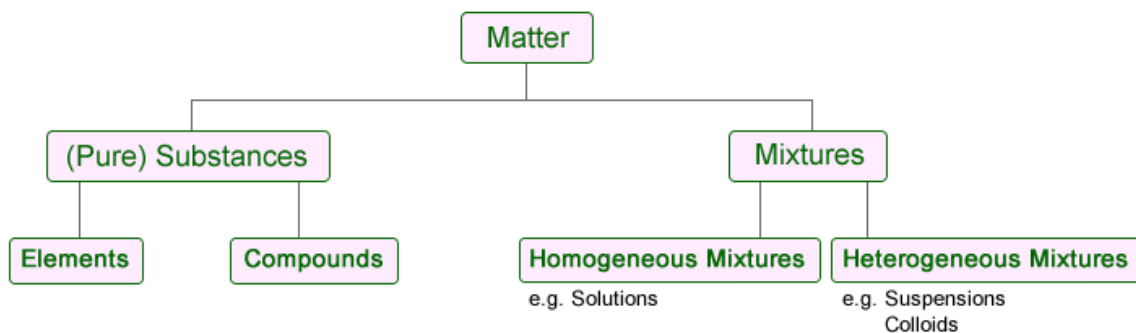


Elements, Mixtures and Compounds

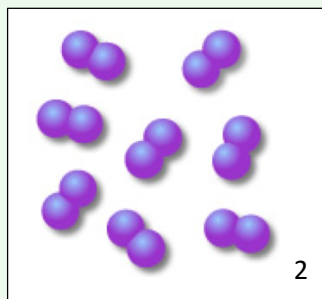
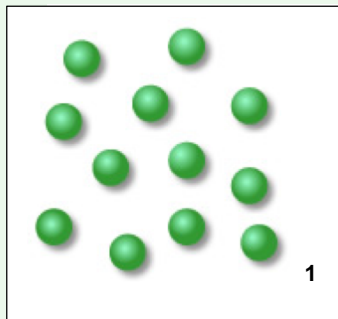
Chemistry is the study of physical matter, such as state of matter (gas, liquid or solid), chemical form (element, mixture or compound), chemical structure (atoms or molecules, etc.).

- The most general term is "**matter**" which can be used to refer to any of "substances", "elements", "mixtures" or "compounds".
- "**substance**", which can be used to refer to either an element or a compound - but not to a mixture because a "substance" always has a definite composition.
- Other useful terms in chemistry are "**element**", "**mixture**" and "**compound**"



Elements

- **consist of only one type of atom** - which may, or may not join together to form molecules or large structures.
- can exist as either atoms (e.g. argon) or molecules (e.g., nitrogen)
- cannot be broken down into a simpler type of matter by either physical or chemical techniques - *though some larger elements break-down spontaneously due to being radioactive.*
- **Elements** are listed in the periodic table.
- Many elements are found in nature and so may be called "naturally occurring elements".
- Other elements have not been found in nature but can be produced in the laboratory.
- A few more elements are thought to exist but are very rare
- even if produced would only exist for a very short time because they are radioactive and would quickly decompose into other elements whose atoms are smaller.



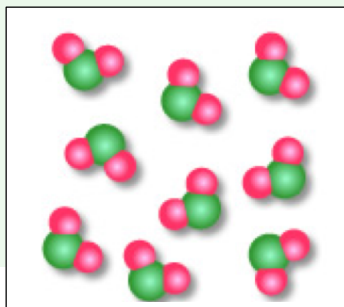
Example 1 : Element existing in the form of atoms.

Example 2 : Element existing in the form of diatomic molecules (eg; Cl_2, O_2)

Compounds

1. **consist of atoms of two or more different elements bound together chemically,**
2. can be broken down into a simpler type of matter (elements) by chemical means; but not by physical means
3. always contains the same ratio of component atoms.
4. have properties different from their component elements (e.g. the compound water (H_2O) is a liquid at room temperature and pressure and has different chemical properties from those of the two elements, hydrogen (H_2) and oxygen (O_2), from which it is formed).
5. A **compound** can be represented by using a chemical formula

