Chapter-4

ELEMENTS, COMPOUNDS, FORMULAE AND SYMBOLS

STUDY NOTES

Matter–Pure or Impure

You must have seen cartons of milk, ghee etc., with markings on them stating that the products inside are pure. Do you think the products are pure?

You might say that they are pure. This is because most people use the term "pure" to describe a product that is not adulterated or a product that is free from harmful substances such as bacteria, fungi, etc.

However, for a scientist, a substance is "pure" if it is composed of only one type of particles or molecules.

Let us first define the term 'substance'.

Substance: A substance may be defined as a form of matter that has a definite chemical makeup. Some substances can be separated into other types of matter by physical processes, while some cannot.

Pure substance: It is a substance composed of only the same type of particles. It has definite properties throughout.

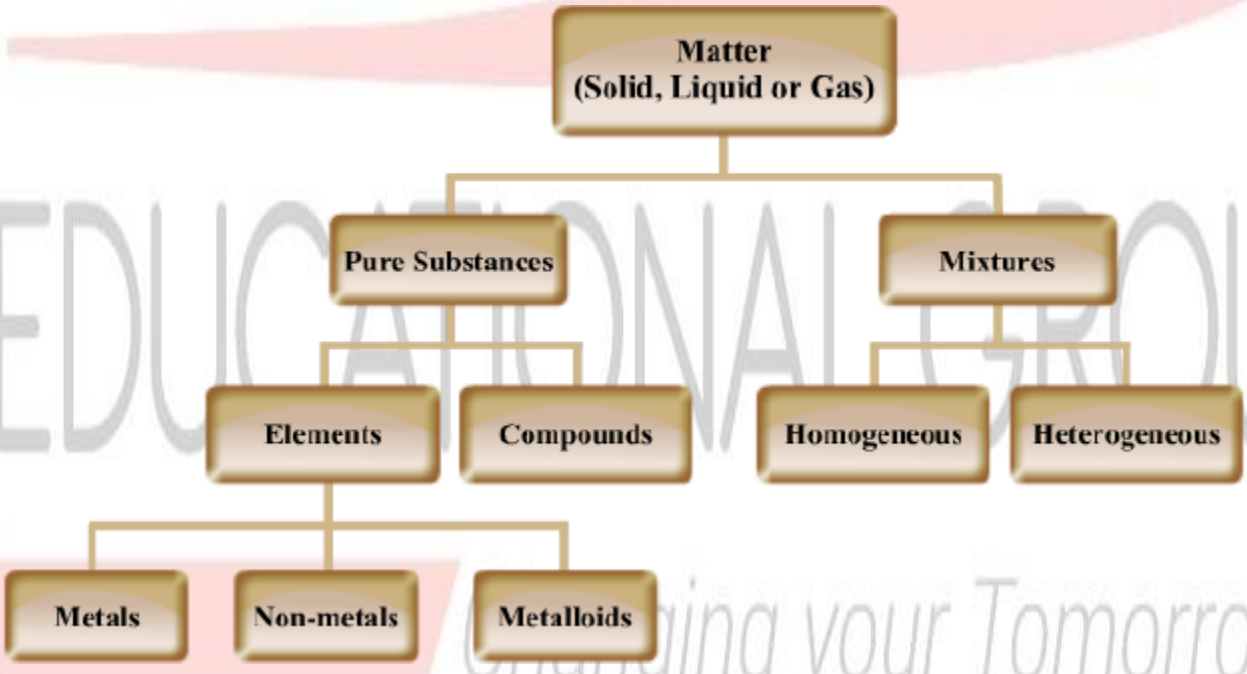
Milk is not made up of the same type of molecules. It consists of molecules of water, proteins, fats, etc. Therefore, chemically, milk is not pure.

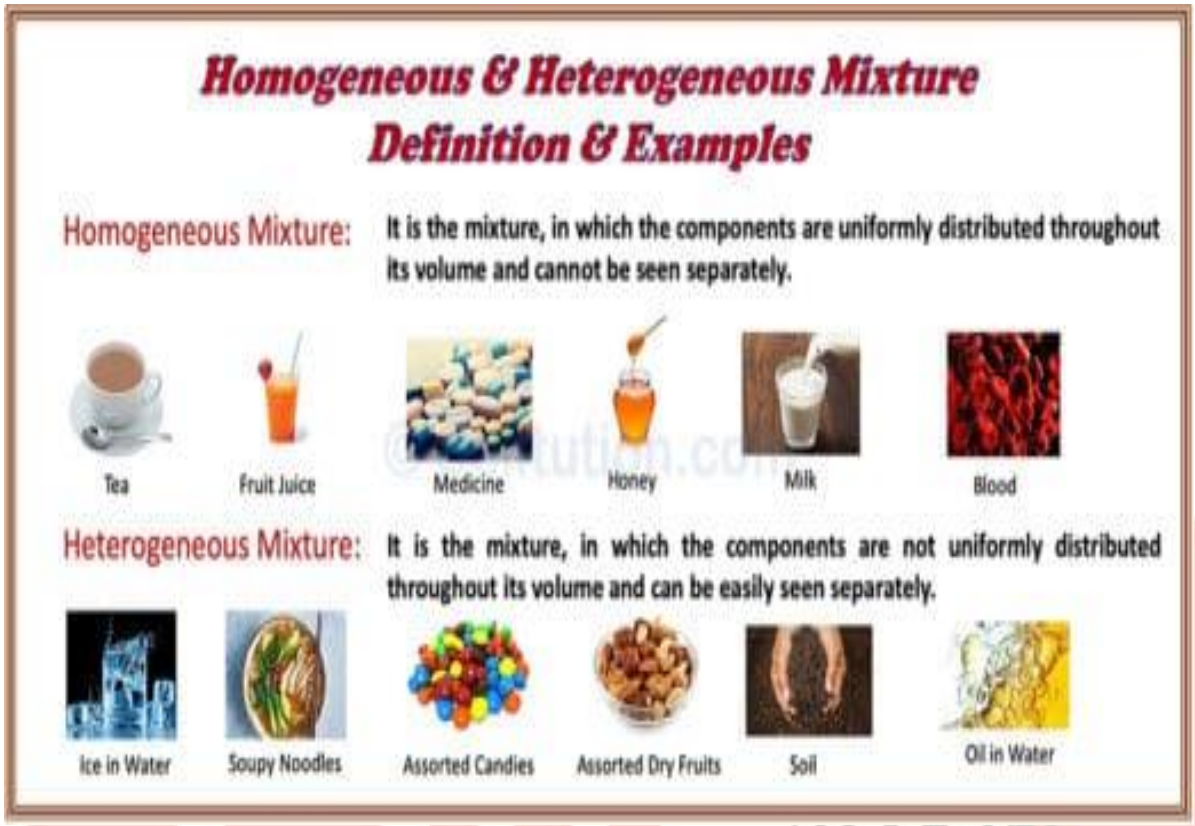
Salt-water solution is not pure as salt can be separated from its solution by evaporation (a physical process).

