Factors that Affect the Rate of Dissolving and Solubility

Dissolving

One very important property of a solution is the rate of _____, or how quickly a solute dissolves in a solvent. When dissolving occurs, there in _____ _____ involved. Therefore, the solute and solvent can be separated using _____ properties such as _____ or _____.

The rate at which a solute dissolves depends on a number of factors:

i) Temperature

Increasing temperature increases the _____ (energy of motion) of the molecules, which increases the frequencies of _____ and the rate of dissolving.

ii) Agitation

Stirring/shaking brings _____ _____ into contact with _____ _____, increasing _____ and the rate of dissolving.

iii) Particle Size

_____ _____ into smaller pieces increases the _____ that is in contact with _____, thus increasing the rate of dissolving.

The Dissolving Process

Whether or not a solute dissolves and to what extent depends on the forces of attraction between:

-
-
-

When the forces of attraction between _____ particles in a mixture are _____ than the forces of attraction between _____ particles in the mixture, a solution forms. The strength of each attraction influences the _____, or the amount of solute that dissolves in a solvent.

The dissolving process can be broken down into three key steps:

1. The _____ holding the _____ together must be broken (_____)

   Ionic compounds –

   Covalent molecules –

2. The _____ forces (between particles) holding the _____ together must be broken (_____)

3. Solute and solvent _____ (_____) and the molecules of solute fill in the spaces between solvent molecules.

Note: *Dissolving is more likely to occur if the energy required (steps 1 and 2) is less than the energy released (step 3).*

Polar and Non-Polar Substances

In general, we can follow the rule of "_____" when trying to predict the solubility of different particles. _____ solutes and _____ solutes dissolve in _____ and _____ dissolve in _____.

Remember, you can use the difference in electronegativities (_____) to predict if a compound is ionic, polar or non-polar.

There are a few possible forces that act between particles, which helps to explain the "like dissolves like" trend:

Dipole-Dipole Attractions – the attraction between the _____ on two different _____ molecules.

Ion-Dipole Attractions – the attractive forces between an ____ and a _____ molecule. Ions posses a _____ and are therefore attracted to the _____ on the polar molecules.

When ions are present in an _____ solution, each ion is _____. This means that water molecules surround the ion. Hydrated ions can conduct electricity and are referred to as _____.

Solubility

Solubility describes the _____ of _____ that can be dissolved in a given _____ of _____ under given conditions.

A solute is described as _____ in a particular solvent if its solubility is _____ than _____.

A solute is described as _____ in a particular solvent if its solubility is _____ than _____.

Substances with solubility between these limits are called _____.

Factors affecting solubility include:

i) Molecular Size

_____ molecules tend to be more soluble than _____ ones.

ii) Temperature

Affects the solubility of gases and solids in liquids.
For gases in liquids: as temp __ solubility __
For solids in liquids: as temp __ solubility __

A _____ (graph) describes how much solute can be dissolved in a given solvent at a certain temperature.

iii) Pressure

Affects the solubility of gases in liquids.
As pressure __ solubility __

Concentration of Solutions

Concentration is defined as the amount of _____ per quantity of _____.

The concentration of a solution can be calculated. The approach for each calculation varies, depending on the _____ of solution.

1. Calculation as Mass/Volume (m/v) Percent

Gives the mass of solute dissolved in a volume of solution, expressed as a percent.

Mass/Volume % =

Examples:

2.00 mL of distilled water is added to 4.00 g of a powdered drug. The final volume of the solution is 3.00 mL. Calculate the percent m/v and then express the drug concentration in g/100 mL.

What mass of a drug is required to make a 2.0 L solution if the recommended concentration is 1.7%?

2. Calculation as Mass/Mass (m/m) Percent

Gives the mass of solute divided by the mass of solution, expressed as a percent.

Mass/Mass % =

Example:

An aqueous solution of calcium chloride has a mass of 23.47 g. The solvent was evaporated and the residue has a mass of 4.58 g. Calculate the m/m % of calcium chloride in the solution. How many grams of calcium chloride would be present in a 100 g sample?

3. Concentration as Volume/Volume (v/v) Percent

Gives the volume of solute divided by the volume of solution, expressed as a percent.

Volume/Volume % =

Example:

Rubbing alcohol is sold as a 70% (v/v) solution. What volume of alcohol is used to make 500 mL of rubbing alcohol?

