CHAPTER NAME : CLASSIFICATION OF ELEMENTS AND PERIODICITY IN PROPERTIES

MODULE NO : 03/03(PERIODICITY I PROPERTIES)

SUBJECT : CHEMISTRY

CLASS : XI

LEARNING OBJECTIVES

Other periodic trends in physical properties will continue…,

3) Electron Gain Enthalpy(Δ_{eg}H/Electron Affinity(EA)
4) Electronegativity(EN)
5) Periodic trends in chemical properties
   ->Periodicity of Valence or Oxidation States
   ->Periodic Trends and Chemical Reactivity
   ->Anomalous Properties of Second Period Elements

1.Electron Gain Enthalpy $\Delta_{eg}H$ /Electron Affinity

It is an atomic property which gives us an idea of the tendency of the element to accept the electron to form an anion

The amount of energy released when an electron is added to a neutral isolated gaseous atom of an element is called Electron Gain Enthalpy(Electron Affinity)

$X(g) + e^- \rightarrow X^-(g) + EA$

$X(g) + e^- \rightarrow X^-(g)$ $\Delta_{eg}H$=-ve(Exothermic process)

II Electron gain enthalpy: When an electron is added to uni-negative ion,energy is absorbed to overcome the repulsive forces. This energy is called second electron affinity

$X^-(g) + e^- \rightarrow X(g)^{2-} - EA$

$X^-(g) + e^- \rightarrow X(g)^{2-}$ $\Delta_{eg}H$=+ve(Endothermic process)

Electron Gain enthalpy is measured in eV/atom, Kcal/mol,KJ/mol

In groups: Electron gain enthalpy decrease from top to bottom as the atomic size increases

In periods: From left to right side Electron gain enthalpy increases due to decrease in size of atoms and increase in the nuclear charge

Zero group elements have completely filled orbitals and hence the addition of any extra electron from out side to these atoms is not possible. Therefore they have practical zero Electron gain enthalpy

Chlorine has highest Electron Gain Enthalpy (i.e. -349KJ/mol)

Electron Gain Enthalpy (ΔegH)

- Depending on the element, the process of adding an electron to the atom can be either endothermic or exothermic.
- For many elements energy is released when an electron is added to the atom and the electron gain enthalpy is negative.

Factors Affecting E G E ($\Delta_{eg}H$)

A. Noble gases have practically zero or +ve EGEs. This is because they have no tendency to gain an additional electron as they already have the stable ns^2np^6 configuration

B. Halogens have high electron affinities. This is due to their strong tendency to gain an additional electron to change into the stable ns^2np^6 configuration.

PERIODIC TREND OF EGE ($\Delta_{eg}H$)

IN A PERIOD-

The EGE increases i.e. become more negative as we move across a period because the atomic size decreases and hence the force of attraction exerted by the nucleus on the electrons increases. Consequently, the atom has a greater tendency to attract additional electron i.e., its electron affinity increases

IN A GROUP-

The EGE decreases (-)vely because the atomic size increases and therefore, the effective nuclear attraction decreases and thus electron affinity decreases

First Electron Affinities

1							18
H −72.8	2	13	14	15	16	17	He --
Li −59.6	Be --	B −26.7	C −153.9	N −7	O −141.0	F −328.0	Ne --
Na −52.9	Mg --	Al −42.5	Si −133.6	P −72	S −200.4	Cl −349.0	Ar --
K −48.4	Ca --	Ga −28.9	Ge −119.0	As −78	Se −195.0	Br −324.6	Kr --
Rb −46.9	Sr --	In −28.9	Sn −107.3	Sb −103.2	Te −190.2	I −295.2	Xe --
Cs −45.5	Ba --	Tl −19.2	Pb −35.1	Bi −91.2	Po −186	At −270	Rn --

Electron Gain Enthalpy ($\Delta_{eg}H$)

- **Explain why –**

(a). electron gain enthalpy of O is less than that of the S.