However, salt (sodium chloride) is a pure substance and cannot be separated into its constituents by any physical process.

Most of the substances that we see around us are actually impure form of matter. Examples: gold in ornaments, steel or aluminium utensils, etc.

Classification of Matter





Characteristics of pure substances

- Pure substances have a perfectly homogeneous nature.
- Pure substances are made up of only one type of atoms (elements)or molecules(compounds).
- Pure substances have a fixed composition.
- Pure substances have a fixed density, melting point, boiling point physical and chemical properties

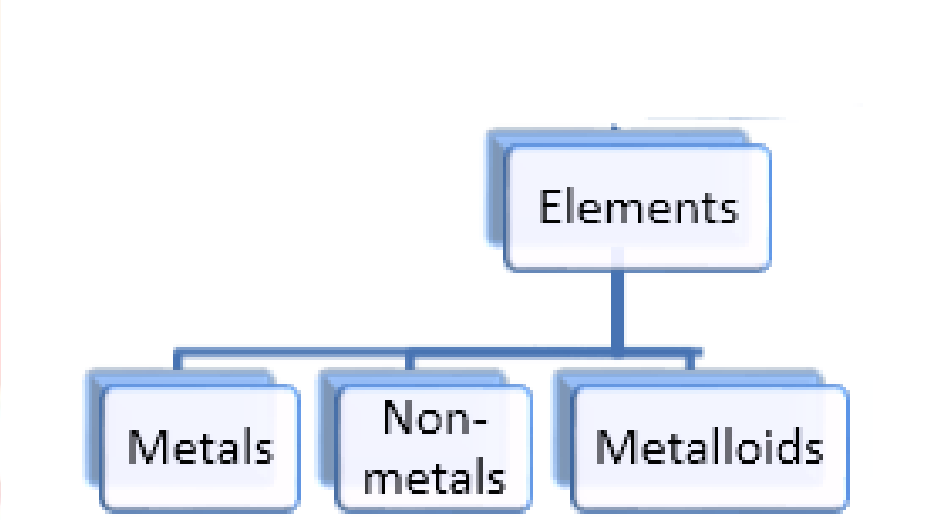
ELEMENTS AND ITS TYPES

Elements:

Pure substances which are made up of only one kind of atoms are known as elements.

They cannot be split up into two or more simpler substances by any of the usual chemical methods.

For example Iron, gold, silver, carbon, oxygen, nitrogen and sodium etc.

