

Topics:

- Conductivity: if a solution conducts electricity then mobile ions are present in solution (Demo!)
- Labeling electrolytes (acids, bases or salts) and nonelectrolytes;
- Arrhenius and Brønsted definitions of Acids and Bases
- Writing acid/base reactions, acid/base conjugate pairs, equilibrium favors reactants or products
- Strengths of acids and bases (conductivity? bright vs. dim) (large or small K_a value?)
- K_a / K_b calculations (I, C, E calculations)
- pH calculations $K_w = 1 \times 10^{-14} = [H_3O^+][OH^-]$ and $pH = -\log [H_3O^+]$ and $pH + pOH = 14$
- Titration problems: concepts & stoichiometry (Titration Lab!)
- Salt hydrolysis: ions that are weak acids or weak bases (Demo!)

Practice Problems:

- 1) How do you know that CH_4 must be a non-electrolyte without testing its conductivity? It is NPC
- 2) Is CaF_2 an electrolyte? Yes How can you tell simply by looking at its formula? It is ionic.
- 3) a) If an ionic compound is insoluble in water, why will its aqueous solution not conduct electricity?
Because the ions are not mobile; they are fixed in the lattice.
b) Nevertheless, all ionic compounds are considered electrolytes. Why?
Because they will conduct electricity either as aqueous solutions or in the molten state.
- 4) Pure H_2SO_4 (l) does not conduct electricity, but H_2SO_4 (aq) does conduct electricity.
a) Why doesn't pure H_2SO_4 (l) conduct electricity? It is covalent and has no ions
b) What does water do to the H_2SO_4 ? It causes it to ionize

Complete this equation: H_2SO_4 (l) + H_2O (l) \rightarrow HSO_4^- (aq) + H_3O^+ (aq)

- 5) Why are all acids electrolytes? because they ionize when dissolved in water
- 6) When CH_3OH (l) is dissolved into water, the resulting solution does not conduct. Write the equation for CH_3OH (l) dissolving into water. CH_3OH (l) + H_2O \rightarrow CH_3OH (aq)
a) What must be in the resulting solution. (ions or molecules)? molecules
b) Why do some people assume that CH_3OH is a base? because it has OH
c) How do you know that it is NOT a base? It is not ionic—there is no metal cation
- 7) Complete the following equation for $Mg(OH)_2$ (s) dissolving into water.
 $Mg(OH)_2$ (s) + H_2O \rightarrow Mg^{2+} (aq) + $2 OH^-$ (aq)
a) $Mg(OH)_2$ solid does not conduct electricity. Why not? There are no mobile ions
b) Why does $Mg(OH)_2$ (aq) conduct electricity? It has mobile ions
c) Why is $Mg(OH)_2$ an Arrhenius base? It releases OH^- when dissolved in water
- 8) A solution of NH_3 in water has a pH of 10. Write the equation for NH_3 (g) dissolving into water.

NH_3 (g) + H_2O \rightarrow NH_4^+ (aq) + OH^- (aq)

9) How would you tell a strong acid from a weak acid by testing conductivities using a light bulb?

In a strong acid the bulb should glow brightly, a weak acid it should glow dimly.

10) All of these compounds are electrolytes. Determine if they are acids, bases or salts.

- a) LiOH base d) MgS ionic
b) HNO₂ acid e) Ba(OH)₂ base
c) HCH₃COO acid f) BeCl₂ ionic

11) The K_a values for these hypothetical acids are listed. Which is the stronger acid? Acid A

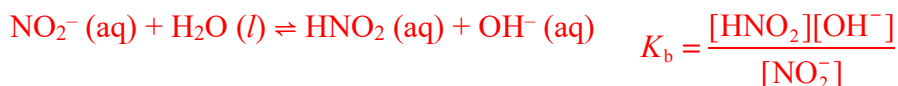
Acid A: K_a = 2.3 × 10⁻⁵

Acid B: K_a = 2.6 × 10⁻⁸

12) Which is a stronger base, NO₂⁻ or HS⁻? HS⁻ How do you know?

HS⁻ is a stronger base because H₂S is a weaker acid. H₂S has a stronger H-X bond than HNO₂.

Write the K_b expression for NO₂⁻. (Write the needed chemical equation first.)



