

## CONCEPT: WEAK ACID-STRONG BASE TITRATIONS

Whenever you titrate a WEAK Species with a STRONG species you use an \_\_\_\_\_ CHART.

The following can be used as a roadmap for determining the pH for a Weak Acid-Strong Base Titration.

### Equivalence Volume ( $V_e$ )

Calculate the equivalence volume,  $V_e$ , in order to determine the volume of titrant required to reach the equivalence point.

The titration of 300.0 mL of 0.100 M  $\text{HNO}_2$  with 0.30 M KOH

### Before any Strong Base is added

The titration of 300.0 mL of 0.100 M  $\text{HNO}_2$  with 0.00 mL of 0.300 M KOH

	$\text{HNO}_2$	+	$\text{H}_2\text{O}$	$\rightleftharpoons$	$\text{NO}_2^-$	+	$\text{H}_3\text{O}^+$
<b>Initial</b>	0.100 M				0.00 M		0.00 M
<b>Change</b>	- x				+ x		+ x
<b>Equilibrium</b>	0.100 - x				+ x		+ x

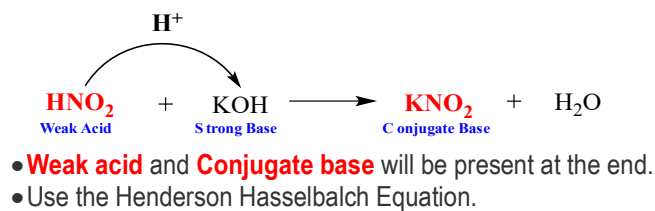
$$K_a = \frac{x^2}{[ ]_0 - x} \therefore x = [\text{H}^+] \therefore \text{pH} = -\log[\text{H}^+]$$

$$\frac{[ ]_0}{K_a} > 500 \quad \text{5\% Approximation Method}$$

### Before Equivalence Point

The titration of 300.0 mL of 0.100 M  $\text{HNO}_2$  with 50.00 mL of 0.300 M KOH

	$\text{HNO}_2$ Weak Acid	+	KOH Strong Base	$\longrightarrow$	$\text{NO}_2^-$ Conjugate Base	+	$\text{H}_2\text{O}$
<b>Initial</b>	0.030 moles		0.015 moles		0.000 moles		
<b>Change</b>	- 0.015 moles		- 0.015 moles		+ 0.015 moles		
<b>Final</b>	0.015 moles		0		0.015 moles		



$$\text{pH} = \text{pK}_a + \log \left( \frac{\text{Conjugate Base}}{\text{Weak Acid}} \right)$$

## CONCEPT: WEAK ACID-STRONG BASE TITRATIONS

### At Equivalence Point

At the equivalence point of a weak acid-strong base titration the solution is \_\_\_\_\_ and pH \_\_\_\_ 7.

□ The titration of 300.0 mL of 0.100 M  $\text{HNO}_2$  with 100.0 mL of 0.300 M KOH.

	$\text{HNO}_2$ Weak Acid	+	KOH Strong Base	$\longrightarrow$	$\text{NO}_2^-$ Conjugate Base	+	$\text{H}_2\text{O}$
Initial	0.030 moles		0.030 moles		0.000 moles		
Change							
Final							

#### At the Equivalence Point

- Only **Conjugate base** will be present at the end.
- Use an ICE chart to find pH.

$$[\text{CB}] = \frac{\text{mole left}}{\text{Total liters}} \quad \therefore K_b = \frac{x^2}{[\text{CB}]}$$

	$\text{NO}_2^-$ Conjugate Base	+	$\text{H}_2\text{O}$	$\longrightarrow$	$\text{HNO}_2$	+	$\text{OH}^-$
Initial							
Change							
Equilibrium							

### After Equivalence Point

After the equivalence point of a weak acid-strong base titration we will have excess strong base remaining.

□ The titration of 300.0 mL of 0.100 M  $\text{HNO}_2$  with 130.0 mL of 0.300 M KOH.

	$\text{HNO}_2$ Weak Acid	+	KOH Strong Base	$\longrightarrow$	$\text{NO}_2^-$ Conjugate Base	+	$\text{H}_2\text{O}$
Initial	0.030 moles		0.039 moles		0.00 moles		
Change							
Final							

#### After the Equivalence Point

- **Strong Base** will be present at the end.

$$[\text{SB}] = \frac{\text{moles left}}{\text{Total moles}} \quad \therefore \text{pOH} = -\log[\text{SB}]$$

### **CONCEPT: WEAK ACID-STRONG BASE TITRATIONS CALCULATIONS**

**EXAMPLE:** Consider the titration of 75.0 mL of 0.0300 M  $\text{H}_3\text{C}_3\text{O}_3$  ( $K_a = 4.1 \times 10^{-3}$ ) with 30.0 of 0.0450 M KOH.

Calculate the pH.

**PRACTICE:** Consider the titration of 50.0 mL of 0.0150 M HF 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 HF is  $3.5 \times 10^{-4}$ .