Name: _____ Date: _____

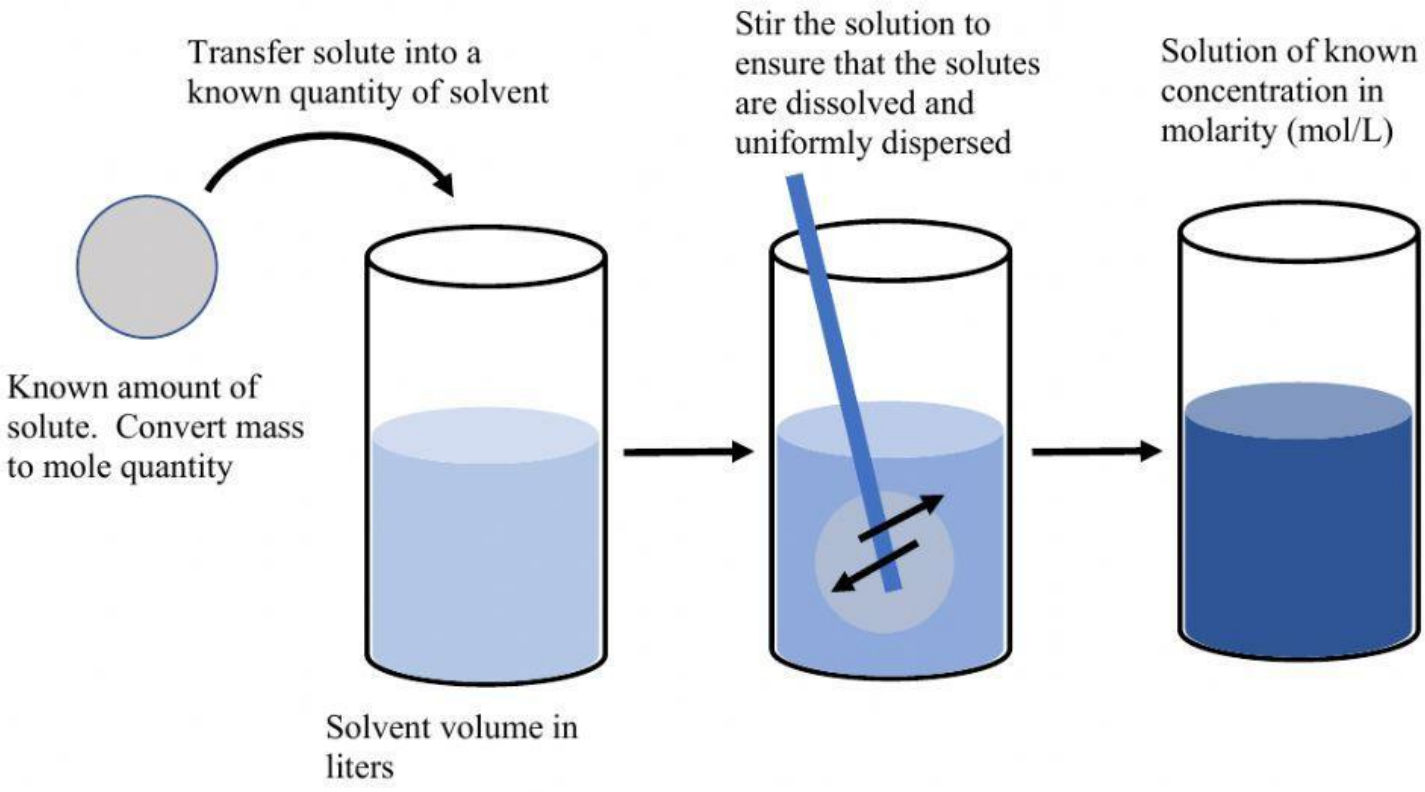
CHEMISTRY
Calculating Concentrations: Part 1 MOLARITY

Concentration of a solution is the quantity of solute dissolved into a known quantity of solvent or in the solution.

Molarity

Molarity is the concentration that describes the mole quantity of solute dissolved in one liter of volume of solution. The concentration of molarity is reported in units of mol/l (moles per liter). Molarity concentration is noted as [X] brackets around the chemical symbol (element) or the chemical formula (compound).

