# Introduction to Chemistry

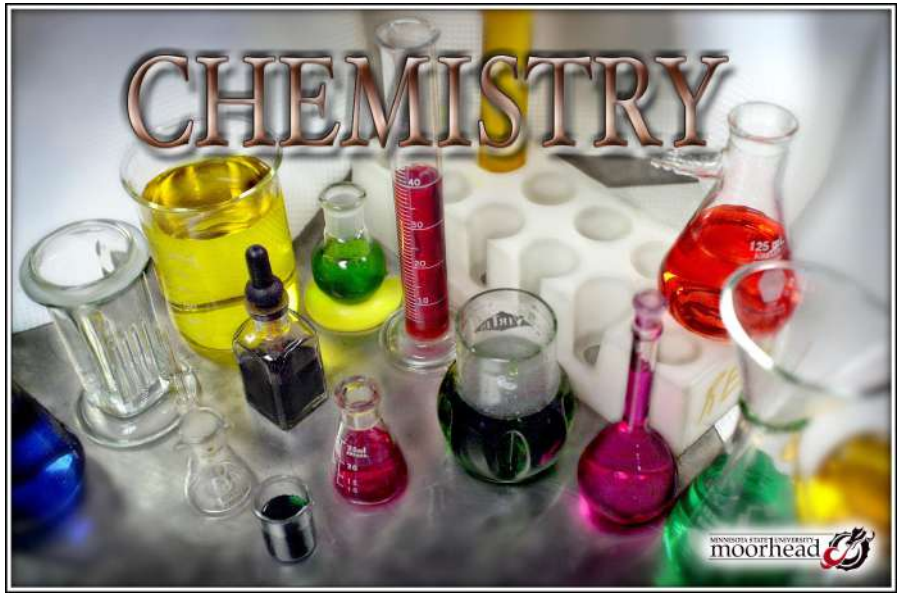
# Unit 2
# Module 1

# Module Concepts

- **What is Chemistry?**
- **Classifying Matter**
  - What is matter?
  - Pure Substance vs. Mixture
  - Element vs. Compound
  - Monatomic vs. Diatomic
  - Ionic vs. Covalent
  - Heterogeneous vs. Homogeneous

# What is Chemistry?

- Chemistry is the study of the composition, structure, and properties of matter and the changes it undergoes.

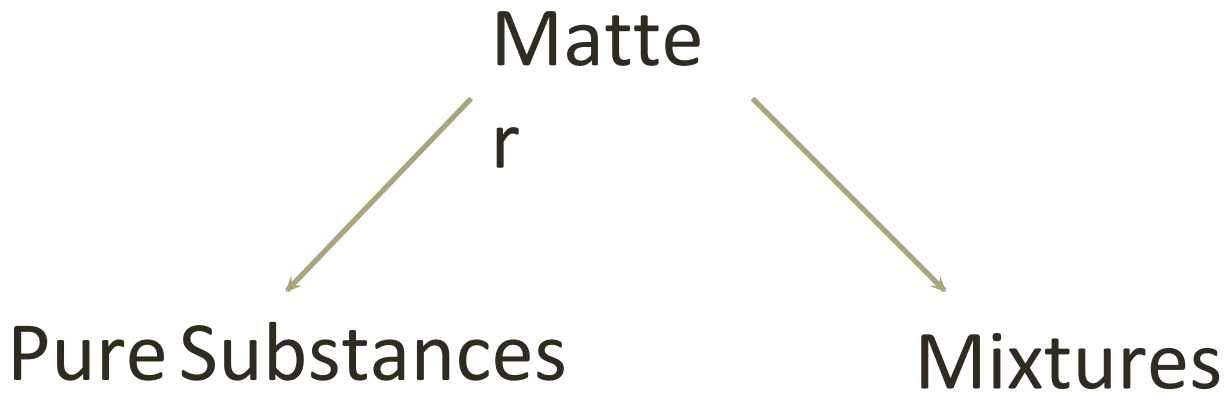


# What is Matter?

- Matter can be defined as anything that has mass and volume.
  - Mass is the quantity of matter in a substance and is measured with a balance.
  - Volume is the amount of space an object occupies.