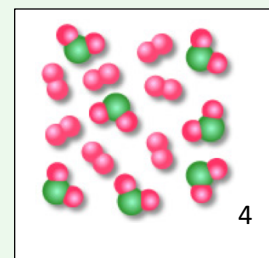
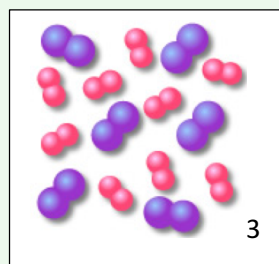
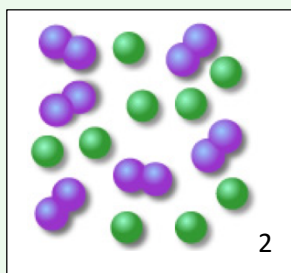
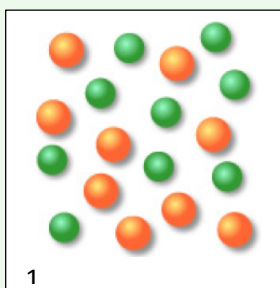
If => a material consists of atoms of two or more elements joined together, always in the same ratio, then the matter forming that material is a compound.



Compound whose molecules consist of one atom of one element chemically joined with two atoms of another element. H_2O

Mixtures

1. consist of two or more different elements and/or compounds - physically intermingled,
2. can be separated into their constituent parts by physical means (e.g. distillation of liquids or separating magnetic and non-magnetic solids using a magnet), and
3. have many of the properties of their constituent parts (e.g. the element "oxygen" is part of the mixture "air" and some of the properties of air are due to the oxygen, albeit somewhat reduced compared with pure oxygen due to the presence of the other constituents of the mixture called "air").



Example 1 : Mixture of two elements, both of which exist as atoms rather than molecules

Example 2 : Mixture of two elements ,one of which exists as atoms, the other as molecules

Example 3 : Mixture of two elements, both of which exist as molecules rather than atoms.

Example 4 : Mixture of an element (that exists in the form of molecules) and a compound.

There are many different types of mixtures, some of which have special names. These include:

- **Homogeneous Mixtures** - in which the two or more substances that form the mixture are evenly distributed throughout the mixture, e.g. vinegar is a homogeneous mixture of ethanoic acid and water.
- **Heterogeneous Mixtures** - in which the two or more substances that form the mixture, are not evenly distributed throughout the mixture, e.g. oil and water.
- **Solutions** - a special type of **homogeneous** mixtures in which one substance (called the "solute") is dissolved in another substance (called the "solvent"), e.g. salt water is salt dissolved in water - in such a way that the salt no-longer exists as solid particles within the water.

- **Suspensions - heterogeneous** fluid mixtures containing solid particles large enough for sedimentation, which means that the particles (compare with the "solute" part of a solution) will eventually settle to the bottom of the container (*unlike in the case of colloids, below*), e.g. particles of sand in water.
- **Colloids - heterogeneous** mixtures in which one is substance microscopically dispersed evenly throughout another substance (for comparison, the size of the particles of "solute" are greater than in the case of a *solution*, but much smaller than in the case of a *suspension*). There are many naturally occurring colloids(emersion), e.g. milk. Colloids are very important in biology and medicine.
- **Alloys** - mixtures in which the main element (or elements) are metal(s). A more technical definition of an alloy is "a partial or complete solid solution of one or more elements in a metallic matrix". Common examples of alloys include bronze, brass and steels.

What is a Substance ?

Definitions of a Chemical Substance:

A substance => can be a pure element or a pure compound

not to a mixture

a "substance" always has a definite composition.

- **Chemical substances** are **any materials** (in any state - solid, liquid or gas) **that have a definite chemical composition.**
- Chemical substances can therefore be either a pure chemical element or a pure chemical compou

Examples of Substances:

Common Name	Chemical Symbol or Formula	Element / Mixture* / Compound	Exists as atoms / molecules
Water	H ₂ O(l)	compound	molecules
Methane	CH ₄ (g)	compound	molecules
Hydrogen	H ₂ (g)	element	molecules
Neon	Ne(g)	element	atoms

*Mixtures are not "substances" (or "pure substances") because pure substances have a definite chemical composition.

What is an Element (in terms of Chemistry) ?

