

# AcidBaseKey

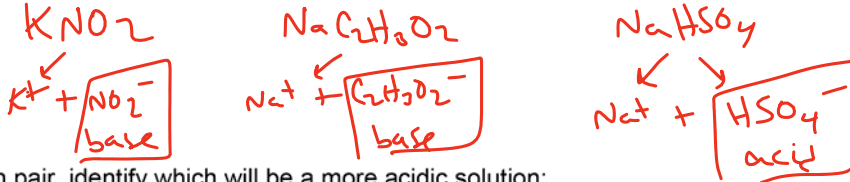
Wednesday, November 30, 2016 1:47 PM

## Acids and Bases

For each of the following salts, predict if a 100 mM solution would be acidic, basic, or neutral.

NaCl  
*neutral*
KNO<sub>2</sub>  
*basic*
sodium acetate  
*basic*
sodium hydrogen sulfate  
*acidic*

Strategy: Break the salt into ions. Is the cation an acid or base? How about the anion? NaCl → Na<sup>+</sup> + Cl<sup>-</sup>. Na<sup>+</sup> is not a proton donor or acceptor. Cl<sup>-</sup> is the conjugate base of a strong acid, so it is NOT a base. Neutral.



For each pair, identify which will be a more acidic solution:

10 mM HCl or 10 mM HF
10 mM H<sub>2</sub>SO<sub>4</sub> or 10 mM HCl
10 mM HNO<sub>3</sub> or 20 μM HNO<sub>2</sub>

Strategy: You need to consider all variables that can influence the amount of H<sub>3</sub>O<sup>+</sup> that is produced: concentration, acid strength, monoprotic vs. diprotic. HCl vs. HF. Equal concentration of monoprotic acids. HCl is a strong acid and HF is a weak acid. HCl will be more acidic.

*strong acid*

*diprotic*

*higher concentration*

Order the following solutions by increasing acidity (lowest pH goes last). A table of pKa is attached.

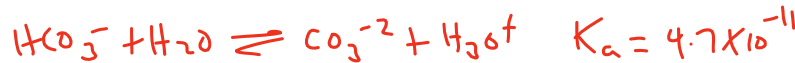
100 mM HF, pKa: 3.2
100 mM HClO, 7.4
100 mM HSO<sub>4</sub><sup>-1</sup>, 1.99
100 mM NH<sub>4</sub><sup>+</sup>, 9.25

*lower pKa = stronger acid*

*NH<sub>4</sub><sup>+</sup>, HClO, HF, HSO<sub>4</sub><sup>-</sup>*

HCO<sub>3</sub><sup>-1</sup> can be an acid or a base. If you have a 100 mM NaHCO<sub>3</sub> solution, will it be acidic or basic?

Hint: Compare the Ka and Kb values. Is this molecule a stronger acid or base?



*K<sub>b</sub> > K<sub>a</sub>*

*so more OH<sup>-</sup> produced*

Hypochlorous acid (HClO) has a pKa of 7.53. What is the Ka? What is the conjugate base? What are the pKb and Kb of the conjugate base?

$$K_a = 10^{-7.53} = 2.95 \times 10^{-8}$$

*ClO<sup>-</sup>*

$$14 - 7.53 = 6.47$$

$$K_b = 10^{6.47} = 2.95 \times 10^{-7}$$

Calculate the pH of each of the following solutions:

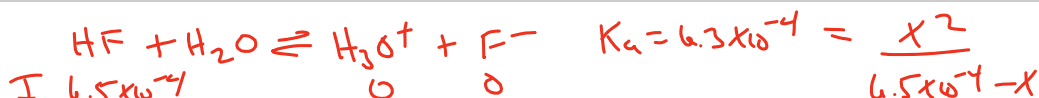
650 μM HCl *← strong acid!*  
*→ 6.5 × 10<sup>-4</sup> M = [H<sub>3</sub>O<sup>+</sup>]*