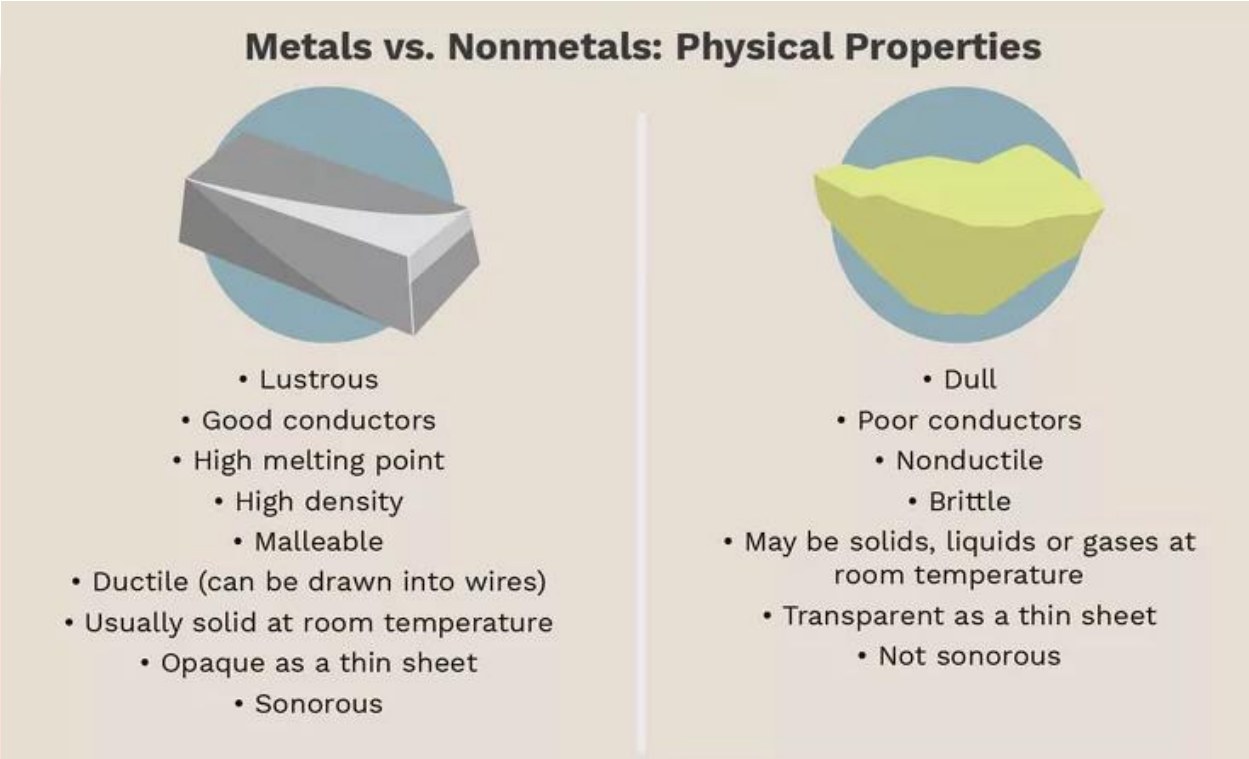


Elements are further grouped into the following three categories:

(i) **Metals,** for example: Iron, copper, gold, sodium, silver, mercury, etc.

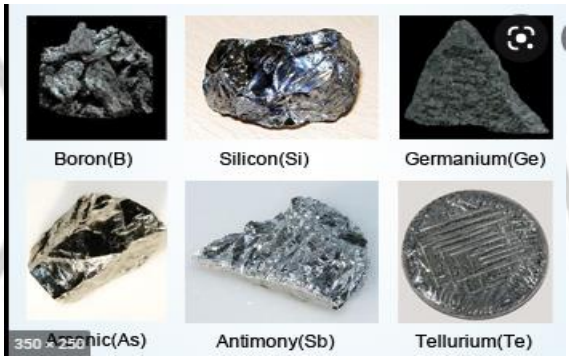
(ii) **Non – metals**, for example: Carbon, oxygen, sulphur, nitrogen, oxygen, hydrogen, etc.

(iii) **Metalloids**: Boron, silicon, germanium, etc.



Metalloids

- Metalloids can be defined as chemical elements whose physical and chemical properties fall in between the metal and the non metal categories



Exceptions

Exceptions

Property	Metals	Non-Metals
Lustre (metallic shine)	All metals have lustre	Have no lustre (except Iodine and Graphite)
Hardness	Very hard (except sodium and potassium)	Not hard (except Diamond- hardest substance)
Malleability (property due to which a substance can be beaten into sheets)	Highly malleable (except Zinc,)	Non malleable
Ductility (property by which a substance can be drawn into wire)	Ductile (except Zinc,)	Non ductile (except Carbon fiber)
Conductivity	Good conductor of heat and electricity (except Tungsten)	Bad conductor of heat and electricity. (except Graphite and gas carbon)
State	Solid (except Mercury and Gallium)	Solid, liquid or gas
Density	High density (except sodium and potassium)	Low density (except diamond)

Bromine is the only liquid non metal

NOTE- Bromine is the only liquid non metal

INERT OR NOBLE GASES

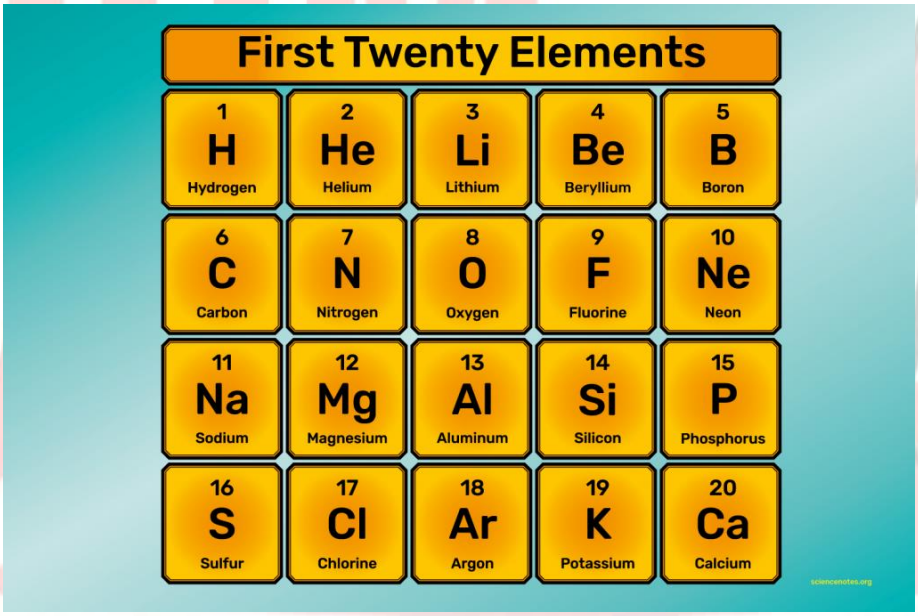
These Elements do not react chemically with other elements or compounds, so they are known as noble or inert gases. They are found in air in traces

