AP Chemistry
Ms. Ye

Name ___________________________________
Date ________________________Block ______

Acids and Bases Unit Inquiry Activity: Part 1

You will receive a set of cards that show various compounds *dissolved in water* (the water molecules are not shown).

1. Sort the cards into three groups based on common features (hint: look at what particles are in the solution). Write the solution card number, molarity, chemical formula, and chemical name for each solution.

Group 1	Group 2	Group 3

2. What do the solutions in each of the three groups have in common?
   Group 1-

   Group 2-

   Group 3-

3. Is there a second way you might sort the cards? If so, explain how.

4. Fill in the table with the chemical formula of the substance dissolved and the ions in the solution

Solution #	Name	Molarity and Chemical Formula	Cation produced when dissolved in water	Anion produced when dissolved in water
1	Hydrochloric acid	0.010 M HCl	H^+	Cl^-
2	Hydrochloric acid	0.005 M HCl		
3	Hydrochloric acid	0.001 M HCl		
4	Formic acid	0.010 M $CHOOH$		
5	Acetic acid	0.010 M CH_3COOH		
6	Sodium chloride	0.010 M $NaCl$		
7	Methanol	0.010 M CH_3OH		
8	Methanol	0.005 M CH_3OH		
9	Sodium Hydroxide	0.010 M $NaOH$		
10	Sodium Hydroxide	0.001 M $NaOH$		
11	Ammonia	0.010 M NH_3		
12	Water	H_2O		

5. Solutions 1, 2, and 3 each contain hydrochloric acid (HCl). How are they *different*?

6. Hydrochloric acid, HCl, is a strong acid, whereas formic acid, CHOOH, and acetic acid, CH_3COOH, are weak acids. Use the Acid-Base Solution cards to explain the difference between a strong acid and a weak acid.

   Strong Acid-

   Weak Acid-

7. What do all solutions with the word ***acid*** in their name have in common in terms of the types of ions they form when dissolved in water?

8. Solutions that form OH- ions when dissolved in water are ***basic*****.** Which solutions are basic?

9. Solutions 6, 7, 8, and 12 are neutral. What do you think this means in terms of H+ and OH- ions?

10. Based on this card sort, come up with a definition for an acid and base.

Acid-

Base-

11. Solution 11 is the result of dissolving ammonia, NH_3, in water. There are no O atoms in this molecule. How is it possible that the solution is basic (where do the OH- ions come from?)

pH of Acids and Bases

Introduction:

In this simulation, you will observe ions and changes in hydronium (H_3O^+) and hydroxide (OH^-) concentrations in several common substances. Remember, the autoionization constant of water K_w is **1.0×10^{-14}** and is equal to the product of [H_3O^+] and [OH^-]. When the "**p**" or negative logarithm is applied to each term, the relationship exists that **pH + pOH = 14**. We can calculate a solution's pH using a logarithm, which determines a number's base-ten exponent. The "p" in pH is a negative logarithm (-log).

What is pH?

pH is a measurement of how acidic or how basic a solution is. The pH scale starts at 0 and goes up to 14. Halfway between 0 and 14 is 7, which is neutral. Compounds are acidic if they have a pH lower than 7. Compounds with a pH higher than 7 are said to be basic or alkaline.

Exactly what makes a compound an acid or a base?

To understand this you must understand water. Water is a molecule made up of three atoms covalently bonded together. Think of water as HOH. Some compounds can cause water molecules to break apart into H^+ and OH^- ions. The H^+ ion is called a hydrogen ion. It is actually proton with no electrons. The OH^- ion is called a hydroxide ion. If you mixed hydroxide and hydrogen ions together, they would immediately pair up and make water molecules.

$$H^+ + OH^- \rightarrow HOH \rightarrow H_2O$$

This is called a neutralization reaction. Hydroxide ions neutralize hydrogen ions.

If, after the neutralization reaction is complete, there are H^+ ions left over, then the solution is acidic. If, after the neutralization reaction is complete, there are OH^- ions left over, then the solution is basic.

Why is pH important to biology?

Most cells can only survive within a certain range of pH. For example, human blood has a pH of about 7.2, which is slightly basic. Any higher or lower and the blood cells would be injured or killed. So you could say that a healthy person's blood has a pH range of 6.9 to 7.2.

Acids denature, or change the shape of proteins in much the same way heat does. As a matter of fact, strong acids like vinegar and lemon juice can be used to actually cook meats like fish and eggs. Seviche is a dish made by mixing raw fish and lime juice and letting it sit for a few hours. Acids, such as bile are used by your digestive system to break down food molecules into simpler monomers.

Bases cause oils and fats to fall apart. Oven cleaners and drain cleaners contain lye, a strong base that dissolves baked on grease and burned fats.

Directions: Use the simulation as well as the introduction reading to answer the following questions:

For the simulation: Go to: **bit.ly/phscalephet**

Part 1: Click on *"Macro"* at the bottom of the screen. Examine the pH scale that is on the left of the screen.

1. Which range of pH values correspond with an acidic solution?

2. Which range of pH values correspond with an basic solution?

3. Can you come up with an explanation as to why the 7 is shown to be a larger font size than all of the other numbers on the pH scale?

Part 2: Click on "*My Solution*" at the bottom of the screen. At the top left hand corner, make sure that you are viewing concentrations in **mol/L**. On the bottom right hand area, make sure that the "H_3O^+/OH^- ratio" has a check mark in the box.

Move the pH slider to create custom liquids with varying pH. Observe how increasing the pH on the slider affects the pH and concentrations of hydronium $[H_3O^+]$ and hydroxide $[OH^-]$.

1. As pH increases, the concentration of hydronium $[H_3O^+]$ ______________________.

2. As pH increases, the concentration of hydroxide $[OH^-]$ _______________________.

3. When the concentration of hydroxide and concentration of hydronium are equal, the pH is ______

Part 3: Click on "*Micro*" and complete the table below.
Choose several of the sample liquids; record their H_3O^+ concentrations; and find the sample's "pH" by taking the ***negative logarithm*** of the liquids H_3O^+ concentration

Sample Liquid Used	**$[H_3O^+]$ Concentration [M]**	**pH (–log $[H_3O^+]$)**

How do your calculations for pH match the pH identified in the simulation?

How does the pH change as $[H_3O^+]$ increases?

Conclusion Questions

1. Acids have (choose one: low/high) pH while bases have (choose one: low/high) pH.

2. Soda pop has a pH of 2.5. What is soda's hydronium concentration $[H_3O^+]$? Show work.

3. What is soda's $[OH^-]$? Show work.

4. An unknown solution is found to have a $[H_3O^+]$ of 3.8×10^{-5}. What is its pH? Show work.

5. What is the above solution's $[OH^-]$? Show work!

APPLICATION: Perform the calculations below

NOTE:

pH + pOH = 14, pH = –log[H⁺], pOH= –log[OH⁻], Kw = 1.0x10⁻¹⁴=[H⁺]x[OH⁻]

$$pH + pOH = 14, \quad pH = -\log[H^+], \quad pOH = -\log[OH^-], \quad K_w = 1.0 \times 10^{-14} = [H^+] \times [OH^-]$$

$[H^+]$	$[OH^-]$	pH	pOH
1.0×10^{-8} M			
	2.2×10^{-3} M		
		4.56	
			12.99