***Demonstration 3***

***Conductivity of Aqueous Solutions of Ionic Compounds, Molecular Compounds, and Household Products***

***OBJECTIVES***

The objectives of this demonstration are; (a) to test for the existence of ions in solution and (b) to classify a substance as strong electrolyte, weak electrolyte, and non-electrolyte.

***INTRODUCTION***

Solutions have different properties than pure substances. Some compounds produce ions when dissolved in water. Ions in water conduct electrical current between the two electrodes of the conductivity cell. Production of ions in an aqueous solution is not limited to ionic compounds. Some covalent compounds also produce ions in aqueous solutions. Examples of those compounds are acids, such as hydrochloric acid (HCl), sulfuric acid (H2SO4), acetic acid (HC2H3O2), and nitric acid (HNO3).

In order for a substance to conduct electricity, it must generate an abundant amount of cations and anions that can move freely in solution. Therefore, solid ionic compounds such as NaCl show no conductivity until dissolved in water.

Substances whose aqueous solutions conduct electricity are called **electrolytes**. In addition to acids, most ionic compounds, including bases, produce ions when dissolved in water; therefore, their solutions conduct electricity. The degree of conductivity does not depend on the amount of substance in the solution (concentration); rather it depends on the degree of ionization of the substance in water. For example, HCl ionizes completely; therefore, a solution of HCl is considered a **strong electrolyte**. Conversely, the degree of ionization of acetic acid in water is less than 0.5%, therefore acetic acid is classified as a **weak electrolyte**.

HCl(aq) H+(aq) + Cl-(aq)

HC2H3O2(aq) H+(aq) + C2H3O2-(aq)

In this demonstration, you will examine the conductivity of different aqueous solutions of several ionic and molecular (covalent) compounds, including several household products (Table 1).

EXPERIMENTAL PROCEDURE

The instructor will demonstrate the use of the conductivity cell. Obtain a conductivity cell and perform the demonstrated conductivity measurements on the following products listed in Table 2.

***Table 1:*** *List of Salts, Acids, Bases, and Household Products.*

|  |  |  |  |
| --- | --- | --- | --- |
| **Salts** | **Acids** | **Bases** | **Household Product/Others** |
| 0.1 M Sodium Chloride | 0.1 M Hydrochloric Acid | 0.1 M Sodium hydroxide | Sucrose solution |
| 0.1 M Calcium Chloride | 0.1 M Sulfuric Acid | 0.1 M Potassium hydroxide | Lemon juice |
|  | 0.1 M Nitric Acid | 0.1 M Ammonium hydroxide | Coffee |
|  | Glacial acetic Acid |  | Coca Cola |
|  | 5% (v/v) Acetic Acid |  | Rubbing Alcohol |
|  |  |  | Gatorade |
|  |  |  | Ocean water |

Record your observations for the conductivity of the products in Table 2.

***Table 2:*** *Conductivity Test.*

|  |  |
| --- | --- |
| Substance/Solution | Conductivity |
| Distilled water | ***None*** |
| Tap water | ***None*** |
| 0.1 M Sodium chloride | ***Strong*** |
| 0.1 M Calcium chloride | ***Strong*** |
| 0.1 M Hydrochloric acid | ***Strong*** |
| 0.1 M Sulfuric acid | ***Strong*** |
| 0.1 M Nitric acid | ***Strong*** |
| Glacial acetic acid | ***None*** |
| 5% (v/v) acetic acid | ***Weak*** |
| 0.1 M Sodium hydroxide | ***Strong*** |
| 0.1 M Potassium hydroxide | ***Strong*** |
| 0.1 M Ammonium hydroxide | ***Weak*** |
| Sucrose solution | ***None*** |
| Lemon juice | ***Weak*** |
| Coffee | ***Depends*** |
| Coca cola | ***Depends*** |
| Rubbing Alcohol | ***None*** |
| Gatorade | ***Strong*** |
| Ocean water | ***Strong*** |

*Question1: Define the following:*

*a. Strong electrolyte:*

***A substance that breaks down completely into ions when dissolved in water. (2pnt)***

1. *Weak electrolyte:*

***A substance that ionizes partially when dissolved in water. (2pnt)***

*Question 2: Among the tested products:*

1. *List the strong acids:*

***Hydrochloric acid, sulfuric acid, and nitric acid. (3pnt)***

1. *List the strong bases:*

***Sodium hydroxide and potassium hydroxide. (2pnt)***

1. *List the weak acids:*

***Acetic acid. (1pnt)***

1. *List the weak bases:*

***Ammonium hydroxide. (1pnt)***

*Question 3: Is there any relationship between the strength of the acid and conductivity?*

***Yes! Strong acid solutions conduct strongly. (1pnt)***

*Question 4: Predict whether a sample of blood would conduct electricity and explain your answer.*

***It would conduct! because blood is rich in ions like sodium ions, calcium ions, and magnesium ions. (1pnt)***

*Question 5: Predict whether a dry sample of table salt would conduct electricity and explain your answer.*

*No! because in crystal structure, the ions are locked in their positions and not free to move around and carry the electrical current. (1pnt)*

*Question 6: Given the results of the conductivity test on water, explain the role of water in conductivity.*

*To free the ions in the molecular or ionic structure. (1pnt)*

*Question 7: Write the chemical equations for ionization of HNO3, NaOH, and CaCl2 in water.*

***HNO3 🡪 H+ + NO3- (3pnt)***

***NaOH 🡪 Na+ + OH-***

***CaCl2 🡪 Ca2+ + 2Cl-***

*Question 8: Based on the conductivity tests, what are the particles present in:*

1. *NaCl solution.*

***Na+ and Cl- (1pnt)***

1. *Sucrose solution.*

***Molecules of sucrose sugar (no ions). (1pnt)***