Announcements – Lecture XVIII – Tuesday, Nov 20th

8.3 What Are Conjugate Acid–Base Pairs?

ARRHENIUS:

ACID: Produces H_3O^+ in water.

$HCl(aq) + H_2O(l) = H_3O^+ + Cl^-$

Acid

BASE: Produces OH^- in water.

$NH_3(aq) + H_2O(l) \Leftrightarrow NH_4^+ + OH^-$

Base

BRONSTED LOWRY

ACID: A proton (H^+) donor ...

$HCl(aq) + H_2O(l) = H_3O^+ + Cl^-$

Acid ... donates H^+ to $H_2O(l)$

BASE: A proton (H^+) acceptor

$NH_3(aq) + H_2O(l) \Leftrightarrow NH_4^+ + OH^-$

Base ... accepts a H^+ from $H_2O(l)$

? ... Notice anything about $H_2O(l)$ in the two examples given above ??

8.3 What Are Conjugate Acid–Base Pairs?

$HCN(aq) + NH_3(aq) \Leftrightarrow NH_4^+ + CN^-$

Acid Base

$NH_4^+ + CN^- \Leftrightarrow HCN(aq) + NH_3(aq)$

Acid Base

$HCN(aq) + NH_3(aq) \Leftrightarrow NH_4^+ + CN^-$

Acid Base Acid* Base*

Acid* – Conjugate acid

Base* – Conjugate base

HCN/CN^- ... Acid/Conjugate base pair

NH_3/NH_4^+ ... Base/Conjugate acid pair

$HCN(aq) + NH_3(aq) \Leftrightarrow NH_4^+ + CN^-$

Acid Base C. Acid C. Base

$+H^+$

$-H^+$

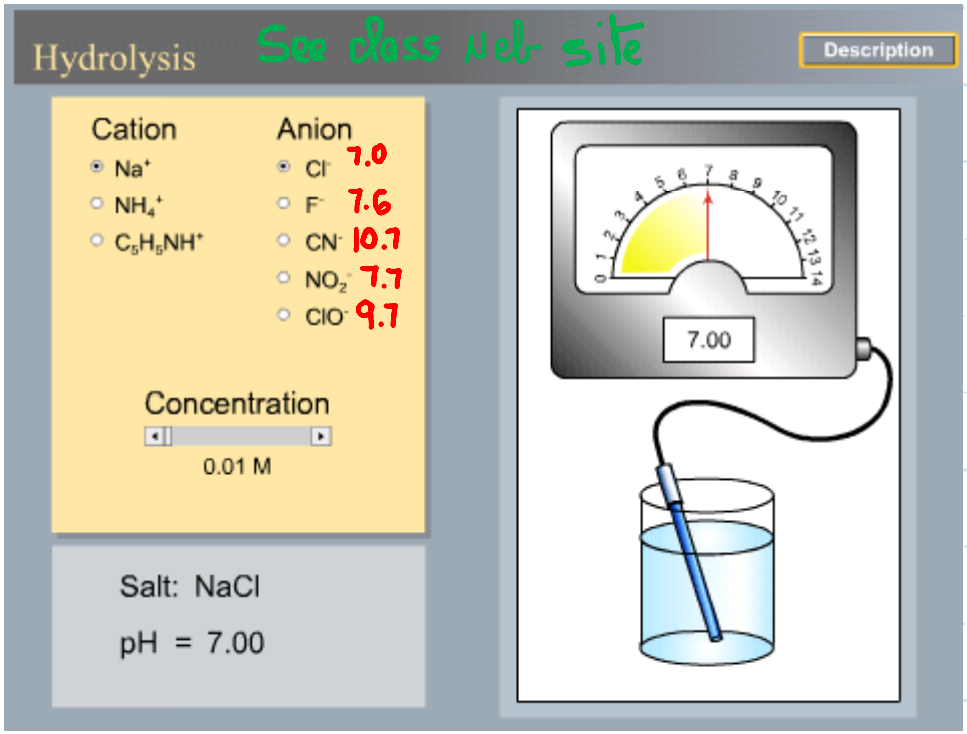
Acid $- H^+$ = its conjugate base

Base $+ H^+$ = its conjugate acid

Cations behaving as acids ?

Anions behaving as bases ?