How to make a solution



Writing Dissociation Equations for Strong Electrolytes

For ionic compounds that are strong electrolytes, the dissociation equation must be balanced—equal number of each element on the left side and right side of the yield arrow. The subscript (aq) means aqueous, "dissolved in water". The ions will separate and become solvated by the water molecules. The coefficients indicate the number of ions released into the water solution.

KI dissolved in water: $KI_{(aq)} \rightarrow K^{+}_{(aq)} + I^{-}_{(aq)}$

$Al(ClO_4)_3$ dissolved in water: $Al(ClO_4)_{3(aq)} \rightarrow Al^{3+}_{(aq)} + 3ClO_{4(aq)}$

Na_2S dissolved in water: $Na_2S_{(aq)} \rightarrow 2Na^{+}_{(aq)} + S^{2-}_{(aq)}$

Equations

Convert ml volume to liter volume	$\text{ml} \cdot \frac{1\ \text{L}}{1000\ \text{ml}} = \text{Liters}$
Convert mass to mole quantity Pure element	$\text{mass} \cdot \frac{1\ \text{mol}}{\text{Atomic mass}} = \text{moles}$
Convert mass to mole quantity Pure compound	$\text{mass} \cdot \frac{1\ \text{mol}}{\text{Formula mass}} = \text{moles}$
Molarity concentration of the entire compound dissolved in water [X] = mol/L	$\text{Molarity} = \frac{\text{mol solute}}{\text{Volume solution}}$
Molarity concentration of the ions dissolved in water [X] = mol/L	$\text{Molarity} = \text{coefficeint} \cdot \frac{\text{mol solute}}{\text{Volume solution}}$

Example #1

Dissolve 55 grams of $NaNO_3$ into 750 ml of water.

- Calculate the moles of $NaNO_3$
- Calculate the volume of water in liters.
- Write the balanced equation to show the dissociation.
- Divide moles of $NaNO_3$ by volume of water (liters)
- Calculate the molarity of $NaNO_3$ in the solution.
- Calculate the molarity of the Na^+ and NO_3^- in the solution.

Sodium nitrate dissociates in water to form dissolved sodium and dissolved nitrate. For every 1 molecule of $NaNO_3$ that dissolves, 1 Na and 1 NO_3 are released into the water.

$$NaNO_{3(aq)} \rightarrow Na^+_{(aq)} + NO_3^-{}_{(aq)}$$

Formula mass = 84.99 g/mol

$$55.0\ \text{g} \cdot \frac{1\ \text{mol}}{84.99\ \text{g}} = 0.647\ \text{mol}$$

$$V(\text{l}) = 750\ \text{ml} \cdot \frac{1\ \text{l}}{1000\ \text{ml}} = 0.750\ \text{l}$$

$$[NaNO_3] = \frac{0.647\ \text{mol}}{0.750\ \text{l}} = 0.853\ \text{mol/l}$$

$$[Na^+] = \mathbf{1} \cdot \frac{0.647\ \text{mol}}{0.750\ \text{l}} = 0.853\ \text{mol/l}$$

$$[NO_3{}^-] = \mathbf{1} \cdot \frac{0.647\ \text{mol}}{0.750\ \text{l}} = 0.853\ \text{mol/l}$$

By dissolving 55 grams of $NaNO_3$ into 750 ml of water, a 0.853 mol/l solution was created. The concentration of the dissociated species in the water is 0.853 mol/l Na^+ and 0.853 mol/l NO_3^-. There is 1 Na and 1 NO_3 per molecule.

Example #2

Dissolve 120 grams of $SrCl_2$ into 1.80 liters of water.

- Calculate the moles of $SrCl_2$
- Calculate the volume of water in liters.
- Write the balanced equation to show the dissociation.
- Divide moles of $SrCl_2$ by volume of water (liters)
- Calculate the molarity of $SrCl_2$ in the solution.
- Calculate the molarity of the Sr^{2+} and Cl^- in the solution.

