Chemistry
Conductivity Lab

Name___________________________________

Conductivity of Aqueous Solution

Objective: You will use the Vernier software and Conductivity Probe to test the conductivity of distilled water and that of a salt solution. Then you will apply the skills learned to investigate the following questions:

- How is the conductivity of ionic compounds affected by the number of ions per formula unit?
- What is the relationship between acid strength and conductivity?
- How do the conductivities of various water-soluble molecular compounds compare?
- How does the conductivity of $NaCl_{(aq)}$ vary as concentration is changed?
- How do the conductivities of NaCl, $MgCl_2$ and $AlCl_3$ compare?

Background:
Dissolving is a general term for when something is placed into a solution and the substance breaks up. It will seem as if the substance is no longer present, but instead the original substance breaks into small pieces. This process would be one of dissolving and not dissociation. An example of dissociation would be when NaCl is broken up into Na^+ and Cl^- ions independent of each other. Dissociation is "the separation of ions that occurs when an ionic compound dissolves". Thus, dissociation is more specific than dissolving. Anything that dissociates also dissolves, but not everything that dissolves can dissociate.

Electrical conductivity is based on the flow of electrons. Metals are good conductors of electricity because they allow electrons to flow through the entire piece of material. Thus, electrons flow like a “sea of electrons” through metals. In comparison, distilled water is a very poor conductor of electricity since very little electricity flows through water. Highly ionized substances are **strong electrolytes**. Strong acids and salts are strong electrolytes because they completely ionize (dissociate or separate) in solution. The ions carry the electric charge through the solution thus creating an electric current. Slightly ionized substances are **weak electrolytes**. Weak acids and bases would be categorized as weak electrolytes because they do not completely dissociate in solution. Substances that do not conduct an electric current are called **non-electrolytes**. Non-electrolytes do not ionize; they do not contain moveable ions.

Representation of Species in Solution:

Ionic compounds:
When a solid ionic compound dissolves in water, the ions become separated, and are written as dissociation reactions. Note that the equation must remain balanced, with the same number of each type of ion on either side of the arrow. Also, the charges of ions must always be included when written alone in solution, but never when part of an ionic compound. Several examples are shown below, with (aq) representing a species dissolved in water. Since ions are formed in each case, they would all conduct a current.

$$NaCl\ (s) \text{ -----------> } Na^+\ (aq) + Cl^-\ (aq)$$

So, for example, the proper representation of $MgCl_2$ in solution would be as Mg^{2+} (aq) + 2 Cl^- (aq).

Covalent Compounds:
Other than acids and bases (discussed later), the covalent compounds in this class that dissolve in water do so without breaking any covalent bonds. These molecular species dissolve without forming any ions, and therefore will not conduct a current and are considered nonelectrolytes. Some examples of these species dissolving in water are shown below.
CH_3CH_2OH (l) --------> CH_3CH_2OH (aq)
$C_6H_{12}O_6$ (s) ---------> $C_6H_{12}O_6$ (aq)
The proper representation of nonelectrolytes in solution are as their original molecular formulas in aqueous states.

Safety:
Goggle, aprons and closed toe shoes are required at all times. Dispose of chemicals as directed by your instructor. Acids can cause sever burns. Wash all affected areas immediately with soap and water and inform your teacher immediately.

Materials:

Conductivity Probe	Labquest	balance
Distilled Water	Graduated Cylinder	Beakers
Stirring Rod	0.01 M NaCl	Wash Bottle

Prelab:

1. Define the following terms. Each definition should include <u>what it is</u> and <u>why it does what it does</u>:

For example: Electrolyte – Conducts electricity readily because all of the compound dissociates into ions when dissolved in water

a) Dissolve-
b) Dissociate –
c) Nonelectrolyte –
d) Strong electrolyte –
e) Weak electrolyte –
f) Salts –
g) Ionic compounds –
h) Molecular compounds –
i) Acids-

2. To determine if a solution is conductive, a conductivity test is performed. This test is based on the an electrical circuit comprising a battery and a bulb that lights when electric current flows and therefore when the aqueous solution is conductive. The following results were found:

Tested solution	Does the bulb light ?	Current (mA)
Distilled water (almost pure)	no	2
Tap water	no	10
sugar water	no	10
Salt water	yes	220
Solution of copper sulfate	yes	160

Based in these results answer the following questions:

a) Distinguish two groups among tested solutions and summarize what observations can be made about each group.
b) An electric current consists of electrically charged particles in motion, what can be concluded about the aqueous solutions tested.

4. Write dissociation reactions for the following ionic compounds: ex.) $H_2A \rightarrow 2\ H^+$ and A^-

a) KBr (s) ---------->

b) BaF_2 (s) ---------->

c) $Fe(ClO_3)_2$ (s) ---------->

Part A: **Conductivity of NaCl?**

Set Up:

1. Set the Conductivity Probe to the 0-2000*u*S/cm setting.
2. Connect the Conductivity Probe to the LabQuest utilizing channel 1.
3. The Conductivity Probe must be rinsed into the between each test, by washing the tip gently with distilled water from your wash bottle.
4. Select Conductivity

Data Collection:

1. Preapre 200ml of the 0.01M solution of NaCl.
2. Place the tip of the Conductivity Probe into the solution. The hole near the tip of the probe should be completely covered by the solution.
3. Start the data collection process by press the Green Collect button at the top right side of the menu bar.
4. Wait a few seconds for your conductivity reading to stabilize.
5. Type in the molarity of the solution you are testing. Select OK.
6. Rinse the Conductivity Probe as outlined in the Set Up.
7. Record the molarity and conductivity in data table.
8. Now make 5 dilutions, measuring the conductivity of each (Use $M_1 \times V_1 = M_2 \times V_2$ to make your dilutions)

9. Test the conductivity of this new solution. When the conductivity reading stabilizes, select KEEP and record the molarity of this solution. (HINT: You just performed a dilution so you will use MV=MV to determine the molarity).
10. Record the conductivity and Molarity in a data table. Show your calculations in the space provided.
11. Rinse the Conductivity Probe as outlined in the Set Up.
12. Test the conductivity of this new solution and record the molarity of the new solution.
13. Rinse the Conductivity Probe as outlined in the Set Up.
14. Repeat steps 9 – 13 until you have successfully tested 5 concentrations.
15. When all five concentrations have been tested, select **STOP** from the top right side of the menu bar.
16. If you cannot see your data points, double click either axis. Select AXIS OPTIONS.
17. On the Y-axis select AUTO SCALE FROM 0.
18. On the X-axis select AUTO SCALE FROM 0.
19. To create your Best-Fit line, Select the LINEAR FIT from the menu bar
20. Type in the formula of the compound tested.
21. Point at the end of the line and drag it to touch the appropriate Best-Fit line. You can also drag the test box closer to the line.
22. Copy results into your lab report in your journal

Data Table 1 for Part A: NaCl

Conductivity	Molarity	Molarity Calculations
	0.010 M	
	0.0 M	