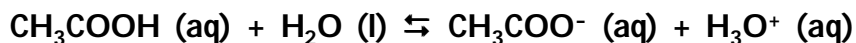


March 27, 2002

- Friday's office hour cancelled
- Registration for Fall Semester
 - ✓ Chem 141 versus Chem 143
 - ✓ Chem 121 (Quantitative Analysis)?
 - ✓ Math? Physics?
- **Quiz on Friday**

1

Back to Equilibrium



I	0.90 mmol/30.00 mL	1.10 mmol/30.00 mL	-
C	-X	+X	+X
E	$3.0 \times 10^{-2} - x$	$3.67 \times 10^{-2} + x$	x

Substituting:

$$1.76 \times 10^{-5} = \frac{(3.67 \times 10^{-2} - x)(x)}{(3.0 \times 10^{-2} + x)}$$

Assume: $x \ll 10^{-2}$

$$\frac{(3.67 \times 10^{-2})x}{(3.0 \times 10^{-2})} = 1.76 \times 10^{-5}$$

$$x' = \boxed{1.44 \times 10^{-5} \text{ M} = [\text{H}_3\text{O}^+]}$$
 (assumption holds: $10^{-5} \ll 10^{-2}$)
2

Effect on pH?

➤ $\text{pH} = -\text{Log}[\text{H}_3\text{O}^+] = \underline{4.84}$

➤ So: $\Delta\text{pH} = 4.75 - 4.84 = \underline{-0.09}$

Compare with adding NaOH to water:

Add: 10.00 mL 0.0100 M NaOH

to 20.00 mL H_2O

$[\text{OH}^-] = \underline{0.100 \text{ mmol OH}^-} = 3.33 \times 10^{-3} \text{ M}$

30.00 mL

So: $\Delta\text{pH} = 7.00 - 11.52 = \underline{-4.52}$ (Huge!)

Very little
change in pH!

pOH = 2.48

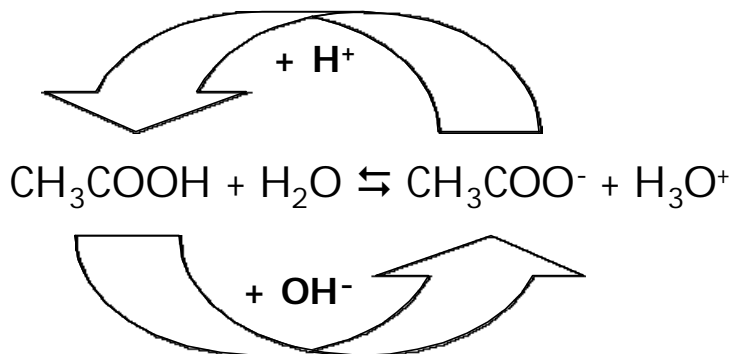
pH = 14.00 - 2.48

pH = **11.52**

3

Buffers

A mixture of a *weak acid* and its *conjugate base*
buffers pH:



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The Henderson-Hasselbalch Equation

➤ Log formulation of the K_a expression:

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

Solve for $[\text{H}_3\text{O}^+]$:

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

$$\text{pH} = \text{p}K_a + \text{Log}([\text{A}^-]/[\text{HA}])$$

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Titration

➤ If K_{rxn} is *large*, then it is useful for titrimetric determinations

➤ We can *predict the pH* of the solution resulting from each addition of titrant in an **acid/base** titration, if we know:

- ✓ Initial concentrations
- ✓ Equilibrium constants

The Process:

- convert to *mmol*
- complete* reaction
- convert to *concentrations*
- ICE to get $[\text{H}_3\text{O}^+]$
- convert to pH

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Example Titration

Let's titrate!

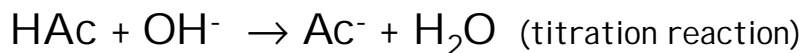
➤ **Analyte:**

50.00 mL 0.100 M Acetic Acid (HAc)

$$K_a = 1.76 \times 10^{-5}$$

➤ **Titrant:** 0.100 M NaOH

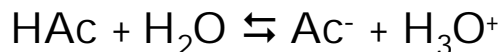
The Chemistry:



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Initial pH (0.00 mL NaOH)

Just HAc (weak acid) alone in solution:



I	0.100 M	-	-
C	-x	+x	+x
E	0.100 - x	x	x

$$K_a = \frac{x^2}{0.100 - x}$$

$$x = 1.318 \times 10^{-3} = [\text{H}_3\text{O}^+]$$

$$\text{pH} = \underline{\underline{2.88}}$$

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