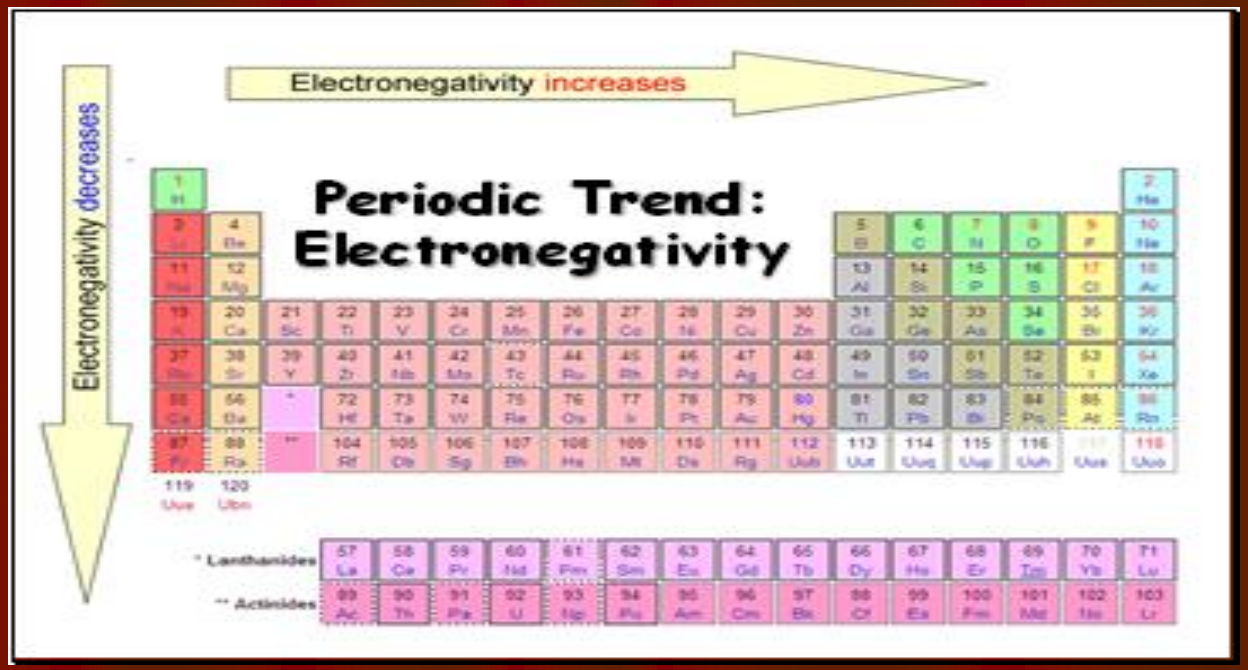
(b). electron gain enthalpy of F is less than that of the Cl.