Definition of a Chemical Element:

- An element is a chemical substance that cannot be broken-down into any simpler substances by chemical reactions.
- It consists of only one type of atom, though the atoms of an element may, or may not, join together to form molecules (that depends on the particular element and so the structure of its atoms).
- All elements are included in the Periodic Table.

List of facts about Chemical Elements:

1. **Elements** consist of only one type of atom - which may, or may not be joined together to form molecules or large structures, so ...
2. **Elements** can exist either as atoms (e.g. argon) or as molecules (e.g., nitrogen)
3. **Elements** cannot be broken down into a simpler type of matter by either physical or chemical techniques - *though some larger elements break-down spontaneously due to being radioactive.*
4. **Elements** are listed in the periodic table.

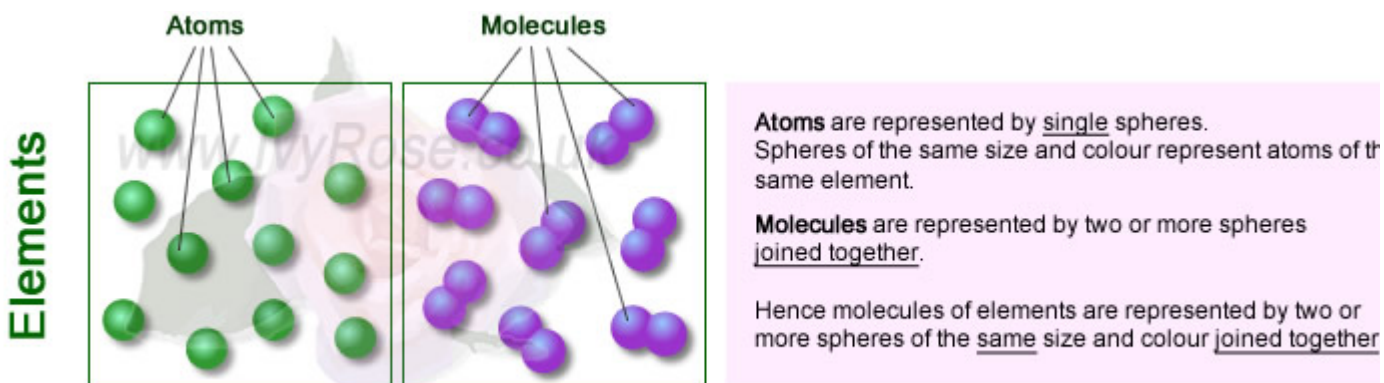
Symbols of Chemical Elements:

- Every chemical element has its own symbol.
- Examples of chemical symbols are N (for the element nitrogen), He (for the element helium) and Pb (for the element lead).

Many elements are found in nature and so may be called "*naturally occurring elements*". Other elements have not been found in nature but can be produced in the laboratory. A few more chemical elements are thought to exist but are very rare and even if produced would only exist for a very short time because they are radioactive and would quickly decompose into other elements whose atoms are smaller.

Do elements consist of atoms or molecules ?

- Some elements exist in the form of atoms e.g. the noble gases neon (Ne), argon (Ar), krypton (Kr), xenon (Xe) and radon (Rn).
- Other elements exist in the form of molecules. For example many common gases exist as diatomic molecules e.g. oxygen (O₂), hydrogen (H₂), and nitrogen (N₂).



<http://www.ivy-rose.co.uk/Chemistry/GCSE/What-is-an-element.php> Illustration (c) IvyRose

What is a Compound ?

Definitions of a Chemical Compound:

- A **compound** is the result of two or more **elements** becoming chemically combined together. The elements react chemically, causing bonds to be formed between the **atoms** involved resulting in **molecules** of the compound.
- The elements react in specific amounts, resulting in a compound that has a specific chemical composition.
- Compounds do not necessarily resemble the elements of which they are composed and cannot be converted back to those elements by physical methods.
- It is very difficult and require a lot of energy to change compounds into their elements by chemical means (reactions).
- A **compound** is a pure substance that consists of two or more **elements** chemically combined in a fixed proportion, that can be further subdivided into simpler substances by chemical (not physical) means only.
- if a quantity of a material consists of atoms of two or more elements joined together, always in the same ratio, then the matter forming that material is a compound. Ex H_2O , CO_2 , $PbCl_2$

