CONDUCTING SOLUTIONS

LAB CND 2.PALM

From *Science with Handhelds*, Vernier Software & Technology, 2002.

INTRODUCTION

In this experiment, you will study the electrical conductivity of water and various water solutions. A solution can contain molecules, ions, or both. Some substances, such as sucrose ($C_{12}H_{22}O_{11}$) and glucose ($C_6H_{12}O_6$), dissolve to give a solution containing mostly molecules. An equation representing the dissolving of sucrose (table sugar) in water is:

$$C_{12}H_{22}O_{11}(s) \longleftrightarrow C_{12}H_{22}O_{11}(aq)$$

where (s) refers to a solid substance and (aq) , which comes from the term aqueous,refers to a substance dissolved in water. Other substances, such as calcium chloride ($CaCl_2$), dissolve in water to produce a solution containing mostly ions. An equation is:

$$CaCl_2(s) \longleftrightarrow Ca^{2+}(aq) + 2\ Cl^{-}(aq)$$

Calcium ions are necessary for muscle contraction, mitochondrial activity, bone formation, and many other metabolic processes. Organisms may obtain minerals such as calcium from their water supply, since ions dissolve in water.

You will determine conductivity of the solutions using a Vernier Conductivity Probe. In this experiment microsiemens, µS, is the unit of conductivity.

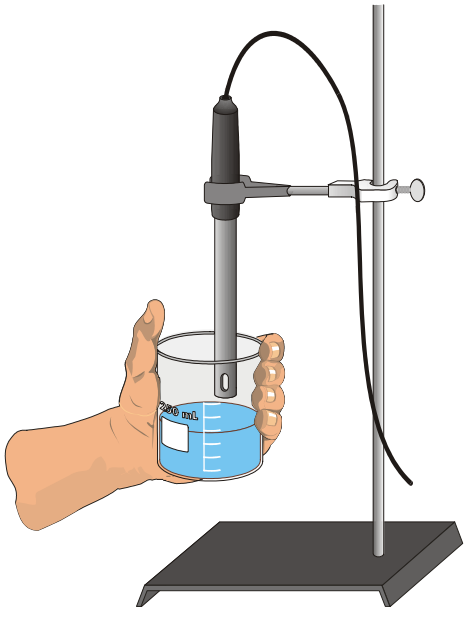

Figure 1

PURPOSE

The purpose of this experiment is to use a Conductivity Probe to test the electrical conductivity of solutions and to determine whether molecules or ions are responsible for the electrical conductivity of solutions. This experiment also introduces the writing of equations for substances dissolving in water.

EQUIPMENT/MATERIALS

LabPro interface
Palm handheld
Data Pro program
Palm Manual (1/class)
Vernier Conductivity Probe
sodium chloride, NaCl, solution
calcium chloride, $CaCl_2$, solution
aluminum chloride, $AlCl_3$, solution
ethanol, C_2H_6O, solution
sucrose, $C_{12}H_{22}O_{11}$, solution
glucose, $C_6H_{12}O_6$, solution
stream or lake water
ocean water (optional)
various foods in solution
deionized water
ring stand
utility clamp

SAFETY

- Always wear an apron and goggles in the lab.

PRE-LAB EXERCISES

Many of the materials you will be using today are found in common household items. A list of common names or uses can be found below:

Sodium chloride, NaCl	Common household salt
Calcium chloride, $CaCl_2$	Used to pickle cucumbers, or to help concrete cure in cold weather
Acetic acid, CH_3COOH	Vinegar
Ethanol, C_2H_6O	Found in gasoline or in alcoholic beverages. Usually obtained from yeast fermentation
Fructose, $C_6H_{12}O_6$	Fruit sugar
Sucrose, $C_{12}H_{22}O_{11}$	Table sugar, beet or cane sugar
Glucose, $C_6H_{12}O_6$	Corn or blood sugar

1. An equation representing the dissolving of sucrose in water is:

$$C_{12}H_{22}O_{11}(s) \longleftrightarrow C_{12}H_{22}O_{11}(aq)$$

Like solid sucrose, the substances glucose, $C_6H_{12}O_6(s)$, and ethanol, $C_2H_6O(l)$, dissolve in water to yield solutions containing mostly molecules. Write equations showing the dissolving of these two liquids in water in Table 1.

