SOLUTIONS

WHAT ARE SOLUTIONS?

A solution is made up of a solute and a ________. The solvent does the ________. The solute is the substance that is dissolved. If a solution is made of two liquids, the one in ________ quantity is the solute. _______ is the universal solvent. Water is a versatile solvent because of its attraction to other molecules and its ________. Solutions are homogeneous mixtures in a single phase (either solid, liquid or gas). Salt water, ______ juice and dust free air (mixture of nitrogen, oxygen, argon, carbon dioxide, water vapor and other gases) are examples of homogeneous mixtures. Brass (solid mixture of copper and ______) is also a homogeneous mixture. Brass is an _______, which is a mixture of metals. Oil and vinegar salad dressing is NOT a solution. _____ water is NOT a solution.

ELECTROLYTES

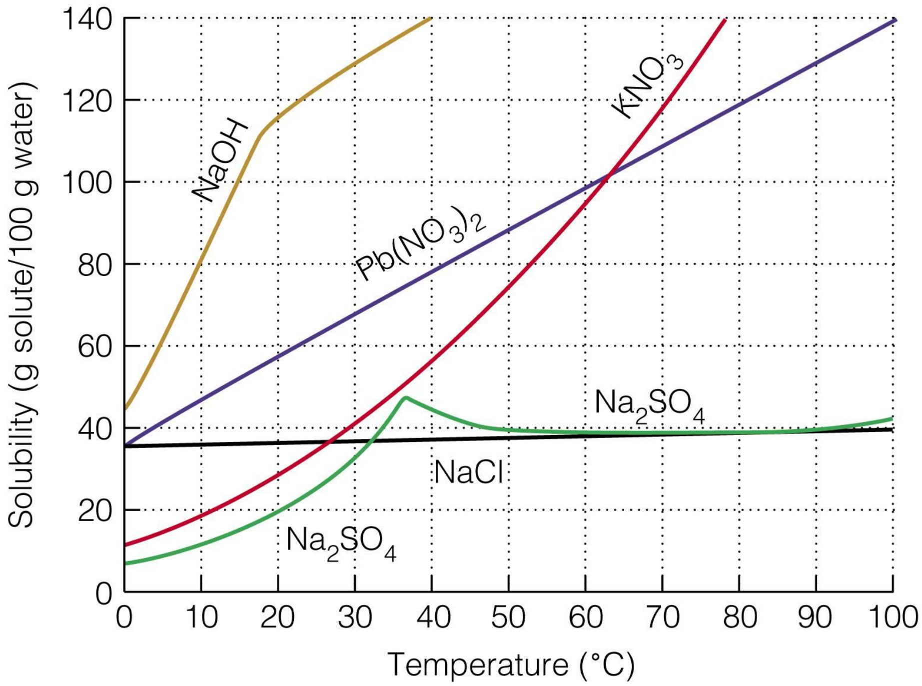
- A great many ionic compounds are ____________________ in water.
- The salt solution is also an excellent __________________________ of electricity (an electrolyte). Free ____________ (such as Na^{+1} and Cl^{-1}) in the solution are able to conduct the electricity and make the light bulb burn ______________________.
- When a salt dissolves (dissociates) in water, the _______________ (positive ion) of the salt is attracted to the oxygen ion (negative ion) of the water. The anion (negative ion) of the salt is attracted to the ____________________ ion (positive ion) of the water.
- When sugar dissolves in water, there are no free ions to conduct electricity. The resulting solution is a ______________________, so the light bulb does NOT light up.

HOW TO SPEED UP THE DISSOLVING PROCESS?

A salt dissolves faster if it is ______________________ or shaken, if the particles are made _____________________ and if the temperature is ______________________. In order to dissolve the solvent molecules must come in ____________________ with the solute.

For gases in a liquid, as the temperature goes up the solubility goes _______________.

For gases in a liquid, as the pressure goes up the solubility goes ______________.



- How many grams of sodium hydroxide (NaOH) will dissolve in 100 g of water at 15ºC?
- How many grams of sodium hydroxide will dissolve in 100 g of water at 40ºC?
- At what temperature will 90 grams of $Pb(NO_3)_2$ dissolve in 100 g of water?
- At what temperature will 30 grams of KNO_3 dissolve in 100 g of water?

COLLIGATIVE PROPERTIES

Vapor Pressure Lowering - The bonds between molecules keep molecules of a liquid from escaping into the _________________ state. In a solution, some of the solvent is busy keeping the solute dissolved. This lowers the vapor pressure. The greater the number of _______________, the more a salt will lower the vapor pressure.

Boiling Point Elevation - The vapor pressure determines the boiling point. When vapor pressure is __________________, the boiling point is higher. The boiling point of a solution is higher than the boiling point of the pure _________________.

Freezing Point Depression - Solids form when molecules make an orderly pattern. The solute molecules _______________ up the orderly pattern. This makes the freezing point lower.

Osmotic Pressure Increase - Osmotic pressure is the ________________ with which a pure solvent moves across a semi-permeable barrier into a container that holds a solution. The bigger the _____________________ in concentration (because of high solute concentration), the stronger the force of osmosis.

