

I. INTRODUCTION

A solution is a homogeneous mixture of two (or more) substances. It is composed of a solvent and a dissolved material called a solute. The solute is dissolved in the solvent. Both solute and solvent can be in any of the three states of matter.

In this experiment we will be considering solutions in which the solvent is a liquid. Most liquid solvents are molecular compounds. Whether a compound will dissolve in a particular solvent depends on what that solvent is. The rule of thumb for solubility in molecular solvents is "like dissolves like". This means that in general, polar compounds are soluble in polar solvents and nonpolar compounds are soluble in nonpolar solvents. Water is an example of a polar solvent. Cyclohexane is an example of a nonpolar solvent.

Water is the most commonly used liquid solvent. It is sometimes called the "universal solvent" because not only does it dissolve polar compounds, but because it is very polar, it even dissolves some ionic compounds.

There are, in addition to the polarity of the solvent, other factors that affect the solubility (how much will dissolve) of a compound in a solvent. One of these is the temperature of the solvent. In general, solids are more soluble in hot solvents than in cold solvents. On the other hand, gases tend to be less soluble in hot solvents than in cold solvents.

The dissolving process is often accompanied by changes in energy. The process may be exothermic; heat energy is released as the substance dissolves. If the process is endothermic, heat energy is absorbed in the process and you will notice a cooling of the system.

There is for most substances a maximum amount that will dissolve in a solvent at a given temperature. When the maximum amount is dissolved, the resulting solution is said to be saturated. If less than the maximum dissolves, the solution is unsaturated.

II. Experiment

A. Effect of Molecular Polarity on Solubility of Liquid Compounds in Water.

Put about 2 mL of deionized water into each of 2 labeled test tubes. Take them to the HOOD where you will add about 2 mL of ethanol to one and about 2 mL of cyclohexane to the other. Mix the contents by spanking the test tubes. (Your instructor will show you how to "spank" a test tube.) Indicate in Table 9.1 whether the compound is soluble or insoluble in water. Then conclude whether the compound is polar or nonpolar.

TABLE 9.1

Tube #	Compound		Soluble (S) or Insoluble (I) water?	Polar or Nonpolar ?
	Name	Formula		
1	ethanol (ethyl alcohol)	C ₂ H ₆ O		
2	cyclohexane,	C ₆ H ₁₂		

SPECIAL WASTE DISPOSAL: Empty both test tubes, one at a time, into the red organic waste container labeled "Flammable Solvents".

B. Effect of Temperature on Solubility of a Molecular Solid , Sucrose, in Water

Add about 5 g of sucrose (sugar) to about 10 mL of "cold" tap water in a beaker and mix well. In another beaker heat about 10 mL tap water until it is nearly boiling then add about 5 g sugar and mix well.

Does more of the sucrose dissolve in the hot water or in the cold water?

What affect does temperature of the water have on the solubility of a solid in water.

C. Effect of Temperature on Solubility of a Gas , CO₂, in Water

Pour about 3 mL of carbonated beverage (which is basically a solution of CO₂ dissolved in water) into a test tube. Place the test tube in a hot water bath. Observe carefully.


Observation:_____


Is the carbon dioxide more soluble or less soluble in water at the higher temperature?

D. Solubility of Ionic Compounds in Water

Take 5 numbered test tubes, each containing about 3 mL of deionized water, to the reagent bench where you will add an equal tiny amount of each solid to its test tube. Mix well by spanking the test tubes. Indicate whether the compound is soluble or insoluble in water.

Table 9.2

Tube #	COMPOUND		Soluble (S) or Insoluble (I) in water?
	NAME	FORMULA	
1	cupric sulfate		
2	cupric carbonate		
3	calcium carbonate 		
4	calcium chloride		
5	calcium nitrate		

 SPECIAL WASTE DISPOSAL Dispose of calcium carbonate mixture in the waste container labeled "waste calcium carbonate"
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Are all ionic compounds soluble in water?_____

E. Solubility and Nature of Solute and Solvent

To each of two numbered test tubes add about 3 mL of deionized water. Take two more numbered test tubes to the HOOD and add about 3 ml of cyclohexane into each. Test the solubility of NaCl and I₂ in each of the solvents.

Table 9.3

Tube #	Solvent	Polarity of Solvent		Soluble (S) or Insoluble(I) in solvent
1	Water		NaCl	
2			I ₂	
3	Cyclohexane		NaCl	
4			I ₂	

SPECIAL WASTE DISPOSAL Dispose of the contents of test tubes 3 and 4 in the special container under the hood that is labeled:
Waste Halogenated Hydrocarbons

F. Saturated, Unsaturated, and Supersaturated Solutions (demonstration)

Look at the examples of saturated, unsaturated and supersaturated aqueous solutions of _____ and write your observations in the table below.

Table 9.4

SOLUTION	OBSERVATION
saturated	
unsaturated	
supersaturated	

Observe what happens when a crystal of _____ is added to each of the solutions.

Table 9.5

SOLUTION	OBSERVATION
saturated	
unsaturated	
supersaturated	

G. Food coloring in hot and cold water

To about 250 mL of hot tap water in a beaker add 1 drop of food coloring. Then add 1 drop of food coloring to about 250 mL of cold tap water in another beaker.

Observations: _____

H. Energy Changes during the Solution Process

Your instructor will demonstrate this part of the experiment. Pour about 25 mL of deionized water into each of 2 Erlenmeyer flasks. Measure the temperature of the water in each flask and record as "Initial Temperature" in the table below. To one flask add about 5 grams of sodium hydroxide and swirl to dissolve. Measure the temperature of the solution and record as the "Final Temperature" in the table. Repeat this procedure with ammonium chloride. Then indicate whether the process is endothermic or exothermic.

Table 9.6

COMPOUND		INITIAL TEMPERATURE	FINAL TEMPERATURE	ENDOTHERMIC OR EXOTHERMIC PROCESS
NAME	FORMULA			
sodium hydroxide				
ammonium chloride				

Report Experiment 9

Chemistry 110 Lab

SOLUTIONS

Name _____ Date _____
(last) (first)

Instructor's Initials _____

A. Consider all of the compounds and elements used in this experiment and list them, along with their characteristics and solubility in water.

1. Molecular Compounds

<u>COMPOUND</u>	<u>Polarity & State of Matter at Room Temp.</u>	<u>S or I</u>
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

2. Ionic Compounds

<u>COMPOUND</u>	<u>State of Matter at Room Temp.</u>	<u>S or I</u>
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

3. List of ELEMENT(s), their characteristics and solubility

<u>Element</u>	<u>State of Matter at Room Temp.</u>	<u>S or I</u>
_____	_____	_____