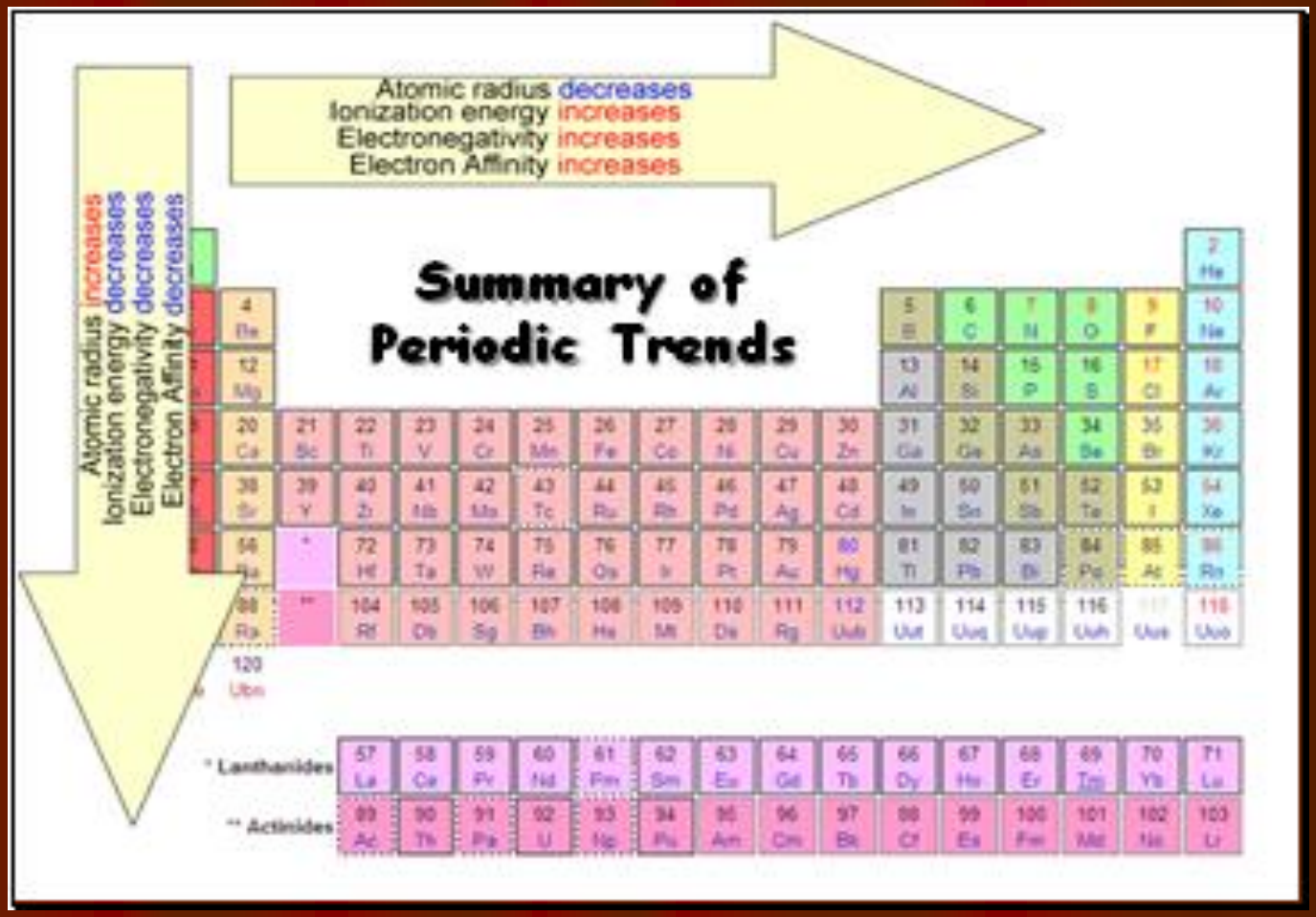
- **Ans:- The electron gain enthalpy of O or F is less than that of the succeeding element. This is because when an electron is added to O or F, the added electron goes to the smaller *n = 2* quantum level and suffers significant repulsion from the other electrons present in this level. For the *n = 3 quantum level (S or Cl), the added* electron occupies a larger region of space and the electron-electron repulsion is much less.**

- 4) Electronegativity(EN): (≅Non-metallic Nature)
- The tendency of an atom to attract the shared electron pair towards itself in a molecule is called Electronegativity
- It is property of an atom in a molecule
- Electronegativity is a relative property and has no units.
- Different scales are used to calculate Electronegativity
- The reference element taken by pauling for the determination of Electronegativity values of other element is Fluorine
- Highest Electronegative value for Fluorine(F)(4.0)
- Electronegativity decreases in group as atomic size increases
- Electronegativity increases in period as atomic size decreases(or Effective nuclear charge increases)
- Noble gas elements have zero EN due to octet configuration

As electronegativity increases, non-metallic character increases

- EN values are used to know the nature of chemical bond
- If EN difference is less than 1.7, the bond is covalent in nature
- If EN difference is equals to 1.7 the bond is 50% ionic in nature
- If EN difference is more than 1.7, the bond is ionic in nature




