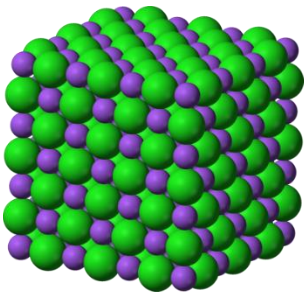
Lect.3. GENERAL CHEMISTRY LABORATORY

Ionic Compound

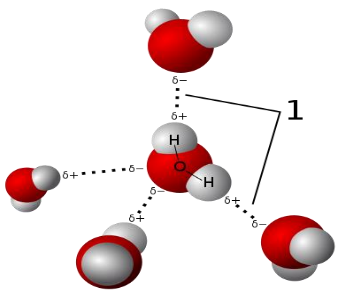
The crystal structure of sodium chloride, NaCl, a typical ionic compound. The purple spheres represent sodium cations, Na^+, and the green spheres represent chloride anions, Cl^-.



In chemistry, an ionic compound is a chemical compound composed of ions held together by electrostatic forces termed ionic bonding.

NaCl in water Na^+ (aq) + Cl^- (aq) .

The compound is neutral overall, but consists of positively charged ions called cations and negatively charged ions called anions. These can be simple ions such as the sodium (Na^+) and chloride (Cl^-) in sodium chloride, or polyatomic species such as the ammonium (NH+) and carbonate, $CO2^-$.



$Kmno_4$ in water K^+(aq) + $mno_4{}^-$ (aq).

H_2O in water H^+(aq) O^-+(aq)

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Concentration Definition

In chemistry, concentration refers to the amount of a substance per defined space.

Another definition is that concentration is the ratio of solute in a solution to either solvent or total solution.

Concentration usually is expressed in terms of mass per unit volume. However, the solute concentration may also be expressed in moles or units of volume ,Instead of volume, concentration may be per unit mass.

Unit of Concentration:

g/cm3, kg/l, M, N, kg/L

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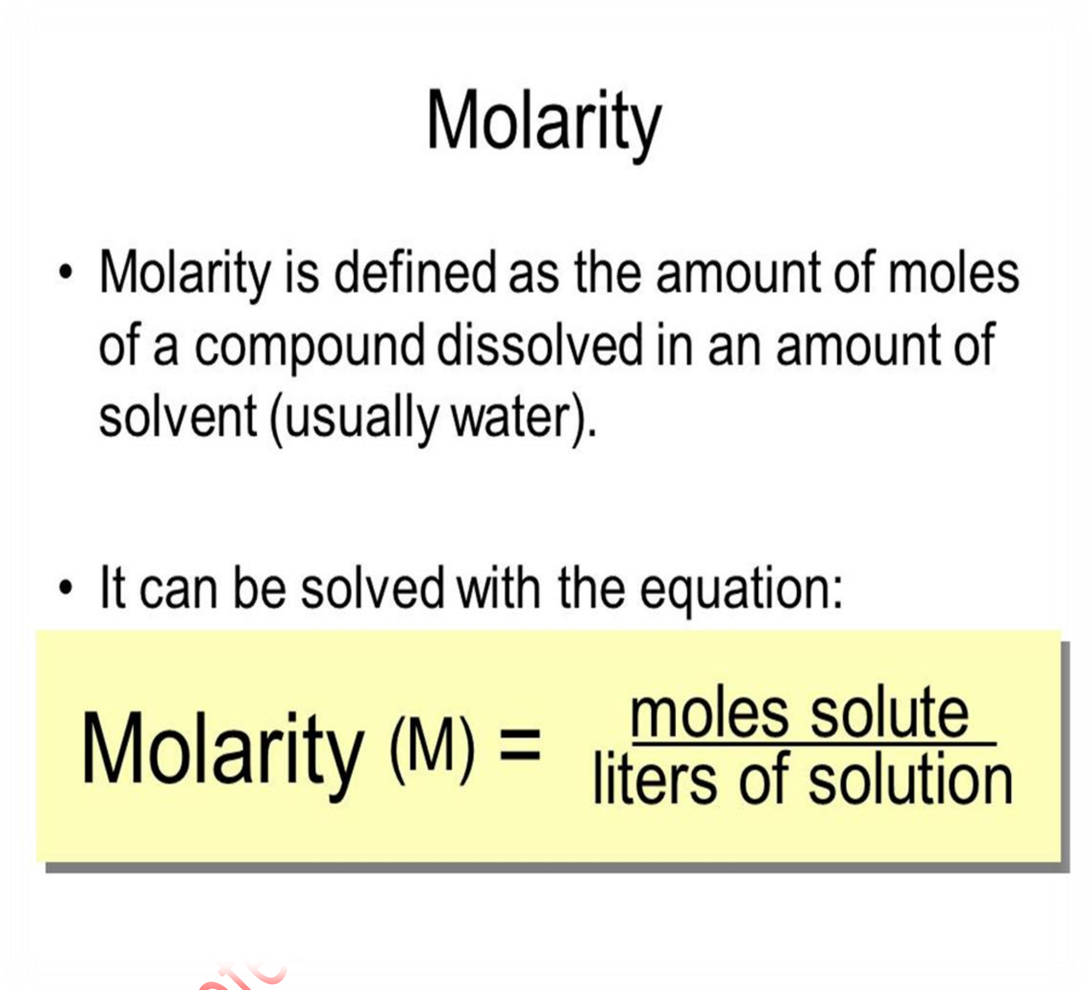

