

Atomic structure, Periodic Table Language of Chemistry

Fundamental of Chemistry

Atoms and Molecules

- **Matter, as a material**, may appear to be 'continuous' or 'whole' in its structure. In reality, it is not so.
- All matter is made up of **tiny units**. In all non-living matter these tiny units are **called 'atoms'**.
- They do not exist independently in nature. In Nature, at least two atoms combine to become a molecule. Example O₂, H₂.
- A **Molecule** is the **single smallest unit** of matter that can exist separately on its own.

4. Properties of Neutrons: (a) They are electrically neutral particles (b) Their mass is slightly higher than that of a proton.(c) They are highly penetrating , but less penetrating than cosmic rays.

1. A Neutron is defined as that fundamental particle that carries no charge, but its mass is equal to that of a proton. It is written as ${}^1_0\text{n}$.

3. An Electron is defined as that fundamental particle which carries one unit of negative charge , and has a mass equal to $1/1837^{\text{th}}$ of that of hydrogen atom.

1. An Element is a pure substance that contains only one kind of particles. These particles may be atoms or molecules.

Atoms are divisible and contain three parts

(a) Electron, that has a negative charge

(b) Proton that has positive energy charge

(c) Neutron that has no charge. Atoms of gold , silver, and copper can exist freely, while atoms of oxygen , hydrogen, nitrogen exist only as pairs : H_2 . O_2 , N_2 .

An atom is the smallest particle of an Element, which may or may not exist independently under laboratory conditions

³. A Proton is defined as that fundamental particle that carries one unit of positive charge, and has a mass nearly equal to that of a hydrogen atom.

Properties of protons:

(a) proton resides in the nucleus at the centre of an atom.

(b) its mass is the same as that of hydrogen at = 1 amu = 1837 times the mass of an electron.

(c) it possesses a unit of positive charge of the value of 1.602×10^{-19} coulombs

2. Properties of Electrons:

(a) Electrons from all sources are alike and have identical mass.

(b) They exist in all Atoms.

(c) An electron carries a unit of negative charge of magnitude -1.602×10^{-19} coulombs.

(d) The mass of an electron is $1/1837$ the mass of a hydrogen atom.

(e) The electron is extremely small and its radius is less than 1×10^{-15}

Atomic number and Isotopes

1. The number of protons present in the nucleus of an atom, is called the Atomic number and is denoted by Z .

2. As the number of Protons and Electrons in a neutral atom is equal, Z also indicates the number of electrons.

3. Mass number is the sum of the number of protons and neutrons in the nucleus of an atom. It is denoted by A .

4. Mass number of a hydrogen atom is equal to the atomic number, because Hydrogen is the only atom that has no Neutrons.

5. Valence Shell is the outermost shell. It can have a maximum of 8 electrons. During formation of a molecule, an atom gains, or loses or shares electrons till it reaches 8 electrons in its valence shell to stabilize. This is the Octet Rule.

6. Isotopes are atoms of the same element having the same atomic number and chemical properties but different mass number. They exhibit the same chemical properties but their physical properties vary and depend on their mass. They occupy the same position in the periodic table, in order of their increasing atomic numbers.

The Periodic Table

What ? A periodic table is a classification arrangement of elements, with similar and dissimilar properties

- Dobereiner's Law of triads
- Newland Law of Octaves
- Mendeleev's classification
- Modern Periodic Law and Modern Periodic Table.

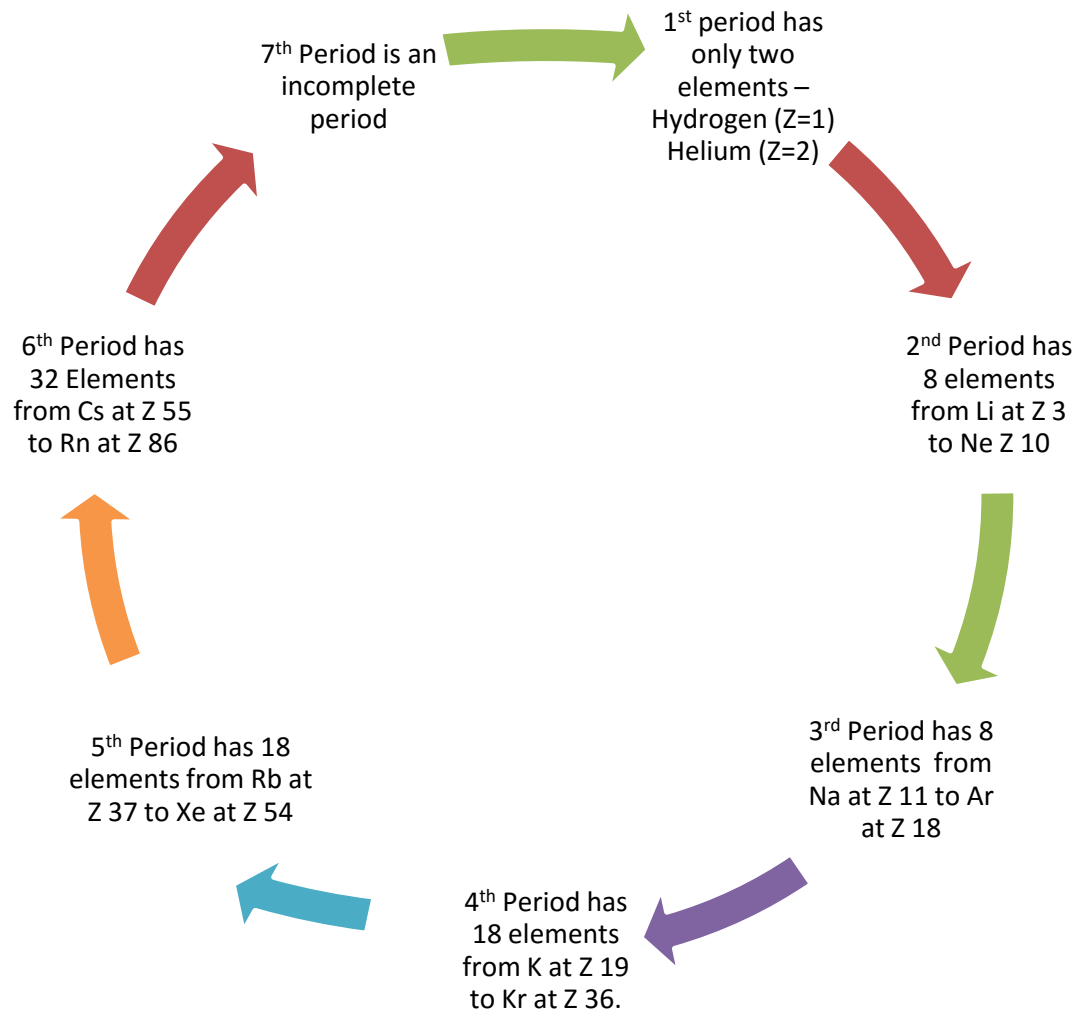
The first three attempts were discarded. Today, Modern Periodic Law states that:

