Unit 4: Chemistry

Part 1: Definitions

**Pure Substance vs Mixture:**

**Pure Substance**

A pure substance is [matter](https://www.chemicool.com/definition/matter.html) which has a specific composition and specific properties. Every molecule of a pure substance has the same chemical composition. Every element is a pure substance. Every compound is a pure substance.

**Examples of pure substances**:

* [Iron](http://www.chemicool.com/elements/iron.html) is an element and hence is also a pure substance.
* Water is a compound and hence is also a pure substance. Although water is made of two different elements, each water molecule has the same structure (H2O).

**Mixture**

A mixture contains two or more [substances](https://www.chemicool.com/definition/substance.html) that are not chemically combined. The properties of a mixture can be altered by changing the ratios of the substances. A mixture contains different molecules of different pure substances.

**Examples of non-pure substances (mixtures)**:

* Salt water is not a pure substance. It is a mixture of two pure substances - sodium chloride and water. Its composition and therefore its properties are not fixed.
* Gasoline is not a pure substance. It is a mixture of hydrocarbons and, depending on the composition of the gasoline mixture, gasoline's properties can vary.
* Air is not a pure substance. Air is a mixture of many elements and compounds, including (but not limited to) oxygen, O2, hydrogen, H2, carbon dioxide, CO2 and many others.
* Brass is a mixture of copper and zinc. Mixtures of metals are often called alloys. Changing the amount of zinc can change the appearance, the malleability, the electrical conductivity and other properties.

**Element vs Compound**

**Element**

An element is a pure [substance](https://www.chemicool.com/definition/substance.html) whose atoms all have the same number of protons: another way of saying this is that all of a particular element's atoms have the same atomic number.

Elements are the simplest pure substances and cannot be broken down using chemical reactions. Elements can only be changed into other elements using nuclear methods.

Although an element’s [atoms](https://www.chemicool.com/definition/atom.html) must all have the same number of protons, they can have different numbers of neutrons or electrons. When atoms of the same element have different numbers of neutrons, they have different masses and are called [isotopes](https://www.chemicool.com/definition/isotopes.html). If atoms of the same element have different numbers of electrons, they will have different charges and are called ions.

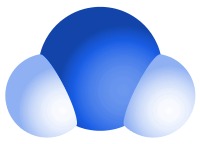
Atoms are generally neutral and have the same number of electrons as protons. If an atom gains extra electrons it will have a negative charge and be called an anion. If an atom loses electrons it will have a positive charge and be called a cation.

**Examples of Elements**

* All known elements are organized in the Periodic Table of the Elements

**Compound**

A compound is a pure substance formed when two or more chemical elements are chemically bonded together.



1 water molecule contain 3 atoms: 2 hydrogen atoms and 1 oxygen atom.

Every water molecule has this same structure.

The type of bonds holding elements together in a compound can vary: two common types are [covalent bonds](https://www.chemicool.com/definition/covalent_bond.html) and [ionic bonds](https://www.chemicool.com/definition/ionic_bonding.html).

Ionic bonds are formed between a positively charged metal ion (cation) and a negatively charged non-metal ion (anion). The ratio of ions is always such that the molecule formed is neutral. Covalent bonds are formed between two (or more) non-metals. The non-metals share electrons such that each will have a full outer shell, or stable octet.

The elements in any compound are always present in fixed ratios. The molecules of a compound are nearly always neutral. The exception are the pol-atomic ions.

**Examples of Compounds**

* Pure water is a compound made from two elements - hydrogen and oxygen. The ratio of hydrogen to oxygen in water is always 2:1. Each molecule of water contains two hydrogen atoms bonded to a single oxygen atom. The chemical formula is H2O. Water is a covalent compound.
* Table salt is a compound made from two elements - sodium and chlorine. The ratio of sodium ions to chloride ions in sodium chloride is always 1:1. The chemical formula is NaCl. Sodium chloride is an ionic compound.
* Pure methane is a compound made from two elements - carbon and hydrogen. The ratio of hydrogen to carbon in methane is always 4:1. The chemical formula is CH4
* The nitrogenous base thymine, found in DNA, is a compound made from 4 elements-carbon, hydrogen, oxygen and nitrogen. The ration of carbon to hydrogen to oxygen to nitrogen is 5:6:2:2. the chemical formula is C5H6N2O2

Part 2: Chemical Reactions

**Chemical vs Physical Change**

**Physical Change**

A physical change is a change to a substance that does not alter the molecules of the substance. The molecules may be rearranged but no chemical bonds are broken and the molecules maintain their chemical composition.

**Examples of Physical Change:**

* Changes of state, like freezing/melting and boiling/condensation.
* Crystallization
* Magnetization. Certain materials can be magnetized by aligning the molecules in the material using a strong magnetic field.
* Dissolving. If you mix sugar into coffee (or tea or whatever) the sugar molecules remain intact. You simple break the crystals down until they are so small they cannot be seen.
* Alloy formation. Metals can be melted and mixed to form alloys that have desirable properties. The individual molecules from each metal do not join; no compounds are formed.

**Chemical Change**

A chemical change is a change in which the atoms of the molecules are rearranged. Chemical bonds are broken or formed or both. NO NEW ATOMS ARE FORMED AND NO ATOMS ARE DESTROYED. In chemical reactions new materials with new properties are created.

Chemical changes occur all around us all of the time. A chemical change is sometimes obvious, but is often not. Evidence of chemical change includes: colour change, gas formation, precipitate formation, energy release in the form of light, heat or sound.

**Examples of Chemical Change:**

* A campfire. As the wood burns heat and light are produced. The wood is transformed into ash. The process cannot be reversed.
* Rotting of food.
* Digestion of food.
* Photosynthesis in plants.
* Rusting of metal.
* Batteries create electricity via chemical reactions.