Solution Chemistry Test Review Sheet

Martin-Regents Chem

Equations:

$$molarity\ (M) = \frac{moles\ of\ solute}{L\ of\ solution}$$

$$ppm = \frac{mass\ of\ solute}{mass\ of\ solution} \times 1{,}000{,}000$$

Dilution: $M_1V_1=M_2V_2$

Reference Tables:

Table E, Table F, Table G, Table T

Info:

1. Properties of a Solution

Solution are classified as **homogeneous (uniform) mixtures**

Solvent is the substance that is dissolving another substance or substances
Solute is the substance that dissolves in a solvent.
***Example: Salt dissolves in water. Salt is the solute and water is the solvent.
-solid in a liquid solution (solid is the solute, liquid is the solvent).Example: salt dissolving in water -gas in a liquid solution (gas is the solute, liquid is the solvent). Carbon dioxide dissolved in soda
-Other types of solutions include liquid in liquid solutions (example: ethanol dissolved in water), gas in gas solutions (example is "air" which includes oxygen dissolved in nitrogen) and solid in solid solutions (example are alloys such as steel, brass, bronze and common metal jewelry).

Solubility is the quantity of a solute that may be added to a given quantity of solvent at a given temperature and pressure

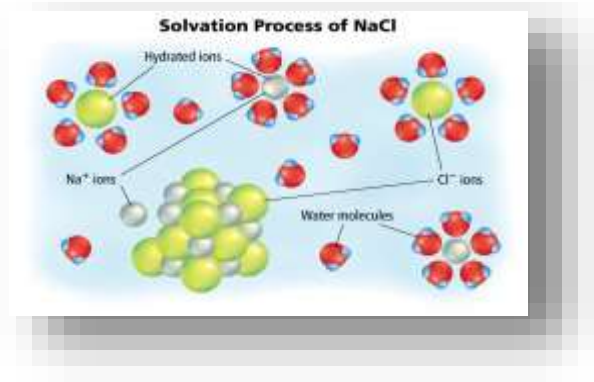
The solubility of a substance is dependent on the **nature of the solute, nature of the solvent, and the temperature of the solvent.**

Concentration is the amount of solute dissolved in a given amount of solvent

Unsaturated Solutions – Solutions that can still dissolve more solute.
Saturated Solutions – Solutions that have dissolved as much as they possibly can. Any more solute added would settle at the bottom and not dissolve.
Supersaturated Solutions - Solutions that contain even more dissolved solute than saturated solutions. • Can happen when some solvent evaporates from a saturated solution. It will form crystals when the solution is disturbed

***A* Precipitate** is an insoluble solid in a liquid. This can occur if a substance is insoluble in a solvent or if more than the maximum amount of a solute that can dissolve in a solvent is added. For example, if you add too much sugar to a glass of ice tea, the extra sugar is visible at the bottom of the glass. The extra sugar is called a precipitate.

When a solute dissolves in solvent, the solvent particles separate the solute particles and surround the solute particles by a process known as **solvation**. For example, when salt dissolves in water, the water molecules separate the positive and negative ions and surround each ion. The negative side of the water polar molecule is attracted to the postive ion and the negative side of the polar water molecule is attracted to the positive ion. This is the reason why the solid salt is no longer visible since each ion is too small to be visible after the ions are separated by the water molecules.



How fast a solute dissolves in a solvent (called the "dissolving rate") is influenced by the following: **stir (agitation), surface area of solute (for solid solutes), pressure (for gas solutes), and temperature**

2. Methods of Calculating Concentration of a Solution

Molarity Calculations

A) Molarity (formula in Reference Table T)= moles of solute/liters of solution

-For Example: 0.5M NaCl (aq) means a concentration of 0.5 moles of NaCl dissolved to form 1 liter of solution.

-Be careful to change all volumes of solution to liters in the formula for Molarity

-For example: a 250ml solution is equal to 0.250 liter solution

Parts per Million Calculations

-Parts Per Million (ppm): formula in Reference Table T

-ppm = grams of solute/grams of solution x 1,000,000

-Make sure that all mass values in the equation are in grams

Dilution Problems

-Use $M_1 \times V_1 = M_2 \times V_2$ to solve dilution problems

Sample Problem:

What is the concentration of a 300ml solution of 0.25M HCl that is diluted to 500ml?