# Two Major Categories of Matter

- Matter comes in many forms, which can be grouped in two categories: pure substances and mixtures.

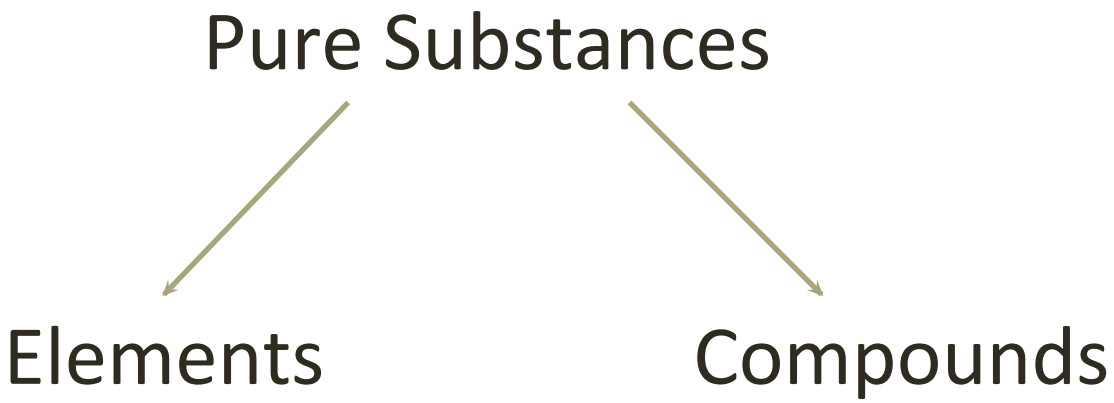


# Pure Substances

- Pure substances are composed of only one type of particle.
  - Pure substances cannot be separated by physical means.
  - Every sample of a pure substance has exactly the same characteristic properties.
  - Every sample has exactly the same chemical composition.

# Pure Substances

- Pure substances fall into one of two categories:  elements or compounds

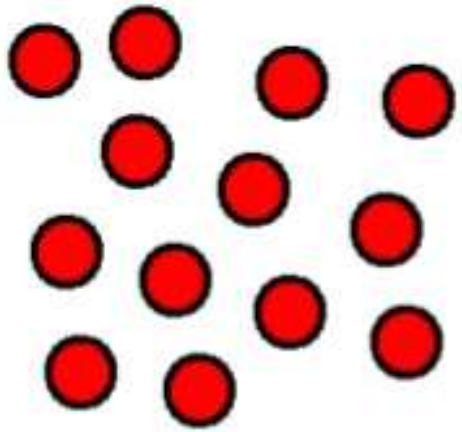


# Pure Substances - Elements

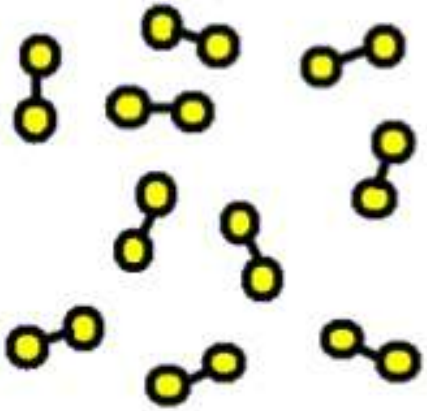
- An element is a pure substance made of only one kind of atom.
  - The smallest part of an element is an atom.
  - An element cannot be broken down further into another substance by either physical or chemical means.

