

**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? \_\_\_\_\_
- 2) Is  $CaF_2$  an electrolyte? \_\_\_\_\_ How can you tell simply by looking at its formula
- 3) a) If an ionic compound is insoluble in water, why will its aqueous solution not conduct electricity?  
  
b) Nevertheless, all ionic compounds are considered electrolytes. Why?
- 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? \_\_\_\_\_  
b) What does water do to the  $H_2SO_4$ ? \_\_\_\_\_  
Complete this equation:  $H_2SO_4$  (l) +  $H_2O$  (l)  $\rightarrow$
- 5) Why are all acids electrolytes? \_\_\_\_\_
- 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) +  $H_2O$   $\rightarrow$   
a) What must be in the resulting solution. (ions or molecules)? \_\_\_\_\_  
b) Why do some people assume that  $CH_3OH$  is a base? \_\_\_\_\_  
c) How do you know that it is NOT a base? \_\_\_\_\_
- 7) Complete the following equation for  $Mg(OH)_2$  (s) dissolving into water.  
 $Mg(OH)_2$  (s) +  $H_2O$   $\rightarrow$   
a)  $Mg(OH)_2$  solid does not conduct electricity. Why not? \_\_\_\_\_  
b) Why does  $Mg(OH)_2$  (aq) conduct electricity? \_\_\_\_\_  
c) Why is  $Mg(OH)_2$  an Arrhenius base? \_\_\_\_\_
- 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) +  $H_2O$   $\rightarrow$

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

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

- a) LiOH \_\_\_\_\_ d) MgS \_\_\_\_\_  
b) HNO<sub>2</sub> \_\_\_\_\_ e) Ba(OH)<sub>2</sub> \_\_\_\_\_  
c) HCH<sub>3</sub>COO \_\_\_\_\_ f) BeCl<sub>2</sub> \_\_\_\_\_

11) The K<sub>a</sub> values for these hypothetical acids are listed. Which is the stronger acid? \_\_\_\_\_

**Acid A:** K<sub>a</sub> = 2.3 × 10<sup>-5</sup>

**Acid B:** K<sub>a</sub> = 2.6 × 10<sup>-8</sup>

12) Which is a stronger base, NO<sub>2</sub><sup>-</sup> or HS<sup>-</sup>? \_\_\_\_\_ How do you know?

Write the K<sub>b</sub> expression for NO<sub>2</sub><sup>-</sup>. (Write the needed chemical equation first.)

13) According to the Brønsted definition, an acid is a(n) \_\_\_\_\_

According to the Brønsted definition, a base is a(n) \_\_\_\_\_

14) Will an aqueous solution of the salt, K<sub>2</sub>SO<sub>3</sub>, be acidic, neutral or basic? \_\_\_\_\_ Explain why.  
*Include a chemical equation which supports your answer.*

15) Complete each acid/base reaction. Circle the H<sup>+</sup> being transferred and draw arrow showing transfer of H<sup>+</sup>. 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, HC<sub>3</sub>H<sub>5</sub>O<sub>3</sub>, has pH = 2.43. What is the [H<sub>3</sub>O<sup>+</sup>] of this solution of lactic acid? What is the K<sub>a</sub> for lactic acid? *Hint: what is [H<sub>3</sub>O<sup>+</sup>]*?



Initial:

Change: \_\_\_\_\_

Equil:

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



Initial:

Change: \_\_\_\_\_

Equil:

- 18) If  $[\text{OH}^-] = 0.000010 \text{ M}$ , what is the  $[\text{H}_3\text{O}^+]$ ? \_\_\_\_\_ What is the  $\text{pH}$ ? \_\_\_\_\_

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

- 20) What is the  $\text{pH}$  of a 0.050 M  $\text{HCl}$  solution?

- 21) What is the hydroxide ion concentration in a solution with a  $\text{pH}$  equal to 10.54?

- 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  $\text{KOH}$ .

a) Write the balanced chemical equation.

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

- 23) 2.75 g of  $\text{NaHSO}_3$  (s) is titrated with an  $\text{NaOH}$  solution of unknown molarity.

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

It takes 31.8 mL of the  $\text{NaOH}$  solution to exactly titrate to the equivalence point. What is the molarity of the  $\text{NaOH}$  solution?

- 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) $\text{NaNO}_2$			
b) $\text{K}_2\text{SO}_4$			
c) $\text{NH}_4\text{I}$			

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: \_\_\_\_\_ Write any hydrolysis reaction(s) below. At equivalence pt, solution is A, B, N?

b) methylamine ( $\text{CH}_3\text{NH}_2$ , a weak base) and nitric acid

Ions in salt: \_\_\_\_\_ Write any hydrolysis reaction(s) below. At equivalence pt, solution is A, B, N?

Answers: 16)  $[\text{H}_3\text{O}^+] = 3.7 \times 10^{-3} \text{ M}$ ;  $K_a = 1.4 \times 10^{-4}$ ; 17)  $[\text{OH}^-] = 2.4 \times 10^{-3} \text{ M}$ ;  $K_b = 1.9 \times 10^{-5}$ ; 18)  $[\text{H}_3\text{O}^+] = 1.0 \times 10^{-9} \text{ M}$ ; pH = 9.00; 19)  $[\text{H}_3\text{O}^+] = 3.3 \times 10^{-12} \text{ M}$ ; pH = 11.48; 20) pH = 1.30; 21)  $[\text{OH}^-] = 3.47 \times 10^{-4} \text{ M}$ ; 22b)  $[\text{H}_2\text{C}_2\text{O}_4] = 0.0912 \text{ M}$ ; 23)  $[\text{NaOH}] = 0.831 \text{ M}$ .