Atomic radius decreases
Ionization energy increases
Electronegativity increases
Electron Affinity increases
Atomic radius increases
Ionization energy decreases
Electronegativity decreases
Electron Affinity decreases
Summary of Periodic Trends
* Lanthanides
** Actinides

5)Periodic trends in chemical properties

->Periodicity of Valence or Oxidation States:

- Valency(valence) is defined as the combining capacity of an element.
- The valency of an element is not always constant
- Exhibition of more than one valency by an element is known as variable valency
- Valency remains constant in group as number of valence electrons are fixed in that group
- Ex. Valency of Group 1 elements is 1(as number of valence electrons is 1)
- Lithium-2,1, Sodium-2,8,1,Potassium-2,8,18,1

Valency varies in period

Based on old concept valency of an element is the number of H-atoms (or) double the number of oxygen atoms that can combine with one atom of that element

Valency with respect to hydrogen across the period increases up to 4 and then decreases to 1							
Ex. Period 3 elements :	Na	Mg	Al	Si	P	S	Cl
Hydrides :	NaH	MgH_2	AlH_3	SiH_4	PH_3	H_2S	HCl
Valency :	1	2	3	4	3	2	1

Valency with respect to oxygen increases from 1 to 7 across the period							
Ex. Period 3 elements :	Na	Mg	Al	Si	P	S	Cl
Oxides :	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	SO_3	Cl_2O_7
Valency :	1	2	3	4	5	6	7

Based on new concept of valency for groups (1-2,13,14 and 15-18)is equal to either number of valence shell e^- or 8 minus number of valence e^-

Ex. Period 2 elements :	Li	Be	B	C	N	O	F
Valence e^- :	1(2,1)	2(2,2)	3(2,3)	4(2,4)	5(2,5)	6(2,6)	7(2,7)
Valency :	1	2	3	4	3	2	1

Highest valency ever known is 8(OsO_4,XeO_4)

Most of the d and f block elements show variable valencies

Oxidation state

- The possible charge with which an atom appears in a compound is called its oxidation state

  OR

  A number assigned to an element in chemical combination which represents the number of electrons lost (or gained, if the number is negative), by an atom of that element in the compound
- Ex. In HCl as chlorine is more elctronegative than hydrogen oxidation state of Cl is -1 where as for Hydrogen is +1
- Oxidation state may be positive or negative or zero or fraction where as Valency is whole number only

-> Periodic Trends and Chemical Reactivity

- Electropositive Nature: (≅Metallic nature) The tendency of an element to loose an electron is called electropositivity.
- As electropositivity increases, metallic character increases
- Electropositivity increases down the group
- Electropositivity decreases across the period
- It is converse of electronegativity

Most electropositive element is Cs in periodic table

Acidic and Basic Nature of Oxides:

- Based on the nature, oxides are classified into 4 types
- Basic oxides or metal oxides: Generally metals form basic oxides, Na_2O,BaO,MgO….
- Acidic oxides or Non-metal oxides: Generally non-metals form acidic oxides,SO_2,CO_2,NO_2….
- Amphoteric oxides: Oxides of metalloids and some metallic oxides are amphoteric(they form acids and basesin water), As_2O_3,GeO_2,ZnO,Al_2O_3….
- Neutral oxides: Some non-metallic oxides are neutral, they don't form acids or bases in water CO,N_2O,NO…
- In groups basic nature of oxides increases(or acidic nature of oxides decreases)
- In periods basic nature of oxides decreases(or acidic nature of oxides increases)

Diagonal Relationship:

In the periodic table the first element of a group has similar properties with the second element of the next group. This is called diagonal relationship

Group-↓	1	2	13	14
2nd PERIOD:→	Li	Be	B	C
3rd PERIOD: →	Na	Mg	Al	Si

The diagonal relationship is due to similar sizes of atoms or ions and same electronegativities of the participating elements.

