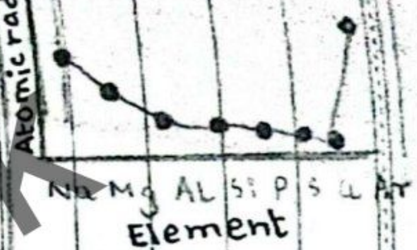
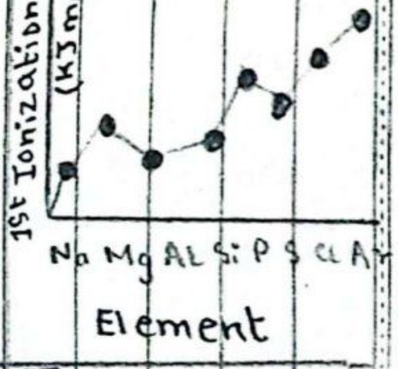
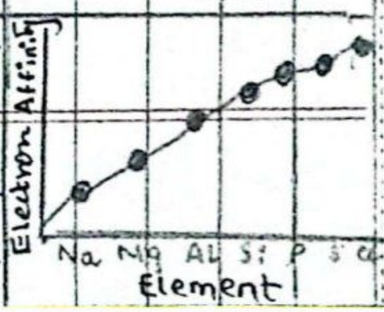
Properties	Defination	Group	Period	Example	Exception	Graph
Atomic / Size / Ionic radii	"Average distance between the nucleus and the outermost orbit of an atom/ion"	Increases —REASON— No. of shells (↑) E.g Li < Na	Decreases Nuclear charge (↑) E.g Al < Mg Anion: Cl⁻ = 0.99 A°, Cl = 1.65 A°	 Cation: Na: 1.54 A° Na⁺ 0.95 A°	Cl < Ar (All noble gases have greater Atomic radii than their preceding halogen)	
Shielding / Screening Effect	"Reduction in force of attraction between nucleus and valence e⁻ by e⁻ present in inner sub-shells."	Increases —REASON— No. of shells (↑)	Remains constant No. of shells (constant)			
Ionization Energy / Potential	"Minimum amount of energy required to remove 1 mole of the most loose held electrons from 1 mole of isolated gaseous atoms to produce 1 mole of uni-positive gaseous ion." → $X_{(g)} \rightarrow X^{+}_{(g)} + 1e^{-}$	Decreases (easy to remove e⁻) —REASON— Atomic size (↑) Nuclear charge (↓) Shielding Effect (↑)	Increases (dif to remove the e⁻) Atomic size (↓) Nuclear charge (↑) ~~Shielding Effect (↓)~~	$Na_{(g)} \rightarrow Na^{+}_{(g)} + e^{-}$ (I.E = 496 kJ/mol)	Mg > Al ($3s^2$ stable) ($3p^1$ less stable) P > S (Full-filled > Half-filled > Partially-filled)	
Electron Affinity	"Amount of energy released / absorbed when an e⁻ is added to a gaseous atoms to form a negative ion"	Decreases (Difficult to add e⁻) —REASON— Nuclear charge (↓) Atomic size (↑) Shielding Effect (↑)	Increases (Easy to add e⁻) Nuclear charge (↑) Atomic size (↓) ~~Shielding Effect (↓)~~	$F_{(g)} + e^{-} \rightarrow F^{-1}_{(g)}$ E.A = -328 kJ/mol $O^{-1} \rightarrow -141$ $O^{-2} \rightarrow +780$	Noble gas = 0 F Cl -328 -349 Halogen → Group → Inc Reason: • Small size • Inter-electronic repulsion	

