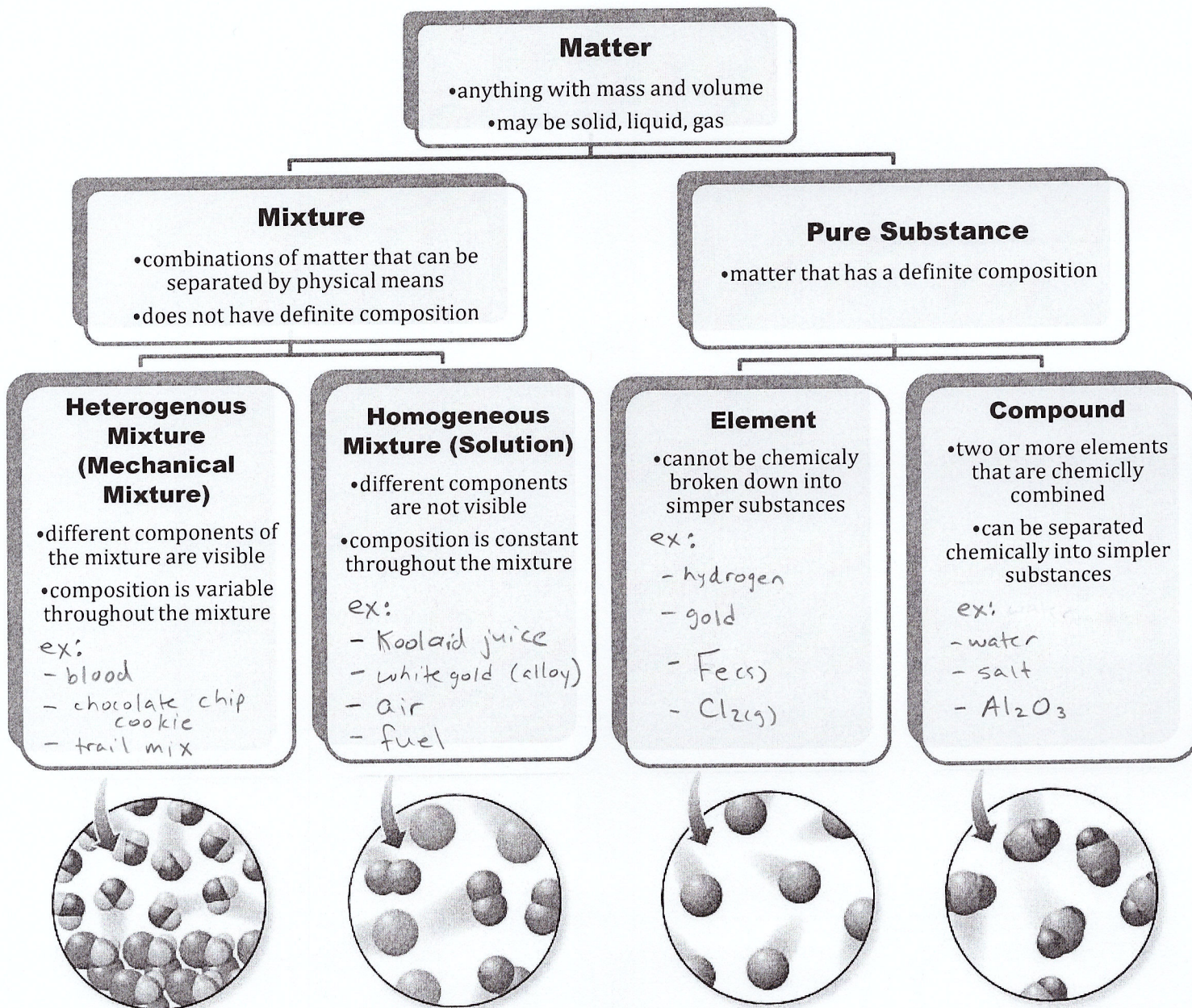


# Solutions

- The following flow chart is a way to classify all matter





- \* • A **solution** is a type of a homogenous mixture
  - A solution is composed of at least one substance dissolved in another
  - The **solvent** is the dissolver and is usually the substance present in the largest quantity (either mass, volume, or amount)
  - The **solute** is what is being dissolved in the solvent
  - Example: When dissolving salt in water, water is the solvent and salt is the solute
  
- Solvents and solutes can be solids, liquids, or gases, which means there are various combinations of solute and solvent phases
  - Examples:
    - liquid in liquid → alcoholic beverage  
water = solvent, alcohol = solute
    - solid in liquid → juice crystals in water  
(solute) (solvent)
    - gas in liquid → carbonated beverages  
CO<sub>2(g)</sub> = solute ; water = solvent
    - solid in solid → metal alloys (ie. steel, brass)
  
- An **aqueous solution** is any solution in which water is the solvent
  - Water is called the “universal solvent” because of its unique ability to dissolve many different types of solutes