# Elements can be either monatomic or diatomic.

- **Monoatomic elements composed of individual discrete (atoms) He**



- **Diatomic elements composed of molecules made up of two atoms that are bonded together $H_2$**



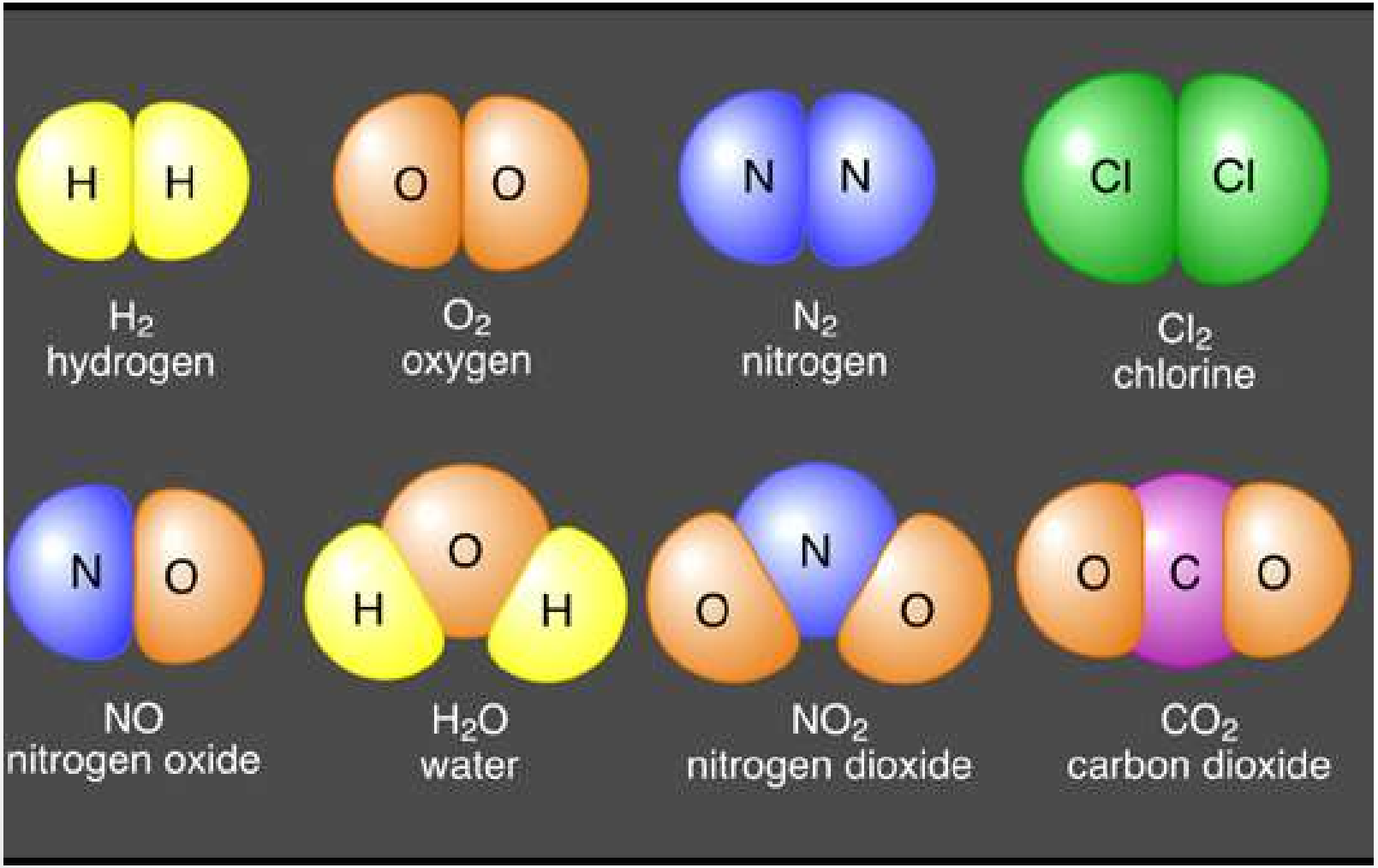
# Pure Substances - Compounds

- A compound consists of molecules made from the atoms of two or more elements that are chemically bonded.
  - A compound can be divided into its composite substances, but only by chemical means.
  - Both the formation and dissolution of compounds involves energy changes.

