Lab Math
Solutions, Dilutions, Concentrations and Molarity

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NBS Molecular Training Class
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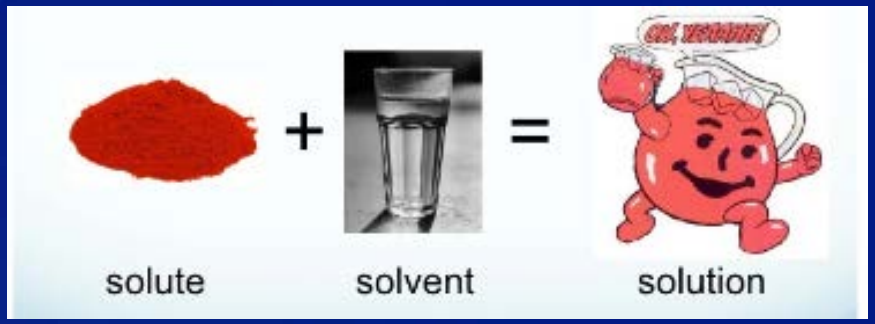
National Center for Environmental Health
Centers for Disease Control and Prevention

Lets Talk About Solutions

- ***Solution -*** a homogeneous mixture of two or more substances.
- ***Solute -*** a substance in a solution that is present in the smallest amount.
- ***Solvent -*** a substance in a solution that is present in the largest amount**.**



- ***Solubility -*** ability of the solute to dissolve in the solvent.

Solutions & Dilutions

- **Preparing solutions and making dilutions**
  - Simple dilutions
  - Mixing parts or volumes
  - Serial dilutions
  - Making fixed volumes of specific concentrations from liquid reagents: (***C1)(V1)=(C2)(V2)***
  - Percent solutions (= parts per hundred)
  - Molar solutions (unit=M=moles/L)

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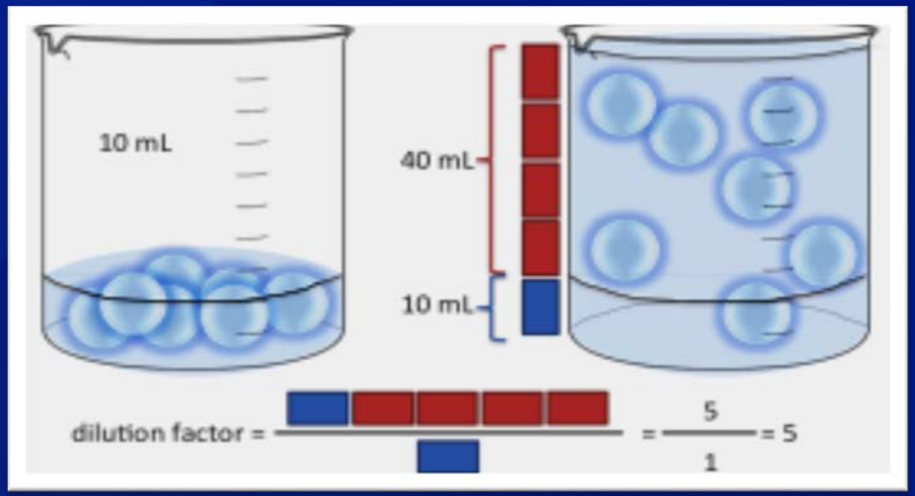
A simple dilution is one in which a unit volume of material of interest (solute) is combined with an appropriate volume of a solvent to achieve the desired concentration



- The *dilution factor is the total number of unit volumes in which your material will be dissolved.*

http://biology.kenyon.edu/courses/biol09/tetrahymena/serialdilution3.htm

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Mixing parts or volumes ≠ simple dilutions

Example: To make up a 1:3 acetic ethanol solution, you are supposed to mix one unit volume of acetic acid and three unit volumes of ethanol.

However, to make 1:3 dilution of acetic acid in ethanol, you would mix one unit volume of acetic acid with two unit volumes of ethanol.

Confused?