- 1) The physical and chemical properties of elements are the periodic functions of their atomic numbers.
- 2) The cause of periodicity in properties is the repetition of similar outer electronic configuration at certain regular intervals.
- 3) Atomic number is the fundamental characteristic of an element. No two elements can have the same atomic number

Salient features of Modern periodic table

- 1) The vertical columns are called groups, and the horizontal, rows are called 'periods'
- 2) Elements of group 1, 2, and 13 to 17, are known as main group elements, or normal elements, or representative elements. Their outermost shell is incomplete.
- 3) Elements of groups 3 to 12 are known as transition elements.

Salient features of the Periodic Table: (a) Grouping of Elements; (b) Electronic configuration is the basis as Atomic number is the fundamental characteristic of an element and no two elements have the same electronic number. (c) Seven Periods as indicated below



Types of Elements

1. **Normal or Representative Elements:** Alkali metals, Alkali earth metals, Boron family, Carbon, Nitrogen, Oxygen family and Halogen (Salt producing)

2. **Transition Elements** in the Middle Part of the Table from Group 3 to 12

3. **Inner Transition Elements (14)**

4. **Noble Gases** or Inert Gases are zero group elements, having 8 electrons in their outermost shell. They do not react.

3.1) Lanthanide series: from Nos. 58 to 71

3.2) Actinide series from No. 90 to No. 103.

Uses of Periodic Table

1. Classification of Elements for easier reference

6. Nature of Oxides: In each Group, the basic character of oxides increases on going down the column, because the metallic or electropositive character of elements increases on going down the Table.

Other uses of the Periodic Table include the following:

- 7. Valency of elements in a Period.
- 8. Reactivity of elements
- 9. Nature of chemical bonding

5. Metallic and non-metallic character of elements, is characterised by the ease with which electrons are gained or lost. This is called 'Reactivity' of metals. Greater ease of loss of electron means higher reactivity.

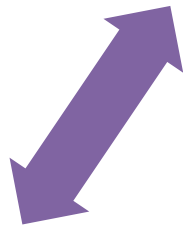
Metallic character increases down a group, so that at the bottom or the base, every Group has a metal. (except Nobel gases)

2. Valency = number of electrons present in its valence shell.

- 3. Groups as per similar properties of the elements.
- 4. Periods as per atomic size. The atomic size increases down the Group (column) and decreases across a Period (row)

Valence of Elements

In the Periodic Table, the acidic character of oxides increases from left to right in a Period.



If a metal forms more than one oxide, the higher valent oxide is more acidic.

Oxides of non-metals (H_2O), CO , N_2O and NO are neutral oxides.



Valence with respect to hydrogen increases from 1 to 4 and then decreases to 1. The valence with respect to Oxygen increases from sodium to chlorine. The valence of noble gases is zero.

Language of Chemistry

Symbols for 92 natural elements based on Latin names- Dalton and Berzelius.

- Symbol is the short form or abbreviation used for name of an Element.

Molecular Formula represents the composition of a molecule of the substance in terms of symbols of elements present in the molecule.

- A formula also indicates the fixed proportion by weight in which atoms combine to form that particular compound.

A Radical is an atom or a group of atoms that behaves like a positive ion or a negative ion.

- Radicals have their own combining power or valence and chemical formulae.

Valence is the combining capacity of an element. It is indicated by the number of hydrogen or chlorine atoms, that combine with or are displaced from a compound, by one atom of an element.

- Valence of both, chlorine and hydrogen is 1. Therefore, it is called monovalent. Other elements with 2, 3, 4 ... Valence are called divalent, trivalent, tetravalent. In cases where atoms gain or lose electrons during flow of charge, the valence is indicated by number of electrons.

Chemical Equations

1. Chemical Equation is a **symbolic representation** of reactants and products in a reaction.
2. Rules for writing chemical equation state that **reactants** are written on the **left side** of the arrow. **Products** are written on the **right side**. **A single arrow in between** the two indicates the direction in which the reaction proceeds. **Double arrows** in opposite direction, indicate that the products formed can recombine to form the reactants. This is **reversible reaction**.
3. Atoms **cannot be created or destroyed** during a reaction (with the exception of nuclear reactions in the Sun).
4. **All the atoms must be accounted for on both sides** of the arrow. Balancing a chemical equation refers to **establishing the mathematical relationship** between the **quantity** of reactants and **products**.