13) According to the Brønsted definition, an acid is a(n) proton donor

According to the Brønsted definition, a base is a(n) proton acceptor

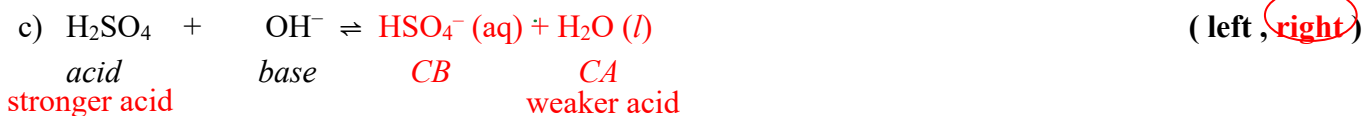
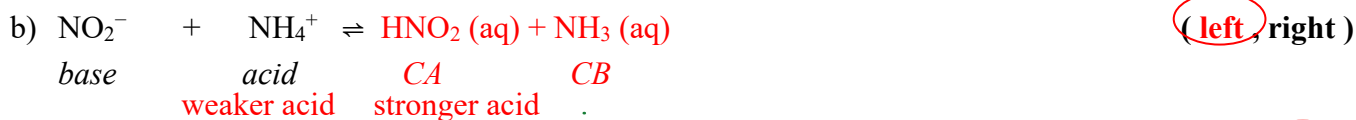
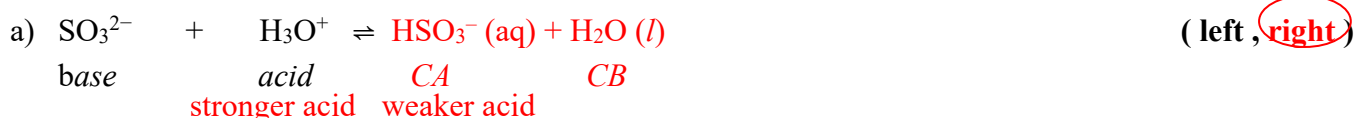
14) Will an aqueous solution of the salt, K₂SO₃, be acidic, neutral or basic? basic Explain why.

Include a chemical equation which supports your answer.

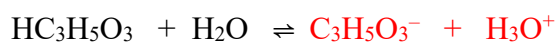
SO₃²⁻ is the conjugate base of a weak acid, so it hydrolyzes.



15) Complete each acid/base reaction. Circle the H⁺ being transferred and draw arrow showing transfer of H⁺. Label conjugate acids and base, label as “stronger acid or weaker acid” and determine if equilibrium lies mainly on the right or the left.



16) A 0.10 M aqueous solution of lactic acid, HC₃H₅O₃, has pH = 2.43. What is the [H₃O⁺] of this solution of lactic acid? What is the K_a for lactic acid? Hint: what is [H₃O⁺]? [H₃O⁺] = 10^{-2.43} = 3.7 × 10⁻³ M



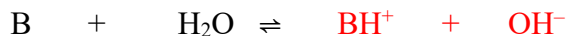
Initial: 0.10 0 0

Change: -3.7 × 10⁻³ +3.7 × 10⁻³ +3.7 × 10⁻³

Equil: 0.10 3.7 × 10⁻³ 3.7 × 10⁻³

$$K_a = \frac{[\text{C}_3\text{H}_5\text{O}_3^-][\text{H}_3\text{O}^+]}{[\text{HC}_3\text{H}_5\text{O}_3]} = \frac{(3.7 \times 10^{-3})^2}{0.10} = 1.4 \times 10^{-4}$$

17) A 0.30 M aqueous solution of hypothetical weak base, B, has pH = 11.38. What is the $[\text{OH}^-]$ of this solution? What is the K_b for this base? $\text{pOH} = 14.00 - 11.38 = 2.62$; $[\text{OH}^-] = 10^{-2.62} = 2.4 \times 10^{-3} \text{ M}$



Initial: 0.30 0 0

Change: -2.4×10^{-3} $+2.4 \times 10^{-3}$ $+2.4 \times 10^{-3}$

Equil: 0.30 2.4×10^{-3} 2.4×10^{-3}

$$K_b = \frac{[\text{BH}^+][\text{OH}^-]}{[\text{B}]} = \frac{(2.4 \times 10^{-3})^2}{0.30} = 1.9 \times 10^{-5}$$

18) If $[\text{OH}^-] = 0.000010 \text{ M}$, what is the $[\text{H}_3\text{O}^+]$? $\frac{1.0 \times 10^{-14}}{0.000010} = 1.0 \times 10^{-9} \text{ M}$ What is the pH? 9.00

19) What is the hydronium ion concentration of a 0.0015 M solution of $\text{Mg}(\text{OH})_2$? What is its pH?

$$[\text{H}_3\text{O}^+] = \frac{1.0 \times 10^{-14}}{2 \times 0.0015} = 3.3 \times 10^{-12}; \text{pH} = -\log(3.3 \times 10^{-12}) = 11.48$$

20) What is the pH of a 0.050 M HCl solution?

