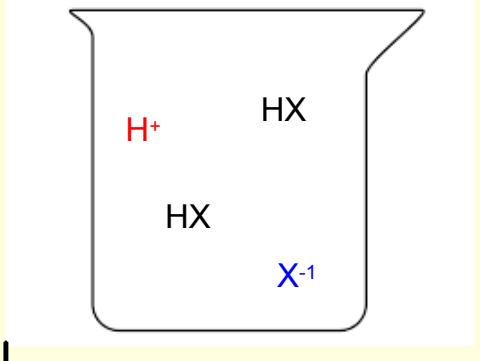


$$HX + H_2O \longrightarrow H_3O^+ + X^{-1}$$

I	10		
S	-2	+2	+2
E	8	2	2

dilute weak

3 particles partial ionization

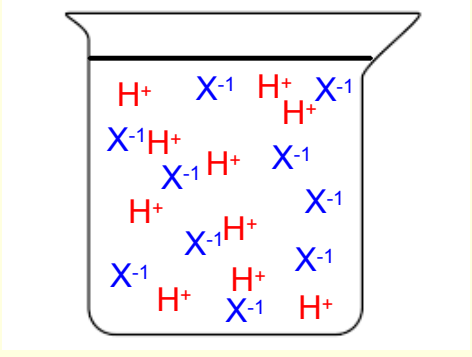


$$HX + H_2O \longrightarrow H_3O^+ + X^{-1}$$

I	3		
S	-1	+1	+1
E	2	1	1

concentrated strong

10 particles 100% ionization

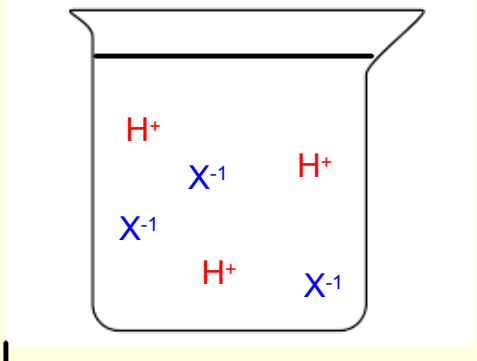


$HX + H_2O \longrightarrow H_3O^+ + X^{-1}$

I	10		
S	-10	+10	+10
E	0	10	10

dilute weak

3 particles 100% ionization



$HX + H_2O \longrightarrow H_3O^+ + X^{-1}$

I	3		
S	-3	+3	+3
E	0	3	3

Review:

pOH = 3.71

pH=

$[H_3O^{+1}]$=

$[OH^{-1}]$ =

Write the hydrolysis reaction of HBr

Write the hydrolysis reaction of NH_3.

Review:

pOH = 3.71

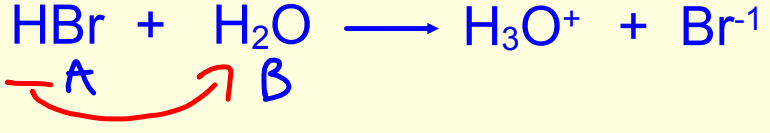
pH= 10.29

$[H_3O^{+1}]$= 5.13×10^{-11}

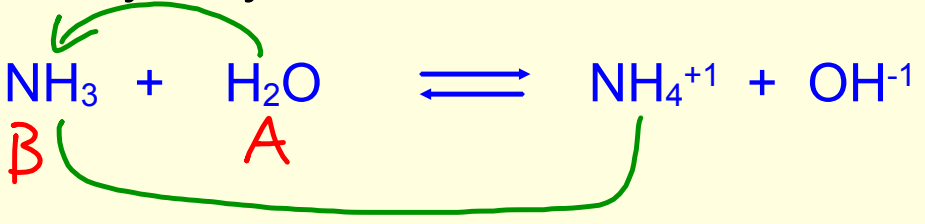
$[OH^{-1}]$ = 1.95×10^{-4}

HBr

Write the hydrolysis reaction of HBr



Write the hydrolysis reaction of NH_3.



Another Review:

Write the hydrolysis reaction of 0.1 M HCl and include an ISE table.

What is:

$[H_3O^{+1}]=$

$[OH^{-1}]=$

pOH =

pH=

Is this an acidic or alkaline solution?

Another Review:

Write the hydrolysis reaction of 0.1 M HCl and include an ISE table.

$$HCl + H_2O \longrightarrow H_3O^+ + Cl^{-1}$$

	HCl	H_2O	H_3O^+	Cl^{-1}
I	0.1			
S	-0.1		+0.1	+0.1
E	0		0.1	0.1

What is:

$[H_3O^{+1}]$= **0.1M**

$[OH^{-1}]$= **1×10^{-13}**

pOH = **13**

pH= **1**

Is this an acidic or alkaline solution? **acidic**

Another Review:

Write the hydrolysis reaction of 0.015 M HCl and include an ISE table.

What is:

$[H_3O^{+1}]=$

$[OH^{-1}]=$

pOH =

pH=

Is this an acidic or alkaline solution?

Another Review:

Write the hydrolysis reaction of 0.015 M HCl and include an ISE table.

$$HBr + H_2O \longrightarrow H_3O^+ + Br^{-1}$$

I	0.015		
S	-0.015	+0.015	+0.015
E	0	0.015	0.015

What is:

$[H_3O^{+1}]$= **0.015**

$[OH^{-1}]$= **6.67 E-13**

pOH = **12.17**

pH= **1.82**

Is this an acidic or alkaline solution? **acidic**