Acids and bases

Name: _____Group: _____

Acids and *bases* are not only important groups of chemical compounds, they are also common in our everyday life. Acid in our stomachs help digest the food we eat. We eat acids when we put vinegar on our salads for its tangy, sour flavor. The characteristic flavor of the grapes is largely due to tartaric acid ($H_2C_2H_4O_6$) and malic acid ($H_2C_2H_4O_5$). Sulfuric acid is used to make car batteries. We use baking soda to make biscuits. Coffee, one of our favorite drinks, contains caffeine, which is a base. The proper function of our body and our health also depends on the delicately balanced acid-base composition of our blood and other body fluids. Acids and bases are also crucial components of living systems, such as the amino acids that are used to synthesize protein and the nucleic acids that code genetic information.

Since we generally speak of *acids* as a group of substances, it is important to find out why we classify them together. The same goes for *bases*. What makes them alike? In this lab, you will examine the properties of acids and bases by performing several tests. Then, try to come up with some generalization of properties of acids and bases.

Part I: Test laboratory acids and bases with litmus papers and indicators.

A common property of acids and bases is that they cause color changes to dyes obtained from plant sources. In fact, these dyes are commonly used in chemistry labs to indicate the presence of acids and bases. For this reason, they are referred to as acid-base indicators.

In this part of the experiment, you will test several common laboratory acids and bases using several common *indicator*s and litmus papers (paper soaked in plant dyes).

1. Set a 24-well plate on a piece of white paper. Put 5 drops of acetic acid ($HC_2H_3O_2$) in 4 different wells. Continue setting up the 24-well plate with 5 drops of the other acids and bases listed in the table below.
2. Tear a piece of red litmus paper in half. Dip the litmus paper into the 1st well containing an acid or a base. Observe what happens and record your observations under “red litmus paper”.
3. Repeat the test with a piece of blue litmus paper by dipping the litmus paper into the 2nd well containing an acid or a base. Record the observations under “blue litmus paper”.
4. Now put a drop of bromothymol blue indicator in the 3rd well containing an acid or a base and a drop of phenolphthalein in the 4th well. Record your observations.

	Red litmus paper	**Blue litmus paper**	**Bromothymol blue**	**Phenolphthalein**
Acetic acid, $HC_2H_3O_2$, a weak acid				
Hydrochloric acid, HCl, a strong acid				
Sodium hydroxide, NaOH, a strong base				
Ammonia NH_3, a weak base				

1. Based on your observations, summarize the behavior of acids and bases when the following tests are performed. You will use these properties to determine whether a household item is an acid or a base in the next part of the experiment.

	acids	**bases**
Red litmus paper		
Blue litmus paper		
Bromothymol blue		
phenolphthalein		

2. Your instructor will write on the board an equation describing the reaction of ammonia NH_3 with water. Copy the equation here. Underline the ion in the equation that accounts for the basic character of aqueous ammonia.

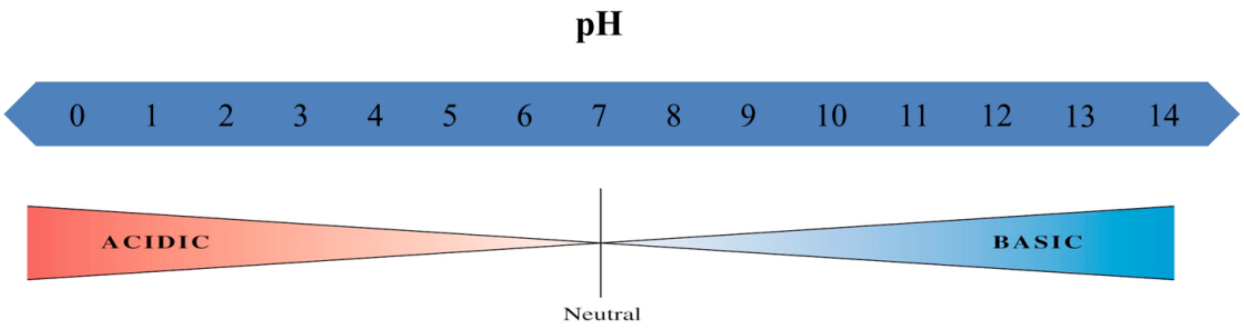
Part II: Test household items with litmus papers and indicators.

1. Rinse the 24-well plate with tap water followed by a rinse with DI water.
2. Put a small amount of the following household items in 4 different wells.
3. Add a few drops of DI water to each well. Stir to dissolve the solid or to mix the liquids. Test with the litmus papers and the indicators. Record the observations.
4. Based on your observations and the general properties of acids and bases noted on the previous page, determine if each of the following items is an acid or a base.