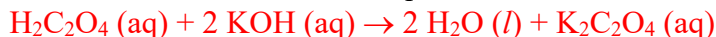
$$\text{pH} = -\log(0.050) = 1.30$$

21) What is the hydroxide ion concentration in a solution with a pH equal to 10.54?

$$\text{pOH} = 14.00 - 10.54 = 3.46; [\text{OH}^-] = 10^{-3.46} = 3.5 \times 10^{-4} \text{ M}$$

22) 25.0 ml of a solution of oxalic acid, $\text{H}_2\text{C}_2\text{O}_4$, of unknown molarity is titrated to the equivalence point with 40.0 ml of 0.114 M KOH.

a) Write the balanced chemical equation.



b) What is the molarity of the oxalic acid solution?

$$? \text{ mol H}_2\text{C}_2\text{O}_4 = 40.0 \text{ mL KOH} \times \frac{0.114 \text{ mol}}{1000 \text{ mL}} \times \frac{1 \text{ mol H}_2\text{C}_2\text{O}_4}{2 \text{ mol KOH}} = 0.00228 \text{ mol H}_2\text{C}_2\text{O}_4$$

$$M_{\text{H}_2\text{C}_2\text{O}_4} = \frac{0.00228 \text{ mol}}{0.0250 \text{ L}} = 0.0912 \text{ M}$$

23) 2.75 g of NaHSO_3 (s) is titrated with an NaOH solution of unknown molarity.

This reaction occurs: $\text{NaHSO}_3 (\text{s}) + \text{NaOH} (\text{aq}) \rightarrow \text{Na}_2\text{SO}_3 (\text{aq}) + \text{H}_2\text{O} (\text{l})$

It takes 31.8 mL of the NaOH solution to exactly titrate to the equivalence point. What is the molarity of the NaOH solution?

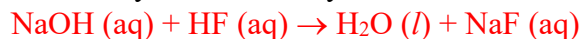
$$2.75 \text{ g} \times \frac{1 \text{ mol}}{104.1 \text{ g}} \times \frac{1 \text{ mol}}{1 \text{ mol}} = 0.0264 \text{ mol}; M_{\text{NaOH}} = \frac{0.0264 \text{ mol}}{0.0318 \text{ L}} = 0.831 \text{ M}$$

24) Determine whether aqueous solutions of the given salts form acidic neutral or basic solutions. To do so, fill in this chart fully. Consult Chart H to determine if the ions should be acidic, neutral, or basic.

Salt	What ions does this salt consist of?	If one of the ions reacts with water, show the equation for that chemical reaction.	Is the salt solution acidic, neutral or basic?
a) NaNO_2	Na^+ & NO_2^-	$\text{NO}_2^- + \text{H}_2\text{O} \rightleftharpoons \text{HNO}_2 + \text{OH}^-$	Basic
b) K_2SO_4	K^+ & SO_4^{2-}	$\text{SO}_4^{2-} + \text{H}_2\text{O} \rightleftharpoons \text{HSO}_4^- + \text{OH}^-$	Basic
c) NH_4I	NH_4^+ & I^-	$\text{NH}_4^+ + \text{H}_2\text{O} \rightleftharpoons \text{NH}_3 + \text{H}_3\text{O}^+$	Acidic

25) For the following acid & base titrations, write the titration reaction. If either ion in the salt product hydrolyzes write the hydrolysis equation, and indicate if the pH at the equivalence point would be acidic, neutral, or basic:

a) Sodium hydroxide and hydrofluoric acid

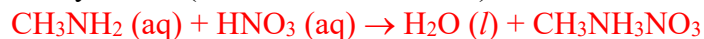


Ions in salt: Na^+ , F^- Write any hydrolysis reaction(s) below. At equivalence pt, solution is A, B, N?

Na^+ : no hydrolysis



b) methylamine (CH_3NH_2 , a weak base) and nitric acid



Ions in salt: CH_3NH_3^+ , NO_3^- Write any hydrolysis reaction(s) below. At equivalence pt, solution is A, B, N?



NO_3^- : no hydrolysis