Concentrations

Contents

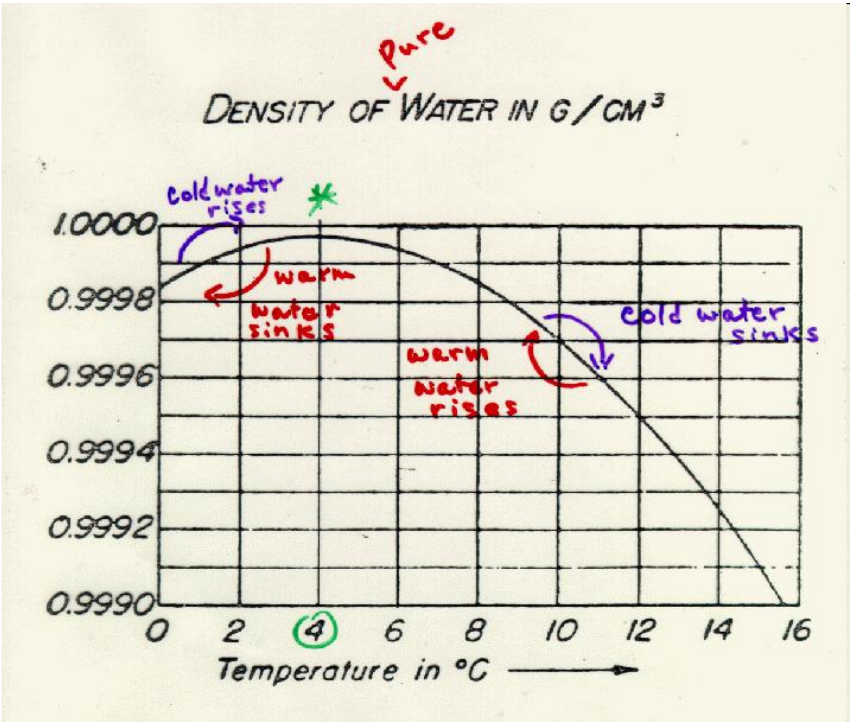
Molarity

- Molarity (M) = moles solute/Liter solution
- Molality(m) = moles of solute/Kg solvent

- What is the major difference between Molarity and molality?

Water = 1g/mL Right?

- The density of water changes and so does the volume.
- As the volume changes so does the molarity.
- Molality, based on mass of solvent, is temperature independent.



Mole Fraction

- Mole Fraction = moles X/ total moles

- 44g of CO_2 dissolved in 54g of water. Determine the mole fraction of each.