	Red litmus paper	**Blue litmus paper**	**Bromothymol blue**	**Phenolphthalein**	**Acid or base?**
Vinegar					
Powdered vitamin C					
Lemon juice					
Baking soda					
Laundry detergent					
Drano, drain cleaner					

Part III: testing acid-base properties of household items using red-cabbage juice

Many important chemical properties of a solution are often related to the acid-base properties of the solution. The most common measure of the acid-base properties of solutions is the **pH.** A pH scale between 0 – 14 is typically used (See the figure below). At room temperature, a pH of 7 is considered to be neutral (neither acidic nor basic). A pH less than 7 is indicates an acidic solution; the lower the pH, the more acidic it is. A pH greater than 7 indicates a basic (or alkaline) solution, the higher the pH, the more basic it is.



The red cabbage leaf contains a dye that can be used as an acid-base indicator. The dye exhibits a wide, but repeatable, range of colors across the entire pH range. For this part of the lab, you will use the red cabbage juice as an indicator to estimate the pH of several common household products. First, you will extract the indicator dye from red cabbage leaves. Then, the red cabbage juice indicator will be added to solutions of known pH, ranging from pH 2 to pH 12 to show the color of the indicator at different pHs. Finally, the red cabbage juice indicator will be added to solutions of several household items. The color of the solutions will be compared to the set of test tubes containing standard pH solutions to estimate the pH of the household items.

1. Put enough small pieces of red cabbage leaves to cover the bottom of a 250-mL beaker. Add 40 mL of **deionized water**. Heat to a gentle boil on a hotplate. Stir often, until the liquid is dark purple (~10 minutes). **Note**: DO NOT USE TAP WATER, otherwise your solution will be blue instead of purple.
2. Allow the mixture to cool for a few minutes. Pour the juice into a 100-mL beaker to use as the indicator. Discard the boiled cabbage leaves in the trash.
3. Put 7 test tubes in a rack. Number them 2, 4, 6, 7, 8, 10 and 12 (the pH of the solutions of known pH).
4. Solutions of known pH are provided in dropping bottles. Add 20 drops of each pH solution into the corresponding test tubes.
5. Use the Beral pipet to add 8 drops of the red-cabbage juice indicator to each test tube. Mix the content in each test tube. Record the color of the indicator at each pH value in the table on the next page. Save the test tubes for comparison.

A. Red cabbage juice with standard pH solutions

pH	Color – be descriptive
2 Strongly acidic	
4 Mildly acidic	
6 Weakly acidic	
7 neutral	
8 Weakly basic	
10 Mildly basic	
12 Strongly basic	

B. Testing household items with red cabbage juice

Sample	Color when red cabbage juice is added	Estimated pH	Acid or base?
vinegar			
Baking soda solution			
Sprite			
Laundry detergent			
Bottled water			
caffeine			

Part IV: Reaction of an acid with a base.

1. Using the materials that you have used in lab so far, design a way to make HCl, a strong acid, neutral.

How can you make the solution neutral?

Carry out your plan. Record the exact steps that were necessary to make your HCl neutral.

2. Using the materials that you have used in lab so far, design a way to make baking soda, a strong base, neutral.

How can you make the solution neutral?

Carry out your plan. Record the exact steps that were necessary to make your baking soda neutral.

When the solution is neutral, it is neither acidic nor basic. Or it doesn't have the properties of either acids or bases anymore, therefore the idea of neutralization.

Questions:

3. When too much acid is produced in the stomach, excess acid can flow back up into the esophagus, causing heartburn. Taking antacids is one way to treat heartburn. Based on your observation in this part of the lab, what can you predict about the active ingredients in antacids?

Here are the formula of some other common laboratory acids and bases.

Common acids	**Common bases**
HBr, HNO_3, H_2SO_4, H_2CO_3, H_3PO_4	KOH, LiOH ,$Ca(OH)_2$, $Ba(OH)_2$

Use <u>the information in this table</u> and <u>the tables you filled out in Pages 2 & 3</u>, answer the following questions.

4. (a) What do the formulas of acids have in common?

   (b) Is there any exception to your generalization about the formula of an acid? If so, name them.

   (c) Look at the household items that were identified as acids, can you identify a common property shared by acids?

   (d) Based on the generalization in (c), name some other common household items that might contains acids.

5. (a) What do the formulas of bases have in common?

   (b) Is there any exception to your generalization about the formula of a base? If so, name them.

(c) Feel the baking soda solution and the detergent solution with your fingers. How do they feel?

(d) Another general property of bases is that they have a bitter taste. Based on this property and the generalization in (c), name some other common household items that might contain bases.