4. Parts per Million (ppm) and Parts per Billion (ppb)

Describes the concentration of very small quantities. Usually expressed in terms of mass/mass relationships.

ppm =

ppb =

Note: Your final answer does not refer to the number of particles per million or billion, but rather the mass of solute compared to the mass of solution.

Example:

A shipment of oranges is returned if it contains more than 25 ppb of mould. A company received 20 000 kg of oranges. What is the maximum mass of mould allowed before the shipment should be sent back?

Molar Concentration

Molarity (C) is the number of _____ of _____ dissolved per _____ of _____.

The equation we use to calculate molar concentration is:

Where, C =
n =
V =

Examples:

What is the molar concentration of 1.20 g of $NaNO_3$ in 80.0 mL of solution?

How many grams of potassium hydroxide will be required to prepare 650 mL of 0.430 M solution?

Preparing Solutions and Dilutions

A _____ solution is a solution with _____.

There are 2 ways to prepare a solution:

i.
ii.

A useful tool in preparing solutions is a _____ → a pear-shaped glass with a flat bottom and a long neck. Volumetric flasks provide are very accurate tools for measuring volumes.

To prepare a solution you should perform the following steps:

1. Determine the _____ required to make the desired _____ and _____ of solution.
2. Measure out and dissolve the _____ in approximately _____ of _____.
3. Raise the _____to the desired total volume by adding more _____.

Diluting is a process that makes a solution that is less concentrated. This can be done by:

i.
ii.

Dilution Calculations:

Step 1: Find the number of _____ you need
Step 2: Find the _____ you need
Step 3: Top up with _____

Example #1
How do you make a 1.50 L solutions of NaCl with a concentration of 6.00 M from a stock solution with a concentration of 15.0 M?

Alternatively we can perform dilution calculations using the following equation:

Where, C_1 =
V_1 =
C_2 =
V_2 =

Lets try this equation to solve the previous example!!!

Example #2
If 85.0 mL of 0.950 M sodium sulfate solution was used to prepare 200 mL of a dilute sodium sulfate solution, what is the new concentration made?

Reactions in an Aqueous Solution-Ionic Equations

When an ionic compound is placed in water, most will _____, which means they are _____ in water. Some ionic compounds will remain as a _____ and are _____.

If an ionic compound dissolves in water, it means that the compound is temporarily splitting apart into its _____. This process is referred to as an ionic compound _____. This is NOT a _____ and the ionic compound will readily _____ when removed from the water source.

Double displacement reactions occur in water, and are a direct result of ionic compounds dissociating into their ions. Recall that a double displacement reaction will only occur if _____, _____ or a _____ forms.

We can show the step-by-step process of a double displacement reaction by writing out an **ionic equation**. There are several different components to an ionic equation.

Term	Definition
Total Ionic Equation	
Net Ionic Equation	
Spectator Ion	

Example #1

Word Equation	Silver nitrate reacts with sodium chloride
Balanced Equation	
Total Ionic Equation	
Net Ionic Equation	
Spectator Ions	

Example #2

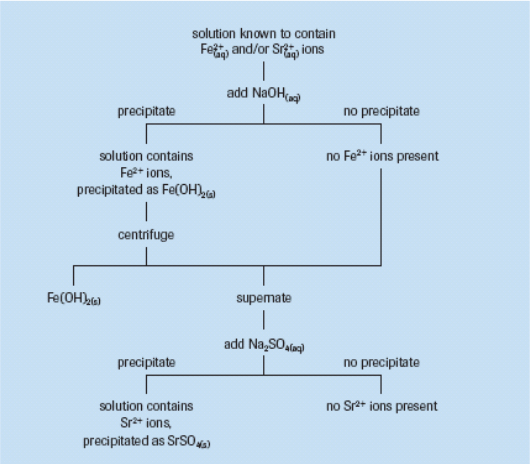
Word Equation	Calcium bromide reacts with lithium chlorate
Balanced Equation	
Total Ionic Equation	
Net Ionic Equation	
Spectator Ions	

Precipitate reactions can be used to generate a precipitation profile for known ions, which can be used to identify ions in solution.

	CO_3^{-2}	OH^{-1}	SO_4^{-2}
Ca^{+2}			
Ba^{+2}			
Unknown	ppt	ppt	ppt

The unknown precipitation profile matches that of _____.

Flow charts can also be used to illustrate what ions may be added to a solution containing many ions to allow for individual separation of ions by precipitation.



