April 1, 2002

- Quiz Review
- Problem Session Today (A531 Cook; 3-4 pm)
- ***It's "Double Quiz" Week!***
  - ☺Comprehensive
  - ☺Counts TRIPLE
  - ☺Replaces the Final Exam
  - ☺No Partial credit!
  - ☺No Periodic Table
  - ☺Can't use a writing implement!
  - ☺Must communicate your answers telepathically
  - ☺Must use only Sanskrit or another dead language
  - ☺If you can read this, you don't need glasses!
  - ☺If you can read this, you may have won 1 million dollars!
  - ☺Happy April Fools Day!

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Polyprotic Acids

- What if an acid has more than one acidic proton?

Example: H_2CO_3

$H_2CO_3 \leftrightarrows H^+ + HCO_3^-$ $\quad K_1 = 4.3 \times 10^{-7}$

$HCO_3^- \leftrightarrows H^+ + CO_3^{2-}$ $\quad K_2 = 4.8 \times 10^{-11}$

If $K_1 >> K_2$: Treat as *separate acids*

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Titration of H_2CO_3

Reaction with OH^- occurs *stepwise:*

H_2CO_3 reacts first:

$$H_2CO_3 + OH^- \rightarrow HCO_3^- + H_2O$$

HCO_3^- reacts only once all H_2CO_3 is gone:

$$HCO_3^- + OH^- \rightarrow CO_3^{2-} + H_2O$$

H_2CO_3: Weak Acid H_2CO_3/HCO_3^-: Buffer

CO_3^{2-}: Weak Base HCO_3^-/CO_3^{2-} : Buffer

HCO_3^-: *Amphoteric* (acts as both acid and a base)

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Dealing with HCO_3^-

- **Will a solution of HCO_3^- be acidic or basic?**

Two equilibria:

$HCO_3^- \leftrightarrows H^+ + CO_3^{2-}$ $K_2 = 4.8 \times 10^{-11}$

$HCO_3^- + H_2O \leftrightarrows H_2CO_3 + OH^-$ $K_b = K_w/K_1 = 2.3 \times 10^{-8}$

$K_b > K_2$, so HCO_3^- is a stronger *base* than acid
(solution will be basic)

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Quantitatively?

- It can be shown that:

$$[H^+] = \left[\frac{K_1K_2[HA^-] + K_1K_w}{K_1 + [HA^-]}\right]^{1/2}$$

✓But HCO_3^- is such a weak acid/base that it dissociates very little: $[HCO_3^-] \approx C_{HCO3-}$

✓Also, if: $C_{HCO3-} >> K_1$ and $K_2 >> K_w$

THEN: $\boxed{[H^+] = (K_1K_2)^{½}}$ $(pH = ½[pK_1 + pK_2])$

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