Molarity

(M) = moles of solute / liters of solution (not solvent).

Unit of Molarity :

Moles\ liters

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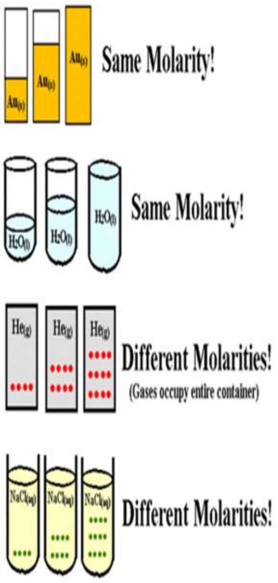
Example For Molarity;



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Example 1:

What is the molarity of a solution containing 0.32 moles of NaCl in 3.4 liters?

$$\text{molarity} = \frac{0.32 \text{ moles NaCl}}{3.4 \text{ L}}$$

$$= 0.094\ \underline{M}\ \text{NaCl}$$

Example 2

2.0 moles of NaCl are dissolved in enough water to prepare 1.0 L of solution, the resulting NaCl solution has a molarity of 2.0 M?

M=2.0 moles.
V=1.0 L.

Answer

(M) = moles of solute / liters of solution

$$(M) = \frac{2.0 \text{ moles}}{1.0 \text{ L.}} = 2.0 \text{ M NaCl solution}$$

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Example 3

What is the molarity of a 0.350 L solution that contains 46 g of KCl?

Step 1: Determine the quantities of solute and solution.

KCl= ∑Atomic mass

=∑39+35.5=74.5 g KCl

1mole KCl=74.5 g KCl

$$\frac{46\text{ g x 1mole}}{74.5\text{g}} = 0.61\text{mole}$$

Step 2: : write (M) = moles of solute / liters of solution.

$$M = \frac{0.61\text{ moles KCI}}{0.350\text{ L solution}} = 1.7\text{ M KC l.}$$

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Example 4

Dissolve 5.00 g of $NiC_{2}.{}_{6}H_2O$ in enough water to make 250 ml of solution calculate Molarity ?