When attempting to separate ions from a solution a piece of lab equipment called a _____ can be used. A centrifuge _____ at very high speeds to separate different particles from each other based on their _____.

The part of the solution that does not settle to the bottom of the centrifuge is called the _____.

Solution Stoichiometry

Recall that stoichiometry involves calculating the amounts of reactants and products in chemical reactions using a balanced chemical equation. Previously you learned how to calculate the amount of atoms, particles or mass of a compound using the stoichiometry strategies. You can apply these same skills when approaching calculations involving solutions, with the addition of a few additional steps.

Example #1

Calculate the concentration of calcium chloride in a solution made by mixing 150 mL of a 0.200 M calcium hydroxide solution with 100 mL of a 0.500 M hydrochloric acid solution.

Example #2

Suppose you want to remove the barium ions from 120 mL of 0.050 00 M aqueous barium nitrate solution. What is the minimum mass of sodium carbonate that you should add?

Strong and Weak Acids and Bases

Strong acid –

Example:

When hydrogen chloride molecules enter an aqueous solution, _____ of the hydrogen chloride molecules dissociate. As a result the solution contains the same percent of H+ ions (in the form of H_3O^+) and Cl ions: 100%

Weak acid –

Example:

On average, only about ____ of the acetic acid molecules dissociate at any given moment.

Notice that the arrow used in the dissociation of a weak acid points in both directions. This indicates that the reaction is _____. The products of the reaction will also react to produce the original reactants.

Some useful terms:

Term	Definition	Example
Monoprotic acid		
Diprotic acid		
Triprotic acid		

In both diprotic and triprotic acids, the dissociation of the first hydrogen ion will results in a stronger acid than the acid formed by the second and third dissociation.

Strong base –

Examples:

Weak base –

Example:

Concentration of an Acid or Base

Recall that when in solution, acids and bases dissociate into ions. When you determine the concentration of hydrogen ions in solution (amount of H+ ions/ total solution volume) you are determining the pH of that particular solution. pH stands for, "the power of hydrogen". The pH of a substance can be determined a number of different ways, such as with the use of pH paper, an electronic pH meter or mathematically using the following formulas:

Square brackets [ ] around a chemical formula represents, "the concentration of"

Examples:

What is the pH of a solution with a $[H_3O^+]$ of 1.0×10^{-5}?

Gastric juice has a pH of 1.5, what is the $[H_3O^+]$?

The relative concentration of $[H_3O^+]$ and $[OH^-]$ ions are as follows:

Acidic
Neutral
Basic

A pH scale is a convenient way to relate the pH of a solution to its degree of acidity/alkalinity.

The pH scale ranges from 1 to 14 and each pH unit represents a factor of 10.

Examples:

A change in pH from 3 to 8 is a(n) _____ increase/decrease in $[H_3O^+]$

A change in pH from 11 to 2 is a(n) _____ increase/decrease in $[H_3O^+]$

Neutralization Reactions

Neutralization occurs when _____ (Arrhenius base) and _____ _____ (acid) are mixed to make _____ and a _____. The general word equation is:

Example:

Aqueous solutions of hydrobromic acid and beryllium hydroxide undergo a neutralization reaction to produce water and beryllium bromide.

Complete the following equations:

___ $H_2SO_{4\,(aq)}$ + ___ $LiOH_{\,(aq)}$ $\rightarrow$

___ $Ca(OH)_{2\,(aq)}$ + ___ $H_3PO_{4\,(aq)}$ $\rightarrow$

Which acid and base would you react together to produce the following salts:

i) KNO_3

ii) $Ca(CH_3COOH)_2$

Acid-Base Titrations

A "titration" refers to a technique that involves the careful measuring of the _____ of one solution required to completely react with a _____ of another.

In an acid-base titration, measuring the volume of a _____ (of _____) allows us to determine the _____ of the _____. In this case an _____ is used to indicate when the neutralization reaction is complete. _____ is the most common indicator used. It will be _____ when added to the ____; neutralization occurs at the first signs of the solution _____ and _____ a _____.

Example #1

In an acid-base titration, 25.00 mL of HNO_3 is required to neutralize 33.00 mL of 0.25 M NaOH. Calculate the molarity of the acid?

Example #2

In an acid-base titration, 43.00 mL of 0.30 M KOH is required to neutralize 10.00 mL of H_2SO_4. Calculate the molarity of the acid?