# Compounds –Cont'd

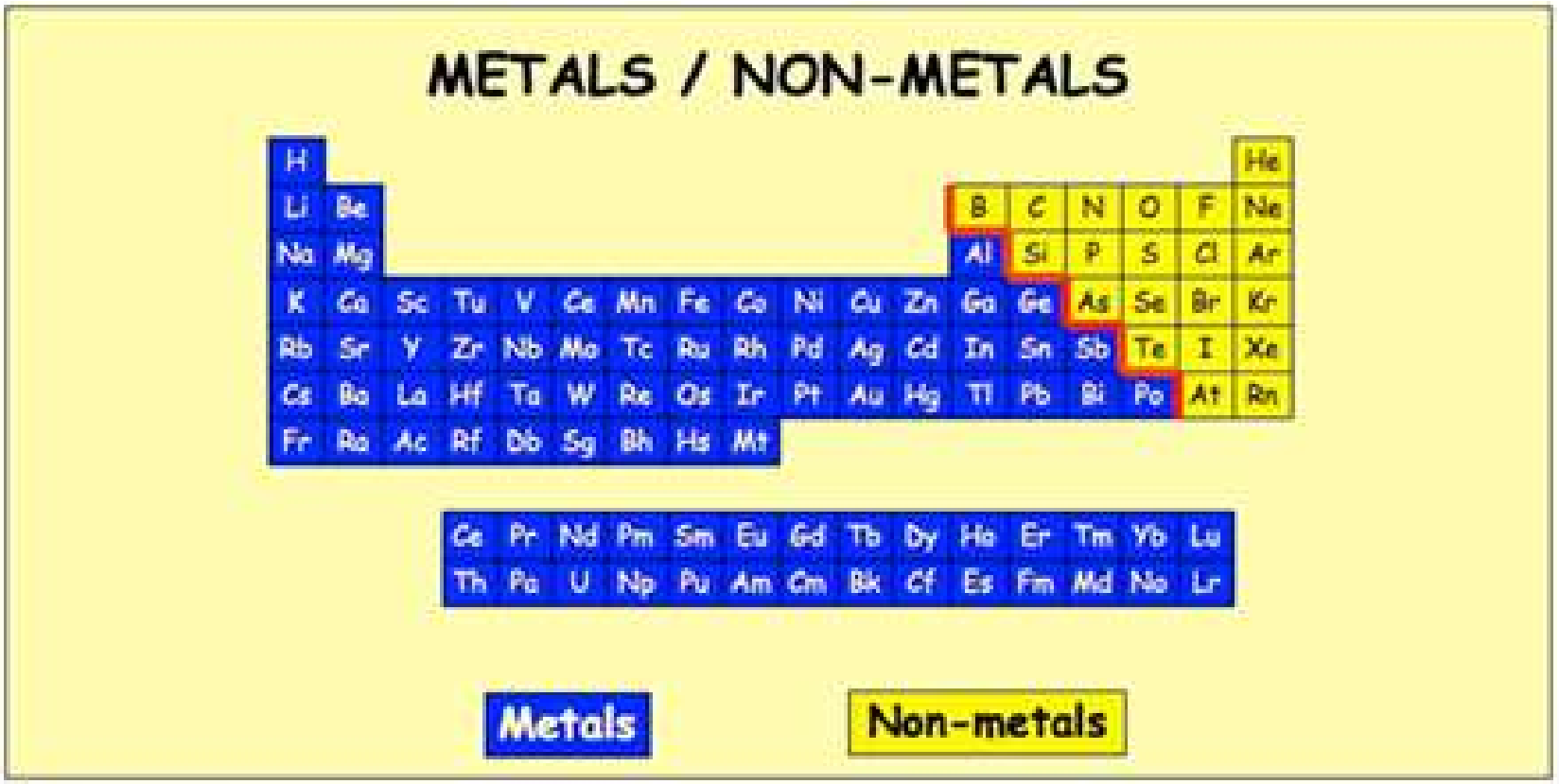
- The properties of a compound differ from its individual elements.
- Within compounds, atoms combine in specific ratios.
- Compounds can be represented by chemical formulas, using the elemental symbols and subscripts which indicate the ratios.