They are six naturally occurring inert gases -------- Helium, Neon, Argon, Krypton, Xenon, and Radon

SYMBOLS OF ELEMENTS

- Each element is denoted by a symbol which is usually the first letter of its name in English or Latin. (always in capital letter)

- If the first letter of more than two elements is same, the symbol is denoted by two letters, first letter is written in capital while the second letter is written in small letter.
- Some symbols have been taken from the Latin, German, or Greek.
- These symbols also represent an atom of that element

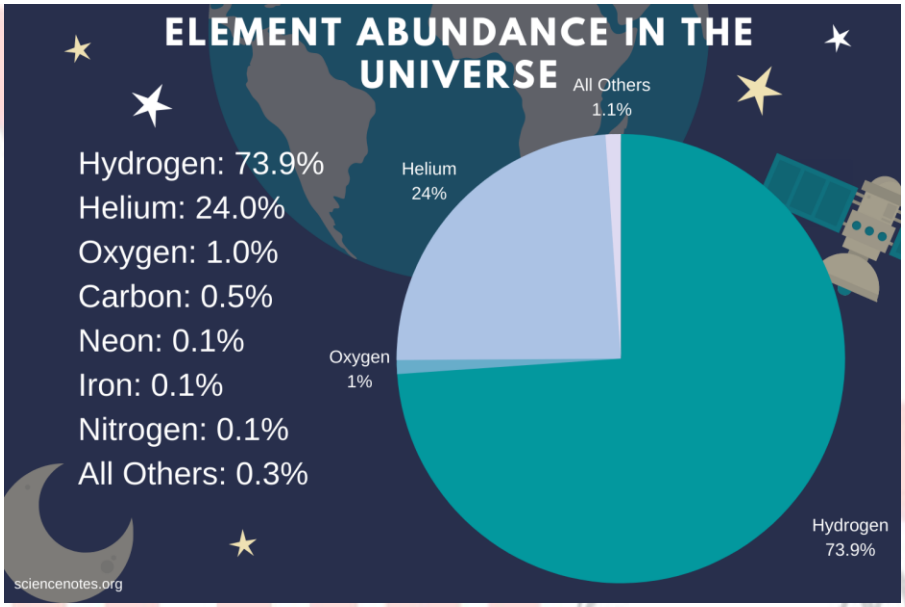


Periodic table showing periods and groups and 20 elements

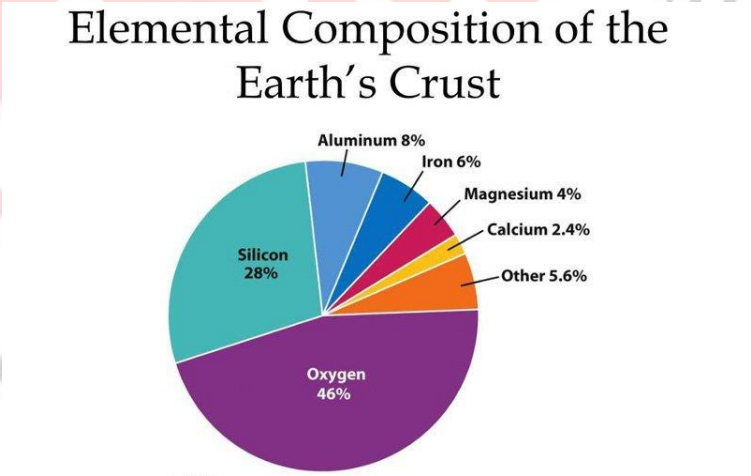
Groups and periods are two ways of categorizing elements in the periodic table. Periods are horizontal rows (across) the periodic table, while groups are vertical columns (down) the table.