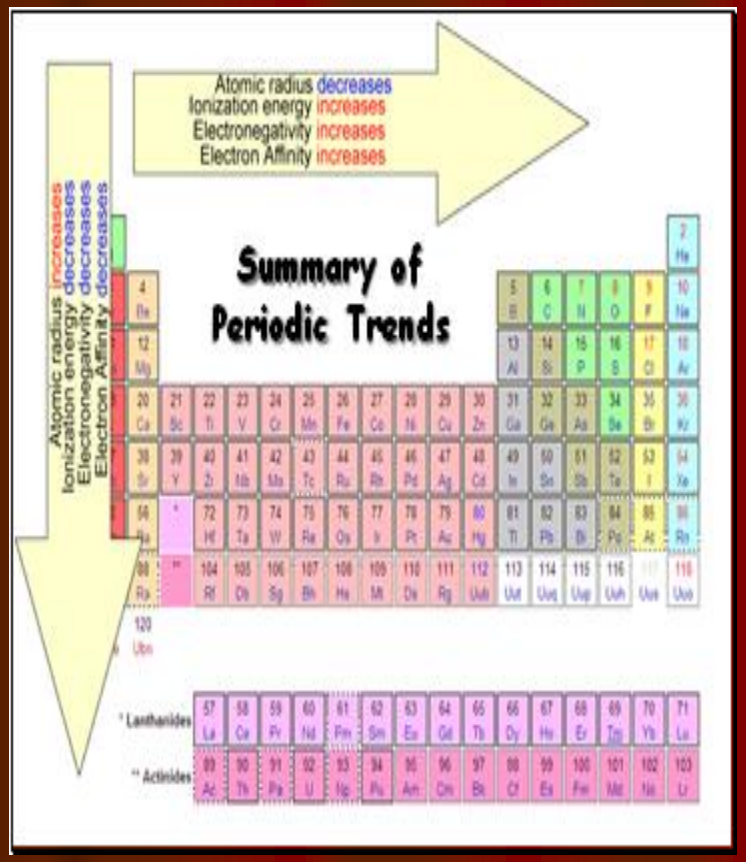
This is relation won't be continue after 14th group

