Battles over pure water or OIL?

One substance with hydrate your body ,

the other will dehydrate (a laxative)

Euphrates River

Tigris River

Who has the ultimate control of these waterways?

Solutes, Solvents, Solutions

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- Solutions are mixtures
- Solutions (solute in a solvent, three types of solutions)
- Solubility (solute/solvent interactions)
- Concentrations (amount of solute per amount of solvent)
- Solution Stoichiometry

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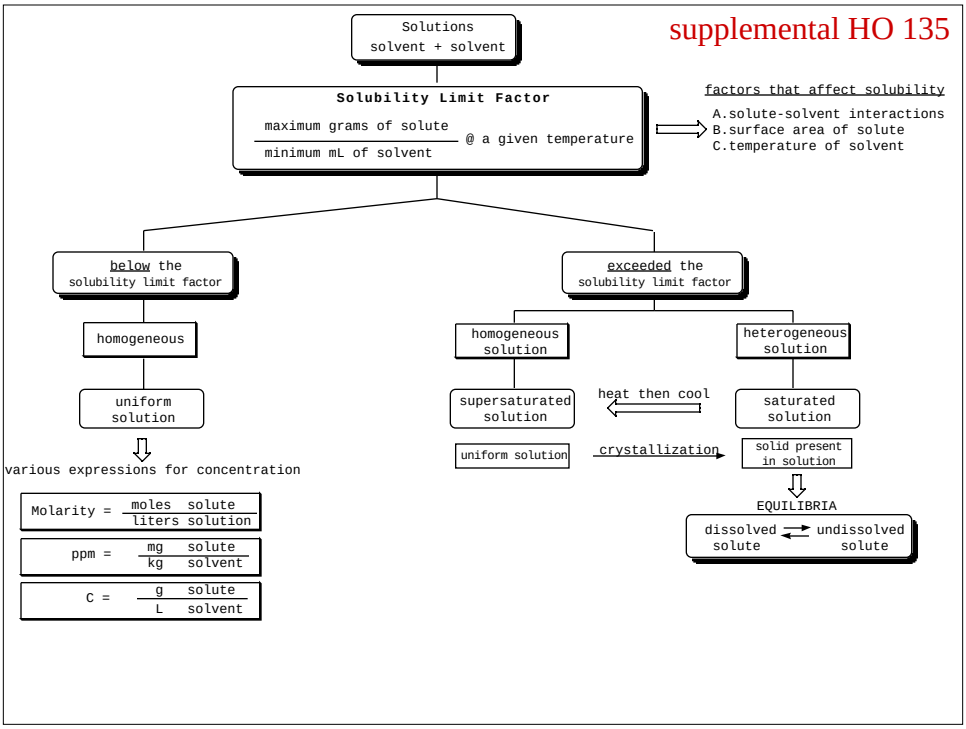

Add to your notes

Solutions (Three Types of Mixtures)

Be sure you are able to give examples of how to prepare each?

- Homogeneous uniform mixture
  - The solute is below its solubility limit in the solvent.
- Heterogeneous saturated mixture
  - The solute has exceeded its solubility limit in the solvent and there is visible solute present in the mixture
- Homogeneous supersaturated uniform mixture
  - The solute is has exceeded its solubility limit in the solvent and the mixture is uniform throughout.

Solubility (solute/solvent interactions)

- Observed Behaviors
  - What is a substance's physical state at room temperature?
  - Prior knowledge of physical properties and structure
- "Like will dissolve Like " Behaviors
  - Polar solutes will have highest solubility in polar solvents
  - Nonpolar solutes will have highest solubility in nonpolar solvents
  - Polar solutes will have lowest solubility in nonpolar solvents
  - Nonpolar solutes will have lowest solubility in polar solvents
- Determining the polar nature of substances
  - Physical Observations - Common Sense Approach
  - Evaluating Substance Structure & Polarity
    - Drawing Lewis Dot Structure

