Chemistry 20

Lesson 15 – Solutions

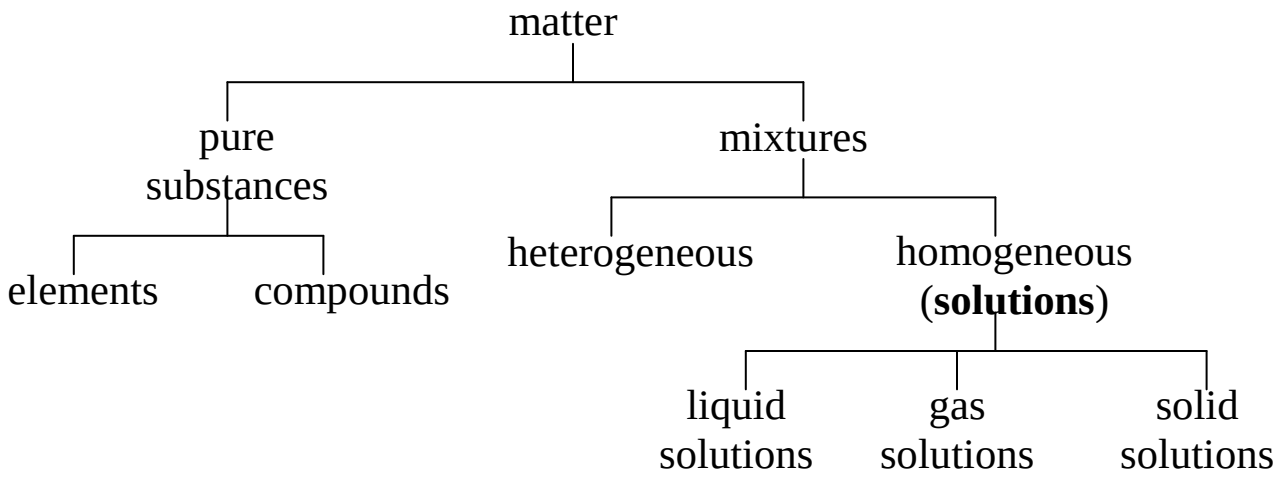
I. Classification of matter

Matter is anything that has mass and occupies space. To organize their knowledge of substances, scientists classify matter. The most common classification system differentiates matter as **heterogeneous** or **homogeneous**. Empirically, heterogeneous substances are non-uniform mixtures that may consist of more than one phase. Sand and water is an example of a heterogeneous mixture. Homogeneous substances are uniform and consist of only one phase. Tap water, which contains many dissolved salts, is an example of a homogeneous mixture.

You can classify many substances as heterogeneous or homogeneous by making simple observations. However, some substances that appear homogeneous may, on closer inspection, prove to be heterogeneous. Homogeneous milk, for example, is actually a heterogeneous mixture where a chemical has been added to keep the insoluble fats in suspension. Chemistry focuses on homogeneous matter, which can be classified as either **pure substances** or **solutions**. This empirical classification system is based on the methods used to separate matter. The parts of both heterogeneous mixtures and solutions can be separated by physical means, such as filtration; distillation; mechanically extracting one component from the mixture; allowing one component to settle; or using a magnet to separate certain metals. Pure substances cannot be separated by physical methods. A compound can be separated into more than one substance only by means of a chemical change. Separating a compound into its elements is called chemical decomposition. Elements cannot be broken down into simpler chemical substances.

Although the classification of matter is based on experimental work, theory lends support to this system. According to theory, elements are composed entirely of only one kind of atom. An atom, according to theory, is the smallest particle of an element that is still characteristic of that element. According to this same theory, compounds contain atoms of more than one element combined in a definite fixed proportion. Both elements and compounds may consist of molecules, distinct particles composed of two or more atoms. **Solutions**, unlike elements and compounds, contain particles of more than one substance, uniformly distributed throughout them.

The following chart and descriptions summarize our classification of matter:



Pure substance – a substance containing only one type of particle.

