CONCEPT MAP

# PERIODICITY IN PROPERTIES

MASTERJEE CLASSES

Class XI

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

$Li^+ < Na^+ < K^+ < Rb^+ < Cs^+$ (Cations)

$F^- < Cl^- < Br^- < I^-$ (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 |
|---|---|---|---|---|---|---|
| ($g/cm^3$) | 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

Atomic radius $\propto 1/Z_{eff}$

Li > Be > B > C > N > O > F

- Down a group : Increases

H < Li < Na < K < Rb < Cs

- van der Waals' radius > Metallic radius > Covalent radius

### Electronegativity

- Across a period : Increases

Li < Be < B < C < N < O < F

- Down a group : Decreases

H > Li > Na > K = Rb > 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

Li < Be > B < C < N > O < F

- Down a group : Decreases

H > Li > Na > K > Rb > 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

$NaH < MgH_2 < AlH_3 < SiH_4$

- 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

$H_3BO_3 < H_2CO_3 < HNO_3$

- Down a group : Decreases

$HNO_3 > H_3PO_4 > H_3AsO_4$

### Acidity of Oxides

- Across a period : Increases

$Na_2O < MgO < Al_2O_3 < SiO_2 < P_2O_5 < SO_3 < Cl_2O_7$

- Down a group : Decreases

$N_2O_3 > P_2O_3$

### Acidity of Hydrides

- Across a period : Increases

$CH_4 < NH_3 < H_2O < HF$

- Down a group : Increases

HF < HCl < HBr < HI