EXPERIMENT 10 **Chemistry 110**

Solutions Part 2

ACIDS, BASES, AND ELECTROLYTES

__PURPOSE:__ The purpose of this experiment is to determine the properties of solutions of acids, bases and electrolytes. Students will also demonstrate an understanding of the process of dissolving.

__PART I. INTRODUCTION__

ACIDS AND BASES:

Acids were first recognized as substances that taste sour (The sour taste of lemons and limes is due to *citric __acid__*), will dissolve certain metals, and will dissolve some types of rocks.

Bases were characterized by their bitter taste and slippery feel (Hand soaps and toothpastes, for
example)

A **neutral** solution is neither basic nor acidic. Acids and bases will react together to form neutral
solutions. One can say that an acid will neutralize a base and vice-versa.

Indicators are dyes that change color depending on whether they are in an acidic or basic solution. Two examples of indicators are litmus and phenolphthalein.

Historically, a water solution was called an "acid" if it showed certain characteristic properties. These include a sour taste, the ability to cause a specific change in the color of substances known as "indicators , and the reaction with certain metals, carbonates and bases. The characteristic properties that led people to identify an aqueous solution as a base were: a bitter taste, a "soapy" or slippery feeling, a specific change in the color of an indicator, and the reaction of the solution with acids and with certain cations.

1) Taste: Foods that contain acids are lemons and rhubarb. The chief acids in these foods are acetic acid (in vinegar), citric acid (in lemons) and oxalic acid (in rhubarb).
   Acids are characterized by a _____________ taste (sweet, sour)

   Bases taste bitter and unpleasant**.(Do not taste or touch laboratory chemicals!)**
   Concentrated lye (sodium hydroxide) dissolves skin. "Frontier soap" had excess lye, and it had none of the mildness and fragrance of our modern soaps.

2) Feel of bases: Soap, household ammonia and the cleaner "TSP" has a slippery feeling. The slippery feeling is caused as the base dissolves the top layer of your skin. (This is not recommended as a test for a base.)

3) Indicators: The color of certain dyes will change as the level of acid or base in the solution changes.

4) Acids react with active metals such as Zn:

$$Zn(s) \quad + \quad 2\ HCl(aq) \quad \rightarrow \quad ZnCl_2(aq) \quad + \quad H_2(g)$$

Strong Acids: HCl, HBr, HI, HNO_3, H_2SO_4, $HClO_4$

Weak Acids: all those acids not listed as strong acids.

Strong Bases (soluble metal hydroxides): LiOH, NaOH, KOH, RbOH, CsOH, $Ca(OH)_2$, $Sr(OH)_2$, $Ba(OH)_2$

Weak Bases: NH_3 (NH_4OH) and other nitrogen-containing compounds.

NEUTRALIZATION REACTION is the name of the characteristic reaction between acids and bases.
Example of Neutralization Reaction:

$$HCl(aq) \quad + \quad NaOH(aq) \quad \rightarrow \quad NaCl(aq) \quad + \quad H_2O(l)$$

Electrolytes are compounds whose aqueous solutions will conduct electricity. Electrical conductivity depends upon charged particles that carry electrical current. In an aqueous solution, the charged particles are ions. The more ions present in the solution, the greater its conductivity.
In today's lab, your instructor will test solutions of non, weak and strong electrolytes.

In today's lab you will observe some characteristic chemical and physical properties of acids and bases. You will also perform some calculations with concentration.

PART II. PROCEDURE

Safety

Safety goggles **must** be worn at all times
Hydrochloric acid, HCl, and acetic acid, $HC_2H_3O_2$ can harm eyes, skin, and clothing. Handle with care. Any acid spilled on the skin or splashed into your eye should be rinsed with a large volume of water.

NaOH and $NH_3(aq)$ solutions are corrosive to the skin and can harm your eyes. Any base spilled on the skin or splashed into your eyes should be rinsed with a large volume of water.

A ELECTROLYTES:

DEMONSTRATION:

Your instructor will submerge electrodes into the following solutions. Record each solutions conductivity below. The conductivity will either be strong, weak, or none:

Solution	**Formula**	**Conductivity (Bright, dim or none)**	**Strong, weak or nonelectrolyte**
1 M hydrochloric acid			
1 M acetic acid			
1 M sodium hydroxide			
1 M aqueous ammonia			
1 M sodium chloride			
1 M ammonium acetate			
2% sucrose (table sugar)	$C_{12}H_{22}O_{11}$ (polar)		
2% ethanol solution	C_2H_60 (polar)		
Deionized water			N/A
Tap water			N/A

Draw a diagram that shows how a solution of sodium chloride conducts electricity. Make sure to show a sample of ions, water molecules and some electrodes

Instructors approval (initials) of drawing_______________

B Acids and Bases

Acid/Base Indicators

In your spot plate add 5 drops of each of the solutions in the table below to 3 different wells. Make sure you write on a paper towel a diagram that shows what is in each well.