“dilution” “dilute”

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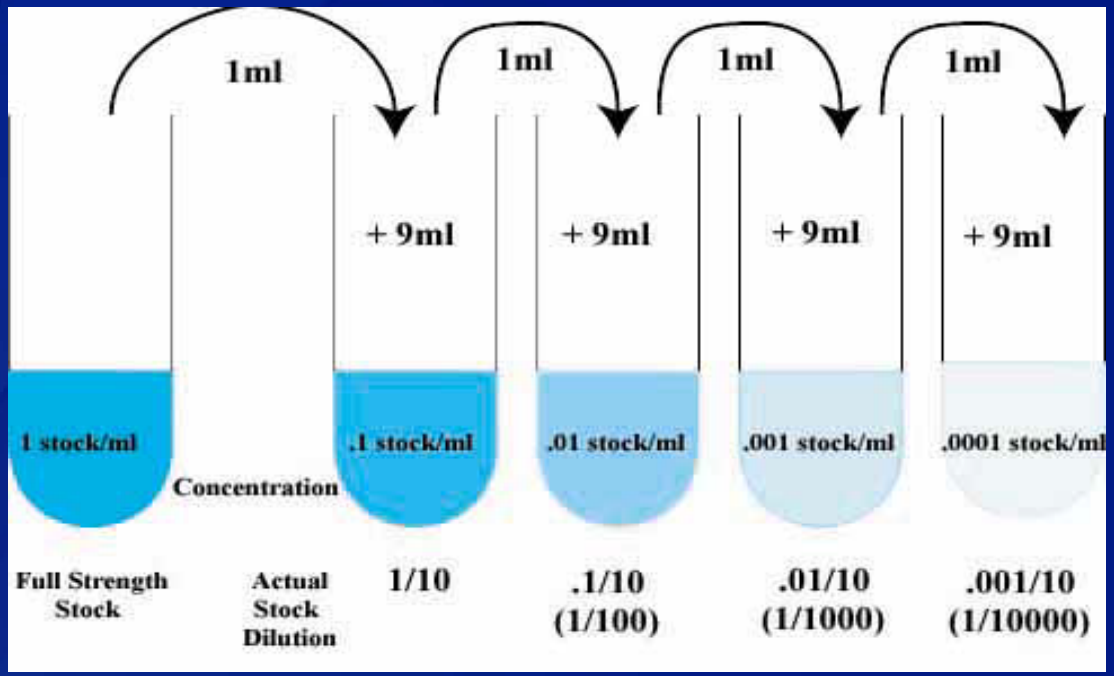
A serial dilution is a series of simple dilutions which amplifies the dilution factor quickly. The source of dilution material for each step comes from the diluted material of the previous.



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Making fixed volumes of specific concentrations from liquid reagents:

(C1)(V1)=(C2)(V2)

C1V1 -source solution attributes; *C2V2 -new solution attributes*

C= concentration ;* *V= volume**

**In whatever units you are working*

Example: Experiment requires a final concentration of 0.1 M Tris, in a total volume of 2ml vials. You have 1M soln. How much stock solution you will need? (C1)(V1)=(C2)(V2)

(1 M) x V1= (0.1 M) x (2 ml)

V1= (0.1 M) x (2 ml) / (1M) = 0.2ml

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Percent solutions (= parts per hundred)

$$\text{Percent by volume (\% (v/v))} = \frac{\text{volume of solute}}{\text{volume of solution}} \times 100\%$$

$$\text{Percent by mass (\% (m/m))} = \frac{\text{mass of solute}}{\text{mass of solution}} \times 100\%$$

Example: A 10% NaCl sol is equal to 10gNaCl in 100ml of solvent, because the solid is measured based upon weight (w) while solvent is measured based upon volume, the NaCl solution should be labeled as 10% w/v NaCl

http://www.chemteam.info/Solutions/Molarity.html

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Molarity (*M*)

- **Is a concentration term for solution**
- **is the number of moles of solute dissolved in one liter of solution.**

To calculate the molarity of a solution, divide the moles of solute by the volume of the solution.