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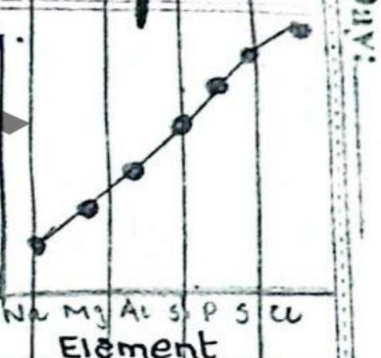
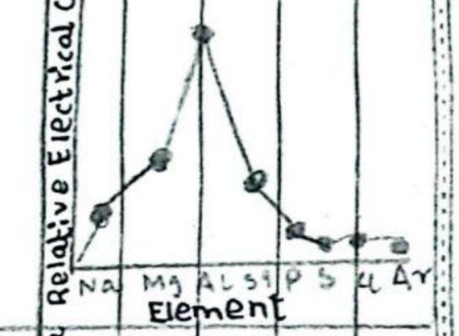
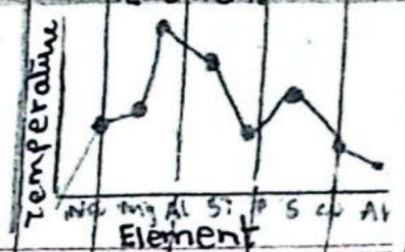
Properties	Definition	Group	Period	Example	Exception	Graph
Electro-negativity	"Measure of tendency of an atom to attract a shared pair of electrons towards itself."	Decrease —REASON— Atomic size (↑) Nuclear attraction (↓)	Increase Atomic size (↓) Nuclear attraction (↑)	F = 4.0 O = 3.5 N = 3.0 Cs = Fr =	Noble gases have value of E.N as 0. REASON: E.N isn't assign to noble gases b/c of thier complete octet-	
Electrical Conductivity (G) Unit: Sm^{-1}, $ohm m^{-1}$)	"Ability of a substance to conduct the electric current due to presence of charged particles" (Free e⁻, ions)	Increase (Na, Mg, Al) Good conductors Moderate (Si) Semi-conductor Decrease (P, S, Cl_2, Ar) Insulators	⇄ Down the group: Increase (I-A, II-A, III-A) Coinage Metals (I-B) Ag > Cu > Au			
Melting Points	Temperature (transition) at which equilibrium is established b/w the liquid & solid state	Decrease Atomic size ↑ Nuclear att ↓	Increase (I-A → IV-A) Decrease (IV-A → VIII-A)		M.P: $P_4 < S_8$ Down grp: Halogens → M.P, B.P (↑) Noble gas	
Boiling Points	Temperature at which the vapour pressure becomes (or equal) equal to external pressure.	Decrease Atomic size ↑ Nuclear att ↓	Increase (I-A → IV-A) Decrease (IV-A → VIII-A)		//	

