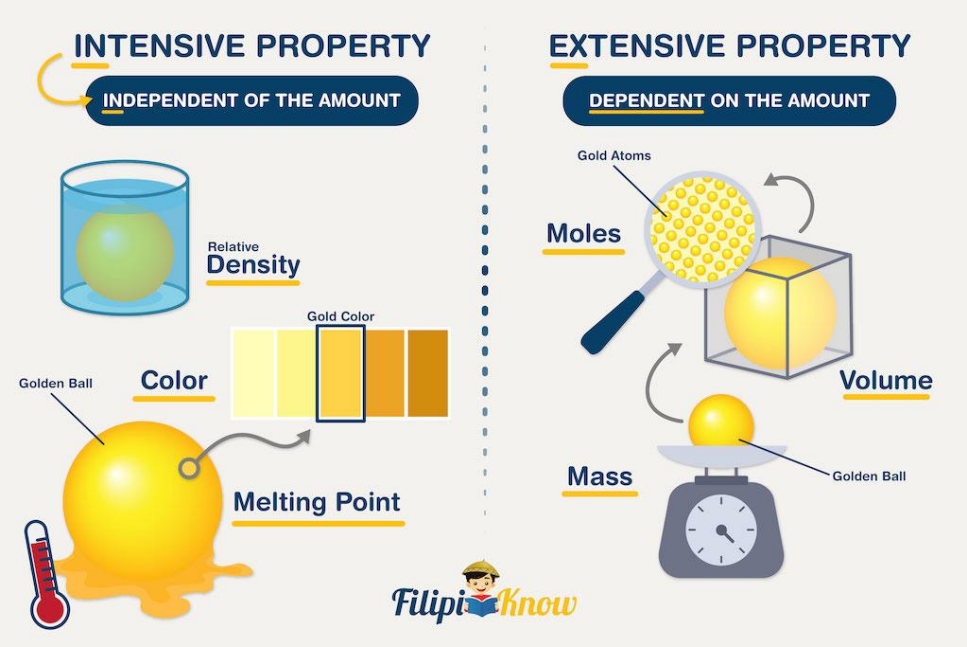
Chemistry is the study of matter and the changes it undergoes. By definition, *matter is anything that occupies space and has mass*. That being said, anything that you can think about is probably made up of matter, and hence, can be studied in chemistry. In this section, we will discuss the properties, states, and types of matter.

Properties of Matter.

All matter has physical and chemical properties. If that property can be measured without changing the chemical composition of that matter, it is a **physical property**.

The physical properties of matter can be further subdivided into extensive and intensive properties.



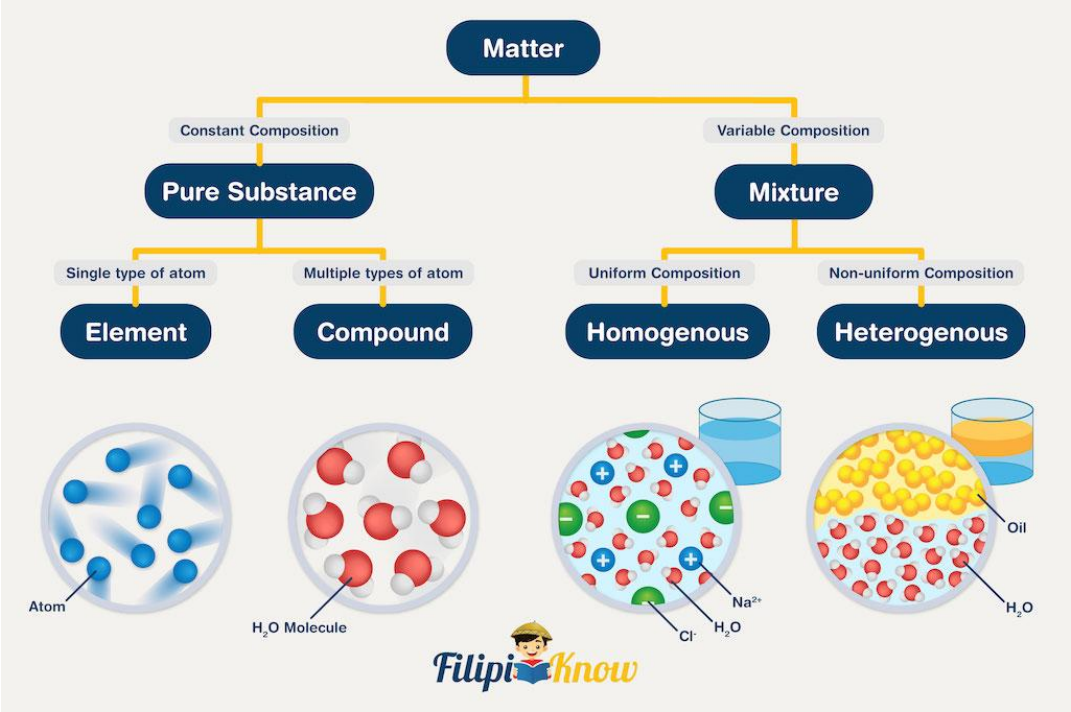
Extensive properties are those that depend on the amount of matter being measured. The classic examples of extensive physical properties are the mass, volume, and number of moles. Decreasing the amount of matter being weighed will definitely decrease the mass of that matter.