Strontium chloride dissociates in water to form dissolved strontium and dissolved chloride. For every 1 molecule of $SrCl_2$ that dissolves, 1 Sr and 2 Cl are released into the water.

$$SrCl_{2(aq)} \rightarrow Sr^{2+}_{(aq)} + 2Cl^-_{(aq)}$$

Formula mass = 158.53 g/mol

$$120.0\ \text{g} \cdot \frac{1\ \text{mol}}{158.53\ \text{g}} = 0.757\ \text{mol}$$

$V(\text{l}) = 1.80\ \text{l}$
(no conversion needed)

$$[SrCl_2] = \frac{0.757\ \text{mol}}{1.80\ \text{l}} = 0.420\ \text{mol/l}$$

$$[Sr^+] = \mathbf{1} \cdot \frac{0.757\ \text{mol}}{1.80\ \text{l}} = 0.420\ \text{mol/l}$$

$$[Cl^-] = \mathbf{2} \cdot \frac{0.757\ \text{mol}}{1.80\ \text{l}} = 0.841\ \text{mol/l}$$

By dissolving 120 grams of $SrCl_2$ into 1.80 l of water, a 0.420 mol/l solution was created. The concentration of the dissociated species in the water is 0.420 mol/l Sr^{2+} and 0.841 mol/l Cl^-. There is 1 Sr and 2 Cl atoms per molecule.

Complete the concentration calculations.

Show your calculations (as best as possible) in the column Your calculations & equations. Type your final answer for each part in the Answer column.

1. You dissolve 35 grams of KCl into 250 ml of water.
   - Calculate the formula mass of KCl
   - Calculate the moles of KCl
   - Calculate the volume of water in liters.
   - Write the balanced dissociation equation
   - Calculate the molarity of KCl in the solution.
   - Calculate the molarity of the K^+ and Cl^- in the solution.

	Answer	Your calculations & equations
Formula Mass of KCl =		
Moles KCl =		
Volume (l) =		
Dissociation Equation		
[KCl] =		
$[K^+]$ =		
$[Cl^-]$ =		

2. You dissolve 290 grams of K_2SO_4 into 900 ml of water.
   - Calculate the formula mass of K_2SO_4
   - Calculate the moles of K_2SO_4
   - Calculate the volume of water in liters.
   - Write the balanced dissociation equation
   - Calculate the molarity of K_2SO_4 in the solution.
   - Calculate the molarity of the K^+ and SO_4^{2-} in the solution.

	Answer	**Your calculations & equations**
Formula Mass of K_2SO_4 =		
Moles K_2SO_4 =		
Volume (l) =		
Dissociation Equation		
$[K_2SO_4]$ =		
$[K^+]$ =		
$[SO_4^{2-}]$ =		

3. You dissolve 25 grams of $MgBr_2$ into 250 ml of water.
   - Calculate the formula mass of $MgBr_2$
   - Calculate the moles of $MgBr_2$
   - Calculate the volume of water in liters.
   - Write the balanced dissociation equation
   - Calculate the molarity of $MgBr_2$ in the solution.
   - Calculate the molarity of the Mg^{2+} and Br^- in the solution.

	Answer	Your calculations & equations
Formula Mass of $MgBr_2$ =		
Moles $MgBr_2$ =		
Volume (l) =		
Dissociation Equation		
$[MgBr_2]$ =		
$[Mg^{2+}]$ =		
$[Br^-]$ =		

4. You dissolve 50 grams of $CaBr_2$ and 100 grams of $Ca(NO_3)_2$ into the same 2.50 liters of water. No chemical reaction happens.

- Calculate the moles of $CaBr_2$
- Calculate the moles of $Ca(NO_3)_2$
- No volume conversion is needed. Volume is already in liters.
- Write the balanced dissociation equations for $CaBr_2$ and $Ca(NO_3)_2$
- Calculate the molarity of $CaBr_2$ in the solution.
- Calculate the molarity of $Ca(NO_3)_2$ in solution.
- Calculate the molarity of the Ca^{2+}, NO_3^-, and Br^- in the solution.

	Answer	**Your calculations & equations**
Formula Mass of $CaBr_2$ =		
Formula Mass of $Ca(NO_3)_2$ =		
Moles $CaBr_2$ =		
Moles $Ca(NO_3)_2$ =		
Volume (l) =		
Dissociation Equation $CaBr_2$		
Dissociation Equation $Ca(NO_3)_2$		
$[CaBr_2]$ =		
$[Ca(NO_3)_2]$ =		
$[Ca^{2+}]$ =		
$[Br^-]$ =		
$[NO_3^-]$ =		