ACID AND BASE PROPERTIES

PURPOSE:

1. To distinguish between acids, bases and neutral substances, by observing their effect on some common indicators.
2. To distinguish between strong and weak acids and bases, by conductivity testing.
3. To identify an unknown, as an acid (strong or weak), a base (strong or weak) or a neutral substance.

PRINCIPLES:

We frequently encounter acids and bases in our daily life. **Acids** were first associated with the sour taste of citrus fruits. In fact, the word **acid** comes from the Latin word **acidus**, which means, "**sour**". In summary, some of the characteristic properties commonly associated with acids and bases in aqueous solutions are the following:

ACIDS	BASES
Sour taste	Bitter taste
Change the color of litmus to red	Change color of litmus to blue
Do not change color of phenolphthalein	Change color of phenolphthalein pink
Reacts with active metals to produce hydrogen gas	Have a slippery, soapy feeling
React with bases	React with acids

When acids and bases react with one another in equal proportions, the result is a **neutralization reaction**, which produces neutral products: salt and water. The following equations represent two typical acid-base neutralization reactions:

$$\underset{\text{Acid}}{HCl(aq)} + \underset{\text{Base}}{NaOH(aq)} \xrightarrow{\text{Neutralization}} \underset{\text{Salt}}{NaCl(aq)} + \underset{\text{water}}{H_2O(l)}$$

$$\underset{\text{Acid}}{H_2SO_4(aq)} + \underset{\text{Base}}{2\,KOH(aq)} \xrightarrow{\text{Neutralization}} \underset{\text{Salt}}{K_2SO_4(aq)} + \underset{\text{water}}{2\,H_2O(l)}$$

- Note: a salt is any compound of a cation (other than H^+) with an anion (other than OH^- or O^{2-}).

Listed below is a summary of the characteristic properties of acids and bases based on the two most common definitions (Arrhenius and Bronstead/Lowry).

	ACIDS		**BASES**	
Arrhenius definition	produce **H^+ ions** in aqueous solution		produce **OH^- ions** in aqueous solution	
Bronstead/Lowry definition	**H^+ donors**		**H^+ acceptors**	
Electrolyte Strength	STRONG ACIDS (strong electrolytes)	WEAK ACIDS (weak electrolytes)	STRONG BASES (strong electrolytes)	WEAK BASES (weak electrolytes)
Extent of dissociation	completely dissociated	partially dissociated	completely dissociated	partially dissociated
Symbols used to show extent of dissociation	→	⇌	→	⇌
Particles present solution	ions only	mostly molecules and a few ions	ions only	mostly molecules and a few ions

Keep in mind that **strong** and **concentrated** are not interchangeable terms when applied to acids and bases:

STRONG: refers to the extent to which an acid or base dissociates in water.

CONCENTRATION: describes how much of an acidic or basic compound is present in a solution

PROCEDURE:

You will determine the conductance and the effect on indicators (Red litmus paper, Blue Litmus paper, and phenolphthalein) of a set of 8 substances. From the data you gather you will be able to determine: the electrolyte character, the formula of the predominant species in solution and the acidic, basic, or neutral character of the solution.

If the solution is acidic or basic, you will be able to determine if the acid or the base is strong or weak.

All your aqueous solutions have the same concentration: 0.1 M

The formulas and the names of your solutions are listed below:

$HC_2H_3O_2(aq)$	acetic acid	$HNO_3(aq)$	nitric acid
D.I. H_2O	deionized water	$NH_3(aq)$	aqueous ammonia
NaOH(aq)	sodium hydroxide	KOH(aq)	potassium hydroxide
NaCl(aq)	sodium chloride		
HCl(aq)	hydrochloric acid		

There are several stations set-up in the lab. All stations have some of the solutions available for testing. You may start working at any station and may go from station to station, in any order depending on availability.

As you move from station to station:

DO: -take with you: - your own Chemplate (rinse very well between tests)
- a 250 mL beaker with D.I. water, and
- your own wash bottle, containing D.I. water

- check if the electrodes are clean before testing (D.I. water t
- rinse the electrodes very well after testing.

DO NOT: - remove reagents from stations
- leave reagent bottles open
- switch droppers from dropper bottles
- remove or disconnect the conductivity apparatus

At each station, you will perform the following tests:

1. Conductance testing
   Check if the electrodes are clean (D.I. water test should give negative test).
   Fill one depression of the Chemplate with 30 drops of the solution to be tested.
   Perform the conductance test as it was done in a previous experiment.
   Record the result
   Do not discard the test solution.

For the tests that follow use a sheet of white paper as a background to better distinguish the color changes.