Chemical Reactions of Period 3 Elements

ELEMENT	REACTION WITH H_2O	REACTION WITH O_2	REACTION WITH Cl_2
Sodium (Na) Highly reactive	(Exothermic) $2Na + 2H_2O \rightarrow 2NaOH + H_2$ (cold) (colourless sol.)	$4Na + O_2 \xrightarrow{\text{Limited}} 2Na_2O$ (sodium oxide) $2Na + O_2 \xrightarrow{\text{Excess}} Na_2O_2$ (sodium per oxide) Golden ⇒ Yellow Flame	$2Na + Cl_2 \rightarrow 2NaCl_{(s)}$ (white solid) ⇒ Bright Orange/Yellow Flame
Magnesium (Mg)	$Mg + 2H_2O \rightarrow Mg(OH)_2 + H_2$ (cold) (Very slight rxn) $Mg + H_2O \rightarrow MgO + H_2$ (steam) ⇒ White flame	$2Mg + O_2 \rightarrow 2MgO_{(s)}$ (white solid) ⇒ Intense White flame	$Mg + Cl_2 \rightarrow MgCl_2$ (white) ⇒ Intense White flame
Aluminium (Al)	(Slow) $2Al + 3H_2O \rightarrow Al_2O_3 + 3H_2$ (steam) $Al + H_2O \rightarrow$ no reaction (cold)	(Slow) $4Al + 3O_2 \xrightarrow[\Delta]{800°C} 2Al_2O_3$	$2Al + 3Cl_2 \xrightarrow{\Delta} 2AlCl_3$ (Pale yellow)
Silicon (Si)	No reaction	$Si + O_2 \xrightarrow{\Delta} SiO_2$	$Si + 2Cl_2 \xrightarrow{\Delta} SiCl_4$ (Powder) (colourless)
Phosphorus (P)	No reaction	Phosphorous (III) oxide $P_4 + 3O_2 \xrightarrow{\text{Limited}} P_4O_6$ Phosp.(V) oxide: $P_4 + 5O_2 \xrightarrow{\text{Excess}} P_4O_{10}$	$P_4 + 6Cl_2 \xrightarrow{\text{Limited}} 4PCl_3$ (colourless fuming liquid) $P_4 + 10Cl_2 \xrightarrow{\text{Excess}} 4PCl_5$ (off-white solid) going towards Yellow
Sulphur (S)	No reaction	$S + O_2 \rightarrow SO_2$ (colourless) ⇒ Pale Blue Flame	$2S + Cl_2 \rightarrow S_2Cl_2$ (orange, evil-smelling)
Chlorine (Cl)	Green Solution $2Cl_2 + 2H_2O \rightleftharpoons 2HCl + 2HOCl$ $2HOCl \xrightarrow{\text{Sunlight}} 2HCl + O_2$ $2Cl_2 + 2H_2O \xrightarrow{\text{Sunlight}} 4HCl + O_2$	Form Cl_2O, Cl_2O_7 → Indirect Method (Doesn't reacts directly)	—

Stored in kerosene or paraffin oil

Group I-A Elements (Alkali Metals)

More electropositive character ← ns¹

I.E2 > I.E1

K lighter than Na, greater Atomic size

Element	Reaction with H_2O	Reaction with O_2	Reaction with Cl_2	Oxides Rxn
Li (Crimson Red)	$2Li_{(s)} + 2H_2O_{(l)} \rightarrow 2LiOH_{(aq)} + H_{2(g)}$	$4Li + O_2 \rightarrow 2Li_2O$ (Normal oxide)	$2Li_{(s)} + Cl_{2(g)} \rightarrow 2LiCl$ (slow)	with water: $Li_2O + H_2O \rightarrow 2LiOH$ with dil acid: $Li_2O + 2HCl \rightarrow 2LiCl + H_2O$
Na (Golden yellow)	$2Na + 2H_2O \rightarrow 2NaOH + H_2$ (cold) $\Delta H = -ve$	$4Na + O_2 \rightarrow 2Na_2O$ (Sodium oxide) (Lim); $2Na + O_2 \rightarrow Na_2O_2$ (Sodium per oxide) (exc)	$2Na + Cl_2 \rightarrow 2NaCl$ (Slow)	with water: $Na_2O + H_2O \rightarrow 2NaOH$; $Na_2O_2 + H_2O \rightarrow 2NaOH + H_2O_2$ with dil acid: $Na_2O + 2HCl \rightarrow 2NaCl + H_2O$; $Na_2O_2 + 2HCl \rightarrow 2NaCl + H_2O_2$
K (violet)	$2K_{(s)} + 2H_2O_{(l)} \rightarrow 2KOH_{(aq)} + H_{2(g)}$ (ice) $\Delta H = -ve$	$2K + O_2 \rightarrow K_2O_2$	$2K + Cl_2 \rightarrow 2KCl$	with water: $K_2O_2 + 2H_2O \rightarrow 2KOH + H_2O_2$ (cold) with dil acid: $K_2O_2 + 2HCl \rightarrow 2KCl + H_2O_2$
Rb (Reddish-violet)	$2Rb_{(s)} + 2H_2O_{(l)} \rightarrow 2RbOH_{(aq)} + H_{2(g)}$ (ice) $\Delta H = -ve$	$2Rb + O_2 \rightarrow Rb_2O_2$	$2Rb + Cl_2 \rightarrow 2RbCl$	with water: $Rb_2O_2 + 2H_2O \rightarrow 2RbOH + H_2O_2$ (cold) with dil acid: $Rb_2O_2 + 2HCl \rightarrow 2RbCl + H_2O_2$
Cs (Blue)	$2Cs_{(s)} + 2H_2O_{(l)} \rightarrow 2CsOH_{(aq)} + H_{2(g)}$ (ice) $\Delta H = -ve$	$2Cs + O_2 \rightarrow Cs_2O_2$	$2Cs + Cl_2 \rightarrow 2CsCl$	with water: $Cs_2O_2 + 2H_2O \rightarrow 2CsOH + H_2O$ (cold) with dil acid: $Cs_2O_2 + 2HCl \rightarrow 2CsCl + H_2O_2$