# Diatomic Element vs. Compound



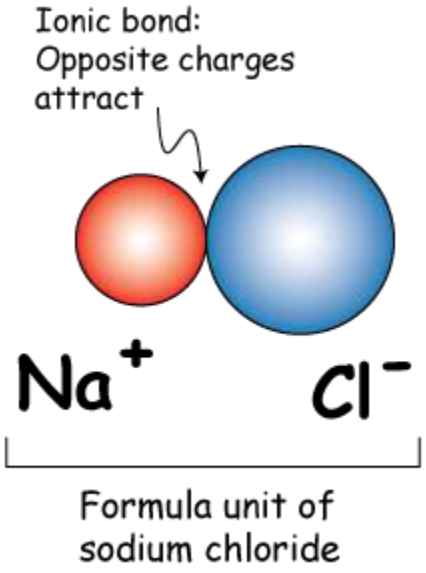
# Compounds - Ionic

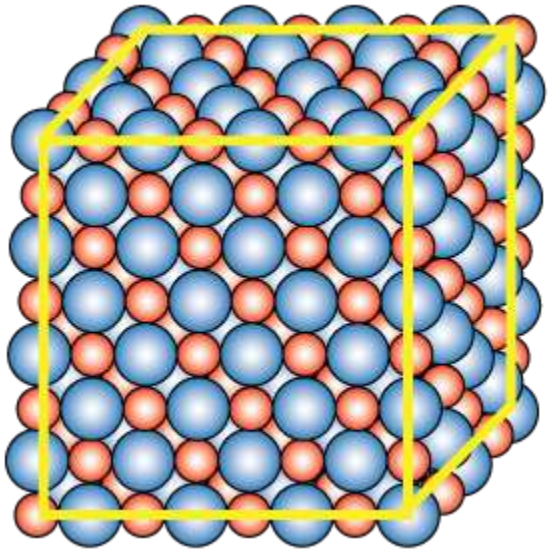
- Ionic compounds generally consist of metals bonded to nonmetals.
  - Metals are elements to the left of the “stairstep” in the periodic table.
  - Nonmetals are elements to the right of the “stairstep” in the periodic table.



# Compounds - Ionic

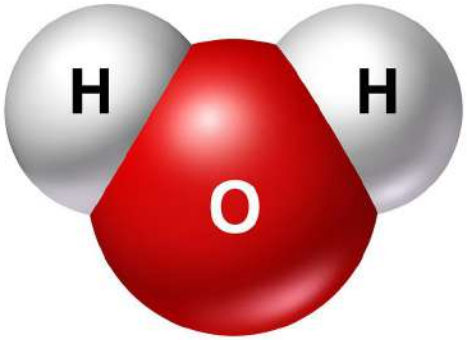
- Ionic compounds consist of “formula units”, the molecular ratio of metals to nonmetals to create a neutral compound. Example, the formula unit for table salt, a common ionic compound, is NaCl, whereas the formula unit for road salt, another common ionic compound, is $CaCl_2$.