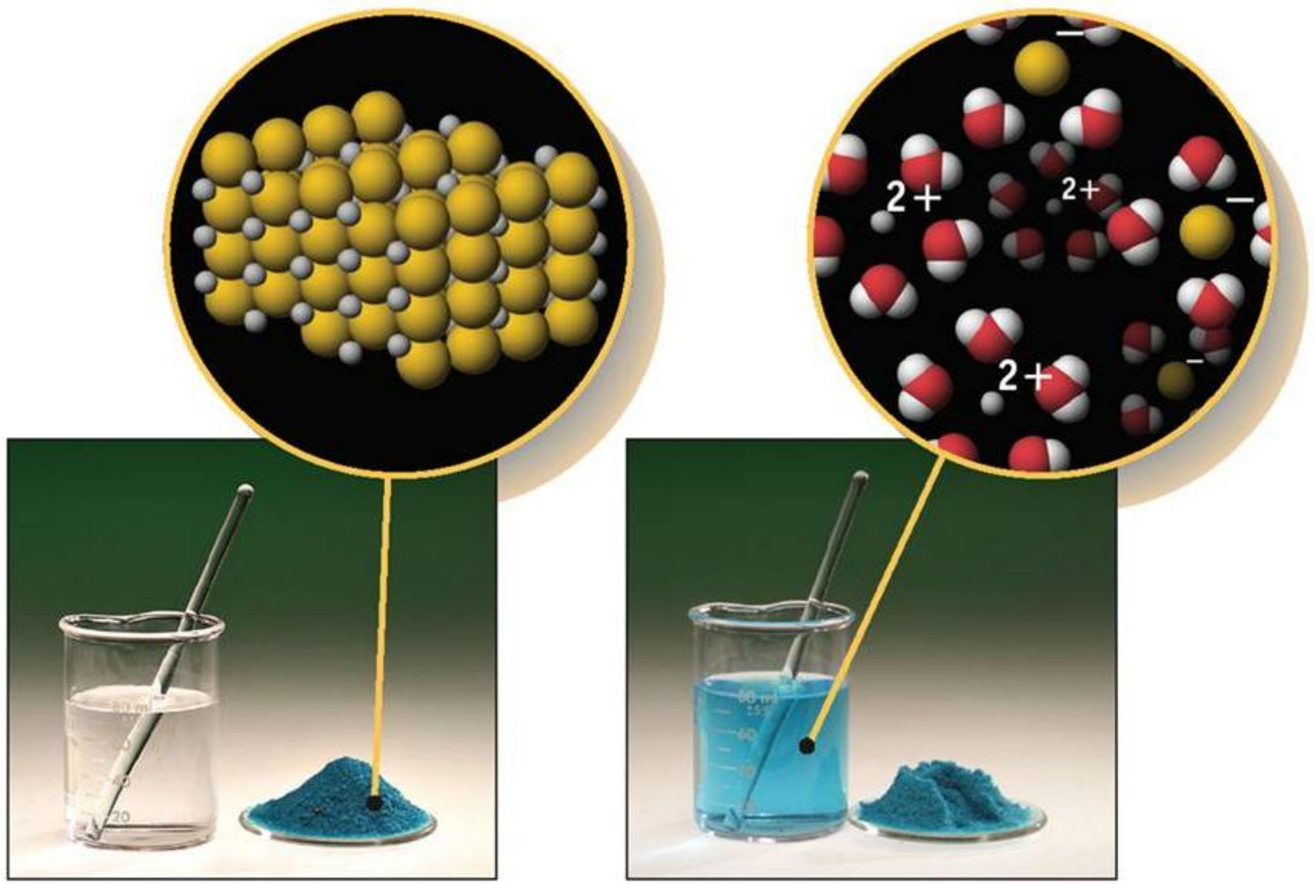
Mole Fraction

- Mole Fraction = moles X/ total moles
- 44g of CO_2 dissolved in 54g of water.
- Moles CO_2 = 1
- Moles H_2O = 3
- X_{co2} = 1/4 = .25
- X_{H2O} = 3/4 = .75

Note: all mole fractions will always add to 1

Percent by volume/mass

- % Mass = mass x/ total mass * 100
- % volume = volume x/ total volume * 100



Parts per Million (ppm)

- ppm is a form of concentration used mostly by biologist.

- Mass/total mass * 1,000,000 = ppm

ppm

- Another way to look at ppm.