8.3 What Are Conjugate Acid–Base Pairs? – Consequences



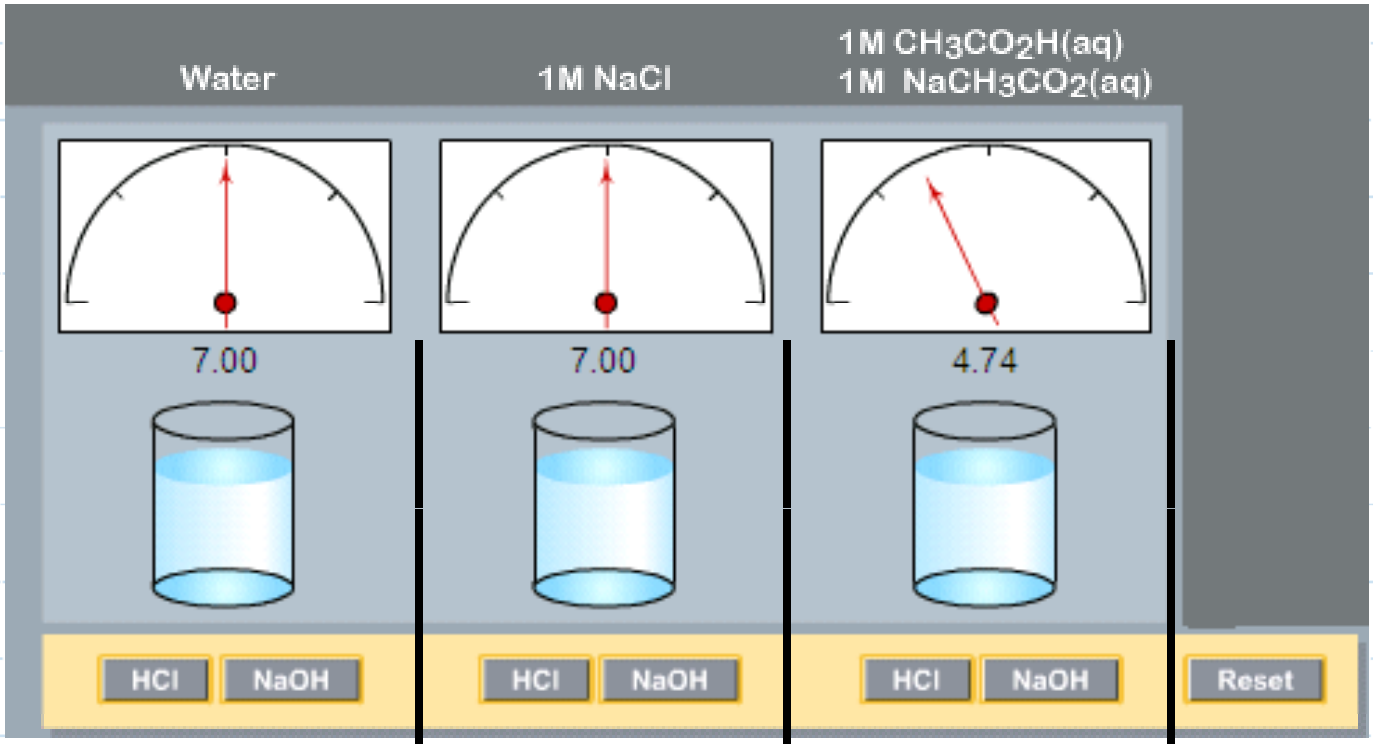
Base	Conjugate acid	
Cl^-	HCl	… strong acid
F^-	HF	all weak acids
CN^-	HCN	
NO_2^-	HNO_2	
ClO^-	HClO	

$CN^- + H_2O(l) \Leftrightarrow HCN(aq) + OH^-$

pH Up … Sodium carbonate … Washing Soda

↳ $CO_3^{2-} + H_2O(l) \Leftrightarrow HCO_3^- + OH^-$

8.10 What Are Buffers?



pH	7.00	7.00	4.74	INITIAL
pH	1.04	1.04	4.65	ADD H_3O^+
pH	12.96	12.96	4.83	Add OH^-

Large pH change

Small pH change

CH_3CO_2H ... acid

$CH_3CO_2^-$ ... base ... Conjugate base of CH_3CO_2H !

8.10 What Are Buffers? – How Do They Resist Drastic pH Changes

Addition of Strong Acid – H_3O^+

1M CH_3CO_2H / 1M $CH_3CO_2^-$

acid — conjugate base

SA + WB = 100%

H_3O^+

$$H_3O^+ + CH_3CO_2^- = H_2O(l) + CH_3CO_2H(aq)$$

OVERALL CHANGES

$[CH_3CO_2^-]$: ↓ ... Reacted with the added H_3O^+.

$[CH_3CO_2H]$: ↑ ... a product of the reaction that removed the H_3O^+.

$[H_3O^+]$: ↑ ... not by much ... a result of $[CH_3CO_2H]$↑.

pH : ↓ ... not by much.

8.10 What Are Buffers? – How Do They Resist Drastic pH Changes

Addition of Strong Base – OH^-

1M CH_3CO_2H / 1M $CH_3CO_2^-$

Acid — Conjugate base

OH^-

WA + SB = 100%

$$OH^- + CH_3CO_2H(aq) = CH_3CO_2^- + H_2O(l)$$

OVERALL CHANGES:

$[CH_3CO_2H]$: ↓ ... Reacted with the added OH^-

$[CH_3CO_2^-]$: ↑ ... A product of the reaction that removed the OH^-

$[OH^-]$: ↑ ... not by much ... a result of $[CH_3CO_2^-]$↑ ... a base

pH : ↑ ... not by much

8.10 What Are Buffers? – How Do They Resist Drastic pH Changes

A buffer solution made from HF and KF has a pH = 2.84.
Addition of OH- will cause –

1. Increase significantly
2. Increase slightly
3. Decrease significantly
4. Decrease slightly
5. Increase
6. Decrease

a) pH ? 2 Adding base ... solution will become more basic

b) pOH ? 4 $[OH^-]$ ↑ ... $pOH = -\log_{10}[OH^-]$ will ↓

c) $[HF]$? 6 $HF(aq) + OH^- = H_2O(l) + F^-$

d) $[F^-]/[HF]$? 5 See (c) ... $[HF]$↓, $[F^-]$↑ ... $[F^-]/[HF]$, ↑