Pure Substances and Mixtures!

- **Substance** – A pure type of matter with a definite composition, formed by chemical bonds.
  - **Element** – Has atoms of *only one type* (hydrogen, carbon, iron, etc.). The atoms may be bonded into molecules, like the two oxygen atoms in an O_2 molecule.
  - **Compound** – Has atoms of *more than one type* bonded together in definite ratios. (Example: Water always has 2 hydrogens for each oxygen... that's why we can write a formula like H_2O.)

- **Mixture** – Matter which is not pure because it has two or more substances mixed together.
  - They haven't bonded together to make a compound. (No chemical reaction.)
  - They can be separated and might even separate spontaneously. (When you stir oil and water together, the oil just floats back to the top.)
  - The ratio can vary, so there's no formula. (Salt water can have just a little salt... or a lot!)

- There are 3 main types of mixture:
  - **Homogeneous mixtures** – Particles of the substances are *evenly spread out*. Homogeneous mixtures are also called **solutions**.
    - *Examples*: Sea water is a solution of water with various salts mixed in. Steel is a solution of iron with carbon mixed in. Blood plasma is a solution of water with various proteins, hormones, and minerals mixed in.
  - **Colloid** – Particles of the substances are *not evenly spread out*. They are clumped, but the clumps are still too small to see or filter out.
    - *Examples*: Jello is a colloid of fruit juices held in place by collagen gel. Smoke is a colloid of tiny ashes suspended in air. Mayonnaise is a colloid of oil, vinegar, and egg.
  - **Heterogeneous mixtures** – The substances are *not evenly spread out*. They have bigger clumps than colloids so they can be filtered and the clumps are heavy enough to settle out on their own if the mixture is a liquid or gas. You might even be able to see the clumps by eye.
    - *Examples*: Sand is a heterogeneous mixture made of small grains of different rocks and minerals. Sand which has been stirred into water is heterogeneous, too – and since it's mostly liquid, the grains will eventually settle to the bottom.

- Solutions are an important type of mixture and have some special terminology and ideas:
  - In a solution, the substance you have more of (usually water) is called the **solvent**. The substance or substances you dissolve into it are called **solutes**.
  - The "strength" of a solution is called its **concentration**. If you've mixed a lot of salt into water, it's concentration is high. If you mix only a little, the concentration is low or "**dilute**".
  - If you add more and more solute, eventually the solution will get "full" and no more dissolves. A solution like this is **saturated**. An **unsaturated** solution can still hold more.
  - The maximum amount of solute you can dissolve into a solvent is called its **solubility**. (That is... when the concentration reaches the solubility... the solution is saturated.)
  - You can speed up the dissolving rate by heating the solution and/or stirring it.
  - Heating the solution also increases the solubility, allowing higher concentrations!
  - If you saturate a solution and then cool it off to lower the solubility, the solution becomes **supersaturated**: it's holding more solute than it should be able to! Any disturbance to the solution will make the extra solute suddenly "fall out" and appear again, undissolved!

Types of Mixture

More details on the 3 types of mixture:

- **Homogeneous mixtures** – Particles of the substances are *evenly spread out*. The dispersed particles are extremely small: atoms, ions, or small molecules (size under 1 nm).
  - We usually call these mixtures **solutions**.
  - A solid solution that has at least one metal in it is called an **alloy**.
  - *Examples*: Sea water is a solution of water with various salts mixed in. Steel is a solution of iron with carbon mixed in. Blood plasma is a solution of water with various proteins, hormones, and minerals mixed in.

- **Colloid** – Particles of the substances are *not evenly spread out*. They are clumped in blobs/grains from sizes of about 1 nm up to 1000 nm (1 μm). Very large molecules such as certain proteins can form a colloid even if they don't clump together, because they're already big enough on their own.
  - The clumps in a colloid are still too small to filter out or even see with a microscope.
  - Some liquid/liquid colloids can only stay mixed with the help of another chemical – these are called **emulsions**. Without that help, they will separate out.
  - If the colloid isn't opaque, you can see a beam of light passing through it. This is called the **Tyndall Effect**. They scintillate (sparkle) under the microscope, too.
  - *Examples*: Jello is a colloid of fruit juices held in place by collagen gel. Smoke is a colloid of tiny ashes suspended in air. Mayonnaise is an emulsion of oil and vinegar made by adding some egg yolk. Without the egg, the liquids separate into a heterogeneous mixture.

- **Heterogeneous mixtures** – The substances are *not evenly spread out*. They are clumped in blobs/grains of at least 1000 nm. If big enough, the clumps might be visible to the eye.
  - The clumps can be very big, even big enough to see with your naked eyes.
  - The clumps are big enough to be filtered out, and sometimes even picked out by hand.
  - If clumps of one substance are floating or suspended in the other, we call it a **suspension**. A suspension will settle out if you wait (like dust in the air). Once settled, it's not a suspension anymore... just a regular heterogeneous mixture.
  - *Examples*: Sand is a heterogeneous mixture made of small grains of different rocks and minerals. Sand which has been stirred into water is a suspension because the grains are floating but will eventually settle to the bottom.

property	homogeneous mixture (solution)	colloid	heterogeneous mixture
settles out?	no	no	if liquid/gas, yes
filters out?	no	no	yes
Tyndall effect?	no	if translucent, yes	if translucent, yes
particle size?	<1 nm	1-1000 nm	>1000 nm

What kind of matter is it?