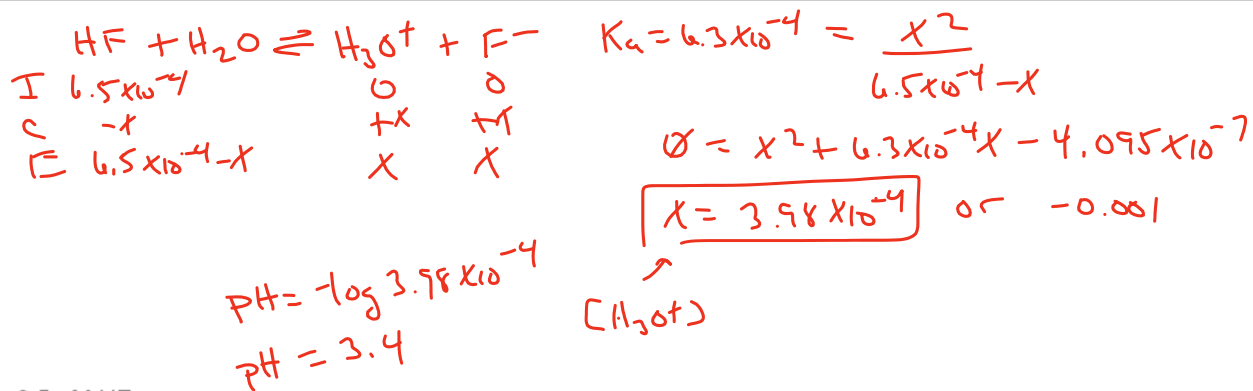
$$pH = -\log(6.5 \times 10^{-4})$$

$$pH = 3.18$$

650 μM HF

*weak acid*

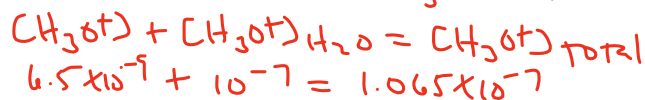




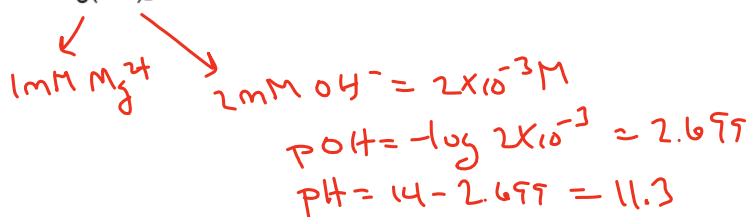
6.5 nM HF



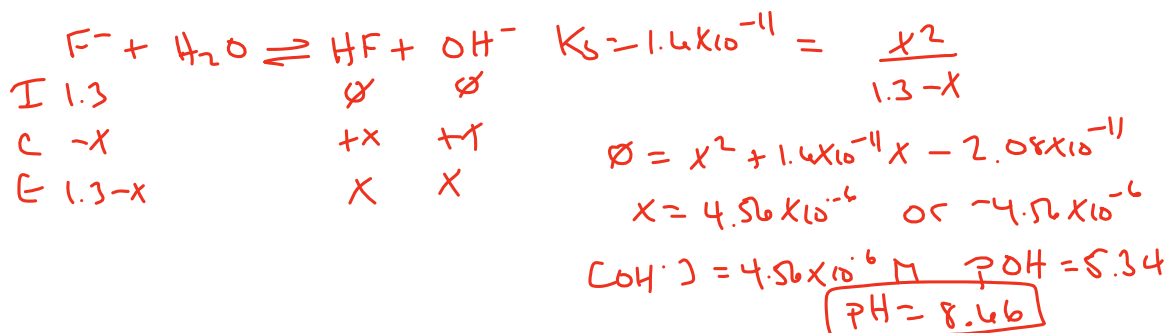
remember when [H<sub>3</sub>O<sup>+</sup>] < 10<sup>-7</sup> when an acid is added, we must account for [H<sub>3</sub>O<sup>+</sup>] from H<sub>2</sub>O (10<sup>-7</sup>)



1 mM Mg(OH)<sub>2</sub>



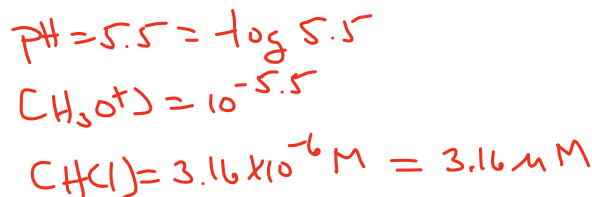
650 mM MgF<sub>2</sub>



For each of the following acids, determine what concentration is needed to have a pH of 5.5. Please answer in micromolar.

Hydrochloric acid

$\downarrow$   
strong acid



Ammonium chloride



I	I	<del>0</del>	<del>0</del>
C	-x	+x	+x
E	I-x	x	x

$$[\text{H}_3\text{O}^+] = x = 10^{-5.5} \text{ M}$$

$$K_a = 5.6 \times 10^{-10} = \frac{(10^{-5.5})^2}{I - 10^{-5.5}}$$

$$5.6 \times 10^{-10} \frac{I}{I - 1.77 \times 10^{-5}} = 10^{-11}$$

$$5.6 \times 10^{-10} I = 1.000177 \times 10^{-11}$$

$$I = 0.01786 \text{ M}$$

$$\boxed{[\text{NH}_4] = 1.786 \times 10^{-4} \text{ M}}$$