Common elements

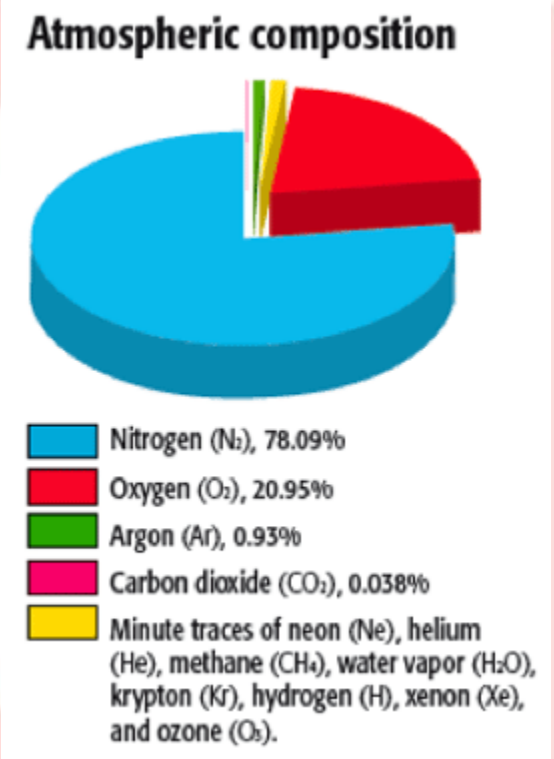
IN UNIVERSE-



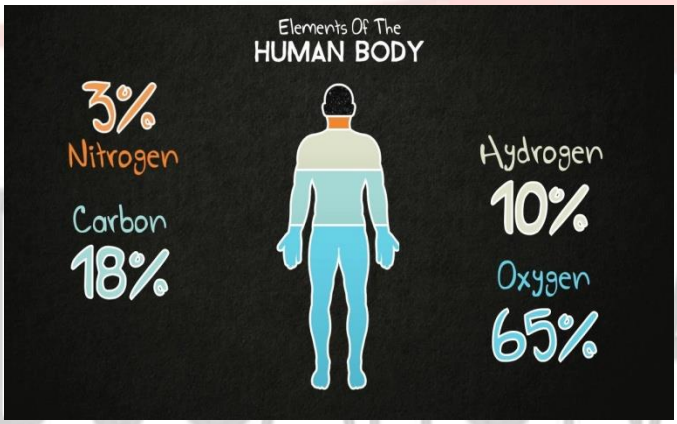
IN EARTH'S CRUST



IN THE ATMOSPHERE



IN HUMAN BODY



COMPOUNDS-

Characteristics of compounds:

- A compound is formed by mixing two or more elements in a fixed ratio by mass. For example, water is formed by mixing hydrogen and oxygen in the fixed ratio of 1:8 by mass.
- The properties of a compound are entirely different from the properties of its constituents.
- For example, oxygen supports combustion and hydrogen is an inflammable gas, while water is neither combustible nor does it support combustion.
- Whenever a compound is formed, it releases or absorbs heat. For example, when nitrogen and hydrogen combines to form ammonia, it releases a lot of heat.
- Since a compound is a pure substance, it will have fixed melting and boiling points. For example, ice melts at 0ºC, while water boils at 100ºC.
- The constituents of a compound cannot be separated using simple physical methods.

For example, water cannot be reduced to hydrogen and oxygen just by heating or filtering.

Electrolysis of acidified water is the only way to separate the constituents.

NOTE- Electrolysis, process by which electric current is passed through a substance or compound in liquid state to effect a chemical change and to separate its constituents

PROPORTION OF ELEMENTS BY MASS-

	Compounds	Elements	Proportion of elements
(a)	H_2O	H : O	1 : 8
(b)	CO_2	C : O	3 : 8
(c)	CaO	Ca : O	5 : 2
(d)	NO_2	N : O	7 : 16

Atoms

'Matter consists of very small particles called atoms'.

The word 'atom' is derived from the Greek word 'atomos' which means 'indivisible'. It was the Greek philosopher Democritus who coined the term.

Elements are the pure substances or matters that consist of only one kind of atoms. For example, Iron is an element that consists of all the atoms of iron.

Dalton's Atomic Theory

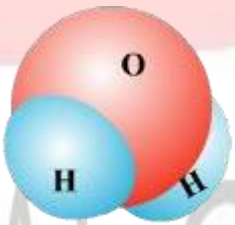
- Dalton asserted that 'atoms are the smallest particles of matter, which cannot be divided further'.
- The postulates of Dalton's atomic theory are as follows:
- All matter is made up of very tiny particles. These particles are called atoms.

- An atom cannot be divided further, i.e., atoms are indivisible.
- Atoms can neither be created nor destroyed in a chemical reaction.
- All atoms of an element are identical in all respects, e.g. in terms of mass, chemical properties, etc.
- Atoms of different elements differ from each other, i.e., they have different masses and chemical properties.
- In a given compound, the relative numbers and types of atoms are constant.

