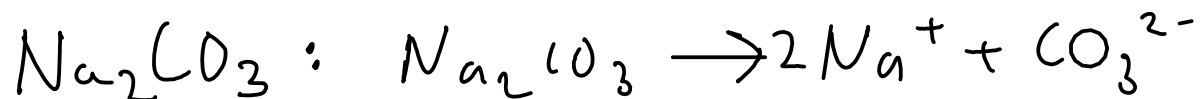


SALTS

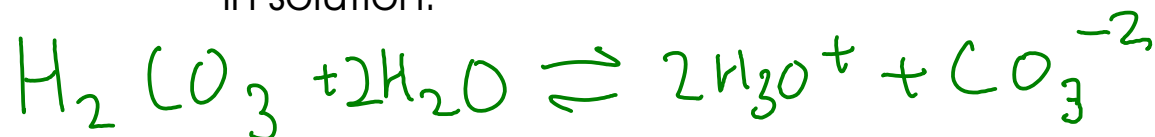
- Compounds that result from the reaction of an acid and a base.
- Salts are strong electrolytes (completely dissociate in water) IF SOLUBLE (not all salts dissolve appreciably).
- Most ionic compounds are considered salts (they can be made by some reaction between the appropriate acid and base)
- Salts have acidic and basic properties! The ions that form when salts are dissolved can be acidic, basic, or neutral.
- Salts made from WEAK ACIDS tend to form BASIC solutions
- Salts made from WEAK BASES tend to form ACIDIC solutions



Do any of these ions have acidic or basic properties?

Na^+ : neutral. Not a proton donor or a proton acceptor

CO_3^{2-} : BASIC, since it can accept protons to form the weak acid CARBONIC ACID in solution.



ACID

BASE

SALT OF A WEAK ACID

ex: $\text{NaC}_2\text{H}_3\text{O}_2$ 

For this reaction to occur, HA MUST be stable in water. In other words, a weak acid.



The anion is a BASE. It can accept a proton from water to form the weak (therefore stable as a molecule!) acid HA

$$K_b = \frac{[\text{HA}][\text{OH}^-]}{[\text{A}^-]} \quad \left| \text{--- This is the base ionization constant for } \text{A}^- \right.$$

Since A^- and HA are a conjugate pair, the ionization constants are related!

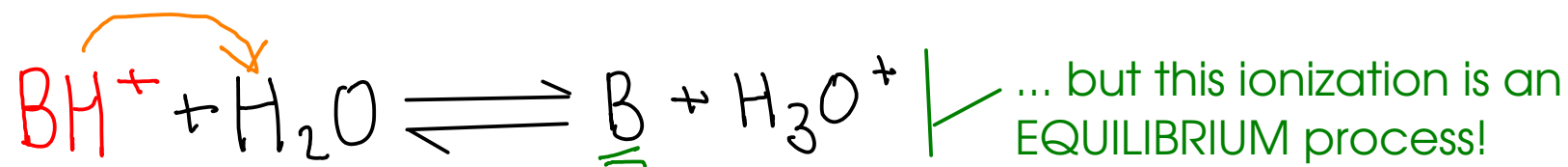
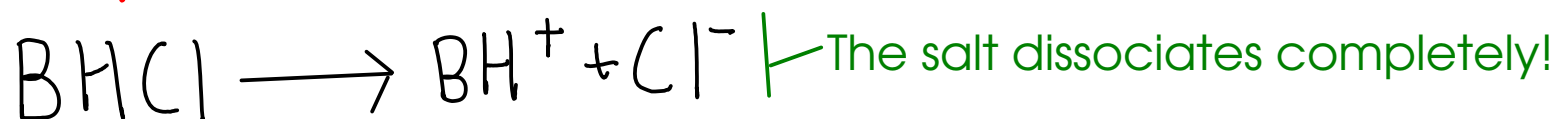
$$K_w = (K_{a,\text{HA}})(K_{b,\text{A}^-})$$

1.0×10^{-14}

$$14 = \text{p}K_a + \text{p}K_b$$

You will generally not find both the K_a AND K_b for a conjugate pair in the literature, since one can be easily converted to the other!

SALT OF A WEAK BASE

ex: NH_4Cl 

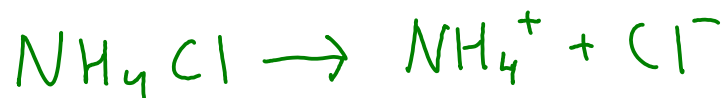
$$K_a = \frac{[\text{B}][\text{H}_3\text{O}^+]}{[\text{BH}^+]} \quad \left| \text{Acid ionization constant for BH}^+ \right.$$

$$K_w = (K_{a,\text{BH}^+})(K_{b,\text{B}})$$

1.0×10^{-14}

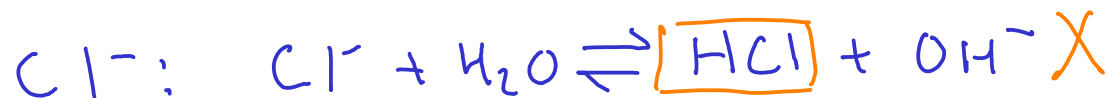
Find the pH for salt solutions just like you would find pH for any other weak acid or weak base solutions. Only trick is to find out whether the salt is actually acidic or basic!

