7.3: Molarity, Molality & Dilution

Remember:

- Have your 7.3 notesheet ready!
- You can pause the video anytime.
- You can rewind the video anytime.
- Write down questions/comments as you go for discussion in class.

Are you ready???



Part I: Molarity and Molality

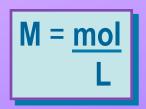
- the concentration of a solution can be measured in a variety of ways.
 - the words "concentrated" and "dilute" can describe a sol'n without specific numerical values. These are <u>qual</u>itative descriptions.
 - <u>quantitative</u> descriptions of concentration (numerical values) can be calculated from specific information about the solution, such as moles of solute and either volume or mass of solvent. <u>Molarity</u> (M) and <u>molality</u> (m) are two such values.
- <u>Molarity</u> (M) = the number of **moles** of solute per 1 liter of total solution.

Molarity (M) =
$$\underline{\text{moles of solute}}_{\text{liters of solution}} = \underline{\text{mol}}_{\text{L}}$$

- Molarity involves a **molar** amount of solute, so if you are given something like grams, you must convert them into moles first.
- Molarity also involves the **volume** (in **liters**) of total solution, so if you are given something like mL, you must convert them into liters first.



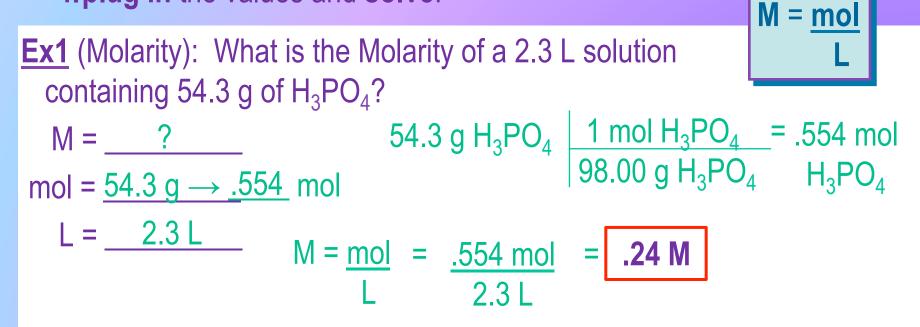
- Molarity also involves the **volume** (in **liters**) of total solution, so if you are given something like mL, you must convert them into liters first.
- once you have moles of solute and liters of solution, just divide. Molarity unit = M
- steps in the calculation:



- 1. set up a "column of information" that lists the info given in the problem, as well as which variable you are solving for (the ?)
- 2. decide which **rearrangement** of the formula you need to solve the problem
- 3.convert units given to those needed to match the units in the formula4.plug in the values and solve!
- **Ex1** (Molarity): What is the Molarity of a 2.3 L solution containing 54.3 g of H₃PO₄?



- 1. set up a "**column of information**" that lists the **info given** in the problem, as well as which variable you are solving for (the ?)
- 2. decide which **rearrangement** of the formula you need to solve the problem
- 3.convert units given to those needed to match the units in the formula4.plug in the values and solve!





- molality (m) = the number of moles of solute per 1 kilogram of solvent.
 Molality (m) = moles of solute kilograms of solvent
 - molality involves a **molar** amount of solute, so if you are given something like grams, you must convert them into moles first.
 - molality also involves the mass (in kilograms) of solvent, so if you are given something like grams, you must convert them into kilograms first.
 - once you have moles of solute and kg of solvent, just divide. Molality unit = m
- the reason we have **two different forms** of concentration values is because of the tendency of a liquid to expand or contract with temperature or pressure fluctuations.
 - this affects the volume of the liquid, which, in turn, affects the Molarity value.