Evaluating Substance Structure & Polarity

- Molecular Substances (discrete units)
  - Draw Lewis dot structures of molecules and evaluating if the molecule is polar.
  - Use of electronic and print media to look up structure
    - http//:www.chemfinder.com
    - use the index of your textbook.
    - Encyclopedias
- Non-Molecular Substances **(large 3D-arrangements of atoms)**
  - Network Covalent (graphite, diamond, sand SiO_2)
  - Ionic Salts (NaCl , $MgSO_4$, $CaCl_2$)
  - Metallic (iron metal,steel)

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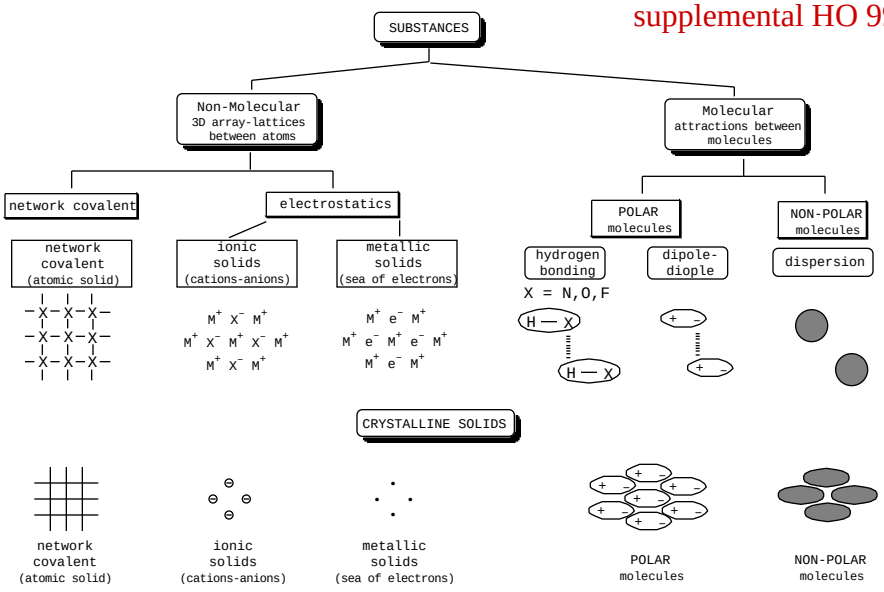
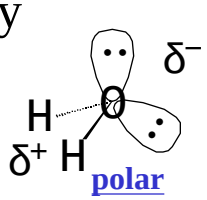


Molecular Substances (discrete units)

Molecular substance solubility in water

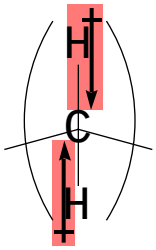
"Like dissolves Like"

to gauge Molecular Polarity



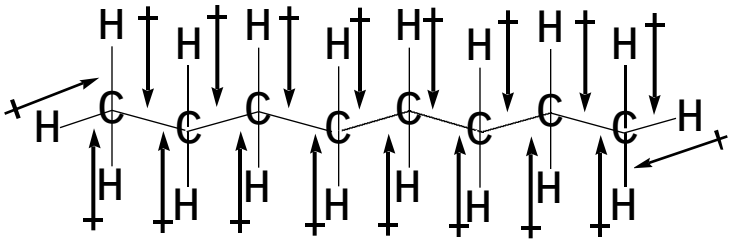
- Sugar dissolves in water
  - Thus sugar molecules must be polar
- Methanol CH_3OH dissolves in water
  - Thus methanol molecules must be polar
- Gasoline -(CH_2)- does not dissolve in water
  - Thus gasoline molecules must be NONPOLAR

Molecular Substances (discrete units)



