

The basic object of classification is to arrange the facts regarding elements and their compounds in such a way so that we may have greatest control over their characteristics with least possible effort. The repetition of similar physical and chemical properties of elements after regular intervals is known as periodicity in properties.

Periodicity in Physical Properties

Ionic Radius

- Across a period : The ionic radii of ions having same charge decreases as atomic number increases.
- Down a group : Increases
 $\text{Li}^+ < \text{Na}^+ < \text{K}^+ < \text{Rb}^+ < \text{Cs}^+$ (Cations)
 $\text{F}^- < \text{Cl}^- < \text{Br}^- < \text{I}^-$ (Anions)
- Cationic radius < Atomic radius < Anionic radius (For isoelectronic species)
- Z/e ratio increases, size decreases and vice-versa.

Atomic Volume

- Across a period : First decreases and then increases.
 Li, Be, B, C, N, O, F, Ne
 (cc/mol) 13 5 5 5 14 11 15 17
- Down a group : Increases
 Li, Na, K
 (cc/mol) 13 24 46

Density

- Across a period : First increases and then decreases.
 Na, Mg, Al, Si, P, S
 (g/cm³) 1.0 1.7 2.7 2.3 1.8 2.1
- Down a group : Decreases
 Be(1.8), Mg(1.7)
- Highest density solid: Os (22.6)
- Highest density liquid: Hg (13.6)

Electron Gain Enthalpy

- Across a period : More negative
 Li, Be, B, C, N, O, F
 (kJ/mol) -60 +66 -83 -122 +31 -141 -328
- Down a group : Less negative
 H, Li, Na, K, Rb, Cs
 (kJ/mol) -73 -60 -53 -48 -47 -46

Atomic Radius

- Across a period : Decreases
 $\text{Atomic radius} \propto 1/Z_{\text{eff}}$
 $\text{Li} > \text{Be} > \text{B} > \text{C} > \text{N} > \text{O} > \text{F}$
- Down a group : Increases
 $\text{H} < \text{Li} < \text{Na} < \text{K} < \text{Rb} < \text{Cs}$
- van der Waals' radius > Metallic radius > Covalent radius

Electronegativity

- Across a period : Increases
 $\text{Li} < \text{Be} < \text{B} < \text{C} < \text{N} < \text{O} < \text{F}$
- Down a group : Decreases
 $\text{H} > \text{Li} > \text{Na} > \text{K} = \text{Rb} > \text{Cs}$
- F is most electronegative element.

Ionic Character

- Across a period : First decreases and then increases.
- Down a group : Increases

Metallic Character

- Across a period : Decreases
- Down a group : Increases

Ionisation Enthalpy

- Across a period : Increases
 $\text{Li} < \text{Be} > \text{B} < \text{C} < \text{N} > \text{O} < \text{F}$
- Down a group : Decreases
 $\text{H} > \text{Li} > \text{Na} > \text{K} > \text{Rb} > \text{Cs}$

Melting and Boiling Points

- Across a period : M.pt. and B.pt. first increase and then decrease.
 Element : Na Mg Al Si P S
 M.pt. (K): 370.8 924 933 1693 317 392
 B.pt. (K) : 1165 1396 2075 2815 557 717.6
- Down a group : They do show regular gradation but pattern of variation is different in different groups.
 Element : Li Na K Rb Cs
 M.pt. (K): 454 370.8 335 312 302
 B.pt. (K) : 1609 1165 1063 973 943

Periodicity in Chemical Properties

Valency

- Across a period : Increases
 $\text{NaH} < \text{MgH}_2 < \text{AlH}_3 < \text{SiH}_4$
- Down a group : Same

Reducing Nature

- Across a period : Decreases
- Down a group : Increases

Oxidising Nature

- Across a period : Increases
- Down a group : Decreases

Strength of Oxyacids

- Across a period : Increases
 $\text{H}_3\text{BO}_3 < \text{H}_2\text{CO}_3 < \text{HNO}_3$
- Down a group : Decreases
 $\text{HNO}_3 > \text{H}_3\text{PO}_4 > \text{H}_3\text{AsO}_4$

Acidity of Oxides

- Across a period : Increases
 $\text{Na}_2\text{O} < \text{MgO} < \text{Al}_2\text{O}_3 < \text{SiO}_2 < \text{P}_2\text{O}_5 < \text{SO}_3 < \text{Cl}_2\text{O}_7$
- Down a group : Decreases
 $\text{N}_2\text{O}_3 > \text{P}_2\text{O}_3$

Acidity of Hydrides

- Across a period : Increases
 $\text{CH}_4 < \text{NH}_3 < \text{H}_2\text{O} < \text{HF}$
- Down a group : Increases
 $\text{HF} < \text{HCl} < \text{HBr} < \text{HI}$