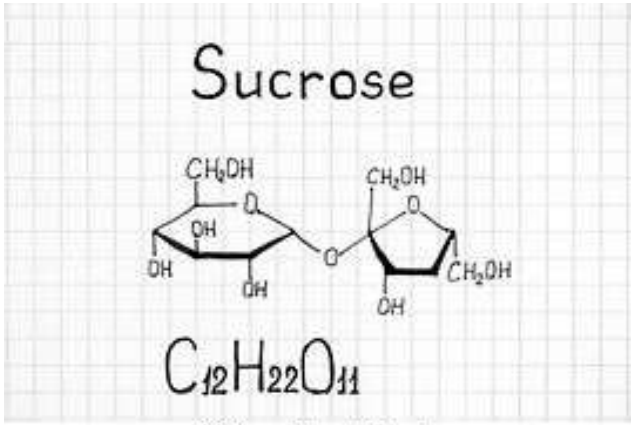



# Compounds - Covalent

- Covalent compounds are often referred to as molecular compounds.
- Covalent compounds are made up exclusively of nonmetals bonded to other nonmetals.
- The chemical combination of elements in a covalent compound is referred to as a “molecule”.
- Examples include water and sugar.



WATER MOLECULE



# Mixtures

- Matter that is comprised of more than one type of particle physically blended together is considered a mixture.

# Mixtures

- A mixture is a blend of two or more kinds of matter.
  - Mixtures can be separated by physical means.
  - The different parts of a mixture are NOT chemically combined.
  - Mixtures cannot be represented by a chemical formula.

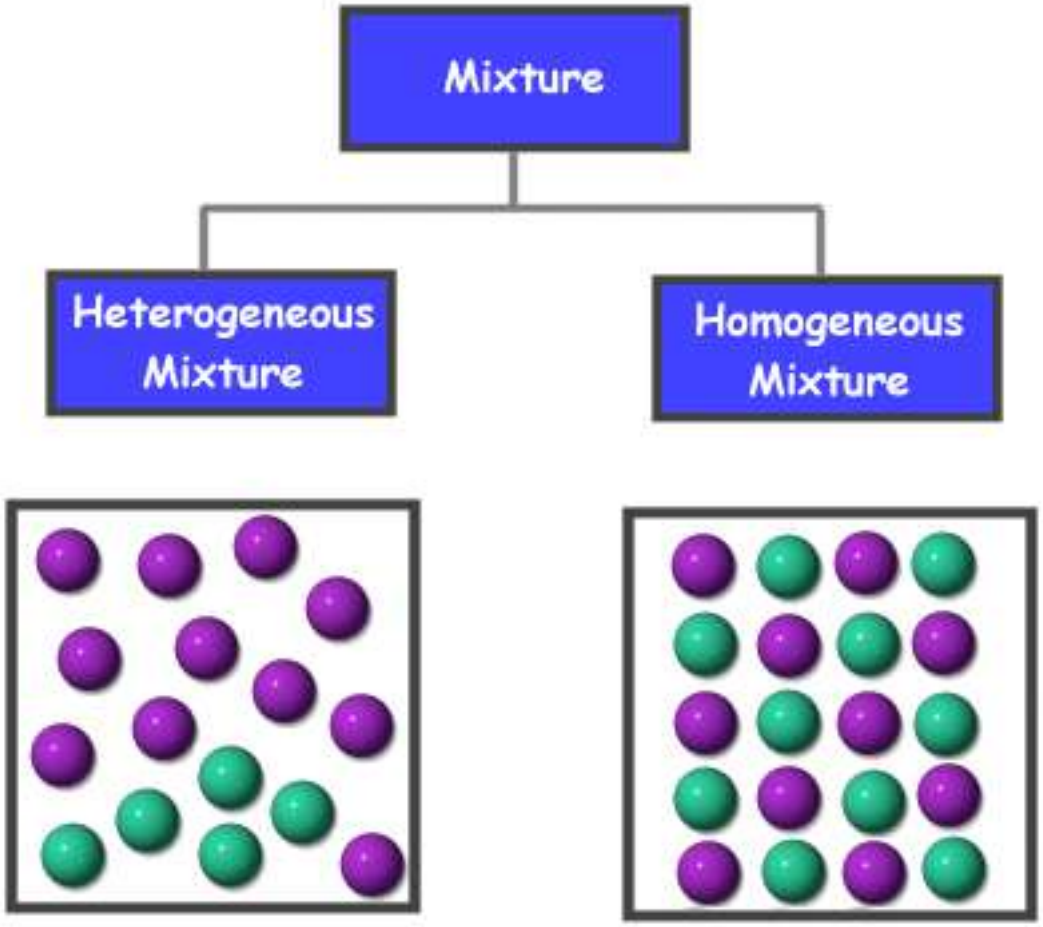
# Types of Mixtures

- Homogeneous mixtures are uniform in composition and have been mixed to the particle level such that there are no “clumps” of one type of particle that have not been spread out.
  - A homogeneous mixture cannot be separated by filtration, but can be separated by evaporation.