A gasoline molecule is a hydrocarbon made of repeating –(CH_2)– units is non-polar; NO net dipole

hydrocarbons are non-polar

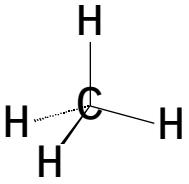


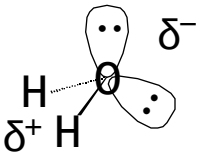
A gasoline hydrocarbon

All dipoles cancel

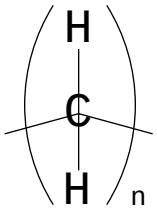
Molecular Substances (discrete units)

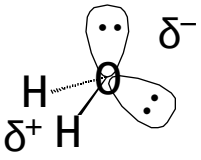
Nonpolar does not dissolve Polar





methane gas does not dissolve in water

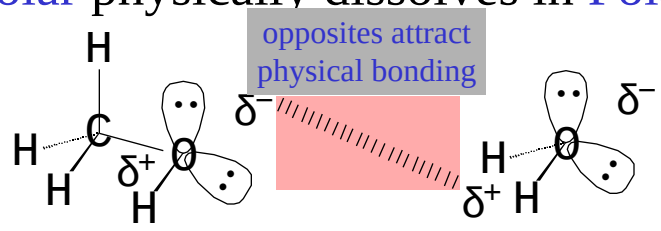




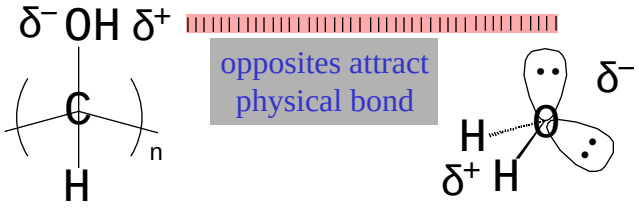
gasoline liquid does not dissolve in water

Molecular Substances (discrete units)

Polar physically dissolves in Polar



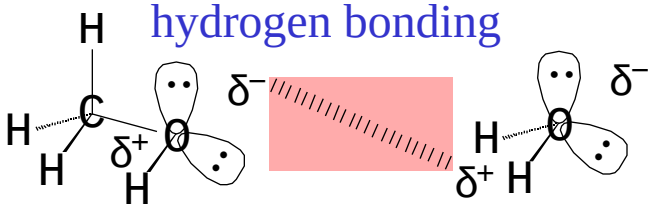
methanol liq dissolves in water



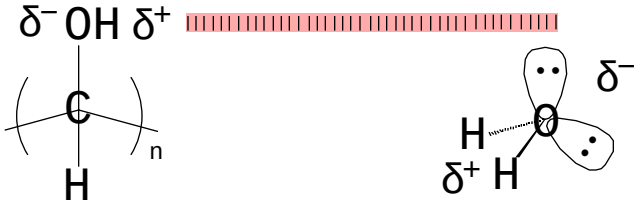
sugar solid dissolves in water

Molecular Substances (discrete units)

The highlighted area is an example of hydrogen bonding



methanol dissolves in water



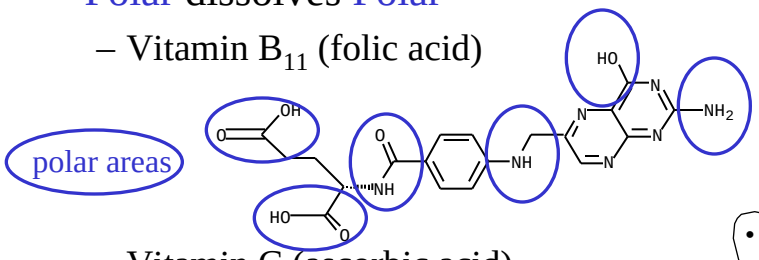
sugar dissolves in water

Molecular Substances (discrete units)

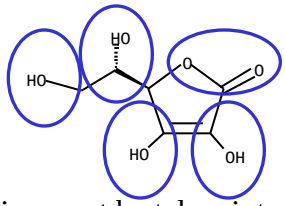
"Like dissolves Like"