Step 1: calculate No of $NiCl_{2}.{}_{6}H_2O$

Ni , 58.6934 , Cl,35.5 , H , 1,O,16

58.6934+35.5 × 2=129.6934

1×2+16=108

129.6934+108 =237.7

$$\frac{5.00.1\text{mol}}{237.7} = 0.0210\text{mol}$$

Step2: calculate Molarity

(M) = moles of solute / liters of solution

$$\frac{0.0210\text{mol}}{0.250\text{L}} = 0.0841\text{M}$$

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Example 5

What mass of oxalic acid $H_2C_2O_4$ is required to make 250 ml of a 0.0500 M solution ?

Step 1: No of moles = Molarity * Volume

$H_2C_2O_4$=1*2+2*12+16*4= 90

90*1000=90.00

Step2: change ml to liter

$$\frac{250\text{ ml} * 1\text{L}}{1000\text{ml}} = 0.250\text{ L.}$$

Moles= (0.0500 M\L) * (0.250 L) = 0.0125 Moles.

Step3: convert moles to grams

0.0125 Mol*90.00 g\mol =1.13 g

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Preparing Solutions:

Solutions are commonly made up in the laboratory from solid materials, from liquids or from other solutions. The descriptions below assume knowledge of the calculations required to determine solution concentrations, the ability to accurately weigh solids and to pipet liquids.

1- From solid material :

(1) Determine the concentration and amount of solution required for the experiment.

(2) Calculate the amount of solute required to prepare the desired solution.

(3) Weigh out the amount of solute calculated in step (2) and obtain a volumetric flask of appropriate volume.

(4) Add the solute to the volumetric flask.

(5) Fill the volumetric flask approximately two thirds full, stopper and mix. Do this by inverting the flask, shaking and returning the flask to upright. Do this ten times. Make sure to hold the stopper in the flask.

(6) Carefully fill the flask to the mark etched on the neck of the flask. Use a wash bottle or medicine dropper if necessary.

(7) Mix the solution thoroughly by stoppering the flask securely and inverting it ten to twelve times.

2- From a liquid material:

(1) Determine the concentration and amount of solution required for the experiment.

(2) Calculate the amount of stock solution or liquid required to prepare the desired solution (a stock solution is one with a known concentration greater than the solution you are preparing).

(3) Use a pipet to measure the amount of solution or liquid calculated in step (2).

(4) Add the solution or liquid to a volumetric flask of appropriate volume.

(5) Fill the volumetric flask approximately two thirds full and mix.

(6) Carefully fill the flask to the mark etched on the neck of the flask. Use a wash bottle or medicine dropper if necessary.

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Solution:

a solution is
a homogeneous mixture composed of two or more substances. such a mixture, a solute is a substance dissolved in another substance, known as a solvent.

(NaCl) in water. The salt is the solute and the water the solvent.

*Solute: the substance being dissolved.

* Solvent: the substance doing the dissolving (the larger amount).

* Solution : a homogeneous mixture of the solute and the solvent.

* Solution= solvent + solute.

* Aqueous (aq)= water solution.

Characteristics

A solution is a homogeneous mixture of two or more substances.

- The particles of solute in a solution cannot be seen by the naked eye.
- A solution does not allow beams of light to scatter.
- A solution is stable.
- The solute from a solution cannot be separated by filtration
- or(mechanically).
- It is composed of only one phase.

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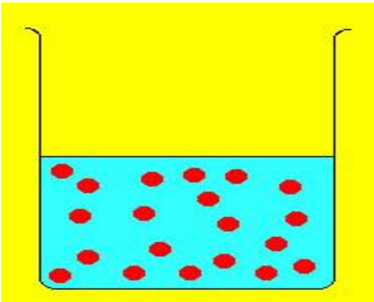
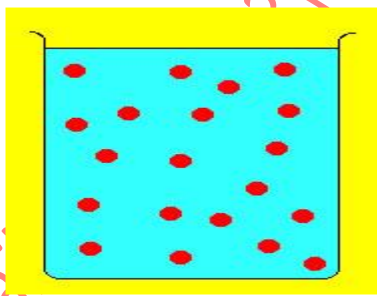
Dilution.

