Honors Chemistry
Ms. Ye

Name _____
Date _____Block _____

Acids and Bases Inquiry Activity

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). What do the solutions in each of the three groups have in common?
   Group 1 Group 2 Group 3

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

3. 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		

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

5. 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?

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

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

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

Acid-

Base-

9. 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?)

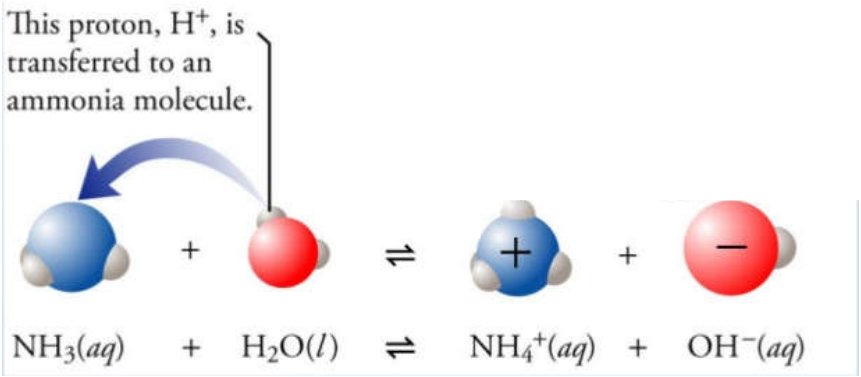
The Arrhenius definition of acids and bases is one of the oldest. An **Arrhenius acid** is a substance that when added to water increases the concentration of **H^+ ions** present. The chemical formulas of Arrhenius acids are written with the acidic hydrogens first. An **Arrhenius base** is a substance that when added to water increases the concentration of **OH^- ions** present. HCl is an example of an Arrhenius acid and NaOH is an example of an Arrhenius base.

$$HCl \rightarrow H^+ + Cl^- \qquad NaOH \rightarrow Na^+ + OH^-$$

Classify the following as an acid or base using the Arrhenius definition of an acid or base.

1. HNO_3 is an Arrhenius _____ and increases the concentration of _____ when added to water.
2. KOH is an Arrhenius _____ and increases the concentration of _____ when added to water.
3. $Ca(OH)_2$ is an Arrhenius _____ and increases the concentration of _____ when added to water.
4. H_2SO_4 is an Arrhenius _____ and increases the concentration of _____ when added to water.

A **Brønsted -Lowry acid** is defined as anything that **donates H^+ ions**; a **Brønsted -Lowry base** is defined as anything that **accepts H+ ions**. This definition includes all Arrhenius acids and bases but, as you will soon see, it is a bit more general because an acid or a base does not have to form a H^+ or OH^- ion. The Brønsted -Lowry concept is based on *the transfer of a proton* (H+) from one substance to another. Look at the example below:



H_2O donates a proton or H^+ so it is classified as the acid in this reaction.

NH_3 accepts a proton or H^+ so it is classified as the base in this reaction.

Look at the following reactions and answer the questions below:

$H_2SO_4 + NH_3 \rightarrow HSO_4^- + NH_4^+$

1. H_2SO_4 goes to HSO_4^-

   a) Did it gain or lose a proton?

   b) Is it a Brønsted -Lowry acid or base?

2. NH_3 goes to NH_4^+

   a) Did it gain or lose a proton?

   b) Is it a Brønsted -Lowry acid or base?

$HC_2H_3O_2 + H_2O \rightarrow H_3O^+ + C_2H_3O_2^-$

3. $HC_2H_3O_2$ goes to $C_2H_3O_2^-$

   a) Did it gain or lose a proton?

   b) Is it a Brønsted -Lowry acid or base?

4. H_2O goes to H_3O^+

   a) Did it gain or lose a proton?

   b) Is it a Brønsted -Lowry acid or base?

$HCO_3^{-1} + HCl \rightarrow Cl^{-1} + H_2CO_3$

5. HCO_3^{-1} goes to H_2CO_3

   a) Did it gain or lose a proton?

   b) Is it a Brønsted -Lowry acid or base?

6. HCl goes to Cl^{-1}

   a) Did it gain or lose a proton?

   b) Is it a Brønsted -Lowry acid or base?

The following are Brønsted -Lowery acids. Determine what species will form when each donates a proton

7. HI _____

8. H_2O _____

9. NH_4^+ _____

10. HNO_3 _____

The following are Brønsted-Lowry bases. Determine what species will form when each accepts a proton.

11. CN^- _____

12. O^{-2} _____

13. HSO_4^{-1} _____

14. PO_4^{-3} _____