CONCEPT: TITRATIONS: DIPROTIC & POLYPROTIC BUFFERS

Diprotic Buffers

- Deal with the presence of ____ equivalence points and Henderson-Hasselbalch Equations as a result of 2 K_a values.
  - □ The relationships between the equivalence points and equations are shown as:

Diprotic Buffers

Dissociation Steps	H_2A _______ Form	$\rightleftharpoons$	HA^- ____________ Form	$\rightleftharpoons$	A^{2-} _______ Form
Ka-Kb Equations	____ • ____ = K_w			____ • ____ = K_w	
Henderson–Hasselbalch Equations	pH = pKa__ + log $\frac{[\quad\quad]}{[\quad\quad]}$			pH = pKa__ + log $\frac{[\quad\quad]}{[\quad\quad]}$	

Henderson-Hasselbalch Equation

$$pH = pKa + \log\frac{[Base]}{[Acid]}$$

EXAMPLE: Calculate the pH of 100 mL of a 0.250 M H_2CO_3 when 120.0 mL of 0.250 M NaOH are added. $Ka_1 = 4.3 \times 10^{-7}$ and $Ka_2 = 5.6 \times 10^{-11}$.

Calculate the equivalence volume needed by the strong species to reach the _____ equivalence point.

Titrant (Reacting Volume)

Volume of strong species reacting = ____________ volume – ____________ volume

Use **STEPS 1 to 3** to setup the ICF Chart.

- □ _______ the 1st equivalence point volume: Start with the acidic form and pK_{a1}.
- □ _______ the 1st equivalence point volume: Start with the intermediate form and pK_{a2}.

ICF Chart (Diprotic Buffers)

	_______ (aq)	+ _______ (aq)	$\rightleftharpoons$ _______ ( )	+ _______ ( )
I_______				
C_______				
F_______				

STEP 4: The Henderson-Hasselbalch Equation is used for a ________ to find the pH of a solution.

- □ Using the **FINAL ROW**, use the moles of the ___________ and ___________ to find the pH.

Henderson–Hasselbalch Equation

$$pH = pK\_\_ + \log\frac{[\quad\quad]}{[\quad\quad]} = -\log(\quad\quad\quad) + \log\frac{[\quad\quad]}{[\quad\quad]} =$$

CONCEPT: TITRATIONS: DIPROTIC & POLYPROTIC BUFFERS

Polyprotic Buffers

● Deal with the presence of ____ equivalence points and Henderson-Hasselbalch Equations as a result of 3 K_a values.

□ The relationships between the equivalence points and Henderson-Hasselbalch equations are shown as:

Polyprotic Buffers

Dissociation Steps	H_3A ______ Form	$\rightleftharpoons$ H_2A^- ____________ Form 1	$\rightleftharpoons$ HA^{2-} ____________ Form 2	$\rightleftharpoons$ A^{3-} ______ Form
Ka-Kb Equations		___ • ___ = K_w	___ • ___ = K_w	___ • ___ = K_w
Henderson–Hasselbalch Equations	pH = pKa__ + log $\frac{[\quad]}{[\quad]}$	pH = pKa__ + log $\frac{[\quad]}{[\quad]}$	pH = pKa__ + log $\frac{[\quad]}{[\quad]}$	

Henderson-Hasselbalch Equation

$$pH = pKa + \log \frac{[Base]}{[Acid]}$$

EXAMPLE: Calculate the pH of 30.0 mL of a 0.10 M $H_3C_6H_5O_7$ when 50.0 mL of 0.20 M NaOH are added. $K_{a1} = 7.4 \times 10^{-4}$, $Ka_2 = 1.7 \times 10^{-5}$ and $Ka_3 = 4.0 \times 10^{-7}$.

Calculate the equivalence volume needed by the strong species to reach the _____ equivalence point.

Titrant (Reacting Volume)

Volume of strong species reacting = ____________ volume – ____________ volume

Use **STEPS 1 to 3** to setup the ICF Chart.

□ _______ the 1st equivalence point volume: Start with the acidic form and pK_{a1}.

□ _______ the 1st equivalence point volume: Start with the intermediate form 1 and pK_{a2}.

□ _______ the 2nd equivalence point volume: Start with the intermediate form 2 and pK_{a3}.

ICF Chart (Polyprotic Buffers)

	_______ (aq)	+ _______ (aq)	$\rightleftharpoons$ _______ ( )	+ _______ ( )	
I_______					
C_______					
F_______					

STEP 4: Using the **FINAL ROW**, use the moles of the ___________ and ___________ to find the pH.

Henderson–Hasselbalch Equation

$$pH = pK\_\_ + \log \frac{[\quad]}{[\quad]} = -\log(\qquad\qquad) + \log \frac{[\quad]}{[\quad]} =$$

CONCEPT: TITRATIONS: DIPROTIC & POLYPROTIC BUFFERS

PRACTICE: Calculate the pH of 75.0 mL of a 0.10 M of phosphorous acid, H_3PO_3, when 80.0 mL of 0.15 M NaOH are added. $K_{a1} = 5.0 \times 10^{-2}$, $Ka_2 = 2.0 \times 10^{-7}$.

PRACTICE: Find the pH when 100.0 mL of a 0.1 M dibasic compound B ($pKb_1 = 4.00$; $pK_{b2} = 8.00$) was titrated with 11 mL of a 1.00 M HCl.

PRACTICE: Suppose you have 50.1 mL of a H_3PO_4 solution that you titrate with 15.4 mL of 0.10 M KOH solution to reach the endpoint. What is the concentration of H_3PO_4 of the original H_3PO_4 solution?