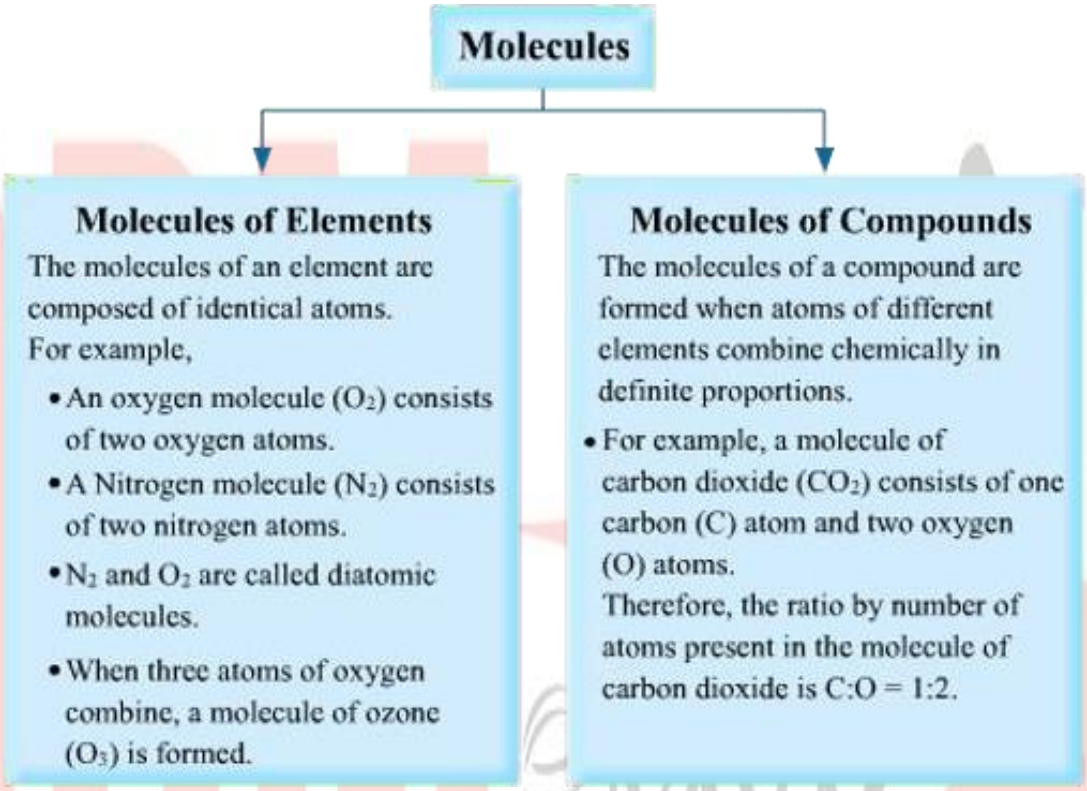
Molecules

- Most atoms are not stable in their free state. So, they combine with other atoms to form molecules.
- The term 'molecule' originates from the French word 'molecule', which means 'extremely minute particle'.
- A molecule may consist of one or more same or different atom(s). For example, a hydrogen molecule is formed when two hydrogen atoms combine with each other.

Hydrogen molecule



Water Molecule



Atomicity of Molecules

Types of Element	Name	Atomicity
Non-Metal	Argon	Monoatomic
	Helium	Monoatomic
	Oxygen	Diatomic
	Hydrogen	Diatomic
	Nitrogen	Diatomic
	Chlorine	Diatomic
	Phosphorus	Tetra-atomic
	Sulphur	Poly-atomic
Metal	Sodium	Monoatomic
	Iron	Monoatomic
	Aluminium	Monoatomic
	Copper	Monoatomic

Elements	**Atomicity**
Helium (He), Neon (Ne), Argon (Ar)	Mono atomic (1 atom per molecule)
Oxygen (O_2), Hydrogen (H_2), Nitrogen (N_2)Chlorine (Cl_2), Fluorine (F_2)	Diatomic (2 atoms per molecule)
Phosphorus (P_4)	Tetratomic (4 atoms per molecule)
Sulphur (S_8)	Polyatomic (8 atoms per molecule)

Molecular Formula: A Brief Overview

- Just like each atom has a unique symbol, each compound has a unique molecular formula.
- The molecular formula of a compound provides information about the names and numbers of atoms of the different elements present in a molecule of that compound.
- Molecular formula is a chemical formula that indicates the kinds of atoms and the numbers of each kind of atom in a molecule of a compound

Examples

- The molecular formula of glucose is $C_6H_{12}O_6$. One molecule of glucose contains 6 atoms of carbon, 12 atoms of hydrogen and 6 atoms of oxygen.
- The molecular formula of water is H_2O. One molecule of water contains 2 atoms of hydrogen and 1 atom of oxygen.

Salient features of chemical formula:

- Compounds are formed when two or more elements combine chemically. Hence, compounds can also be represented using symbols.
- The notation used for representing any compound is called chemical formula of that compound.
- Each compound has a unique chemical formula.
- The chemical formula of any compound tells us about : The different elements which combine to form the compound and the number of atoms of each element present in a molecule of the compound
- For example, H2O is the chemical formula of water. This denotes that there are two atoms of hydrogen and one atom of oxygen present in one molecule of water.

Writing Chemical Formulae

To write the chemical formula of a compound, one should have prior knowledge of two things.

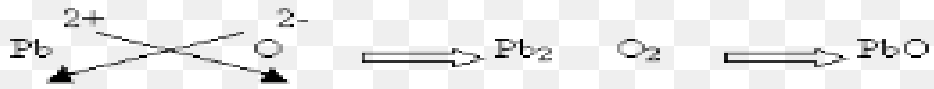
- The symbols of the constituent elements.
- The combining capacity of the atom of each element constituting the compound.

Example 1 – Sodium chloride (common salt)

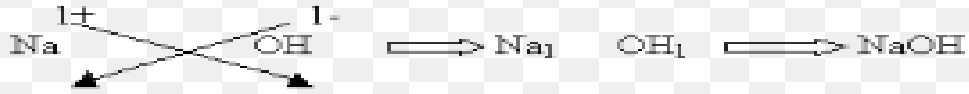
Example 2 – Sodium oxide

Example 3 – Aluminium oxide

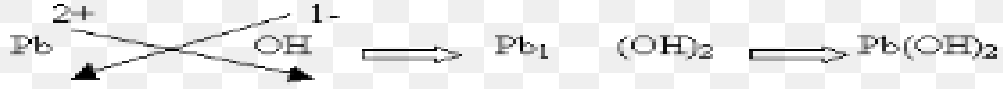
Example 4 – Lead oxide



Example 5 – Sodium hydroxide (caustic soda)



Example 6 – Lead hydroxide



Subscript number if same should not be written.

