

CLASS X THE PERIODIC PROPERTIES OF ATOMS

PERIODIC PROPERTIES

in a period the number of valence electrons and the nuclear charge increases from left to right. It increases the force of attraction between them. In a group the number of filled shells increases and valence electrons are present in higher shells. This decreases the force of attraction between them and the nucleus of the atom. These changes affect various properties of elements and they show gradual variation in a group and in a period and they repeat themselves after a certain interval of atomic number. Such properties are called **periodic properties**.

Atomic radius

What happens to atomic radii in a group and period and why?

Atomic radius is the distance between the centre of atom and the outermost shell. In a period, atomic radius generally decreases from left to right.

2nd Period	Li	Be	B	C	N	O	F
	155	112	98	91	92	73	72
3rd Period	Na	Mg	Al	Si	P	S	Cl
	190	160	143	132	128	127	99

In a period there is a gradual increase in the nuclear charge. Since valence electrons are added in the same shell, they are more and more strongly attracted towards nucleus. This gradually decreases atomic radii.

Atomic radii increase in a group from top to bottom.

Element	Atomic radius	Element	Atomic radius
Li	155	F	72
Na	190	Cl	99
K	235	Br	114
Rb	248	I	133

As we go down a group the number of shells increases and valence electrons are present in higher shell and the distance of valence electrons from nucleus increases.

Also, the number of filled shells between valence electrons and nucleus increases

Both the factors decrease the force of attraction between nucleus and valence electron.

Therefore, atomic size increases on moving down a group.

Ionization energy

Negatively charged electrons in an atom are attracted by the positively charged nucleus. For removing an electron this attractive force must be overcome by spending some energy.

The minimum amount of energy required to remove an electron from a gaseous atom in its ground state to form a gaseous ion is called **ionization energy**.

It is measured in unit of kJ mol^{-1} .

It is a measure of the force of attraction between the nucleus and the outermost electron.

Stronger the force of attraction, greater is the value of ionization energy. It corresponds to the following process:

If only one electron is removed, the ionization energy is known as the **first ionization energy**.

If second electron is removed the ionization energy is called the **second ionization energy**.

Ionization energy decreases in a group from top to bottom

This is because the force of attraction between valence electrons and nucleus decreases in a group from top to bottom.

The ionization energy increases in a period from left to right.

This is because the force of attraction between valence electron and nucleus increases in a period from left to right.

Electron affinity:

The tendency of element to gain an additional electron. This ability is measured by **electron affinity**. **It is the energy change when an electron is accepted by an atom in the gaseous state.**

Electron affinity is assigned a positive value when energy is released during the process.

Greater the value of electron affinity, more energy is released during the process and greater is the tendency of the atom to gain electron.

In a group, the electron affinity decreases on moving from top to bottom as less and less amount of energy is released.

In a period, the electron affinity increases from left to right, as more and more amount of energy is released

Electro negativity

Electro negativity is *relative tendency of a bonded atom to attract the bond-electrons towards it self. It just compares the tendency of various elements to attract the bond-electrons towards themselves.*

Electro negativity decreases in a group from top to bottom.

Electro negativity increases in a period from left to right.

Electro negativity is related to ionization energy. Elements with low ionization energies have low electronegativity because their nuclei do not exert a strong attractive force on electrons.

Elements with high ionization energies have high electronegativity due to the strong pull exerted on electrons by the nucleus.

Oxides and its nature: Metals react with oxygen to form oxides by loss of electrons. These oxides on dissolution in water form bases.

Reactivity of elements: *Down the group reactivity of metals increases* as the tendency to lose electrons increases due to increased atomic size.

Reactivity of non- metals decreases down the group because of the increased atomic size and the tendency to gain electrons decreases.

On moving across the period, the reactivity first increases due to the decrease in the metallic character and increase in non metallic character.

Metallic and Non-metallic Properties

The metallic character of an element is expressed in terms of its electron releasing tendency while non-metallic character in term of electron accepting tendency.

In group metallic character of the element increases down the group due to increasing atomic size or because outermost electrons are farther away from the nucleus .So they can be easily lost.

In periods metallic character of the element decreases along a period due to decrease in atomic size along a period or outermost electrons are closer to nucleus. So they can not be easily lost.

Periodic Properties of the Elements –X Chemistry BY JSUNIL

Periodic Properties Check your understanding

- 1) What is the atomic radius of an atom?
- 2) What is the trend in atomic radius across a period?
- 3) The trend in atomic radius across a period is caused by _____.

- 4) What generally happens to atomic radii as one goes down a group or a family?
- 5) Write the equation for the ionization of an atom.
- 6) What is an ion?
- 7) What is ionization energy?
- 8) Which group or family has the lowest ionization energy?
- 9) Group 18 or 8A, the noble gases, have the highest ionization energy (True or False).
- 10) Elements with a high ionization energy lose electrons easily (True or False).
- 11) The increase in ionization energy across a period is caused by _____.
- 12) Why does ionization energy generally decrease going down a group or family?
- 13) What is meant by electron shielding?
- 14) What is the second ionization energy of an atom?
- 15) What is electron affinity?
- 16) Write the equation for electron affinity for an exothermic process.
- 17) Write the equation for electron affinity for an endothermic process.
- 18) Which group or family gains electrons most easily?
- 19) What is a cat ion?
- 20) What is an anion?

Solutions

- 1) One-half the distance between the nuclei of identical atoms combined in an element or a compound.
- 2) There is a gradual decrease as you go from an alkali metal to a noble gas.
- 3) additional electrons in the same principal energy level being more strongly attracted by the more positive nucleus.
- 4) Atomic radii of main group elements generally increase.
- 5) $X + \text{energy} \rightarrow X + e^-$
- 6) An atom or a group of atoms (a polyatomic ion) having a positive or negative charge.
- 7) The energy required to remove one electron from an atom.
- 8) Group or Family I (alkali metals).
- 9) True
- 10) False
- 11) An increase in nuclear charge which strongly attracts electrons in the same energy level.
- 12) Electrons are removed from higher principal energy levels meaning they are further from the nucleus. The force of attraction between the electron and the nucleus has decreased.
- 13) Electron shielding results from a greater number of electrons found between the positive nucleus and the valence electrons which results in a smaller attraction.
- 14) The energy required to remove a second electron from an atom.
- 15) The energy change that occurs when an electron is acquired by a neutral atom.
- 16) $X + e^- \rightarrow X^- + \text{energy}$
- 17) $X + e^- + \text{energy} \rightarrow X^-$
- 18) The halogens (Group or Family 17)
- 19) An atom that has more protons than electrons resulting in a positive ion.
- 20) An atom that has more electrons than protons resulting in a negative ion.