$$\text{Molarity } (M) = \frac{\text{moles of solute}}{\text{liters of solution}}$$

http://www.chemteam.info/Solutions/Molarity.html

Vocabulary to know

Avogadro's Constant: The number of objects in a mole: 6.02×10^{23}

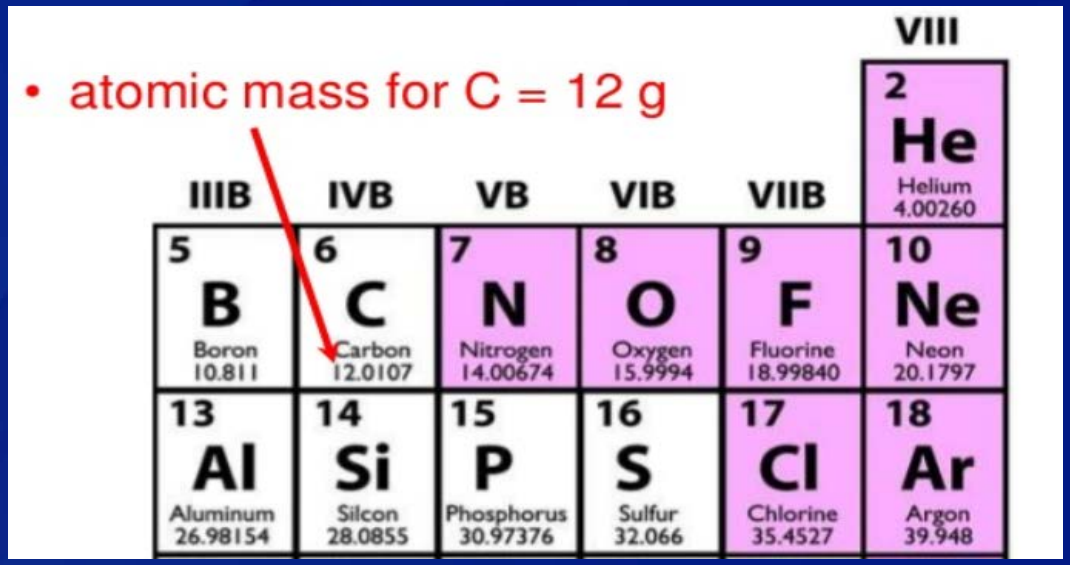
Mole: amount of a substance that contains 6.02×10^{23} particles. A mole of any pure substance has a mass in grams exactly equal to that substance's atomic or molecular mass

Molarity: A unit of concentration equal to the number moles of solute in a 1L of solution.

A mole of any pure substance has a mass in grams exactly equal to that substance's atomic or molecular mass (mass of one mole of a substance).

MM of CO_2 = ^{12}C+ $^{16}0_2$ = 48g/mole

($6.02x10^{23}$ molecules of CO2= 48g)



Molarity dilutions:

- **1M** solution of NaCl (23Na 35Cl) = 58 g NaCl dissolved in 1 liter of H2O
- **1mM** (miliM) = 1:1000 dilution of 1M or 10^{-3}
- **1µM** (microM) = 1:1000 dilution of 1mM or 1:1,000,000 of 1M or 10^{-6}
- **1nM** (nanoM)= 1:1000 dilution of 1 µM or 1:1,000,000,000 of 1M or 10^{-9}
- **1pM** (picoM) = 1:1000 dilution of 1 nM or 1:1,000,000,000,000 of 1M or 10^{-12}

What's the **µM** concentration of a 1:10000 dilution of a solution containing 87 g of NaCl per litter?

$$\text{1M NaCl} = 58\ \text{g/L} \Rightarrow \frac{?M}{87\ g/L} = \frac{1M}{58\ g/L} \Rightarrow \frac{?M \times 58\ g/L}{1M \times 87\ g/L} = 1.5M$$

1:10000 dilution of 1.5M = 0.00015 M x 1000 mM = 0.15 mM = 150 **µM**

Slide from Dr. Carlos Saavedra- NY State NBS

What is the molarity when 0.75 mol is dissolved in 2.5L of solution?

$$\text{Molarity (M)} = \frac{\text{moles of solute}}{\text{liters of soln}} = \frac{0.75\ \text{mol}}{2.50\text{L}} = 0.300\text{M}$$

Calculate the molarity of 25g KBr dissolved in 750ml.

MM of KBr = (39.1K+79.9Br) = 119 g/mol

$$\frac{25\text{g}}{119\ \text{g/mol}} = 0.210\ \text{mol} \quad \Rightarrow \quad \frac{0.210\ \text{mol}}{0.75\ \text{L}} = 0.280\text{M}$$

What is the molarity of 500ml NaOH sol, if it contains 6g NaOH?