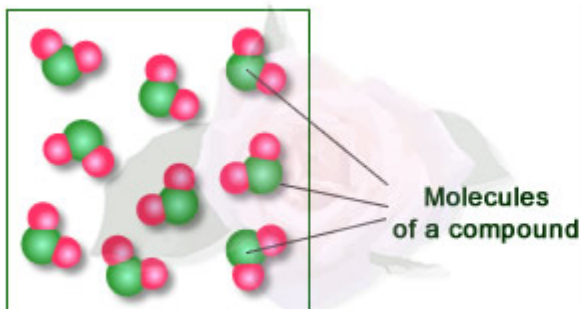
List of facts about Compounds:

1. **Compounds** consist of **molecules** formed from atoms of 2 or more different elements bound together chemically.
2. **Compounds** can be broken down into a simpler type of matter (**elements**) by chemical means; not by physical means
3. **Compounds** always contains the same ratio of component elements.
4. **Compounds** have properties different from their component elements e.g. the compound water (H_2O) is a liquid at room temperature and pressure and has different chemical properties from those of the two elements, **hydrogen** (H_2) and oxygen (O_2), from which it is formed.
5. **Compounds** can be represented using chemical formulae.
6. A **molecule** is the smallest part of a compound whose properties are those of the compound.

Do compounds consist of atoms or molecules ?

Compounds consist of **molecules** - which are, in turn, formed from **atoms**.

Compounds



Atoms are represented by single spheres. Spheres of the same and colour represent atoms of the same element.

Molecules are represented by two or more spheres joined together.

Molecules of Elements are represented by two or more spheres of the same size and colour joined together.

Molecules of Compounds are represented by two or more spheres of different sizes and colours joined together.

<http://www.ivy-rose.co.uk/Chemistry/GCSE/What-is-a-compound.php> Illustration (c) IvyRose

What is a Mixture ... in terms of Chemistry ?

Definition of a (Chemical) Mixture:

- **Mixtures** are formed by just mixing together two or more substances.
- Those substances may also be referred to as "constituents" or "components" - and may be either elements or compounds, and be composed of either atoms or molecules.
- There are no chemical reactions between the constituents of mixtures, which can therefore also be separated without any chemical reactions taking place.
- Each compound or element in the mixture will carry their original chemical properties (eg: A mixture of Iron and Sulphur. Both Iron and Sulphur will show their individual properties iron-magnetism. S will show its properties).

List of facts about Mixtures:

1. **Mixtures consist of two or more different elements and/or compounds - physically intermingled.**
2. **Mixtures** can include:
 - at least two different types of atoms, or
 - at least two different types of molecules, or
 - at least one type of atom and at least one type of molecule.
3. **Mixtures** can be formed from the intermingling of their constituents in any ratios or proportions (unlike compounds, which are formed from *specific ratios* of amounts of other elements).
4. **Mixtures** can be separated into their constituents by **physical means**.
5. **Mixtures** have many of the properties of their constituents (e.g. the element "oxygen" is part of the mixture "air" and some of the properties of air are due to the oxygen part - but those properties are generally less strong/intense than those of pure oxygen because of the presence of the other constituents of the mixture called "air", e.g. many substances, such as wood, burn in air and burn even more vigorously in pure oxygen).
6. **Mixtures** do not have fixed precise melting and boiling points (which elements and compounds do have), but instead mixtures melt/freeze and boil/condense over a range of temperatures according to the physical properties of the different constituents of the mixture.
7. Because no chemical reaction takes place when a **mixture** is formed, no energy (e.g. heat, light or electrical energy) is released or absorbed during the formation of a mixture.

Do mixtures consist of atoms or molecules ?

Mixtures can consist of either atoms or molecules - but must include at least two different atoms or molecules.

Atoms are represented by single spheres.
Spheres of the same size and colour represent atoms of the same element.

Molecules are represented by two or more spheres joined together.

Molecules of Elements are represented by two or more spheres of the same size and colour joined together.

Molecules of Compounds are represented by two or more spheres of different sizes and colours joined together.

Mixtures