On the other hand, **intensive properties** are independent of the amount of matter being considered. Classic examples of intensive properties are color, melting point, boiling point, and density. The density of water, regardless of whether you use 1 mL or 1 L of it, will be the same at a certain temperature.

Meanwhile, **chemical properties** describe the characteristic ability of a substance to react to form new substances. Classic examples of chemical properties include flammability and susceptibility to corrosion.

Types of Matter.

Matter can be classified into two general categories: pure substance or mixture. The diagram below summarizes the differences between the two types of matter.



1. Pure substance.

A **substance** is a form of matter that has a definite composition and distinct properties. A pure substance can be further classified into two categories: elements and compounds.

A substance that cannot be broken down into simpler substances using any chemical means is known as an **element**. With the successful synthesis of Oganesson (Og), there are 118 known elements to date. The introduction of Oganesson also completes the modern periodic table. Scientists are currently on their way to extending the periodic table of the elements.

When two or more types of elements are used in fixed proportion with one another to form a single substance, a **compound** is formed.

Did You Know?

The element Oganesson is by far the heaviest element in the periodic table and the second element that is named after a living person (the first one is the Seaborgium). This element was named after Yuri Tsolakovich Oganessian, a Russian nuclear physicist who is considered the world's leading researcher in superheavy chemical elements.

2. Mixture.

The other general classification of the matter is **mixture**. By definition, a mixture is a combination of two or more substances in which the substances retain their distinct identities.

Mixtures can be further subdivided into heterogeneous and homogeneous mixtures. In a **homogeneous mixture**, the composition of the mixture is the same all throughout. In other words, if you cannot recognize the individual components of a mixture, then it is homogeneous. For example, dissolving a small amount of table salt in one glass of water results in a homogeneous mixture we usually call a solution.

The **solution** is composed of two components: the solute(s) and the solvent. The component that exists in the greatest amount is the **solvent**, while **solute** is/are the component/s that exist in minor amount/s. When studying the chemistry of solutions, you will often encounter the word

“aqueous.” In most cases, an aqueous solution means that water exists in the greatest proportion in the solution and hence, acts as a solvent.

Meanwhile, If you can differentiate the components of a mixture, then it is a **heterogeneous mixture**. Heterogeneous mixtures can be further subdivided into suspension and colloids.

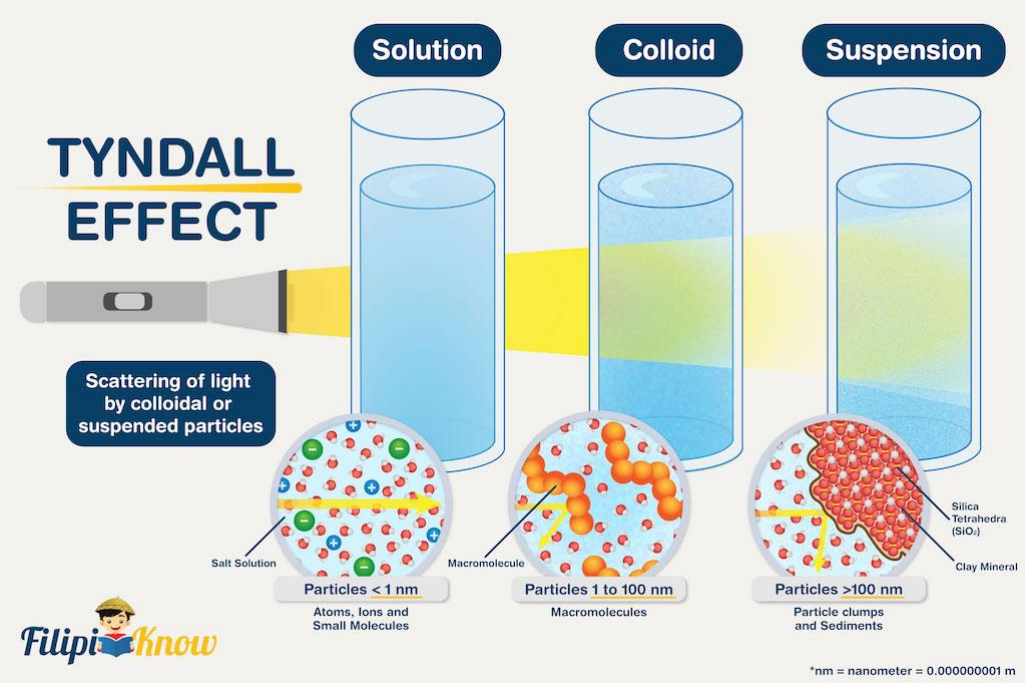
Adding a scoopful of sand to a glass of water results in a mixture where you can distinguish sand from water (since water cannot dissolve sand). The sand-water mixture is a **suspension**.

