Using Conductivity to Explore a Chemical Reaction

The motion of charged particles causes electricity. Electrolytes are substances that form ions (charged particles) in solution, allowing the solution to conduct electricity. Non-electrolytes do not form ions in solution; therefore a solution of a non-electrolyte will not conduct electricity. In this experiment, we will be exploring the conductivity of a series of substances and solutions and using the change in a solution's conductivity to monitor the progress of a reaction and determine the concentration of a reactant.

Safety Concerns: You will be using fairly strong acids and bases in lab, these are potentially corrosive to skin and clothing. If these substances get on you or your clothes, wash the affected area immediately under a stream of water. If large spills occur, inform the instructor immediately.

Calibrating the Conductivity Probe:

1. On the computer desktop, open the "Chemistry and Physics" folder, then the "Chemistry lab folder" folder and open the file "conductivity1.cmbl". Live conductivity readings should appear in the upper and lower left corners of the screen. The range switch on the probe box should be set to "0-20000".
2. From the –Experiment– menu, select –Calibrate– and click "Calibrate Now". Immerse the conductivity probe in deionized water and enter "0" in the left calibration box, then click "Keep". Dab the probe dry and immerse it in the calibration standard. Enter the conductivity value of the standard (written on the bottle) in the right calibration box and click "Keep". The conductivity probe should now be calibrated. Remember to rinse the probe with deionized water before attempting to take any other readings.

Conductivity of Electrolytes vs. Non-electrolytes:

1. Place 100 mL of deionized water in a 150 mL beaker and add a magnetic stir bar. Place the beaker on a stir plate and clamp the conductivity probe in the solution. Record the conductivity reading.
2. Weigh out approximately 0.2 g of sugar (record the mass to 0.001 g) and add it to the beaker while stirring. When all of the sugar has dissolved, record the conductivity reading.
   - ► What does this reading tell you about the behavior of sugar when it dissolves in water?
3. Discard the solution and add 100 mL of fresh deionized water to the beaker. Weigh out approximately 0.1 g of sodium chloride (record the mass to 0.001 g) and add it to the beaker while stirring. Record the conductivity reading.
   - ► What does this reading tell you about the behavior of sodium chloride when it dissolves in water?
4. Weigh out an additional 0.1 g of NaCl and add it to the solution from step 3 above. Record the conductivity reading.
   - ► How much did the reading change? What does this tell you about the relationship between conductivity and concentration?
5. Discard the solution and add 100 mL of fresh deionized water to the beaker. Obtain about 35-40 mL of the stock sulfuric acid solution in a small, clean, dry beaker. Most of this will be used in the next section. For this part of the experiment add only 2-3 drops of the stock sulfuric acid solution to the beaker of deionized water while stirring. Record the conductivity reading. Add 2 or 3 more drops and record the conductivity reading again.
   - ► What do these readings tell you about the behavior of sulfuric acid in water?

Determination of the Concentration of a Barium Hydroxide Solution:

1. Rinse a burette thoroughly with 2-3 mL of stock sulfuric acid solution. Discard this rinse in a waste beaker and repeat this rinsing an additional one or two times. Then fill the burette with stock sulfuric acid solution. Place the burette in a burette clamp on a ring stand. (TIP: position the burette clamp near the top of the ring stand to provide a more stable mount for the burette and to allow additional clamps to be placed lower on the stand.)
2. Place 25.0 mL of barium hydroxide solution in a clean 150 mL beaker with a magnetic stir bar. Be sure that you use the correct glassware to get the precision needed for the 25.0 mL of barium hydroxide solution. Place the beaker on a stir plate and clamp the conductivity probe in the solution. If the liquid in the beaker is not deep enough to immerse the bottom portion of the probe, add 25 mL of deionized water to the beaker.
   - ► Question for thought: think about it now, answer it later for additional insight into what you're doing in this experiment. How does adding water at this point affect the results of the reaction?
3. In Logger Pro, click the "Collect" button. This should activate the "Keep" button immediately to the right of "Collect". With the conductivity probe in the solution, click "Keep". A dialog box should pop up, enter "0" for the total volume of acid added at this point in the experiment and click "Enter".
4. Record the initial burette reading (to the hundredths place) and add approximately 1 mL of sulfuric acid from the burette to the barium hydroxide solution in the beaker. Record the exact volume of acid added (to the hundredths place). Allow the solution to stir for a few seconds until the conductivity reading stabilizes, then click "Keep" and enter the total volume of acid added to the reaction. Observe and record any changes in the appearance of the solution.
5. Continue adding sulfuric acid in approximately 1 mL increments (always record the exact amount used), clicking "Keep" and recording the ***total*** volume of acid added since the beginning of the experiment after each addition. You should collect at least 6-8 data points ***<u>after</u>*** the conductivity reaches a minimum value.

Be sure that each person saves or prints a properly formatted and annotated Conductivity vs. Volume of Titrant graph before you leave lab. The easiest way to attach the graph to your hand-in is to use the Snipping Tool accessory and paste the graph directly into a Microsoft Word file. Find the Snipping Tool accesory under the Start menu: All programs: Accessories: Snipping Tool. Select only the graph itself, not the data, when using the Snipping Tool. Paste the graph directly into an empty Microsoft Word file and email this file to yourself. Then you can easily copy and paste the graph into your hand-in at a later time.

Questions for Analysis:

The following questions are designed to help you interpret your data. It may be helpful for you to answer these questions while you are in the lab and can interact with the instructor but you are not required to record the answers to these questions in your lab notebook.

1. Why does the conductivity change as it does in your graph? How is this change in conductivity related to your observations of the solution's appearance?

2. What is the significance of the point of minimum conductivity? How many mols of acid were added to the reaction at this point in the reaction? Using the balanced chemical equation, how many mols of barium hydroxide must have reacted at this point? What was the concentration of the original barium hydroxide solution?