- \* • **Electrolytes** are aqueous solutions that conduct electricity
  - All **soluble ionic compounds** will form electrolytic solutions when dissolved in water (ie.  $\text{NaCl}_{(aq)}$ ,  $\text{KBr}_{(aq)}$ ,  $\text{CuSO}_{4(aq)}$ )

### Solubility of Some Common Ionic Compounds in Water at 298.15 K

Ion	Group 1 ions $\text{NH}_4^+$ $\text{NO}_3^-$ $\text{ClO}_3^-$ $\text{ClO}_4^-$ $\text{CH}_3\text{COO}^-$	$\text{F}^-$	$\text{Cl}^-$ $\text{Br}^-$ $\text{I}^-$	$\text{SO}_4^{2-}$	$\text{CO}_3^{2-}$ $\text{PO}_4^{3-}$ $\text{SO}_3^{2-}$	$\text{IO}_3^-$ $\text{OOC}^-\text{COO}^{2-}$	$\text{OH}^-$
Solubility greater than or equal to 0.1 mol/L <b>(very soluble)</b>	most	most	most	most	Group 1 ions $\text{NH}_4^+$	Group 1 ions $\text{NH}_4^+$ $\text{Co}(\text{IO}_3)_2$ $\text{Fe}_2(\text{OOC}^-\text{COO}^-)_3$	Group 1 ions $\text{NH}_4^+$
Solubility less than 0.1 mol/L <b>(slightly soluble)</b> <u>insoluble</u>	$\text{RbClO}_4$ $\text{CsClO}_4$ $\text{AgCH}_3\text{COO}$ $\text{Hg}_2(\text{CH}_3\text{COO})_2$	$\text{Li}^+$ $\text{Mg}^{2+}$ $\text{Ca}^{2+}$ $\text{Sr}^{2+}$ $\text{Ba}^{2+}$ $\text{Fe}^{2+}$ $\text{Hg}_2^{2+}$ $\text{Pb}^{2+}$	$\text{Cu}^+$ $\text{Ag}^+$ $\text{Hg}_2^{2+}$ $\text{Pb}^{2+}$ $\text{Tl}^+$	$\text{Ca}^{2+}$ $\text{Sr}^{2+}$ $\text{Ba}^{2+}$ $\text{Ag}^+$ $\text{Hg}_2^{2+}$ $\text{Pb}^{2+}$ $\text{Ra}^{2+}$	most	most	most

- \* • **Non-electrolytes** are aqueous solutions that do not conduct electricity
  - **Molecular compounds** that are able to dissolve in water (such as sugar) will produce a non-electrolytic solution. Most molecular compounds do not dissolve in water though.

\*\*\*Now try Practice Problems\*\*\*



## Practice Problems

- Determine if the following substances will be electrolytic or non-electrolytic.
  - $\text{KCl}_{(s)}$  in water
  - $\text{AgCH}_3\text{COO}_{(s)}$  in water
  - $\text{C}_2\text{H}_5\text{OH}_{(l)}$  in water
  - $\text{NaSO}_{4(s)}$  in water
  - $\text{O}_{2(g)}$  in water
- “Natural gas” is actually a solution of many different gases. The table below shows ranges of composition for a typical sample of natural gas.
  - What compound is the solvent in natural gas?
  - Name three solutes in natural gas.

### Typical Composition of Natural Gas

COMPONENT	FORMULA	PERCENTAGE BY MASS
methane	$\text{CH}_{4(g)}$	70% - 90%
ethane	$\text{C}_2\text{H}_{6(g)}$	0% - 20%
propane	$\text{C}_3\text{H}_{8(g)}$	0% - 20%
butane	$\text{C}_4\text{H}_{10(g)}$	0% - 20%
carbon dioxide	$\text{CO}_{2(g)}$	0% - 8%
oxygen	$\text{O}_{2(g)}$	0% - 0.2%
nitrogen	$\text{N}_{2(g)}$	0% - 5%
hydrogen sulphide	$\text{H}_2\text{S}_{(g)}$	0% - 5%
other gases	Ar, He, Ne, Xe	less than 1%

- You are given two jars that both contain a white, crystalline solid. You are told that one of them is table sugar (sucrose) and one is table salt (sodium chloride). Without tasting them, what test could you perform to determine which to put in the sugar bowl and which to put in the salt shaker?

**Answers:**

1.
  - a. Electrolytic
  - b. Non-electrolytic
  - c. Non-electrolytic
  - d. Electrolytic
  - e. Non-electrolytic
  
2.
  - a. Methane
  - b. Any three of the other gases listed in the table other than methane
  
3. Dissolve both of the samples in water and see which one is electrically conductive (ie. see if the solution is electrolytic or not). Sugar (a nonpolar molecular substance) will be non-electrolytic and will not conduct electricity. Salt (a soluble ionic compound) will be electrolytic and will conduct electricity.