Often it is necessary to take a concentrated solution and dilute it. However, we want to dilute it in a controlled way so that we know the concentration after dilution. The way this is done can be extracted from the following figure of dilution.





Dilute Solution of Known Molarity

The solution dilution calculator tool calculates the volume of stock concentrate to add to achieve a specified volume and concentration. The calculator uses the formula $M_1V_1 = M_2V_2$ where "1" represents the concentrated conditions (stock solution Molarity and volume) and "2" represents the diluted conditions (desired volume and Molarity). To prepare a solution of specific Molarity based on mass, please use the Mass Molarity Calculator. To dilute a solution of concentrated acid or base of known w/w% strength, please use the Acid & Base Molarity Calculator.

$M_1V_1 = M_2V_2$

$M_{1=}$ initial molarity

$M_{2=}$ final molarity

V_1 = initial volume

$V_{2=}$ final volume

- C_1 = initial concentration or molarity
- V_1 = initial volume
- C_2 = final concentration or molarity
- v_2 = final volume

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Dilution:

The process of making a substance less concentrated by adding a solvent, such as water.

Example 6

How would you prepare 500.0 ml of 0.2500M NaOH solution Starting from concentration of 1M solution?

$M_1V_1 = M_2V_2$

$M_{1=}$ 1M V_1=?

M_2 =0.250M $V_{2=}$500 ml.

$V_{1=}$ M_2*V_2\ M_1

$$\frac{0.250M \times 500ml}{1M} = 125ml$$

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Example 7

A student pipets exactly 5.00mL of 3.47 x 10-2 M $FeCl_3$ solution
into a vol flask and add enough water to make 250mL of solution. What is the concentration of the diluted solution?

M1=3.47 x 10^{-2}M
V1=5.00mL
M2=?
V2=250mL

M1*V1 = M2*V2

M2=3.47 x 10-2 *5.00\250mL = 6.94 x 10^{-4} M

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Example8

The% of sulfuric acid is 45% and specific gravity is 1.23 g\mol prepare 0.125M in 100Ml of H_2SO_4?(when the atomic mass of S=32,H=1,O=16).
M.Wt= ∑Atomic mass of element.
M.Wt=(H*1)+(S*32)+(O*16).

M.Wt=(1*2)+(1*32) +(16*4)=98.

H_2SO_4=98.

$$\frac{98}{2} = 49$$

$$M = \frac{SP.G*\% *10}{M.Wt}$$

$$M = \frac{1.23*45*10}{49} = 11,295\ M$$

M_1= 11,295 M V_1 =?

M_2= 0.125 M V_2= 100 Ml

M1*V1 = M2*V2

$$V_1 = \frac{0.125\ M * 100\ Ml}{11,295\ M} = 1.1\ Ml\ of\ H_2SO_4$$

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Example9

Prepare 0.25 M in 200 Ml of HCl when% of acid is 37.5, specific gravity is1.19g\mole(when the atomic mass of H=1,Cl=35.5)

M.Wt= ∑Atomic mass of element.

M.Wt=(H*1)+(Cl *1)

1+35.5=36.5glmole

M=SP.G*% *10\ M.Wt

$$M = \frac{1.19g\backslash mole*37.58*10}{36.5} = 12.23M.$$

$M_{1=}12.23M$, V_1 =?

$M_{2= 0.25M}$ $V_{2=200Ml}$

M1*V1 = M2*V2

$$V_1 = \frac{0.25M \ *200}{12.23} = \quad 4.1ml\ HCl$$

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Preparing of sulfuric acid solution

Always ADD Acid (AA) to water !Agreat amount of heat is liberated ,when a sulfuric acid is added to water .
The temperature of solution will rise rapidly ,In fact the temperature may rise so fast that the solution ,will boil and possibly,
spatter a strongly acidic solution . consider immersing you mixing vessel in a bucket of ice to control the solution temperature ,Always add the acid to water very slowly while stirring continuously .