CONCEPT: TITRATIONS: WEAK ACID–STRONG BASE

- This type of titration has the _____________ as the titrate and the _____________ as the titrant.
  - □ When a weak species reacts with a strong species use an **ICF (I______, C________, F_______) Chart.**
  - □ The **ICF** Chart is used to calculate the __________ amounts of compounds.
  - □ The units of an **ICF** Chart will be in _________.

Before the Equivalence Point

- In this part of the titration, the moles of weak acid is ____________ the moles of strong base.
  - □ As the Strong Base neutralizes the Weak Acid, some Conjugate Base is formed.

EXAMPLE: Consider the titration of 75.0 mL of 0.0300 M $HC_3H_3O_3$ ($K_a = 4.1 \times 10^{-3}$) with 12.0 mL of 0.0450 M KOH. Calculate the pH.

STEP 1: Setup an ICF Chart with the strong species set as a _______________.

- □ The strong species must then react with its chemical _______________.

ICF Chart (Weak Acid-Strong Base)

	_______ (aq) +	_______ (aq) ⇌	_______ ( ) +	_______ ( )
I_______				
C_______				
F_______				

STEP 2: Using the **INITIAL ROW**, place the given amounts in ____________.

- □ In an ICF Chart we only care about the _________________, ________________, & _________________.

STEP 3: Using the **CHANGE ROW**, looking at the reactants subtract from their initial amounts by the ______ mole amount.

- □ Using the Law of Conservation of Mass, whatever you lose as a reactant you _______ that amount to products.

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

$$pH = pK_a + \log \frac{[CB]}{[WA]}$$

$$pH = pK_b + \log \frac{[CA]}{[WB]}$$

CONCEPT: TITRATIONS: WEAK ACID–STRONG BASE

PRACTICE: In order to create a buffer 7.510 g of sodium cyanide is mixed with 100.0 mL of 0.250 M hydrocyanic acid, HCN. What is the pH of the buffer solution after the addition of 12.0 mL of 0.300 M NaH? $K_a = 4.9 \times 10^{-10}$.

CONCEPT: TITRATIONS: WEAK ACID–STRONG BASE

At the Equivalence Point

● In this part of the titration the moles of weak acid is _____________ the moles of strong base.

  □ The weak acid and strong base have been _____________ and only the conjugate base remains.

EXAMPLE: Consider the titration of 75.0 mL of 0.0300 M $HC_3H_3O_3$ (K_a = 4.1 X 10^{-3}) with 50.0 mL of 0.0450 M KOH. Calculate the pH.

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

ICF Chart (Weak Acid-Strong Base)

	_______ (aq)	+ _______ (aq)	⇌ _______ ( )	+ _______ ( )
I_______				
C_______				
F_______				

STEP 4: Using the **FINAL ROW**, determine the concentration of the conjugate base.

  □ Divide its final _________ at by the total volume used in the chemical reaction.

STEP 5: Setup an ICE Chart for the conjugate base that has it reacting with __________.

  □ For **Ionic Bases**, ___________ the neutral metal cation.

pH & pOH Formulas

pH + pOH = 14

pH = - log [H^+]
[H^+] = 10^{-pH}

pOH = - log [OH^-]
[OH^-] = 10^{-pOH}

ICE Chart (Conjugate Base)

	$C_3H_3O_3^-$ (aq)	+ _______ ( )	⇌ _______ ( )	+ _______ ( )
I_______				
C_______				
E_______				

STEP 6: Using the **EQUILIBRIUM ROW**, setup the equilibrium constant expression with ______ and solve for ____.

  □ Check if a shortcut can be utilized to avoid the ________________ formula.

ICE Chart Shortcut

500 Approximation Method

When the ratio of [ ]$_0$ to K is __>__ 500 you can ignore the __– x__.

$K_w = K_a \times K_b$ ⇒

$\frac{[\ ]_0}{K}$ = __________ =

_______ = $\frac{[x^2]}{[\quad - x]}$

Quadratic Formula

$$\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

STEP 7: The ____ variable will equal **[** **]** and can be used to solve pOH.

CONCEPT: TITRATIONS: WEAK ACID–STRONG BASE

PRACTICE: Consider the titration of 75.0 mL of 0.60 M HNO_2 with 0.100 M NaOH at the equivalence point. What would be the pH of the solution at the equivalence point? The K_a of HNO_2 is 4.6×10^{-4}.

CONCEPT: TITRATIONS: WEAK ACID–STRONG BASE

After the Equivalence Point

- In this part of the titration the moles of weak acid is _____________ the moles of strong base.
  - □ There will be ________ strong base remaining after it has neutralized the weak acid.

EXAMPLE: Consider the titration of 75.0 mL of 0.0300 M $HC_3H_3O_3$ ($K_a = 4.1 \times 10^{-3}$) with 75.0 mL of 0.0450 M KOH. Calculate the pH.

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

ICF Chart (Weak Acid-Strong Base)

	________ (aq) +	________ (aq) ⇌	________ ( ) +	________ ( )
I________				
C________				
F________				

STEP 4: Using the **FINAL ROW**, determine the concentration of the strong base.

- □ Divide its final _________ by the total volume used in the chemical reaction.

STEP 5: Recall, the concentration of the strong base will be equal to ______.

pH & pOH Formulas

pH + pOH = 14

pH = - log $[H^+]$
$[H^+] = 10^{-pH}$

pOH = - log $[OH^-]$
$[OH^-] = 10^{-pOH}$

PRACTICE: Calculate the pH of the solution resulting from the mixing of 55.0 mL of 0.100 M NaCN and 75.0 mL of 0.100 M HCN with 0.0090 moles of NaOH.