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 HNO_2 with 0.30 M KOH

Before any Strong Base is added

The titration of 300.0 mL of 0.100 M HNO_2 with 0.00 mL of 0.300 M KOH

	HNO_2 +	H_2O ⇌	NO_2^- +	H_3O^+
Initial	**0.100 M**	X	**0.00 M**	**0.00 M**
Change	**- x**		**+ x**	**+ x**
Equilibrium	**0.100 - x**		**+ x**	**+ x**

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

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

Before Equivalence Point

The titration of 300.0 mL of 0.100 M HNO_2 with 50.00 mL of 0.300 M KOH

	HNO_2 (Weak Acid) +	KOH (Strong Base) →	NO_2^- (Conjugate Base) +	H_2O
Initial	**0.030 moles**	**0.015 moles**	**0.000 moles**	X
Change	**- 0.015 moles**	**- 0.015 moles**	**+ 0.015 moles**	
Final	**0.015 moles**	**0**	**0.015 moles**	

$$HNO_2 \text{ (Weak Acid)} + KOH \text{ (Strong Base)} \xrightarrow{} KNO_2 \text{ (Conjugate Base)} + H_2O \quad (H^+ \text{ transferred from } HNO_2 \text{ to } KOH)$$

- **Weak acid** and **Conjugate base** will be present at the end.
- Use the Henderson Hasselbalch Equation.

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

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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 HNO_2 with 100.0 mL of 0.300 M KOH.

	HNO_2 (Weak Acid)	+ KOH (Strong Base)	→ NO_2^- (Conjugate Base)	+ H_2O
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.

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

	NO_2^- (Conjugate Base)	+ H_2O	→ HNO_2	+ 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 HNO_2 with 130.0 mL of 0.300 M KOH.

	HNO_2 (Weak Acid)	+ KOH (Strong Base)	→ NO_2^- (Conjugate Base)	+ H_2O
Initial	0.030 moles	0.039 moles	0.00 moles	
Change				
Final				

After the Equivalence Point

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

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

<u>CONCEPT:</u> <u>WEAK ACID-STRONG BASE TITRATIONS CALCULATIONS</u>

EXAMPLE: Consider the titration of 75.0 mL of 0.0300 M $H_3C_3O_3$ ($K_a = 4.1 \times 10^{-3}$) 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 3.5×10^{-4}.