0.100 M NH_4Cl ... Find the pH of the solution



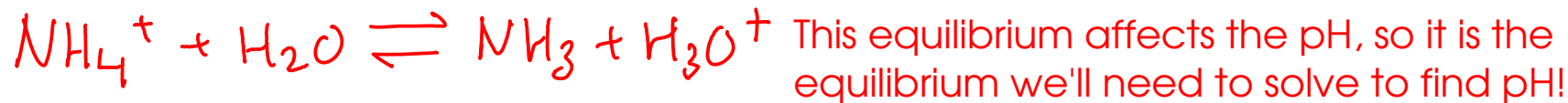
Acidic, basic, or neutral salt?

This is the WEAK BASE ammonia. Stable in water.



This is a STRONG ACID, which does not exist as a stable molecule in water.

The conjugate of a strong acid or base is NEUTRAL - does not affect pH!





$$K_{a, \text{NH}_4^+} = \frac{[\text{NH}_3][\text{H}_3\text{O}^+]}{[\text{NH}_4^+]}$$

We can get K_a for the acid from K_b for the base!

$$K_{b, \text{NH}_3} = 1.8 \times 10^{-5}$$

$$K_a \times K_b = 1.0 \times 10^{-14}$$

$$\text{So, } K_a = 5.56 \times 10^{-10} \quad (\text{for } \text{NH}_4^+)$$

SPECIES	INITIAL CONC	CHANGE	EQUILIBRIUM CONC
H_3O^+	0	+ x	x
NH_3	0	+ x	x
NH_4^+	0.100	- x	0.100 - x

$$\frac{x^2}{0.100 - x} = 5.56 \times 10^{-10}$$

$$\downarrow \begin{array}{l} x \ll 0.100 \\ 0.100 - x = 0.100 \end{array}$$

$$\frac{x^2}{0.100} = 5.56 \times 10^{-10}$$

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

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

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

Compare:

pH = 1.00 for 0.100 M strong acid

pH = 2.16 for 0.100 M nitrous acid

pH = 7.00 for distilled water

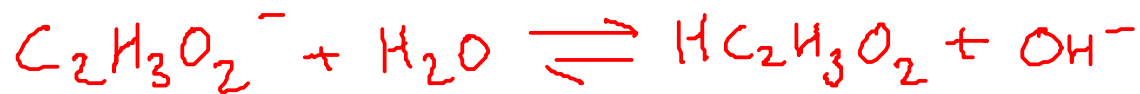
0.100 M $\text{NaC}_2\text{H}_3\text{O}_2$, Find pH



Check the ions formed to see if they are acidic, basic, or neutral!

Na^+ : Cannot be a B-L acid (no H), also not likely to be B-L base, since it's positively charged.

$\text{C}_2\text{H}_3\text{O}_2^-$: Has protons, but also has a negative charge - so it may be more likely to receive protons!



Acetic acid is a WEAK ACID and stable in water, so the acetate ion CAN function as a BASE!



$$K_{b, \text{C}_2\text{H}_3\text{O}_2^-} = \frac{[\text{HC}_2\text{H}_3\text{O}_2][\text{OH}^-]}{[\text{C}_2\text{H}_3\text{O}_2^-]}$$

K_b for acetate ion isn't in the chart in the appendix, but the K_a for acetic acid (the conjugate acid of acetate ion) is available!

$$K_{a, \text{HC}_2\text{H}_3\text{O}_2} = 1.7 \times 10^{-5}; \quad K_a \times K_b = 1.0 \times 10^{-14}, \text{ so}$$

$$K_b = 5.88 \times 10^{-10}$$



$$K_b, \text{C}_2\text{H}_3\text{O}_2^- = \frac{[\text{HC}_2\text{H}_3\text{O}_2][\text{OH}^-]}{[\text{C}_2\text{H}_3\text{O}_2^-]} = 5,88 \times 10^{-10}$$

SPECIES	INITIAL CONC	CHANGE	EQUILIBRIUM CONC
OH^-	0	+ x	x
$\text{HC}_2\text{H}_3\text{O}_2$	0	+ x	x
$\text{C}_2\text{H}_3\text{O}_2^-$	0,100	- x	0,100 - x

$$\frac{x^2}{0,100 - x} = 5,88 \times 10^{-10}$$

↓ $x \ll 0,100$, so $0,100 - x \approx 0,100$

$$\frac{x^2}{0,100} = 5,88 \times 10^{-10}$$

$$x = 7,67 \times 10^{-6} = [\text{OH}^-]$$

$$7.67 \times 10^{-6} = [\text{OH}^-]$$

$$\text{pOH} = -\log_{10}(7.67 \times 10^{-6}) = 5.12$$

Calculate pOH, then convert to pH using 'pH + pOH = 14'

$$\text{pH} = 14.00 - 5.12$$

$$\text{pH} = 8.88$$

Compare:

pH = 7.00 for pure distilled water

pH = 13.00 for 0.100 M strong base

pH = 11.13 for 0.100 M ammonia

0.100 M NaCl, Find pH



Check these ions to see if they're acid, basic, or neutral:

Na^+ : Cannot be a B-L acid (no H), also not likely to be B-L base, since it's positively charged.

Cl^- : Cannot be a B-L acid (no H), but can it act as a base?



↑ This is a STRONG ACID, which does not exist as a stable molecule in water.

So, chloride ion is ALSO a neutral ion!

Since neither sodium ion nor chloride ion affect the water equilibrium, the pH of this solution will be the same as the pH of pure water: 7.00