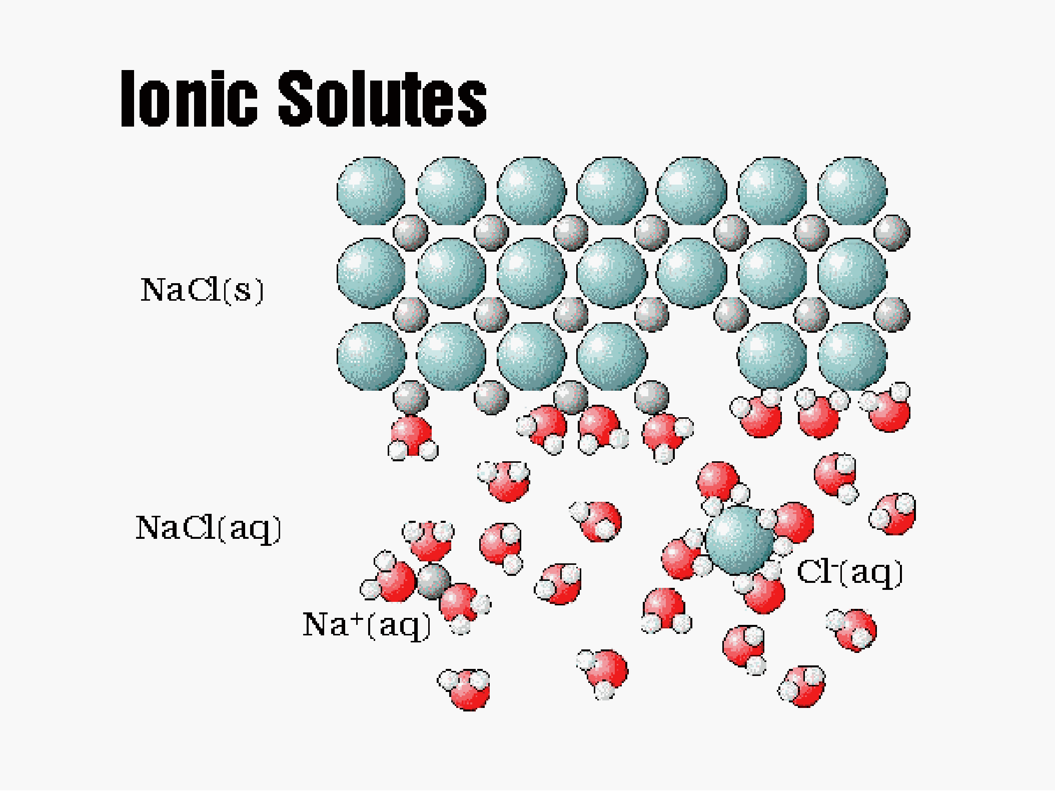
- 1mg/1L of water
- 1L H_2O = 1000 mL
- 1000 mL = 1000g
- 1000g = 1,000,000mg
- 1mg / 1,000,000 mg water