# Types of Mixtures – cont'd

- Heterogeneous mixtures are not uniform in composition, but have visible parts or layers.

# Homogeneous vs. Heterogeneous Mixtures: Particle Level Diagrams



# Separation of Mixtures

- Physical separation techniques can be used to separate the components of a mixture.
- These techniques take advantage of the different physical properties of the components.

# Separation Techniques

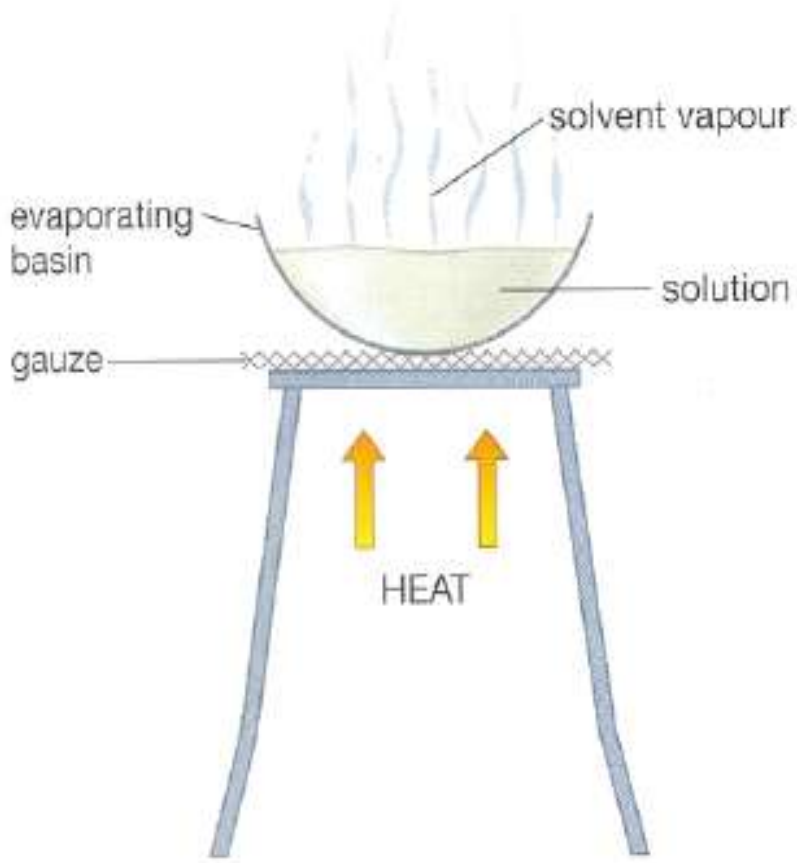
- The following is a list of common separation techniques:
  - Filtration takes advantage of differences in state of matter or particle size; good for separating heterogeneous mixtures like sandy water.

(a)

(b)

