

Chapter 9

Monoprotic Acids & Bases

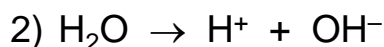
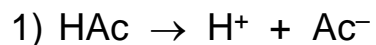
- I. Weak Acids
- II. Weak Bases
- III. Buffers
- IV. Making a Buffer

I. Weak Acids

Ex: Calculate the pH of a 0.150 M acetic acid solution ($K_a = 1.76 \times 10^{-5}$)

I. Weak Acids (cont.)

2 sources of H^+ :



We assume $[Ac^-] \gg [OH^-]$, so 2) is ignored.

This breaks down in a general case if:

1) K_a is very small (large pK_a)

2) $[HA]_{\text{formal}}$ is very small

I. Weak Acids (cont.)

Ex: What is the pH of a weak acid (HA) with a pK_a of 9.0, and a formal concentration of 1.0×10^{-6} ?

i. Normal way: assume all H^+ comes from HA

ii. "The Method"

II. Weak Bases

Ex: Calculate the pH of a 0.0500 M $\text{Ca}(\text{CN})_2$ solution.

III. Buffers

Def: A mixture of a weak acid and its conjugate base (or a weak base and its conjugate acid) which resists changes in pH when acids or bases are added.

III. Buffers (cont.)

Ex: Consider a 1.00-L buffer made by adding 0.140 mol cyanic acid (HCNO) and 0.110 mol potassium cyanate (KCNO) to sufficient water. Calculate the pH of the buffer:

- before any acid or base is added.
- after addition of 0.0150 mol HNO_3^*
- after addition of 0.0150 mol NaOH^*

*assume no change in volume

III. Buffers (cont.)

Ex:

- Calculate the pH of a solution that is 0.200 M in NH_3 and 0.300 M in NH_4Cl .
- Calculate the pH after 100.0 mL of 0.0500 M NaOH is added to 400.0 mL of buffer.
- Calculate the pH after 100.0 mL of 0.0500 M HCl is added to 400.0 mL of buffer.
- Calculate the pH after 100.0 mL of 1.00 M HCl is added to 400.0 mL of buffer.

IV. Making a Buffer

Buffer Capacity (β):

informal definition: how well a buffer resists a pH change when strong acid or strong base is added

β is at a maximum when $\text{pH} = \text{pK}_a$



when choosing a buffer system, find a pK_a close to the desired pH

IV. Making a Buffer (cont.)

Ex: If you want buffer at $\text{pH} = 7.60$, one choice would be TRIS* ($\text{pK}_a = 8.08$).

*Tris(hydroxymethyl)aminomethane
TRIS or THAM, $(\text{HOCH}_2)_3\text{CNH}_2$

Making the buffer:

You want 250.0 mL of 0.200 M tris buffer at $\text{pH} = 7.60$.

IV. Making a Buffer (cont.)

Three methods:

First method:

Weigh out appropriate amounts of tris and tris-H⁺, then dissolve to a final volume.

Ex: You have solid tris (FW = 121.135) and solid tris-HCl (FW = 157.597)

IV. Making a Buffer (cont.)

Second method:

Weigh out appropriate amount of tris, add strong acid to desired pH, and dilute to final volume.

Ex: You have solid tris and ~0.500 M HCl. How much solid should you start with? Approximately how much HCl will be added?

IV. Making a Buffer (cont.)

Third method:

Weigh out appropriate amount of tris-H⁺, add strong base to desired pH, and dilute to final volume.

Ex: You have solid tris-HCl and ~0.500 M NaOH. How much solid should you start with? Approximately how much NaOH will be added?