The elements present under diagonal relationship have very close properties

Ex. BeO amphoteric, Al_2O_3 amphoteric

->Anomalous Properties of Second Period Elements

- The first element of each group in ‘s’ and ‘p’ block except noble gases differ in many aspects from the other members of their respective group due to the following reasons:-
- Small size
- Large (charge/radius) ratio
- High electronegativity
- Absence of vacant orbitals
- Ex. Lithium forms covalent compounds rest of the group members(Na,K,Rb…..) form ionic compounds.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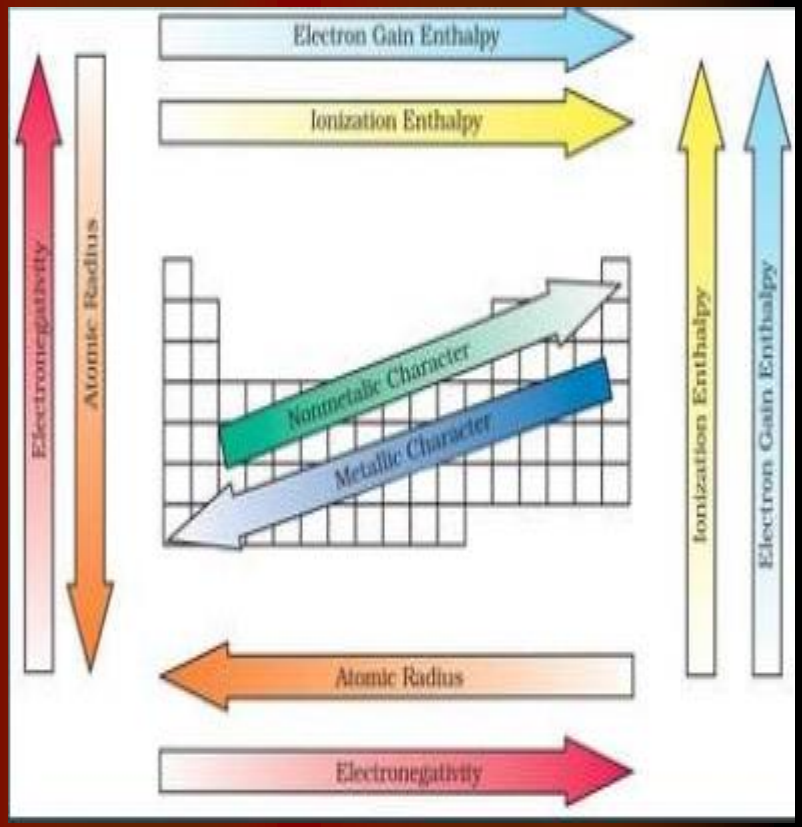
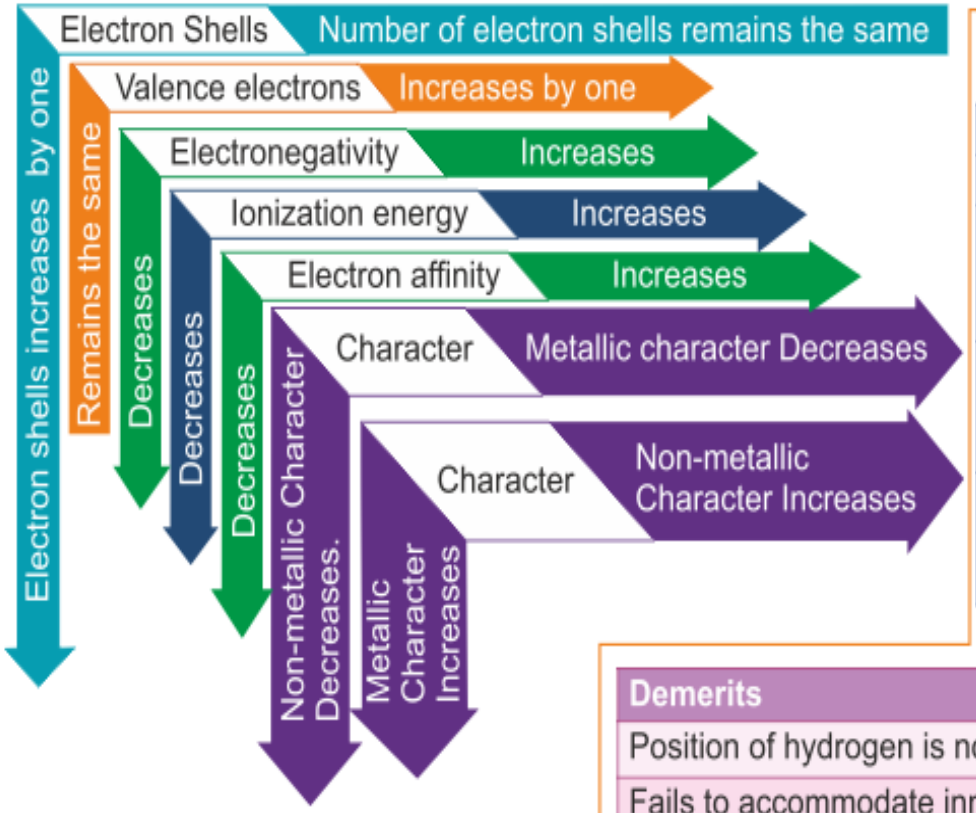

Electron Gain Enthalpy
Ionization Enthalpy
Electronegativity
Atomic Radius
Nonmetallic Character
Metallic Character
Ionization Enthalpy
Electron Gain Enthalpy
Atomic Radius
Electronegativity

Periodic Properties



Merits and Demerit of Periodic Table

Merits
Based on atomic number.
Position of elements are related to electronic configuration.
Periodic properties shows gradual variation at regular intervals.
Its easier to remember, understand and reproduce.

Demerits
Position of hydrogen is not satisfactory.
Fails to accommodate inner transition elements.
Few elements are not arranged according to their electronic configuration.


Thank you