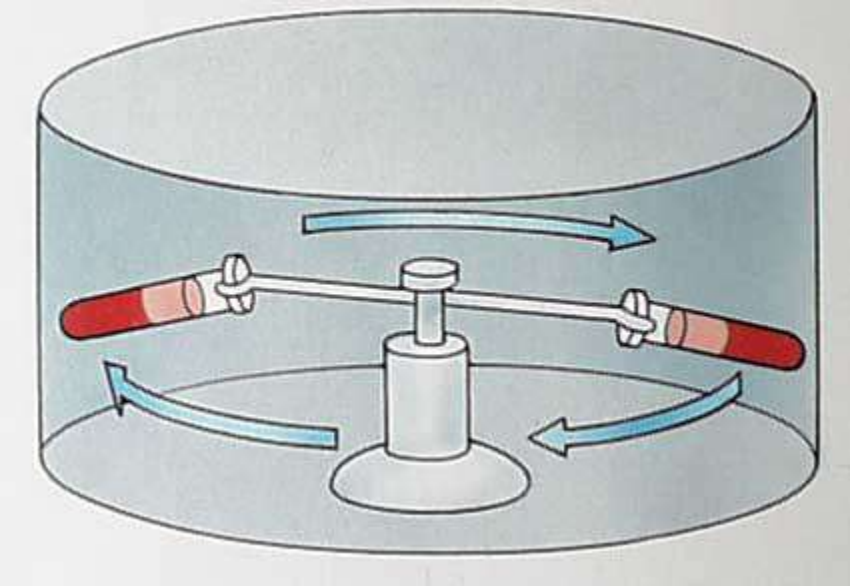
# Separation Techniques – Cont'd

- Evaporation takes advantage of differences in boiling points; can be used to separate heterogeneous or homogeneous mixtures; liquid components of mixture are lost to air through evaporation.



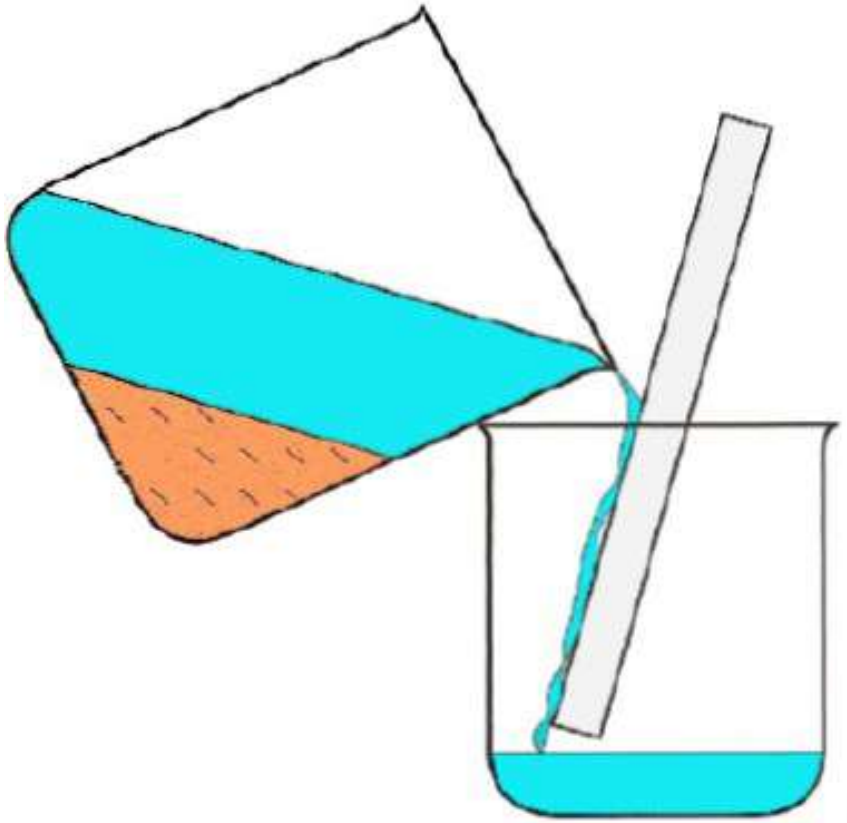
# Separation Techniques – Cont'd

- Centrifuge takes advantage of differences in density; must be followed by filtration or decanting; separates heterogeneous mixtures only.



# Separation Techniques – Cont'd

- Decanting takes advantage of differences in density; a crude separation technique for heterogeneous mixtures.
- Others include sifting, magnetism, etc.



# Visual Summary