Colloids, on the other hand, are quite tricky because, at first glance, it appears as if they are solutions. Let’s take for example a glass of fresh milk. At first glance, milk appears as if it is a solution since we know that milk is made up of multiple components, but we can only see a single liquid phase. However, when we look under the microscope, milk actually appears as globules suspended in a certain liquid matrix. Milk behaves like this because it is made up of fats and water, and we know that these two do not mix completely.

If that is the case, then *how do suspension and colloid differ from one another?* In terms of size, particles present in the suspension are so large that eventually, the particles settle at the bottom. In contrast, colloids are composed of particles that are small enough (usually from 1 to 1000 nanometers) for them to remain dispersed in their matrix.

When studying the chemistry of colloids, you will often hear the terms dispersed and continuous phase. The component/s of mixture that is/are being dispersed is the **dispersed phase**, while the component where it is being dispersed is the **continuous phase** or the **dispersion medium**.

Aside from microscopy, there is another more simple way to differentiate colloids from solution. This is done by just using a flashlight! When a beam of light is passed through a colloid, the dispersed phase scatters it. This phenomenon is known as the **Tyndall effect**. Solutions do not exhibit this scattering effect; instead, you will see a clean transmission of light from one end of the glass to the other.



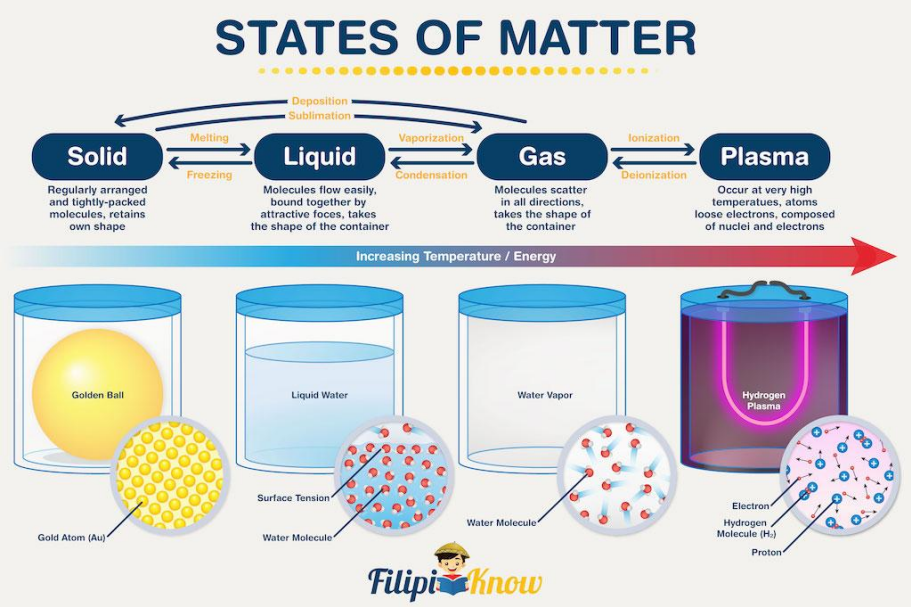
Lastly, there are different kinds of colloids depending on the nature of the dispersed and continuous phase. You can also encounter the term “hydrocolloid”, which is basically a colloidal system wherein water acts as the dispersion medium.

Colloid Type	Dispersed Phase	Continuous Phase	Example
Solid sol	Solid	Solid	steel, opal
Solid emulsion or Gel	Liquid	Solid	butter, cheese
Solid foam	Gas	Solid	plastic foam, lava
Sol	Solid	Liquid	milk of magnesia, paint

Emulsion	Liquid	Liquid	mayonnaise, milk
Foam	Gas	Liquid	whipped cream, soap suds
Solid Aerosol	Solid	Gas	smoke
Liquid Aerosol	Liquid	Gas	fog, mist

States of Matter.

Recent advances in science allow us to classify states of matter more meticulously. To demonstrate how far we've come, there are a total of 22 known states of matter today, and more are expected to be discovered in the years to come. However, in this learning material, we will focus our attention on the four most basic states of matter (yes, four, not three!) and what separates them from one another. The figure below gives you a headstart!



Let's start with solids. During our elementary days, we were all taught that solids have their own shape and do not occupy the shape of their container. That's because solids are made up of molecules (or atoms) arranged in a regular, repeating manner. Furthermore, the molecules or atoms are fixed in their position, and this confers shapes to solids.

Liquid and gases, on the other hand, have molecules (or atoms) that can move freely, although liquid molecules are more compact and hence, have more restricted movement. One major consequence of this property is the lack of shapes of liquids and gases, therefore they are dubbed as the states of matter that copy the shape of their container.

Now, you are probably least familiar with the 4th state of matter which is plasma. Back in my elementary and high school days, plasma was not being taught as a state of matter (*Can you guess my age now?*). To put it simply, plasma is just like gas; however, the difference is that gases are made up of neutral molecules or atoms, while plasma is made up of charged molecules or atoms. In other words, you can say that plasma is a charged gas!

For plasma to occur though, extremely harsh conditions are required. As a result, we can only observe plasma on the surface of very hot objects, such as the stars.