

## Solutions

**Introduction:**

Much of chemistry occurs in solutions. For example, many of the chemical reactions that occur in the body, occur in the blood or in cells. These all contain solutions. Solutions are homogeneous mixtures. They are made of a solvent, the material that does the dissolving, and a solute, the material that gets dissolved. Not all solutes are soluble, able to dissolve, in any solvent. How soluble a substance is depends on several factors that you will be determining today. One factor has to do with the structure and nature of the solute and solvent. Certain substances are considered polar if they have a difference in charge from one end of the molecule to the other. Polar substances tend to dissolve in only polar solvents and nonpolar substances tend to dissolve much better in nonpolar solvents. In today's lab you will be determining the factors that influence solubility.

**Solutions of liquids in water**

Take 2 test tubes with approximately 2 ml of de-ionized water to the hood.

To one of the test tubes add about 2ml of ethyl alcohol and stir with your stirring rod.

To the other test tube of water add about 2ml of cyclohexane and stir. Don't forget to clean your stirring rod.

	<b>Soluble in water?</b>	<b>polar or nonpolar</b>	<b>ionic or molecular</b>
Water	_____		
Alcohol			
Cyclohexane			

**Disposal:** Empty both test tubes into the red organic waste container.

**Solutions of gases in water**

Using a ringstand, ring wire gauze and 250 ml beaker, set up a water bath. Take a test tube to the reagent bench and obtain about 3 ml of the soda beverage. Place the test tube in the water bath.

Observations: \_\_\_\_\_

Soda is dissolved carbon dioxide  $\text{CO}_2$  in water (with sugar and other flavorings)

Is the carbon dioxide more soluble in hot water or in cold water? \_\_\_\_\_

Explain \_\_\_\_\_

## Solutions of solids in water

Take 6 test tubes with about 3 ml of de-ionized water to the reagent bench. With a pencil label the test tubes with the formulas of the following compounds. Add a small amount (about the size of a pea) of the compounds to the appropriate test tube. Stir.

### Ionic compounds in water

Substance	Formula of compound	Ionic or Molecular solid?	Soluble or insoluble?
Copper (II) sulfate in water			
Copper (II) carbonate in water			
Calcium carbonate in water			
Calcium chloride in water			
Calcium nitrate in water			

Are all ionic compounds soluble in water? \_\_\_\_\_

### Factors that affect solubility

#### Demonstration: Food coloring in hot and cold water

Your instructor will put 1 drop of food coloring in a 250 ml beaker of hot water and a 250 ml beaker of cold water

Observations: \_\_\_\_\_

\_\_\_\_\_

Explain the difference between the beaker of hot water and the beaker of cold water.

\_\_\_\_\_

\_\_\_\_\_

#### Demonstration: sugar in hot water and in cold water

Your instructor will put 50 g of sugar in cold water and stir and 100 g of sugar in hot water and stir

Observations: \_\_\_\_\_

\_\_\_\_\_

Explain the difference between the hot solution and the cold solution.

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How does temperature affect the solubility of a solid in water?

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**Demonstration : Iodine in water and in cyclohexane NaCl in water and in cyclohexane**

Your instructor will pour about 3 ml of cyclohexane into two test tubes in the hood and de-ionized water into the other two test tubes. Your instructor will then place about a pea sized amount of NaCl into each of the solvents and the same amount of iodine crystals in the remaining test tubes.

<b>Solute</b>	<b>Solvent</b>	<b>Soluble or insoluble</b>	<b>Polar or nonpolar solute</b>	<b>Polar or nonpolar solvent</b>
<b>Sodium Chloride</b>	<b>Water</b>			
<b>Sodium Chloride</b>	<b>Cyclohexane</b>			
<b>Iodine</b>	<b>Water</b>			
<b>Iodine</b>	<b>Cyclohexane</b>			

What conclusion can you make from the above table about the type of solute that best dissolves in a certain type of solvent ?

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**Demonstration: super saturation**

Your instructor will show you saturated, unsaturated and supersaturated solutions of sodium acetate

What does each of the solutions look like?