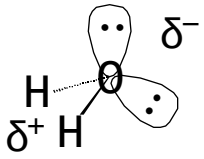
Where ever there are N and O atoms, there are polar areas

- Polar dissolves Polar
  - Vitamin B_{11} (folic acid)



  - Vitamin C (ascorbic acid)





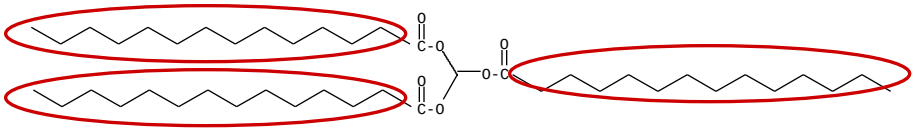
Water soluble vitamins

Water-soluble vitamins must be taken into body daily, as they cannot be stored are excreted within four hours to one day, ref. Nutritional Healing

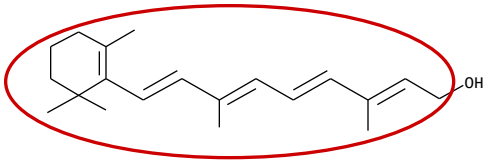
Molecular Substances (discrete units)

"Like dissolves Like"

- Non-Polar dissolves Non-Polar nonpolar areas
  - triacylglycerine, a non-polar human body fat (lipid)



  - Vitamin A, retinol (fat soluble; lipid soluble)



Vitamins D, E, & K are fat soluble - What would be their overall polarity?
Oil-fat soluble vitamins can be stored longer in the body's fatty tissue and liver. ref. Nutritional Healing

Molecular Substances (discrete units)

Predict whether the substance is polar or nonpolar based on it solubility behavior in H_2O

sugar	$C_6H_{12}O_6$	polar
baby oil	$C_{20}H_{42}$	nonpolar
candle wax	$C_{40}H_{82}$	nonpolar
ethanol	C_2H_5OH	polar
oxygen	O_2	nonpolar
iodine	I_2	nonpolar

Non-Molecular Substances (large 3D-arrangements of atoms)

Non-Molecular Substances

extended arrangements of repeating units

- Network Covalent Substances
  - (X–X– X–X– X–X– X–X)
- Metallic
  - ($M^+e^-M^+e^-M^+e^-M^+e^-M^+e^-M^+e^-$)
- Ionic Salts
  - (M^+X^- M^+X^- M^+X^- M^+X^- M^+X^- M^+X^-)

Non-Molecular Substances

- Network Covalent Substances
  - Generally insoluble in most solvents

Non-Molecular Substances (large 3D-arrangements of atoms)

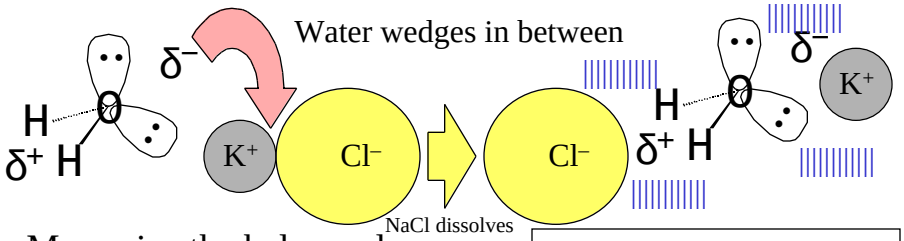
Non-Molecular Substances

- Metallic ($M^+e^-M^+e^-M^+e^-M^+e^-M^+e^-M^+e^-$)
  - M^+ in a sea of electron e^-
- Metal mixture solutions
  - Alloys are solid solutions of metal mixtures
    - bronze a homogeneous mixture of Cu and Sn
    - brass a homogeneous mixture of Cu and Zn
    - steel a homogeneous mixture of Fe and less than 3% by mass C
  - Amalgams
    - Any alloy of mercury metal

