POLYPROTIC ACID-BASE TITRATIONS

CHEM 251 SDSU

POLYPROTIC ACIDS/BASES

- As the polyprotic acids and bases are all weak acids or bases, they can be treated similarly when it comes to pH titrations.
- The key variation is the increase in equivalence points and how the pH is determined at those points.

SAMPLE PROBLEM

Plot the titration curve for the titration of 12.0 mL of 22.0 mM potassium carbonate with 30.0 mM HNO_3.

Determine the pH after the following volumes of titrant have been added:

A) 2.00 mL of titrant
B) 5.00 mL of titrant
C) 8.80 mL of titrant
D) 10.00 mL of titrant
E) 13.00 mL of titrant
F)17.60 mL of titrant

PH BEFORE THE V_{EQ}

- Before any titrant is added the pH is determined by the K_a.
- Before the equivalence point the analyte will be in excess (dominant species).
- As titrant is added the concentration of the conjugate to the analyte is increased.
- This results in a buffer being formed - Henderson-Hasselbach equation.

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PH AT INTERMEDIATE EQUIVALENCE POINTS

- At the **intermediate equivalence points** the moles all of the weak polyprotic acid has been converted into a single form, between two equilibria.
    - $H_3A \rightleftharpoons \mathbf{H_2A^-} \rightleftharpoons \mathbf{HA^{2-}} \rightleftharpoons A^{3-}$

- We must incorporate the two K_a values into the calculation of the pH.

$$[H^+] = \sqrt{\frac{K_{a_1}K_{a_2}F + K_{a_1}K_w}{K_{a_1} + F}}$$

For H_2A^-

$$[H^+] = \sqrt{\frac{K_{a_2}K_{a_3}F + K_{a_2}K_w}{K_{a_2} + F}}$$

For HA^{2-}

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PH BETWEEN EQUIVALENCE POINTS

- At this stage the polyprotic acid (or base) begins to act as a buffer once again.
- The Henderson-Hasselbach trick of using volumes can apply, but with a little twist.
- You must account for the volume of titrant that went into getting to the prior equivalence point(s).

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PH AT THE FINAL EQUIVALENCE POINT

- At the final equivalence point the weak acid (base) has been fully (de)protonated.
- It can be treated as a simple monoprotic weak acid (base) by using K_{a1} (K_{b1}).
- You must remember to account for the dilution of the acid (find the new formal concentration).

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