Step 1:

Given 6g NaOH on 0.500L sol, **Need** molarity (M)

Step 2:

Conversion factors MM of NaOH = (23Na+16O+1H) = 40g/mol

Step 3:

Calculate molarity

$$\frac{6\text{g}}{40\ \text{g/mol}} = 0.150\ \text{mol} \quad \Rightarrow \quad \frac{0.150\ \text{mol}}{0.500\text{L}} = 0.300\text{M NaOH}$$

How many grams of KCl are needed to prepare 125mL of a 0.720 M KCl solution?

Step 1:

Given 125ml (0.125L) of 0.720M KCl, **Need** grams of KCl

Step 2:

Conversion factors MM of KCl = (39.1K+ 35.5Cl)= 74.6 g/mol

Step 3:

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

$$125\ \cancel{ml} \times \frac{1\ \cancel{L}}{1000\ \cancel{ml}} \times \frac{0.720\ \cancel{M}\ KCl}{1\ \cancel{L}} \times \frac{74.6\ g\ KCl}{1\ \cancel{M}} = 6.71\ g\ KCl$$

In conclusion:

What is the molarity of “X” grams of your favorite substance dissolved in “X” mL of solution?

To solve it, you convert grams to moles, then divide by the volume, like this:

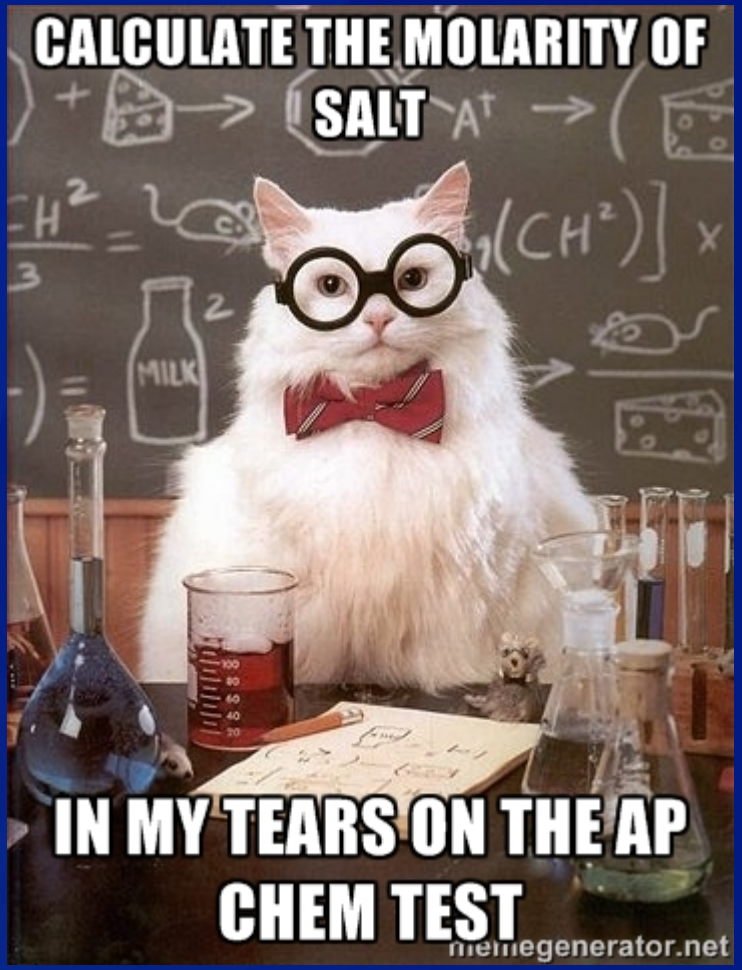
$$\frac{\text{grams}}{\text{molar mass}} = \text{moles}$$

$$\frac{\text{moles}}{\text{volume}} = \text{molarity}$$

GOLDEN RULE:

ALWAYS TO CHECK UNITS!!!

Homework


CALCULATE THE MOLARITY OF SALT
IN MY TEARS ON THE AP CHEM TEST
memegenerator.net

Thank you!

The findings and conclusions in this presentation are those of the author and do not necessarily represent the views of the Centers for Disease Control and Prevention.

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