2. An equation showing the dissolving of $CaCl_2$ in water is:

$$CaCl_2(s) \longleftrightarrow Ca^{2+}(aq) + 2\ Cl^{-}(aq)$$

Like $CaCl_2$, the substances NaCl and $AlCl_3$ dissolve in water to give solutions containing mostly ions. Write equations in Table 2 showing these two solids dissolving in water.

PROCEDURE

1. Secure the Conductivity Probe with the ring stand and utility clamp as shown in Figure 1.
2. Plug the Conductivity Probe into Channel 1 of the LabPro interface. Set the selector switch on the side of the Conductivity Probe to the 0-20000 range. Connect the handheld to the LabPro using the interface cable. Firmly press in the cable ends.
3. Press the power button on the handheld to turn it on. To start Data Pro, tap the Data Pro icon on the Applications screen. Choose New from the Data Pro menu or tap (New) to reset the program.
4. Set up the handheld and interface for the Conductivity Probe.
   a. If the handheld displays CONDUCT(micS) in CH 1, proceed directly to Step 5. If it does not, continue with this step to set up your sensor manually.
   b. On the Main screen, tap [Setup].
   c. Tap [CH1:] to select Channel 1.
   d. Press the Scroll buttons on the handheld to scroll through the list of sensors.
   e. Select CONDUCT 20000(micS) from the list of sensors.
   f. Tap [OK] to return to the Main screen.
5. Test the conductivity of each solution listed in the data table. You can do the tests in any sequence.
   a. Place the Conductivity Probe into a small sample of the test solution. The hole near the probe end must be completely submerged in the solution.
   b. Once the conductivity reading displayed on the handheld has stabilized, record the reading in Table 3.

c. To avoid contaminating the solutions, rinse the probe with clean, deionized water after each test. Blot the outside of the probe end dry with a tissue or paper towel. It is not necessary to dry the *inside* of the hole near the probe end.

DATA SHEET

Name _____
Name _____
Period _____ Class _____
Date _____

CONDUCTING SOLUTIONS

DATA TABLES

Table 1	
Compound	**Equation for Dissolving in Water**
$C_6H_{12}O_6(s)$	
$C_2H_6O(l)$	

Table 2	
Compound	**Equation for Dissolving in Water**
NaCl(s)	
$AlCl_3(s)$	

Table 3		
Solution	**Material**	**Conductivity (µS)**
1	Distilled water	
2	Sodium chloride, NaCl	
3	Calcium chloride, $CaCl_2$	
4	Aluminum chloride, $AlCl_3$	
5	Ethanol, C_2H_6O	
6	Sucrose, $C_{12}H_{22}O_{11}$	
7	Glucose, $C_6H_{12}O_6$	
8	Tap water	
9	Stream water	
10	Ocean water	
11		
12		

QUESTIONS

1. Which solutions conduct electricity best, those containing mostly ions or those containing mostly molecules?

2. Does deionized water conduct electricity well? Explain.

3. Does tap water conduct electricity? Account for this observation.

4. Consider the conductivity readings for the NaCl, $CaCl_2$, and $AlCl_3$ solutions. What trend do you observe? Account for this trend.

5. How does the conductivity of ocean water compare to pond or stream water? How can you account for this?

6. Which foods in solution conducted electricity well? How can you account for this?

7. Suggest three other substances whose water solutions would conduct electricity well. Explain how you decided on your choices.

EXTENSIONS

1. Test your predictions for Question 7 above.