mol

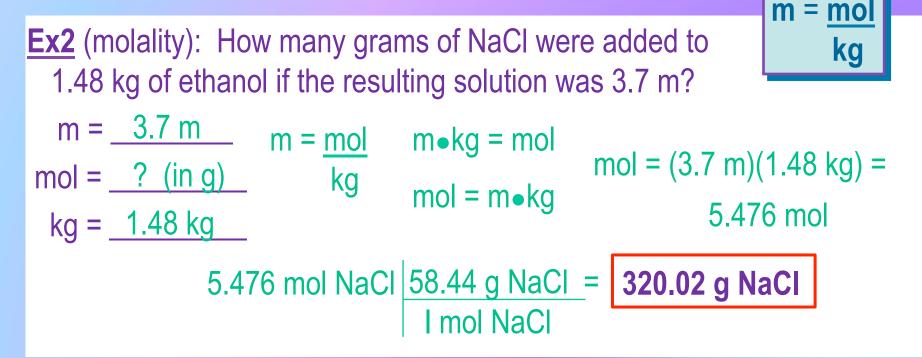
kg

- the reason we have **two different forms** of concentration values is because of the tendency of a liquid to expand or contract with temperature or pressure fluctuations.
 - this affects the volume of the liquid, which, in turn, affects the Molarity value.
 - therefore, if the temperature or pressure **remains the same**, Molarity is used as the measure of concentration.
 - however, molality does not involve volume, it involves mass (in kg), which does not fluctuate with changes in temperature or pressure.
 - therefore, if the temperature/pressure **changes**, molality is used as the measure of concentration.

Ex2 (molality): How many grams of NaCl were added to 1.48 kg of ethanol if the resulting solution was 3.7 m?



- 1. set up a "**column of information**" that lists the **info given** in the problem, as well as which variable you are solving for (the ?)
- 2. decide which **rearrangement** of the formula you need to solve the problem
- 3.convert units given to those needed to match the units in the formula4.plug in the values and solve!





Part II: Dilution Calculations

- most acids, bases, and other chemical solutions are sold in very concentrated form to save on shipping costs and storage space (smaller volume and mass). (Think of frozen concentrated orange juice.)
- however, most experiments call for very diluted versions of these solutions.
- to dilute a solution, you combine distilled water with the concentrated solution until the proper, lower-concentration solution is formed.
- there are four parts to the dilution equation:

1. M_D = Molarity of the diluted (or desired) solution 2. M_C = Molarity of the concentrated (or stock) solution 3. V_D = volume of the diluted (or desired) solution

4.V_c = volume of the concentrated (or stock) solution

$$\mathbf{M}_{\mathbf{C}}\mathbf{V}_{\mathbf{C}}=\mathbf{M}_{\mathbf{D}}\mathbf{V}_{\mathbf{D}}$$

- Ex3 (Dilution): How many mL of 12 M HCl is needed to produce 1.5 L of a solution that is 3.8 M? Also, how many mL of distilled water must be used to make this 3.8 M solution?

volume of the conc. sol'n, so the formula will need to be rearranged like this: • in addition to the V_C, you will also need to know

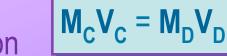
the volume of distilled water to use to dilute the

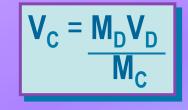
concentrated solution. You can calculate this

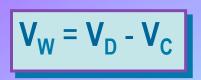
volume of water by using this equation:

- in most cases, you need to calculate V_{c} , the
- 3. $V_{\rm D}$ = volume of the diluted (or desired) solution 4.V_c = volume of the concentrated (or stock) solution
- 1. M_D = Molarity of the diluted (or desired) solution 2.M_c = Molarity of the concentrated (or stock) solution

there are four parts to the dilution equation:







- set up a "column of information" that lists the info given in the problem, as well as which variable you are solving for (the ?)
 decide which rearrangement you need to solve the problem
 convert units given to those needed to match the units in the formula
 plug in the values and solve!
- **Ex3** (Dilution): How many mL of 12 M HCl is needed to produce 1.5 L of a solution that is 3.8 M? Also, how many mL of distilled water must be used to make this 3.8 M solution?

$$M_{D} = \underline{3.8 \text{ M}} \qquad V_{C} = \underline{M_{D} V_{D}} = V_{C} = (\underline{3.8 \text{ M}})(\underline{1.5 \text{ L}}) = .475 \text{ L} M_{C} = \underline{12 \text{ M}} \qquad M_{C} = \underline{1.5 \text{ L}} \qquad .475 \text{ L} \qquad \underline{12 \text{ M}} \qquad .475 \text{ L} \qquad \underline{12 \text{ M}} \qquad .475 \text{ L} = \underline{475 \text{ mL HCI}} V_{C} = \underline{?} \qquad V_{W} = V_{D} - V_{C} = 1500 \text{ mL} - 475 \text{ mL} = \underline{1025 \text{ mL H}_{2}O}$$

 $V_{w} = V_{D}$

- Make sure notesheet is completely filled in
- Preview the funsheets (7.3a and 7.3b)
- Rewind and review any parts that were not clear
- Bring both notesheet and funsheet packets to class

