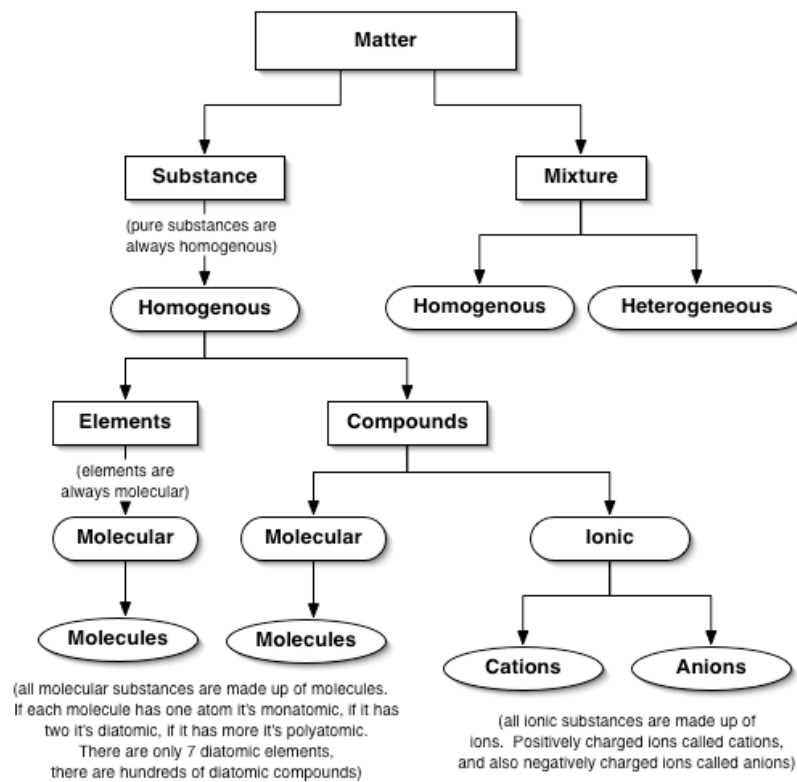


# CLASSIFYING MATTER

Elementary Chemistry 192 — Cañada College

Chemistry is the science of matter. Matter is anything that occupies space and has mass. There are different kinds of matter, this handout is intended to help you differentiate between the classifications of matter.

**Substances & Mixtures.** The first the classification of matter is the distinction between pure substances and mixtures of substances. A pure substance is something that has a definite composition. Pure table salt (a substance) for example is always 39.3% sodium and 60.7% chloride by weight. Every sample of salt, everywhere in the universe is the same. Pure salt has the same melting point, the same taste, the same color and density. Mixtures are materials that contain two or more substances. Unlike a pure substance, a mixture of substances can have variable composition. Pepper (a mixture) in France may contain 43% carbon, 8% hydrogen, and 49% oxygen. Pepper in Italy may contain a different composition. Pepper in Brazil may taste different or have a different melting point than pepper in Rome. Both are mixtures that we call pepper, both contain the same substances, but the ratio of substances in the mixture can vary from one sample to another resulting in very different tastes, colors, densities, and other physical properties.



**Homogenous & Heterogeneous.** We can also ask ourselves if a sample is homogenous or heterogeneous. Homogenous materials are uniform in appearance and properties throughout a sample. Pure substances are always homogenous. If we take the salt out of our table salt shaker and cut it in half, each half has the same appearance (white crystals) and properties (taste for example). No matter how many times we cut the sample, we always get piles with the same appearance and properties. Matter containing two or more phases is heterogeneous (a phase is a homogenous part of a system separated from other parts by a physical boundary). Mixtures can either be homogenous or heterogeneous. Some mixtures, like lemonade are homogenous. No matter how many times you divide a

sample, it always has the same appearance and properties—every sip of lemonade from the same pitcher tastes just as sweet. Don't confuse this with a pure substance though. The lemonade your grandmother makes may taste very different from the lemonade your father makes. Lemonade is a mixture and different samples can taste very different, but each sample uniform throughout. This is different than a chocolate chip cookie. The chocolate and cookie dough are separate. If you cut a cookie in half, you might have more chocolate than dough on one half than another. Every bite of a chocolate chip cookie might taste different, one more sweet than the next. A chocolate chip cookie is heterogeneous.

**Elements & Compounds.** Elements and compounds are examples of a pure substance. As with all pure substances it doesn't matter how you divide the sample, even the smallest subdivision will have the same composition. Any physical means of trying to separate the sample, crushing it, cutting it, sifting it, combing it will always produce two piles of matter with equal appearance and properties. This is true for both elements and compounds. But there are chemical processes that can react with the microscopic particles that make up matter and change one type of matter into another. Thought to be magic in the dark ages, chemical transformation can destroy a material like table salt and decompose it into *new substances that never existing in the original sample*. By running enough electricity through table salt you can decompose it into sodium metal (a shiny silvery metal that explodes on contact with water) and chlorine gas (a toxic green gas that burns skin). Almost all the matter in the universe can be broken down into simpler matter, except for about 100 substances. Elements are matter that cannot be broken down by chemical means into simpler substances. In contrast to the roughly 100 elements listed in the periodic table, there are billions of billions of pure substances that can be decomposed into elements. A compound is a distinct substance made of two or more elements chemically combined in a definite proportion by mass.

**Molecular & Ionic.** All elements are made up of atoms of the given element. Two or more of those 100 types of atoms can also be combined to form the particles of molecular compounds (called molecules). When you have two or more types of atoms in matter, the atoms can develop a charge (we'll discuss how in later chapters). Charged atoms are called ions. All compounds are built up from either neutral atoms or charged atoms (ions). If the compound is made up of ions, the particles of that substance stick to one another (similar to the way a pile of magnets stick to one another). Compounds made up of ions are called ionic. Substances made up of small, uncharged particles are called molecular. (Elements can never be ionic, since they are made up of only one type of atom). Molecular substances (both compounds and elements) can be further described by how many atoms exist in their molecules. If there is only one atom per molecule, it's a monatomic substance. Molecular substances with exactly two atoms per molecule are diatomic. There are seven diatomic elements (and hundreds of diatomic compounds). Molecular substances with 3 or more atoms per molecule are polyatomic (such as the elements P<sub>4</sub>, S<sub>8</sub>, and countless molecular compounds). Ionic compounds can never be monatomic, diatomic, or polyatomic (because they are not composed of molecules).