Put 3 pieces of red litmus paper, 3 pieces of blue litmus paper and 3 pieces of universal indicator paper on a paper towel. Using a stirring rod transfer a drop of the each solution acid to the end of both litmus papers. Clean your stirring rod between each sample. Record the color of each solution on the litmus papers in the table below.

From the top of your lab bench find the dropper bottle of Phenolphthalein. Add 1 or 2 drops to each of the solutions in the table and record the color. Repeat the process in the last set of wells using universal indicator from a dropper bottle.

Solution	**Color of indicator**			
	Red litmus	**Blue litmus**	**Phenolphthalein**	**Universal indicator**
1 M acetic acid				
1 M hydrochloric acid				
1M sodium chloride				
1 M ammonia				
1 M Sodium Hydroxide				

What color of litmus paper can be used to test a solution to see if it is acidic?

____________litmus
(red, blue)

1) Reaction of acids with metals:

Drop a small piece of "mossy zinc" into one well with hydrochloric acid and into another well with Acetic acid. Record your observations

Observation____

In which acid does the reaction occur more vigorously?________________________

2) Reaction of acids with carbonates:

In a clean test tube put approximately 1 ml of 1 M HCl (From the side bench). In another test tube put approximately 1 ml of 1 M acetic acid (From the side bench). To each tube a small (about a match head size) amount of solid sodium carbonate powder.

Observation____

In which acid does the reaction occur more vigorously?________________________

3) Reaction of acids with bases:

a. In a clean test tube put 1 ml of 1 M HCl (From the side bench). Measure the temperature this solution. (Don't forget units)

____

b. Add one drop of phenolphthalein to the above solution.

In another test tube put slightly more than 1 ml of 1 M NaOH (From the side bench). Then add it to the above HCl solution. Measure the temperature.

____

What happened to the temperature?_______________

What happened to the color of the solution?_______________

(If a color change did not occur, add a few more drops of 1 M NaOH)

What color of litmus paper could you use to test a solution to see if it is basic?

__________litmus
(red, blue)

	What are 4 properties of acids?		What are 4 properties of bases?
1		1	
2		2	
3		3	
4		4	

C. CONCENTRATION PROBLEMS

Perform the following problems before leaving the lab.

1. 148.2 g of Cupric sulfate are dissolved in enough water to make 2.00 x 10^3 mL of total solution. What is the molar concentration?

Answer___________________

2. When the same amount of cupric sulfate from problem 1 is dissolved in 1,375 g of water, what is the molal concentration of the resulting solution?

Answer___________________

3. How many grams of sucrose (molar mass 342g/mole) would it take to produce 4.5 X 10^3 ml of a 1.5 M solution?

Answer___________________

4. What would be the final volume, in ml, of a 1.25 molar solution made with 275 grams of sucrose?

Answer___________________

5. 1.000 x 10^3 ml of a solution of H_2SO_4 made by adding 571.6 g of sulfuric acid to water has a density of 1.3294 g/ml. (molar mass of sulfuric acid is 98.08 g/mol)
   What is the molar concentration?

   What is the molal concentration?

   First find the mass of one liter of the solution (use density)

   Find the mass of the water in one liter of solution (use a subtraction)

   Find the molality

   Answer______________________________

Chemistry 110 Lab Report Date _______________

Name ____

Lab Section ____________________ Initials_________

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A. ELECTROLYTES:

Solution	**Formula**	**Conductivity**
1 M hydrochloric acid		
1 M acetic acid		
1 M sodium hydroxide		
1 M aqueous ammonia		
1 M sodium chloride		
1 M ammonium acetate		
2% sucrose (table sugar)	$C_{12}H_{22}O_{11}$ (polar)	
2% ethanol solution	C_2H_60 (polar)	
Deionized water		
Tap water		

Draw a diagram that shows how a solution of sodium chloride conducts electricity. Make sure to show a sample of ions, water molecules and some electrodes

B Acids and bases:

Solution	Color of indicator			
	Red litmus	**Blue litmus**	**Phenolphthalein**	**Universal indicator**
1 M acetic acid				
1 M hydrochloric acid				
1M sodium chloride				
1 M ammonia				
1 M Sodium Hydroxide				

What color of litmus paper can be used to test a solution to see if it is acidic?

____________litmus
(red, blue).

What color of litmus paper could you use to test a solution to see if it is basic?

_____________litmus
(red, blue)

	What are 4 properties of acids?		What are 4 properties of bases?
1		1	
2		2	
3		3	
4		4	

Concentration Problems

1. The concentration of glucose (molar mass 180 g/mol) in the fluid of the spine is 75 mg / 100g of water. What is the molal concentration?

Answer__________________

2. The federal limit for cadmium in drinking water is .01 mg per liter of solution. What is the molar concentration?

Answer__________________

3. What volume of a .20 M solution of K_2SO_4 solution contains 75 g of the solute?

Answer__________________

4. How many grams of sodium hydroxide are needed to prepare 2.5 liters of a 6.0 Molar solution?

Answer__________________