Announcements – Lecture XIX – Thursday, Nov 19th

1. **Final Lab – Saturday, December 5th … 1-4pm … ISB 155/160 (A-E)**

   a) Print lab prior to coming to lab -- use the 'Print Friendly Version' located on the top left hand side of the page – this is the version that contains the 'Data Sheet' that you will hand in upon completing the lab.

   b) The pre-lab quiz associated with this lab is the 'TA Evaluation' that that can be found in your Class Owls. Completing this by Friday, December 11th is equivalent to a perfect quiz score.

2. 

iClicker:
Choose any letter: A-E

8.8 What are pH and pOH

pH – Acidity and Basicity – Example III

a) A 0.15M aqueous solution of an acid HA has a measured pH equal to 0.82 ✓
b) A 0.45M aqueous solution of an acid HB has a measured pH equal to 0.69
c) Tom, I have no idea.

Which is the stronger acid? 

a) $pH = -\log_{10}[H_3O^+]$

$= -\log_{10}(0.15) = 0.82$ ... expected pH if HA is a strong acid ... 100%

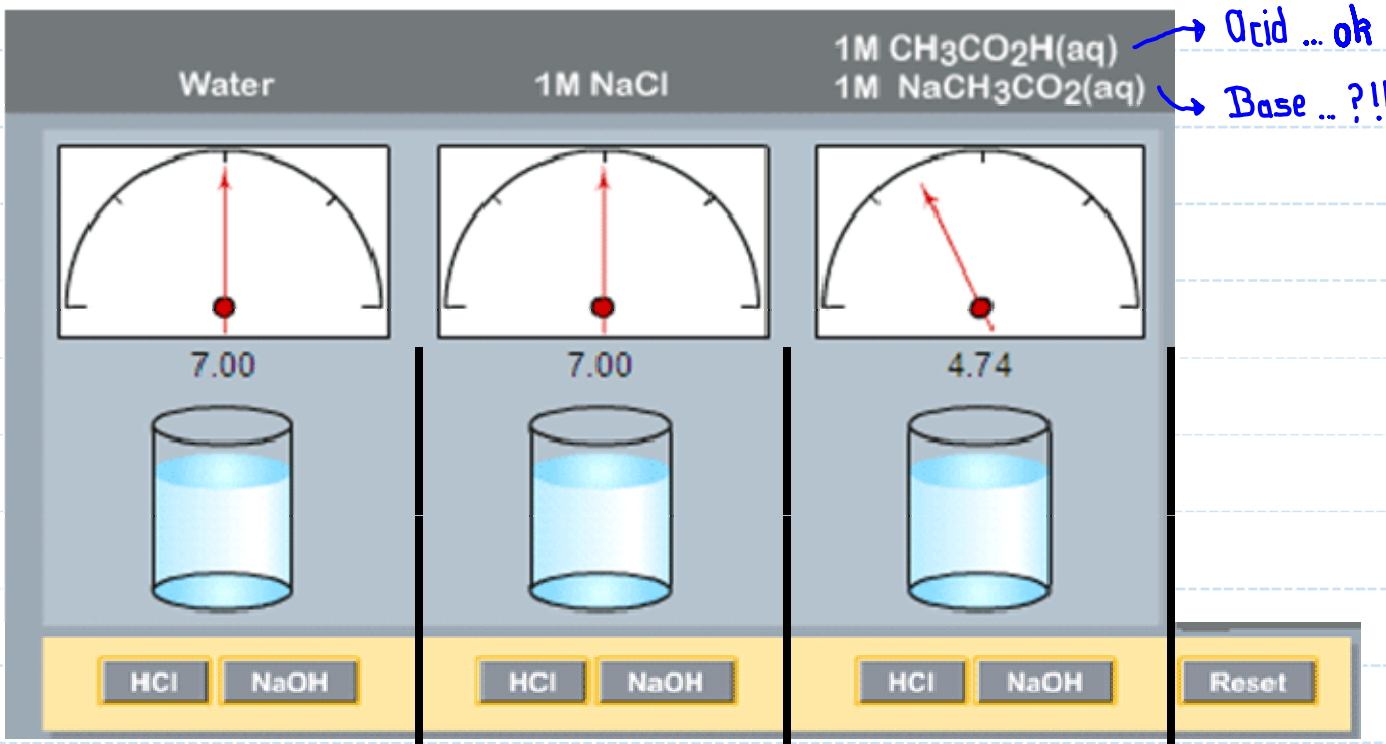
b) $pH = -\log_{10}[H_3O^+]$

$= -\log_{10}(0.45) = 0.35$ ... expected pH if HB is a strong acid ... 100%

$HA(aq) + H_2O(l) \rightarrow H_3O^+ + A^-$ ... strong acid.

