Conductivity of Electrolyte Solutions

Description: Different substances are characterized as non-, weak, or strong electrolytes by testing to see if they complete an open circuit.

Materials:

Electrolyte display (Dabney 125)

Single-bulb display can be found in Dabney 114

Procedure:

Perform demonstration in a dark room.

1. Remove the stoppers from the bottles and lower the light bulb rack into the jars. Plug in the electrolyte tray and turn the power switch on to view all of the solutions at once. Alternatively, one can unscrew the light bulbs prior to turning the power switch on. This allows for the instructor to test solutions individually. When the demonstration is complete, turn the power switch off and then raise the light bulb rack out of the electrolyte solutions.

2. The electrolyte tray contains the following solutions:

Deionized H_2O	0.1 M NaOH
Tap H_2O	0.1 M NH_3
0.1 M $C_{12}H_{22}O_{11}$	0.1 M CH_3COOH
0.1 M NaCl	NaCl (s)
0.001 M NaCl	0.1 M CH_3OH
0.1 M HCl	0.1 M $(NH_4)_2SO_4$

3. Students can construct a table in their notebooks to document the “glow” observed when the solution of interest is tested. The solutions should appear as below:

4. An alternative to introduce acid base reactions is to show that ammonia and acetic acid (both at 0.1 M) are weak electrolytes but when the solutions are added together they generate a strong electrolyte through a Brønsted acid-base reaction (NH_4Cl)

Discussion:

The circuit in this demonstration is composed of two copper wire electrodes connected to a light bulb. The electrodes are inserted into various aqueous solutions and the circuit is completed (light bulb glows) if the solution allows charge to flow from one electrode to another. This only occurs if the solution contains a weak or strong electrolyte. Substances are classified as electrolytes if when dissolved, they generate ions in solution. The movement of charge through the solution is a result of the migration of ions, not free electrons. Strong electrolytes are typically *soluble* ionic compounds, or strong acids/bases. Weak electrolytes are typically weak acids/bases, although dilute solutions of strong electrolytes (such as 0.001 M NaCl) also have a weak glow illustrating the relationship between intensity and ion concentration.

Safety:

Be sure not to touch the exposed electrodes when the apparatus is plugged in. Wear gloves and protective eyewear when preparing solutions (if needed).

References:

Vitz, E.; Kistler, M. *J. Chem. Educ.* **2004**, *81*, 63.

Haworth, D. T.; Bartelt, M. R.; Kenney, M. J. *J. Chem. Educ.* **1999**, *76*, 625.