

# AP CHEMISTRY

## TOPIC 7: ACIDS & BASES, PART D

## EXAMPLES, PART II

Day 81:

- Polyprotic acids
- Amphoteric substance
- Acid-Base salts

Example #1: Calculate the pH of a 0.10 M  $\text{NH}_4\text{Cl}$  solution.  $K_b$  value for  $\text{NH}_3$  is  $1.8 \times 10^{-5}$ .



( $\text{NH}_4^{+1}$ , conjugate acid of a weak base,  $\text{Cl}^{-1}$ , conjugate base of a strong acid)

The chlorine ion,  $\text{Cl}^{-1}$ , has no effect on the solution to make it basic or acidic.

$$K_a = \frac{K_w}{K_b} = \frac{1.00 \times 10^{-14}}{1.8 \times 10^{-5}} = 5.56 \times 10^{-10}$$

	$[\text{NH}_4^{+1}]$	+	$[\text{H}_2\text{O}]$	$\leftrightarrow$	$[\text{NH}_3]$	+	$[\text{H}_3\text{O}^{+1}]$
<b>I</b>	0.10 M		-		0		0
<b>C</b>	- x		-		+ x		+ x
<b>E</b>	0.10 M - x		-		x		x

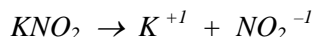
$$K_a = 5.56 \times 10^{-10} = \frac{[\text{NH}_3][\text{H}_3\text{O}^{+1}]}{[\text{NH}_4^{+1}]} = \frac{x^2}{0.10 - x} = \frac{x^2}{0.10}$$

$$x^2 = (0.10) \times (5.56 \times 10^{-10}), \quad x = \sqrt{5.56 \times 10^{-11}} = 7.45 \times 10^{-6}$$

$$[\text{H}_3\text{O}^{+1}] = 7.45 \times 10^{-6} \text{ M}$$

$$\text{pH} = -\log(7.45 \times 10^{-6}) = \mathbf{5.13}$$

Example #2: Calculate the pH of a 0.30 M  $\text{KNO}_2$  solution.  $K_a$  value for  $\text{HNO}_2$  is  $4.0 \times 10^{-4}$ .



( $\text{K}^{+1}$ , conjugate acid of a strong base,  $\text{NO}_2^{-1}$ , conjugate base of a weak acid)

The sodium ion,  $\text{K}^{+1}$ , has no effect on the solution to make it basic or acidic.

$$K_b = \frac{K_w}{K_a} = \frac{1.00 \times 10^{-14}}{4.0 \times 10^{-4}} = 2.5 \times 10^{-11}$$

	$[\text{NO}_2^{-1}]$	+	$[\text{H}_2\text{O}]$	$\leftrightarrow$	$[\text{HNO}_2]$	+	$[\text{OH}^{-1}]$
<b>I</b>	0.30 M		-		0		0
<b>C</b>	- x		-		+ x		+ x
<b>E</b>	0.30 M - x		-		x		x

$$K_b = 2.5 \times 10^{-11} = \frac{[\text{HNO}_2][\text{OH}^{-1}]}{[\text{NO}_2^{-1}]} = \frac{x^2}{0.30 - x} = \frac{x^2}{0.30}$$

$$x^2 = (0.30) \times (2.5 \times 10^{-11}), \quad x = \sqrt{7.50 \times 10^{-12}} = 2.74 \times 10^{-6}$$

$$[\text{OH}^{-1}] = 2.74 \times 10^{-6} \text{ M}$$

$$\text{pOH} = -\log(2.74 \times 10^{-6}) = 5.56$$

$$\text{pH} = 14 - 5.56 = \mathbf{8.44}$$