

# Acid Base Properties of Salts

*Recommended for Chapter(s): 7*

## Demo #025

### Materials NOT in box

1. Safety goggles.

### Procedure

1. Pour 60 mL of each of the solutions into separate 100 mL beakers.
2. Ask students to predict if the solution is acid, basic, or neutral.
3. Write the following chart on the board

Color	PH
Red	2
Red-Orange	3
Orange	4
Orange-Yellow	5
Yellow	6
Green	7
Green-Blue	8
Green-Violet	9
Violet	10

4. Put 1 dropper full of universal indication into each of the beakers to identify the pH.
  - a. 0.1 M KI solution should turn green (pH= 7.0 neutral).
  - b. 0.1 M  $\text{NH}_4\text{Cl}$  solution should turn orange (pH = 4.6 acidic).
  - c. 0.1 M  $\text{NaHSO}_3$  solution should turn red-orange (pH = 4.5 acidic).
  - d. 0.1 M  $\text{NH}_4\text{C}_2\text{H}_3\text{O}_2$  solution should turn green (pH = 7.0)
  - e. 1.0 M  $\text{NaC}_2\text{H}_3\text{O}_2$  solution should turn blue-green (pH = 8.9 basic)

### Safety

1. Wear safety goggles.

### Clean Up

1. Pour all solution in waste bottle.
2. Return the materials to the cart in the demonstration library room.

### Stockroom Notes

1. Empty waste bottle down the drain with plenty of water.
2. Replace glassware with clean glassware.
3. If needed refill any material that is used up.

- a. Make sure at least 100 mL of each solution.
- b. When refilling the universal indicator make sure that you use Fisher universal indicator (S80043A) it should be green in color.
4. Return items to demonstration tub.
5. Return tub to the demonstration library.
  - a. Goggles go in the goggle box

## Discussion

The acid base properties of salts can be determined by looking at what type of acid and base could have formed the salt. The following chart summarizes the acid/base properties of salts. For example the salt NaCl could have been formed by reaction the strong acid HCl and a strong base NaOH in the following reaction  $\text{HCl} + \text{NaOH} \rightarrow \text{NaCl} + \text{H}_2\text{O}$  therefore, according to the chart NaCl is neutral.

Acid	Base	Salt
Strong Acid	Strong Base	Neutral
Strong Acid	Weak Base	Acidic
Weak Acid	Strong Base	Basic
Weak Acid	Weak Base	$K_a > K_b$ Acidic $K_a < K_b$ Basic $K_a = K_b$ Neutral * $K_a$ and $K_b$ are of values for the salt ions

\* This chart may not hold true for polyprotic acids

### KI

$\text{K}^+$  came from KOH which is a strong base.

$\text{I}^-$  came from HI which is a strong acid.

Therefore the solution will be neutral. (pH = 7.0)

### $\text{NH}_4\text{Cl}$

$\text{NH}_4^+$  came from  $\text{NH}_3$  which is a weak base.

$\text{Cl}^-$  came from HCl which is a strong acid.

Therefore the solution will be acidic. (pH= 4.6)

### NaHSO<sub>3</sub>

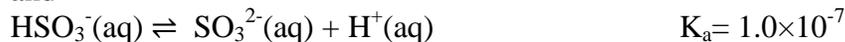
Na<sup>+</sup> came from NaOH which is a strong base.

HSO<sub>3</sub><sup>-</sup> came from H<sub>2</sub>SO<sub>3</sub> which is a weak acid.

However since H<sub>2</sub>SO<sub>3</sub> is polyprotic acid both of the following reactions must be considered:



and



Since K<sub>a</sub> is larger than K<sub>b</sub> the solution will be acidic. (pH = 4.5)

### NH<sub>4</sub>C<sub>2</sub>H<sub>3</sub>O<sub>2</sub>

NH<sub>4</sub><sup>+</sup> came from NH<sub>3</sub> which is a weak base.

C<sub>2</sub>H<sub>3</sub>O<sub>2</sub><sup>-</sup> came from HC<sub>2</sub>H<sub>3</sub>O<sub>2</sub> which is a weak acid.

Need to compare K<sub>a</sub> and K<sub>b</sub> values

$$\text{NH}_4^+ \quad K_a = \frac{K_w}{K_b(\text{NH}_3)} = \frac{1.0 \times 10^{-14}}{1.8 \times 10^{-5}} = 5.6 \times 10^{-10}$$

$$\text{C}_2\text{H}_3\text{O}_2^- \quad K_b = \frac{K_w}{K_a(\text{HC}_2\text{H}_3\text{O}_2)} = \frac{1.0 \times 10^{-14}}{1.8 \times 10^{-5}} = 5.6 \times 10^{-10}$$

Since K<sub>a</sub>=K<sub>b</sub> the solution will be neutral. (pH = 7.0)

### NaC<sub>2</sub>H<sub>3</sub>O<sub>2</sub>

Na<sup>+</sup> came from NaOH which is a strong base.

C<sub>2</sub>H<sub>3</sub>O<sub>2</sub><sup>-</sup> came from HC<sub>2</sub>H<sub>3</sub>O<sub>2</sub> which is a weak acid.

Therefore, the solution will be basic. (pH = 8.8)

K<sub>a</sub> /K<sub>b</sub> values for weak acids/bases of interest in this demonstration.

Acid/Base	What ion it would form in a salt	K <sub>a</sub> (Ion)	K <sub>b</sub> (Ion)
NH <sub>3</sub>	NH <sub>4</sub> <sup>+</sup>		1.8×10 <sup>-5</sup>
H <sub>2</sub> SO <sub>3</sub>	HSO <sub>3</sub> <sup>-</sup> SO <sub>3</sub> <sup>2-</sup>	K <sub>a1</sub> =1.5×10 <sup>-2</sup> K <sub>a2</sub> =1.0×10 <sup>-7</sup>	
HC <sub>2</sub> H <sub>3</sub> O <sub>2</sub>	C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> <sup>-</sup>	1.8×10 <sup>-5</sup>	

*Materials for demo 025*

1. 0.1 M KI
2. 0.1 M  $\text{NH}_4\text{Cl}$
3. 0.1 M  $\text{NaHSO}_4$
4. 0.1 M  $\text{NH}_4\text{C}_2\text{H}_3\text{O}_2$
5. 1.0 M  $\text{NaC}_2\text{H}_3\text{O}_2$
6. Five 100 mL beakers
7. Five Glass stir rods
8. Waste bottle
9. Universal Indicator (Fisher S80043A)