$HB(aq) + H_2O(l) \Leftrightarrow H_3O^+ + B^-$ ... weak acid.

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 changes

Small pH changes.

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

W: Weak S: Strong A: Acid B: Base

1. SA + SB = 100% $H_3O^+ + OH^- = H_2O(l) + H_2O(l)$

2. SA + WB = 100% $H_3O^+ + NH_3(aq) = NH_4^+ + H_2O(l)$

3. WA + SB = 100% $HCN(aq) + OH^- = CN^- + H_2O(l)$

4. WA + WB = ?

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 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?

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

acid base

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

acid base

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

acid base acid* base*

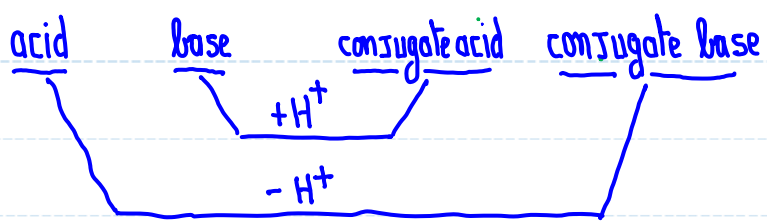
acid* = Conjugate acid.

base* = Conjugate base.

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

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

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



Acid - H^+ = its conjugate base.

Base + H^+ = its conjugate acid.

Cations behaving as acids?

Anions behaving as bases?

Hydrolysis

Cation	Anion	
Na^+	Cl^-	7.0
NH_4^+	F^-	7.6
$C_5H_5NH^+$	CN^-	10.7
	NO_2^-	7.7
	ClO^-	9.7