Ultimately, colligative properties depend only on the number of _________________________ particles in solution.

MEASURING CONCENTRATION

Concentration is a measure of the amount of solute dissolved in a certain amount of solvent. A concentrated solution has a ____________________ amount of solute. A dilute solution has a _____________________ amount of solute. For chemistry applications, the concentration term *molarity* is generally the most useful. Molarity is the number of moles of _________________________ in 1 Liter of the solution.

$$M = \frac{mol}{L}$$

Example: What is the molarity of a solution with 2.0 moles of NaCl in 4.0 Liters of solution?

1) What is the molarity of a solution with 3.0 moles dissolved in 250 mL of solution?
2) How many moles of NaCl are needed to make 6.0 L of a 0.75 M NaCl solution?
3) 0.200 moles of NaOH are dissolved in a small amount of water then diluted to 500. mL. What is the concentration?
4) 1.25 moles of NaCl are dissolved in a small amount of water then diluted to 625 mL. What is the concentration?
5) How many moles are in 2.00 L of a 3.00 M solution of sulfuric acid (H_2SO_4)?
6) How many moles are in 1500 mL of a 3.2 M solution of nitric acid (HNO_3)?

Example: 10.3 g of NaCl are dissolved in a small amount of water then diluted to 250 mL. What is the concentration?

7) 20.3 g of NaOH are dissolved in a small amount of water then diluted to 500. mL. What is the concentration?
8) 80.6 g of KCl are dissolved in a small amount of water then diluted to 500. mL. What is the concentration?
9) 125 g of $NaC_2H_3O_2$ are dissolved in a small amount of water then diluted to 750. mL. What is the concentration?

Example: How many grams of $CaCl_2$ are needed to make 625 mL of a 2.00 M solution?

10) How many grams of sugar are needed to make 125 mL of a 0.500 M $C_6H_{12}O_6$ solution?
11) How many grams of sodium hydroxide are needed to make 500. mL of a 0.750 M NaOH solution?
12) How many grams of aluminum nitrate are needed to make 600. mL of a 0.500 M $Al(NO_3)_2$ solution?

DILUTION

The number of moles of solute doesn't change if you add more solvent.

$$M_1 \times V_1 = M_2 \times V_2$$

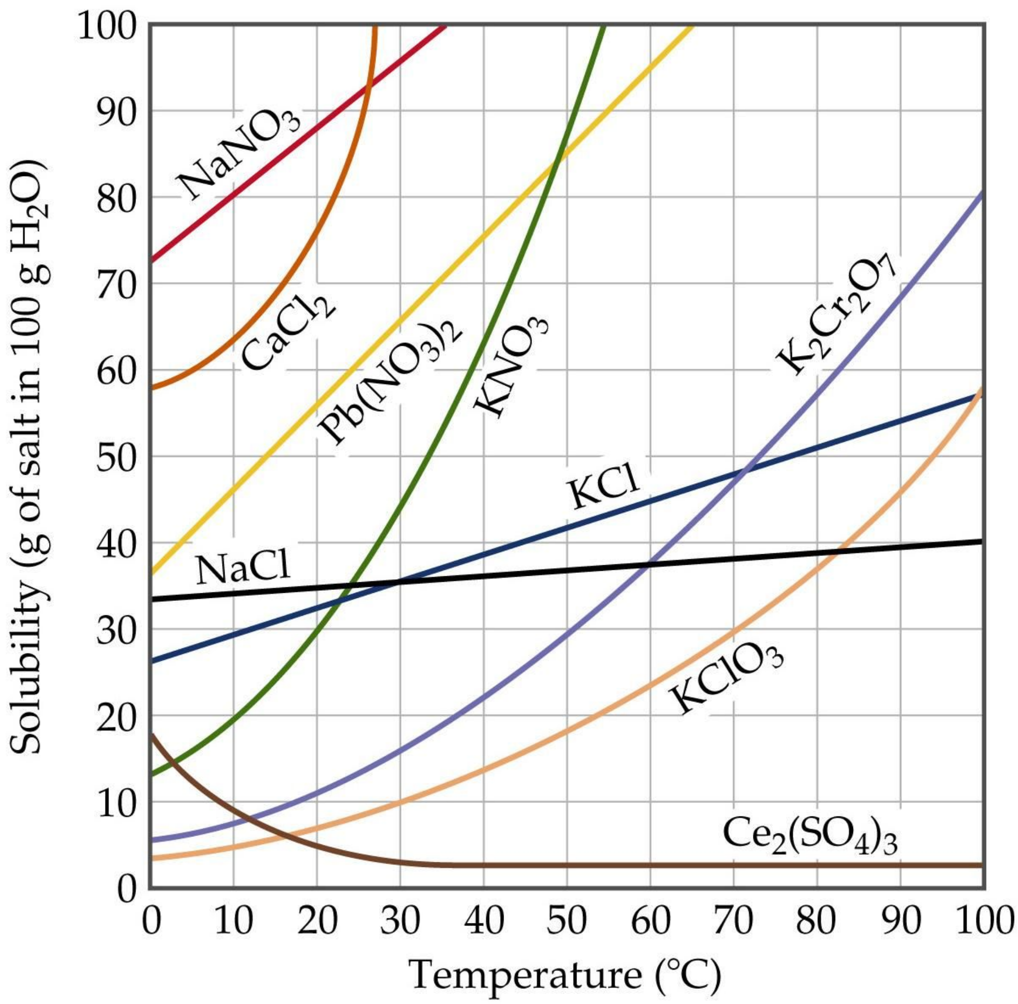
M_1 and V_1 represent the starting concentration and volume. M_2 and V_2 represent the _ _ _ _ _ _ _ _ _ _ _ _ _ _ concentration and volume.