Non-Molecular Substances

- Aqueous Solutions
  - Water is used as a solvent
    - The symbol (aq) is used to represent an aqueous mixture
- Ionic Salts (aqueous solutions)
  - Water is capable of dissolving a large number of salts
  - Some solubility rules for ionic salts need to be memorized

Solubility Rules for Ionic Salts in H_2O



- Memorize the below rules:
- All ionic salts of group I ions,
  - Li^+, Na^+, K^+ are solubule in water
- All ionic salts of nitrate ion,
  - NO_3^- are solubule in water
- All ionic salts of ammonium ion,
  - NH_4^+ are solubule in water

This solubility separation is called "solvation-dissociation" with physical attractions between the polarity of water and ion charge

Solubility Summary

Solubility is define as the ability for solute to dissolves in a given amount solvent.

1. A solution is a mixture **solute** and **solvent**.
   There are three types of solutions:
   a. soluble solute unsaturated solution - homogeneous solution, solute is below its solubility limit. of the solvent.
   b. insoluble solute saturated solution - heterogeneous solution, solute is above its solubility limit of the solvent.
   c. soluble solute supersaturated solution - homogeneous solution, solute exceeded its solubility limit of the solvent.
2. "**Like dissolves like**." The general solubility of substances can be predicted:
   a. Polar solutes are most soluble in polar solvents.
   b. Nonpolar solutes are most soluble in nonpolar solvents.
3. Solute Solvent Interactions
   a. hydrogen bonding-hydrogen bonding; dipole-dipole

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Solution Concentration (amount of solute per amount of solvent)

- The ratio of the amount of solute to the amount of solution is known as the concentration of the solution.

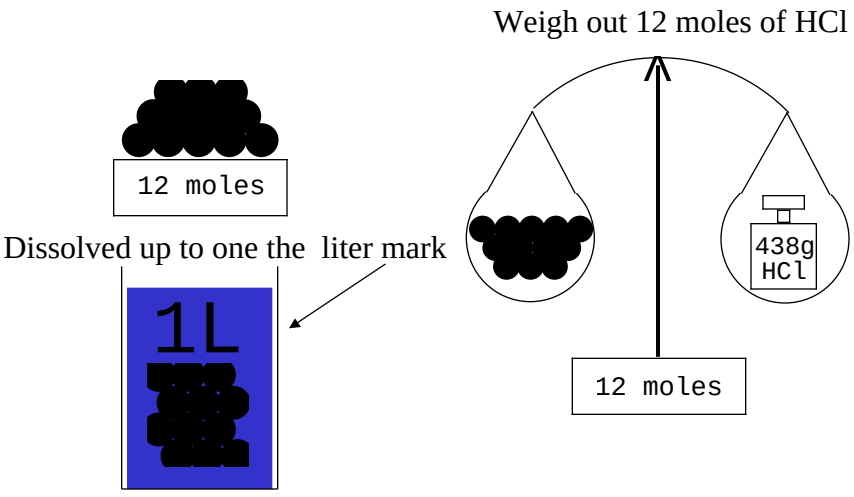
$$\text{Concentration} = \frac{\text{amount of solute}}{\text{amount of solution}}$$

Molarity

- Molarity is a way of counting particles in solution

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

- Aqueous Standard Stock Solution of known Molarity
  - Calculate molar mass
  - Calculate the number of moles of substance
  - Determine the mass of substance in grams
  - Identify the total volume of solution



The solution above affords a concentration which is
a ratio of 12 moles of solute per one liter of solution
A 12 molar solution of HCl = 12 M HCl

Standard Stock Solution Calculation

Prepare 500 mL of a 1 M KCl stock solution.