Remember:
mg/L

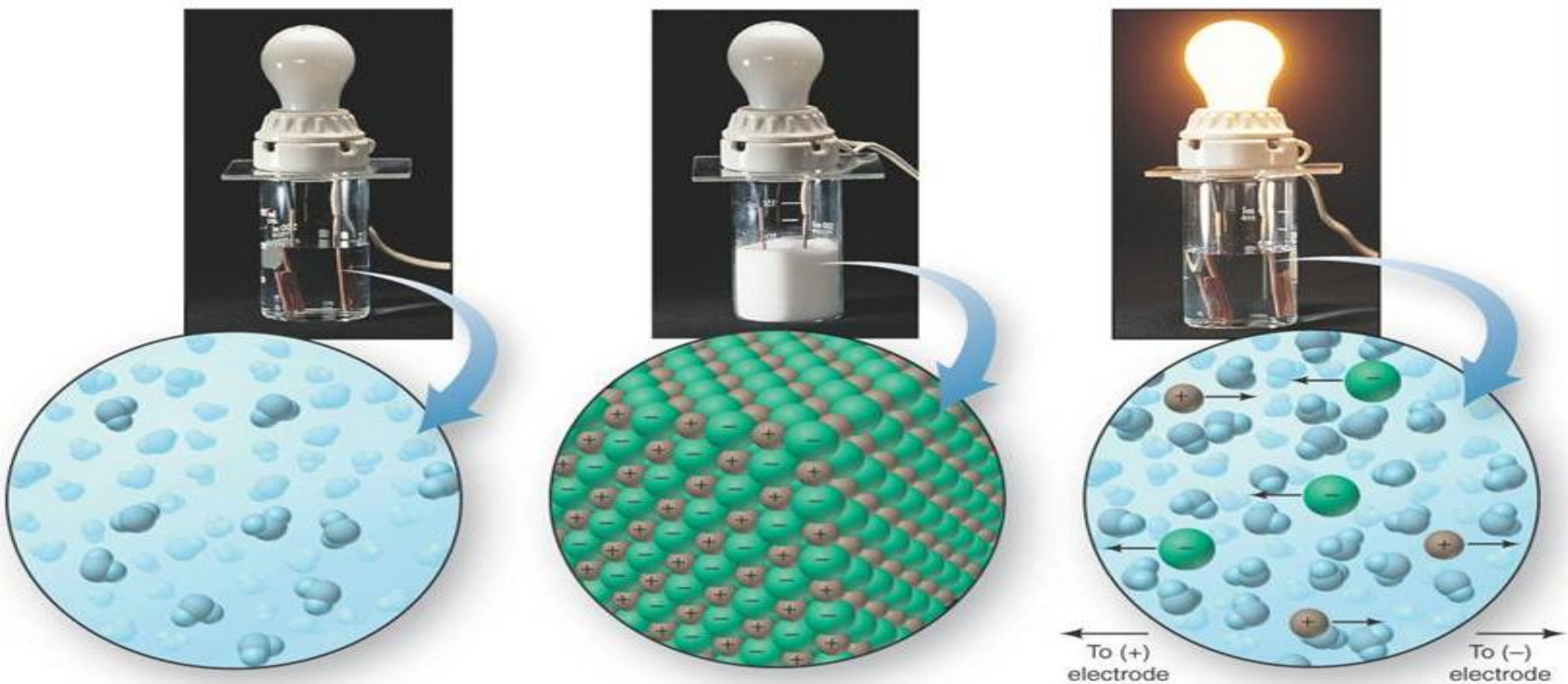
Ionic vs. Molecular

- Ionic compounds dissociate in solution increasing their concentrations

$$NaCl \rightarrow Na^{+} + Cl^{-}$$



Electrolyte: Conducts e^-



A Distilled water does not conduct a current

B Positive and negative ions fixed in a solid do not conduct a current

C In solution, positive and negative ions move and conduct a current

Typical problem?

- 500mL of 1.00M Na_3PO_4 is added to 300mL of water.
- What are the concentrations of each of the ion present?

Note: you also need to know what ions are present

answer

- 500mL of 1.00M Na_3PO_4 is added to 300mL of water.
- Dilution: M1V1 = M2V2

  M1 * 500 = x * 800

  M1 * 500/800 = x
- Na^+ = 1M * 3 = 3M * 500/800 = **1.875M**

- PO_4^{-3} = 1M *1 = 1M * 500/800 = **0.625M**

Solution Stoichiometry

- 25 mL of .5M NaOH is mixed with 10 ml of .25M HNO_3.
- Write out equation.
- Determine the number of moles.
- Determine the limiting reactant
- Determine the concentration of a excess reactant or product.

Typical Problem

What is the final concentration of Cl^- ion when 250mL of 0.20M $CaCl_2$ solution is mixed with 250mL of 0.40M KCl solution?

a) 0.10M

b) 0.20M

c) 0.30M

d) 0.40M

e) 0.60M

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We are adding .4M to .4M. This means the volume will stay .4M

Equation

- $NaOH + HNO_3 \rightarrow NaNO_3 + H_2O$

- The relationships between volume, concentration, and rate used are all linear. Use this to your benefit.

Determine moles/limiting reactant $NaOH + HNO_3 \rightarrow NaNO_3 + H_2O$

- M = mol/L
- 25 mL of .5M NaOH
  - Moles = .0125 mol

- 10 ml of .25M HNO_3
  - moles = .0025 moles

They are being used at the same rate and since the HNO_3 is in smaller quantity it is the LR.

Determine the concentration of the salt ($NaNO_3$)

$$NaOH + 1HNO_3 \rightarrow 1NaNO_3 + H_2O$$

Determine the number of moles of product.

.0025 mol HNO_3 ($1NaNO_3/1HNO_3$) = .0025mol $NaNO_3$

Determine the number of concentration M = mol/L

Mol = .0025

Vol: 25mL + 10mL = 35mL or .035L

.0025/.035 = .0714M

note: The volume is increased which dilutes everything.

Typical AP Problem

- How many mL of 0.40M $FeBr_3$ solution would be necessary to precipitate all of the Ag^+ from 30mL of a 0.40M $AgNO_3$ solution?

$FeBr_3 + 3AgNO_3 \rightarrow Fe(NO_3)_3 + 3AgBr(s)$

a. 10

b. 20

c. 30

d. 60

e. 90

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