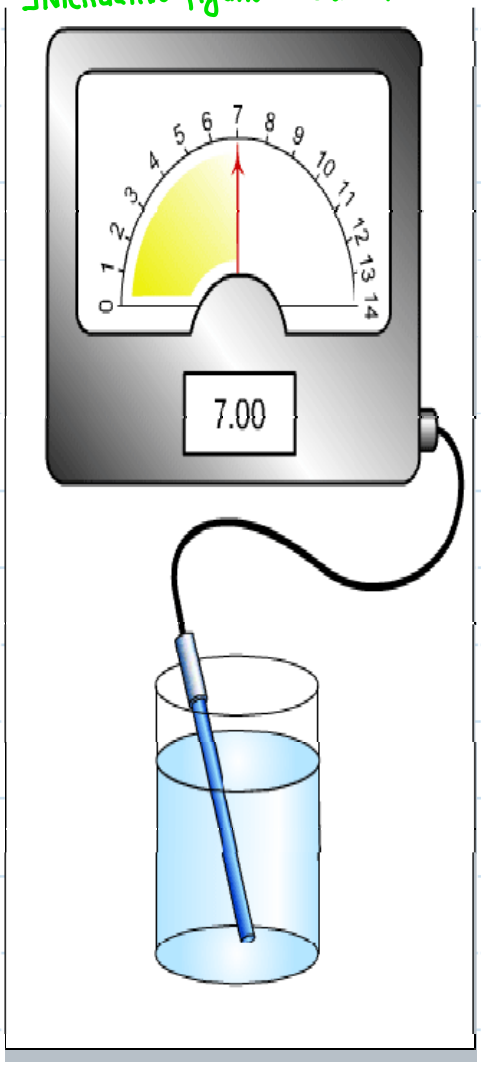
Concentration

0.01 M

Salt: NaCl

pH = 7.00

Interactive figure on class web site



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

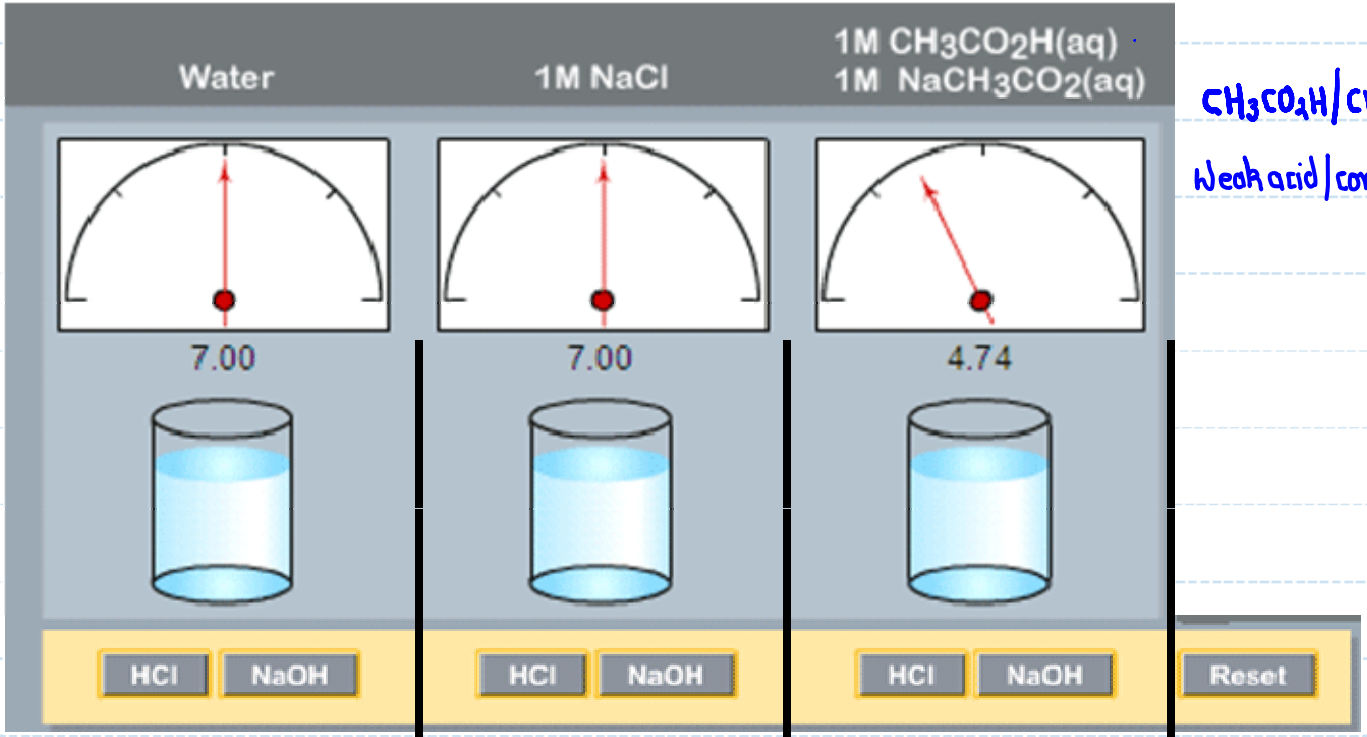
$CN^-(aq) + H_2O(l) \rightleftharpoons HCN(aq) + OH^-$

Pools!

pH Up ... sodium carbonate ... Washing Soda

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

8.10 What Are Buffers?



$CH_3CO_2H/CH_3CO_2^-$

Weak acid/conjugate base

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 changes

Small pH changes.