- Aqueous Stock Solution Molarity
  Calculate molar mass

KCl

1 K x 39.1 =	39.1
1 Cl x 35.5 =	35.5
	74.6 g/mol

- Calculate the number of moles of substance in the given volume

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

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

$$(500 \times 10^{-3}\ \text{L}) \times (1\ \text{M}) = 0.5\ \text{moles KCl}$$

- Determine the mass of substance in grams

$$(0.5\ \text{moles KCl}) \times 74.6\ \text{g/mol} = 40\ \text{g KCl}$$

- Identify the total volume of solution
  Dissolve 40 g of KCl up to a total volume of 500 mL

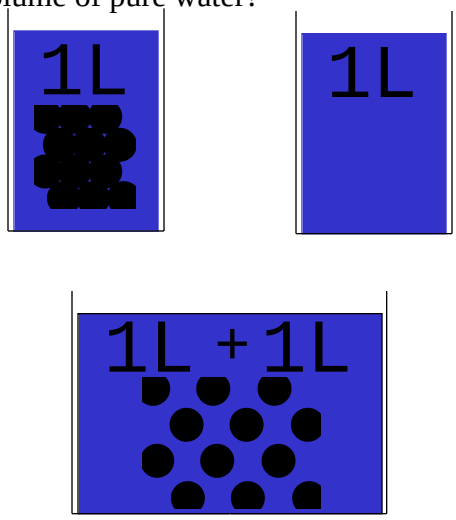
Dilution

- Often it is necessary to make dilute solutions from existing stock solutions
- Dilution is simply adding more solvent
- The moles of solute in a dilution remain unchanged

$$\text{"n" moles of solute} = (\text{Molarity}) \times (\text{liters of solution})$$

$$M_1V_1 = n = M_2V_2$$

What would happen if our one liter of 12 molar HCL was mixed with an equal volume of pure water?



What is the new molar concentration of the two liter solution?

12 moles per 2 liters of solution or 6 molar = 6 M HCl

A dilution of a stock solution

- Prepare a 100-mL solution of a 0.1 M KCl from a 1 M KCl stock solution

$$M_1V_1 = M_2V_2$$

M_1: Starting concentration; M_2: Ending concentration

Solving for V_1

$$V_1 = \frac{M_2V_2}{M_1} = \frac{(0.1\ M) \times (100\text{-mL})}{(1M)}$$

Final Answer: = 10 mL of 1 M KCl

10 mL of 1 M KCl needs to be diluted to a total of 100 mL in preparing a this diluted solution.

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Titrations

- Solution Stoichiometry

TITRATION

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Titration - The process of adding a standard solution from a buret to a sample until a reaction is complete, at which time the volume is accurately measured.

Neutralization - The reaction of an acid with a base to produce salt and water.

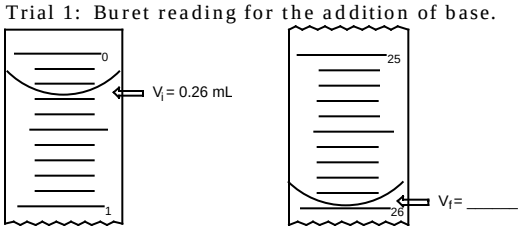
$$HCl\ (aq) + NaOH\ (aq) \text{ -----> } NaCl\ (aq) + H_2O\ (l)$$

where the

$$\frac{M_A V_A}{M_B V_B} = \frac{\text{molar coefficient of acid}}{\text{molar coefficient of base}}$$

Example 1: NaOH of known molarity in the buret below is titrated to a 10.00 mL HCl sample of unknown molarity. Complete the table for Trial 1. Using the given titration data from Trial 1 an 2, calculate the average M of the unknown acid.

Trial 1: Buret reading for the addition of base.



Titration Data	Trial 1		Trial 2
Volume of unknown acid, V_A	10.00 mL		10.00 mL
Base burette, final reading	mL		25.90 mL
Base burette, initial reading	mL		0.30 mL
Volume of standard base titrated, V_B	mL		mL
Molarity of standard base, M_B		0.1191 M	
Molarity of unknown acid, M_A	M		M
Average M of unknown acid		M	