M_1 = 0.25M V_1= 300ml M_2= unknown or X V_2 = 500ml

- Insert values into equation: 0.25M x 300ml = M_2 x 500ml
- Solve for the unknown, M_2 = 0.15M

*It makes no difference if you convert the volume to liters or not when using this formula

3. Solubility of Ionic Compounds

Electrolytes are substances that form ions in solution (conduct electricity)

Solubility of ionic compounds (Table F)

Sample Problems:

1. Which of the following ionic compounds would form a precipitate in water?

a) $CaCl_2$ b) $SrSO_4$ c) $BaCO_3$ d) $Ba(OH)_2$

- $CaCl_2$ is soluble since Cl is a halide and Ca is not in the exception column in Table F
- $SrSO_4$ is insoluble since sulfates are soluble but Sr is in the exception column in Table F
- $BaCO_3$ is not soluble and would form a precipitate (insoluble solid) since CO_3 is a carbonate and Ba is not in the exception column in Table F
- $Ba(OH)_2$ is soluble because even if hydroxides are not soluble in Table F, Ba is in the exception column

4. Writing a Precipitation Reaction

Example: Complete and balance the following precipitation reaction when calcium chloride reacts with sodium sulfate. **(You must include the phases of each substance)**

$CaCl_2$ (aq) + Na_2SO_4 (aq) →

Step #1: Determine products realizing that this is a "double replacement" chemical reaction. Write the formulas of the products correctly. Total charge of ions should be neutral in the formula
Products are: NaCl and $CaSO_4$

Step #2: Check Table F to determine if NaCl and $CaSO_4$ are soluble

Step #3: The substance that is insoluble forms a precipitate. The precipitate is $CaSO_4$.

Step #4: Balance the Reaction Equation

$CaCl_2$ (aq) + Na_2SO_4 (aq) → $2NaCl_{(aq)}$ + $CaSO_{4(s)}$

5. Solubility Curves (Reference Table G)

At a given temperature:
On the line= saturated solution
Above the line= supersaturated
Under the line= unsaturated

Sample problems using Table G
What is the maximum amount of NH_4Cl that can be dissolved in 100ml of water at 40 degrees Celsius?
Step #1: Realize that 100ml of water is the same as 100g of water since density of water is 1g/ml
Step #2: Go to 40 degrees Celsius on the "x" axis of the Table G graph and go to the curve labeled NH_4Cl
Step #3: Read the amount of the solute that can be dissolved on the "y" axis which equals 47 grams

-This represents a saturated solution since the maximum amount of solute is dissolved (47g/100ml)
-Any amount less than 47g at 40 degrees Celsius would be called an "unsaturated" solution
-Any amount more than 47gr at 40 degrees Celsius would be called a "saturated" solution

***Make sure you pay attention to what the question is asking because you are not always asked about 100g/ml.**

6. Colligative Properties

Solute particles in solution increase Boiling Point; decrease Melting Point

*The greater the concentration of solid solute particles in a solution, the greater the amount of the temperature difference of the boiling point and melting point of a solution compared to the boiling point and melting point of the solvent without the solute.

Sample Problem

Which ionic compound increases the boiling point of 100 mL water the most?
a) 1 mole of NaCl b) 1 mole of $CaCl_2$ c) 1 mole of Na_3PO_4

Step #1: Determine how ions are formed and how many moles of ions
Dissociation of Ionic Solute: $NaCl\ (s) \rightarrow Na^+\ (aq) + Cl^-\ (aq)$
Soluble ionic compounds separate into the individual positive and negative ions
Do not separate the atoms of polyatomic ions. The polyatomic ions stays together as an ion. For example:

$$CaSO_4\ (s) \rightarrow Ca^{2+}\ (aq) + SO_4^{\ 2-}\ (aq)$$

Step #2: The substance that produces the most ions will increase the boiling point of the water solution the most. NaCl produces 2 ions, $CaCl_2$ produces 3 ions and Na_3PO_4 produces 4 ions ($3Na^{1+}$ and 1 PO_4^{3-}) Answer: Na_3PO_4