<b>solution</b>	<b>observation</b>
saturated	
unsaturated	
supersaturated	

Your instructor will now add a small crystal of sodium acetate to each of the solutions. Record what happens

<b>solution</b>	<b>observation</b>
saturated	
unsaturated	
supersaturated	

**Demonstration: Heat of Solution**

Your instructor will put approximately 25 ml of de-ionized water into 2 different Erlenmeyer flasks. The initial temperature is to be recorded before a substance is added. In one flask about 5 g of ammonium nitrate will be added. To the other flask about 5 g of sodium hydroxide will be added. Record the initial and final temperatures in the table below.

<b>substance name</b>	<b>Formula</b>	<b>initial temperature</b>	<b>final temperature</b>	<b>endothermic or exothermic</b>
sodium hydroxide				
ammonium nitrate				

Which ionic substances dissolve in water?

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Which ionic substances do not dissolve in water?

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Which molecular substances dissolve in water?

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Why?

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Which molecular substances do not dissolve in water?

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Why?

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How can many solids be made more soluble in water?

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How can gases be made more soluble in water?

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What are the factors that influence how a substance dissolves in water?

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What was the most important concept you learned today about solutions?

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**Problems (To be completed before you leave the lab)**

1. What is the percent m/m concentration of an aqueous solution of sodium nitrate in which there are 24.34 grams of solute in 138.87 grams of solvent?

Answer\_\_\_\_\_

2. How many grams of copper (II) sulfate are dissolved in 247 ml of water if the concentration is 48.6% m/v?

Answer\_\_\_\_\_

3. How many ml of alcohol are needed to make 4.50 L of a 25.0 % aqueous solution? (Assume the volumes are additive.)

Answer\_\_\_\_\_

4. If vinegar is a 5.0% m/v solution of acetic acid in water, how many grams of acetic acid are dissolved in a 1.0L bottle of vinegar?

Answer\_\_\_\_\_

## Chem. 100 Lab Report

Name \_\_\_\_\_

Date \_\_\_\_\_

Lab Section \_\_\_\_\_

Initials \_\_\_\_\_

### EXPERIMENT 7 SOLUTIONS

#### Solutions of liquids in water

	polar or nonpolar	ionic or molecular	Soluble in water?
Water			_____
Alcohol			
Cyclohexane			

#### Solutions of gases in water

Is the carbon dioxide more soluble in hot water or in cold water? \_\_\_\_\_

Explain \_\_\_\_\_

#### Solutions of solids in water

##### Ionic compounds in water

Substance	Formula of compound	Ionic or Molecular solid?	Soluble or insoluble?
Copper (II) sulfate in water			
Copper (II) carbonate in water			
Calcium carbonate in water			
Calcium chloride in water			
Calcium nitrate in water			

Are all ionic compounds soluble in water? \_\_\_\_\_

## Factors that affect solubility

### Food coloring in hot and cold water

Explain the difference between dispersion of food coloring in the beaker of hot water and the beaker of cold water.

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### Sugar in hot water and in cold water

How does temperature affect the solubility of a solid in water?

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### Iodine in water and in cyclohexane NaCl in water and in cyclohexane

Solute	Solvent	Soluble or insoluble	Polar or nonpolar solute	Polar or nonpolar solvent
Sodium Chloride	Water			
Sodium Chloride	Cyclohexane			
Iodine	Water			
Iodine	Cyclohexane			

What conclusion can you make from the above table about the type of solute that best dissolves in a certain type of solvent ?

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Which ionic substances do not dissolve in water?

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Which molecular substances dissolve in water?

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Why?

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How can gases be made more soluble in water?

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**Problems (Show all work)**

1. Some communities add sodium fluoride to their water because of its benefits to the teeth. What is the percent m/m of NaF if 64.6 mg of solute is dissolved in every 40,000 g of water. (Put answer in scientific notation)

Answer\_\_\_\_\_

2. Saline solution is often used in hospitals and by optometrists. It is a 0.92% (m/v) aqueous solution of sodium chloride. How many grams of NaCl would be found in 1.59 liters of saline solution

Answer\_\_\_\_\_