Mixture – a substance containing two or more types of particles.

heterogeneous mixture – individual components are mixed together but remain separate and distinct

homogenous mixture – individual components are mixed on an atomic, molecular scale

Solution – A homogeneous mixture consisting of a **solute** (the dissolved substance) and a **solvent** (substance which dissolves the solute or the substance in greater abundance)

A solution may not be separated by filtration.

II. Aqueous Vs Liquid

Students often confuse the terms aqueous and liquid. **Aqueous** means that a compound is **dissolved in water** (aqua) to form a solution ($NaCl_{(aq)}$, $HBr_{(aq)}$, $NH_{3\,(aq)}$), while liquid means that the compound is in that **state of matter**. For example, a salt like sodium chloride is easily dissolved in water at room temperature to form $NaCl_{(aq)}$, but to melt $NaCl_{(s)}$ requires that we raise the temperature of the compound to its melting point of 801^{o}C. $NaCl_{(l)}$ is pretty hot stuff!

III. Types of Solutions

Usually, the substance present in a greater amount is considered as the solvent. Solvents can be gases, liquids, or solids. The solution that forms has the same physical state as the solvent.

Gaseous Solutions

If the solvent is a gas only gases can be dissolved, thus gaseous solutions are made by dissolving a gas in another gas. All gases mix in all proportions to produce homogeneous mixtures, or solutions. Air, for example, is a solution of oxygen, and many other gases dissolved in nitrogen. An example for a gaseous solution is air (oxygen and other gases dissolved in nitrogen).

Liquid Solutions

Liquid solutions are made by dissolving solids, liquids or gases in liquids. Examples include:

⇒ **solid in liquid**

- Sucrose (table sugar) in water.
- Sodium chloride or any other salt in water forms an electrolyte: When dissolving, salt dissociates into ions (see Lesson 20).

⇒ **liquid in liquid**

- Alcoholic beverages are basically solutions of ethanol in water.
- Petroleum is a solution of various hydrocarbons.

⇒ **gas in liquid**

- Oxygen in water.

Solid Solutions

If the solvent is a solid, gases, liquids, and solids can be dissolved.

⇒ **Gas in solid**

- Hydrogen dissolves rather well in metals, especially in palladium; this is studied as a means of hydrogen storage.

⇒ **Liquid in solid**

- Mercury in gold, forming an amalgam.
- Hexane in paraffin wax.

⇒ **Solid in solid**

- A solid solution of one metal (or several) in another is called an **alloy**. For example, brass is a solid solution in which zinc atoms have been mixed homogeneously into the solid crystal of copper atoms. This is accomplished by pouring molten zinc into molten copper.
- Steel is a solution of carbon atoms in a crystalline matrix of iron atoms.
- Polymers containing plasticizers.

IV. Assignment – Substance Identification Activity

Problem:

You are given **seven** samples; some are mixtures and some are pure substances. Your task is to determine, through observation and experiment, whether the substance is:

- a pure substance
- a solution
- or a heterogeneous mixture

Materials for making the determination include:

scoopula	eye droppers
magnifying lenses	Bunsen burner

Prelab:

Write a proper procedure:

- Consider the different substances you will be working with and determine a general procedure to test each substance. Note: **Make sure you use only small amounts of each sample to determine what type of substance it is**.
- Create a data table to note your observations and findings.
- **Check your procedure** with your kind and benevolent teacher before you begin.

  Remember, you are **not** being asked to identify each substance, rather you are determining what **type** of substance it is.

Write-up Format

- **Title**
- **Purpose**
- **Background Information** - What lab techniques will you be using for this lab? What definitions should you know for this lab?
- **Materials** - List all materials used. Perhaps use a diagram.
- **Procedure** - List of steps, in point form, used to carry out the exercise. *Anyone* should be able to read and follow your instructions and successfully complete the exercise.
- **Observations** - Use a data chart to indicate your results. Be sure to be clear and specific as to what you are referring to.
- **Conclusions**:
  A. Indicate your results.
  B. Comment on the effectiveness of your procedure. How would you improve or change it?