SOME COMMON COMPOUNDS-THEIR STATE, FORMULAE AND ELEMENTS

Compounds	*State*	*Formulae*	*Elements present*
1. Water	Liquid	H_2O	Hydrogen and oxygen
2. Common salt [Sodium chloride]	Solid	NaCl	Sodium and chlorine
3. Sand [Silicon oxide]	Solid	SiO_2	Silicon and oxygen
4. Hydrochloric acid	Liquid	HCl	Hydrogen and chlorine
5. Sodium hydroxide	Solid	NaOH	Sodium, oxygen and hydrogen
6. Marble and chalk [Calcium carbonate]	Solid	$CaCO_3$	Calcium, carbon and oxygen
7. Sulphuric acid	Liquid	H_2SO_4	Hydrogen, sulphur and oxygen
8. Nitric acid	Liquid	HNO_3	Hydrogen, nitrogen and oxygen
9. Calcium hydroxide	Solid	$Ca(OH)_2$	Calcium, oxygen and hydrogen
10. Glucose	Solid	$C_6H_{12}O_6$	Carbon, hydrogen and oxygen
11. Cane sugar	Solid	$C_{12}H_{22}O_{11}$	Carbon, hydrogen and oxygen
12. Vinegar [Acetic acid]	Liquid	CH_3COOH	Carbon, hydrogen and oxygen
13. Baking soda [Sodium bicarbonate]	Solid	$NaHCO_3$	Sodium, hydrogen, carbon and oxygen