2. Red Litmus Paper Test
   Immerse the strip of "red" (actually pink) litmus paper in the solution you are testing. Remove the strip and examine its color.
   You may obtain two possible results:
   (a) The "red" litmus paper turns blue (actually faint lavender), or
   (b) The "red" litmus paper stays "red"; indicate "NO CHANGE" in your lab

notebook.
(c) Do not discard the test solution.
(d) Discard the used litmus paper in the trashcan.

3. Blue Litmus Paper Test
   Immerse the strip of "blue" (actually faint lavender) litmus paper in the solution you are testing.
   Remove the strip and examine its color.
   You may obtain two possible results:
   (a) The "blue" litmus paper turns "red" (actually faint lavender), or
   (b) The "blue" litmus paper stays "blue"; indicate "NO CHANGE" in your lab notebook.
   (c) Do not discard the test solution
   (d) Discard the used litmus paper in the trashcan.
4. Phenolphthalein Test
   Place a sheet of white paper underneath the Chemplate, as a background.
   Add 2 drops of phenolphthalein solution to the test solution.
   Note any color change. If the solution remain colorless, so indicate.
   Discard your test solution
   Wash your Chemplate with plenty of tap water.
   Rinse your Chemplate with D.I. water from your wash bottle.

ACID AND BASE PROPERTIES
REPORT FORM

NAME:_____ PARTNER: _____

		Conductance (+, +/-, or -)	Electrolyte Character (SE, WE or NE)	Color with Red Litmus paper*	Color with Blue Litmus paper**	Color with phenolphtalein solution	Formula of predominant particles	Acid, Base or Neutral***	Strong or Weak
1	**$HC_2H_3O_2$ (0.1M)**	+/–							
2	**DI H_2O**	–							
3	**NaOH (0.1M)**	+							
4	**NaCl (0.1M)**	+							
5	**HCl (0.1M)**								
6	**HNO_3 (0.1M)**								
7	**NH_3 (0.1M)**								
8	**KOH (0.1M)**								

* The original color of "Red" Litmus paper is actually Pink.
- If its color does not change, report : N.C. (No Change)
- If its color changes to faint lavender, report "Blue"

** The original color of "Blue" Litmus paper is actually Faint Lavender
- If its color does not change, report : N.C. (No Change)
- If its color changes to Pink, report "Red"

*** If the solution is neutral, do not complete the last column (Strong or Weak)

PART I: A STUDY OF ACIDIC BEHAVIOR

1. List below the **formulas** and the **names** of all the acids used in this experiment
Do not forget to include the state designation "aq", after the formula.
FORMULAS NAMES

2. Which acids, listed in number (1) above are **strong acids**?
Give their formulas below:

_____

For each strong acid listed, write an equation that illustrates its ionization reaction:

3. Which acids, listed in number (1) above are **weak acids**?
Give their formulas below:

_____

For each weak acid listed, write an equation, that illustrates its ionization reaction:

4. What do all acids (STRONG and WEAK) have in common, in terms of the particles they contain in aqueous solution ?

_____

5. What is the essential difference between STRONG ACIDS and WEAK ACIDS, in terms of the particles they contain in aqueous solution ?

_____

6. The following questions refer to the effect of Acids on Indicators.
A) What is the effect of acids on the color of red litmus paper?

_____

B) What is the effect of acids on the color of blue litmus paper?

_____

C) What is the color of an acidic solution to which phenolphthalein is added?

_____

7. What causes acids to behave the same way toward the indicators used in this experiment?

_____

8. Can you distinguish between a strong and a weak acid by using **only** the indicators mentioned above ? (Assume that no conductivity apparatus is available)_____
Explain your answer.

PART II: A STUDY OF BASIC BEHAVIOR

1. List below the **formulas** and the **names** of all the bases used in this experiment
   Do not forget to include the state designation "aq", after the formula.
   FORMULAS NAMES

2. Which bases, listed in number (1) above are **strong bases**?
   Give their formulas below:

   _____

   For each strong base listed, write an equation that illustrates its dissociation reaction:

3. Which bases, listed in number (1) above are **weak bases**?
   Give their formulas below:

   _____

   For each weak base listed, write an equation, that illustrates its ionization reaction:

4. What do all bases (STRONG and WEAK) have in common, in terms of the particles they contain in aqueous solution ?

   _____

5. What is the essential difference between STRONG BASES and WEAK BASES, in terms of the particles they contain in aqueous solution ?

_____

6. The following questions refer to the effect of Bases on Indicators.
A) What is the effect of bases on the color of red litmus paper ?

_____

B) What is the effect of bases on the color of blue litmus paper ?

_____

C) What is the color of a basic solution to which phenolphthalein is added?

_____

7. What causes bases to behave the same way toward the indicators used in this experiment ?

_____

8. Can you distinguish between a strong and a weak base by using **only** the indicators mentioned above ? (Assume that no conductivity apparatus is available) _____
Explain your answer.