Example: 2.0 L of a 0.88 M solution are diluted to 3.8 L. What is the new molarity?

13) 6.0 L of a 0.55 M solution are diluted to 8.8 L. What is the new molarity?
14) You have 150 mL of 6.0 M HCl. What volume of 1.3 M HCl can you make?
15) 6.0 liters of a 0.55 M solution are diluted to a 0.35 M solution. What is the final volume?
16) You need 450 mL of 0.15 M NaOH. All you have available is a 2.0 M stock solution of NaOH. How do you make the required solution?

SOLUBILITY

Solubility is the ____________________________________ amount of substance that will dissolve at that temperature (usually measured in grams/liter). If the amount of solute dissolved is less than the maximum that could be dissolved, the solution is called a(n) ______________________________ solution. A solution which holds the maximum amount of solute per amount of the solution under the given conditions is called a(n) _________________________________ solution. A(n) ______________________________ solution contains more solute than the usual maximum amount and are unstable. They cannot permanently hold the excess solute in solution and may release it suddenly. A(n) ____________________ crystal will make the extra come out. Generally, a supersaturated solution is formed by dissolving a solute in the solution at an elevated temperature, at which solubility is __________________________ than at room temperature, and then slowly cooling the solution.



Is the solution unsaturated, saturated or supersaturated?

a) 45 g of KCl is dissolved in 100 g of water at 60ºC ____

b) 90 g of $Pb(NO_3)_2$ is dissolved in 100 g of water at 40ºC ______________________________________

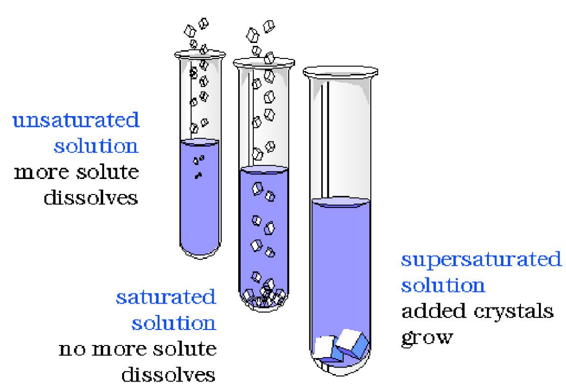
c) 30 g of KNO_3 is dissolved in 100 g of water at 20ºC ____

d) 10 g of $KClO_3$ is dissolved in 100 g of water at 50ºC ____

_____________________ means that two liquids can dissolve in each other.

______________________ means they cannot.

Oil and ________________ are immiscible.



Compounds in Aqueous Solution and Double Replacement Reactions

The ____________________ of ions when an ionic compound dissolves in water is called dissociation. Although no compound is completely insoluble, compounds of very ________ solubility can be considered insoluble.

Using the solubility rules printed on page 6 of the NCDPI Reference Tables for Chemistry, determine whether the following salts are soluble in water.

a) sodium chloride __________________

b) mercury (I) acetate __________________

c) potassium nitrate __________________

d) nickel carbonate __________________

e) barium sulfate __________________

f) ammonium bromide _________________

g) calcium sulfide __________________

In a double-replacement reaction, two compounds exchange partners with each other to produce two different compounds. The general form of the equation is

$$AB + CD \rightarrow AD + CB$$

Signs that a double-replacement reaction has taken place include a color change, the release or absorption of energy, evolution of a gas, and formation of a ________________________________ (which is a solid that will not dissolve in water). Ions that are not involved in the overall reaction are called ______________________ ions. The ______ ionic equation indicates only the species that actually take part in the reaction.

Identify the spectator ions and the precipitate and write the balanced net ionic equation for each of the following.

Example: $(NH_4)_2SO_4 + BaF_2 \rightarrow$ ____

a) $BaCl_2 + AgNO_3 \rightarrow$ ____

b) $Pb(NO_3)_2 + KI \rightarrow$ ____

c) $(NH_4)_2SO_4 + Ba(NO_3)_2 \rightarrow$ ____

d) $K_2S + Zn(C_2H_3O_2)_2 \rightarrow$ ____

e) $Sr_3(PO_4)_2 + Al(OH)_3 \rightarrow$ ____