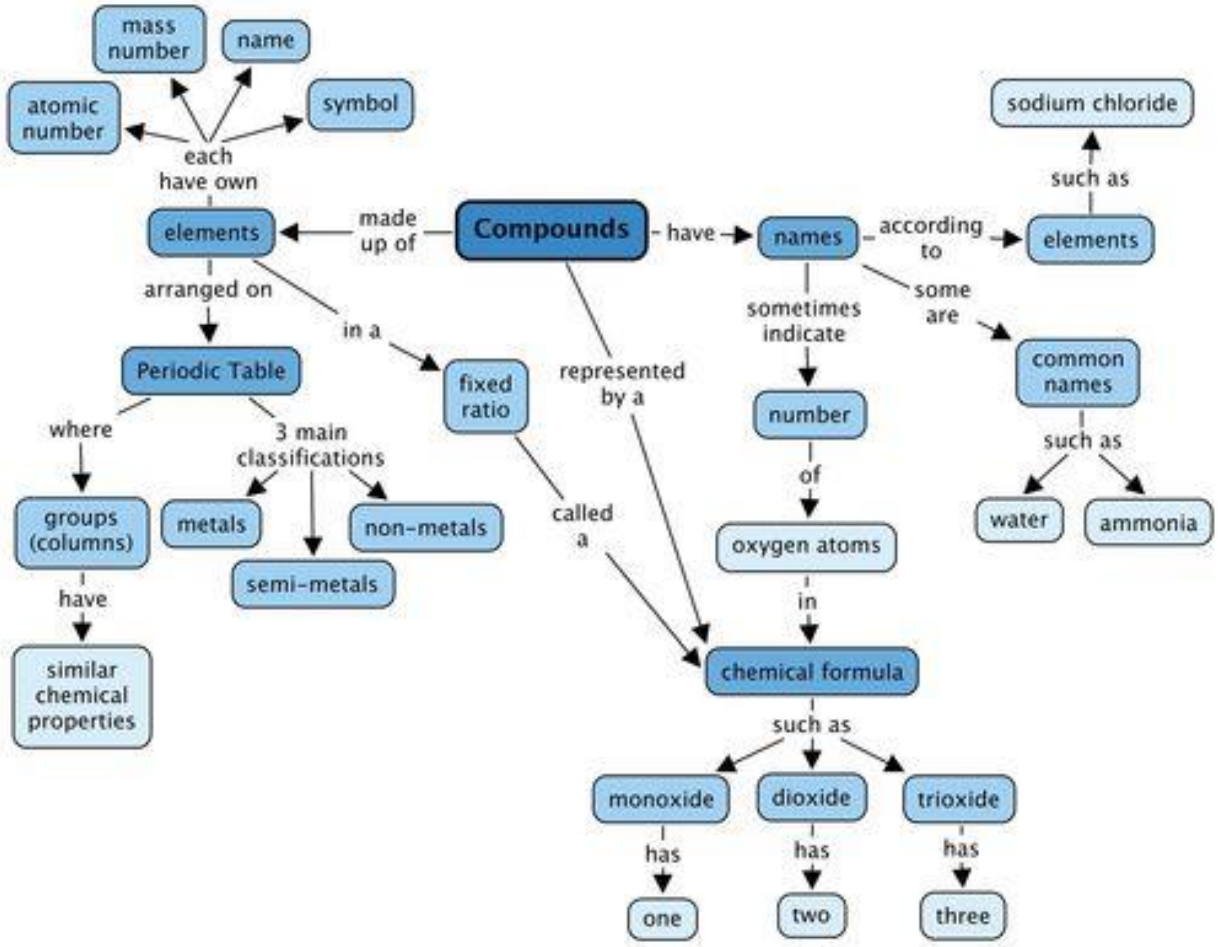
USES OF ELEMENTS AND COMPOUNDS ON THE BASIS OF THEIR PROPERTIES

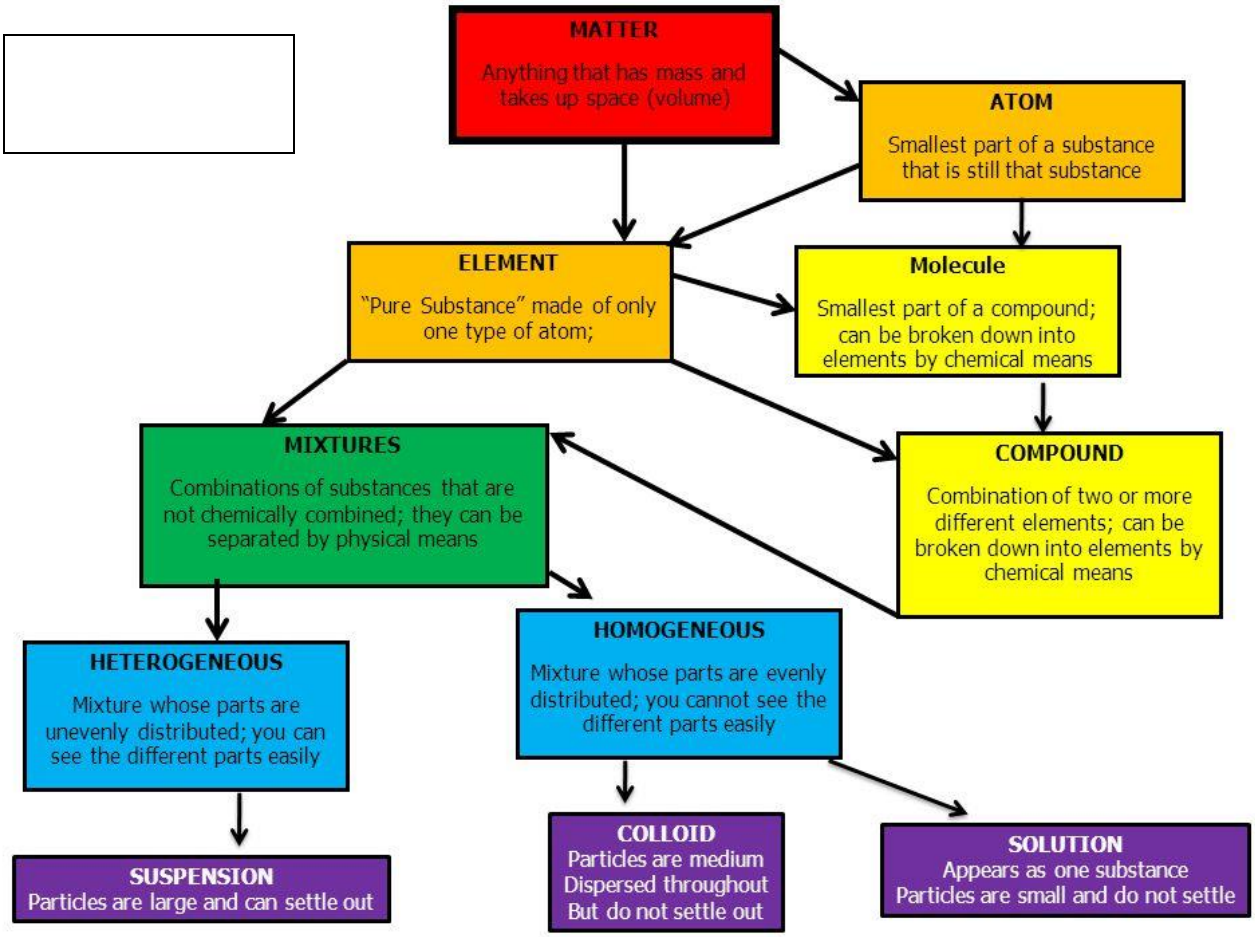
1. **GOLD, PLATINUM AND SILVER-**
   - Lusturous , shine and look very attractive
   - Do not tarnish
   - Used for making jewellery
2. **COPPER , ALUMINIUM-**
   - Good conductors of heat and electricity
   - Used to make utensils and electric wires
   - Copper mixed with zinc and tin produce brass and bronze which are stronger and durable

- Used in statues , utensils ,door knobs, handles, machine parts, electrical fittings

3. **IRON-**
   - Heavy tools and machines
4. **DIAMOND-**
   - Hardest naturally occurring substance
   - Used as a gem
   - Impure diamond used to cut glass
5. **GRAPHITE-**
   - Used in pencils and lubricants
6. **COAL, WOOD AND NATURAL GLASS-**
   - Used as fuels
7. **WATER-**
   - Universal solvent
   - Helps in transportation of substances in plants
   - Used to prepare medicinal and industrial importance
   - Used in drinking, washing, cooking etc in our day today life
8. **PLASTIC-**
   - Non conductor
   - Used in making bags, shoes, balls, bats, tyres , pipes, utensils
9. **SAND-**
   - Compound used to prepare glass
10. **ARGON & NEON**-
    - Filled in electric bulbs
    - Doesn't react with the tungsten filament of the bulb and prevents it from destruction

CONCEPT MAP


mass number
name
atomic number
symbol
each have own
elements
made up of
Compounds
have
names
according to
elements
sodium chloride
such as
arranged on
in a
Periodic Table
fixed ratio
represented by a
sometimes indicate
some are
common names
number
of
oxygen atoms
in
chemical formula
such as
where
3 main classifications
groups (columns)
metals
non-metals
semi-metals
called a
have
similar chemical properties
water
ammonia
monoxide
dioxide
trioxide
has
one
two
three


MATTER
Anything that has mass and takes up space (volume)
ATOM
Smallest part of a substance that is still that substance
ELEMENT
"Pure Substance" made of only one type of atom;
Molecule
Smallest part of a compound; can be broken down into elements by chemical means
MIXTURES
Combinations of substances that are not chemically combined; they can be separated by physical means
COMPOUND
Combination of two or more different elements; can be broken down into elements by chemical means
HETEROGENEOUS
Mixture whose parts are unevenly distributed; you can see the different parts easily
HOMOGENEOUS
Mixture whose parts are evenly distributed; you cannot see the different parts easily
SUSPENSION
Particles are large and can settle out
COLLOID
Particles are medium
Dispersed throughout
But do not settle out
SOLUTION
Appears as one substance
Particles are small and do not settle