Normal oxide (M_2O) + $H_2O \rightarrow 2MOH$

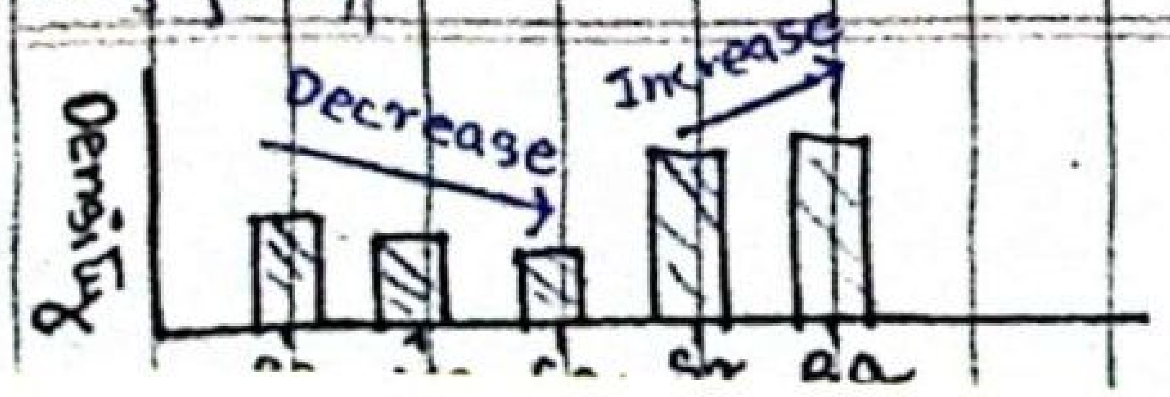
Peroxide (M_2O_2) + $H_2O \rightarrow 2MOH + H_2O_2$

Superoxide (MO_2) + $H_2O \rightarrow 2MOH + H_2O_2 + O_2$

Group II-A Elements (Alkaline Earth Metals)

Element	Reaction with H_2O	Reaction with O_2	Reaction with N_2	CO_3^{-2}	NO_3^-
Be (no flame colour)	No reaction even with steam or at red hot temp.	quite insoluble in H_2O ← $2Be + O_2 \rightarrow 2BeO$ (amphoteric) (covalent)	$3Be + N_2 \rightarrow Be_3N_2$ (volatile)	$BeCO_3 \xrightarrow{25^\circ C} CO_2 + BeO$	$2Be(NO_3)_2 \rightarrow 2BeO + 4NO_2 + O_2$
Mg 12 24 (no flame colour)	$Mg + H_2O \rightarrow MgO + H_2$ (cold); $Mg + 2H_2O \rightarrow Mg(OH)_2 + H_2$ (steam)	quite insoluble in H_2O ← $2Mg + O_2 \rightarrow 2MgO$ (Basic) (ionic)	$3Mg + N_2 \rightarrow Mg_3N_2$ (non-volatile)	$MgCO_3 \xrightarrow{540^\circ C} CO_2 + MgO$	$2Mg(NO_3)_2 \rightarrow 2MgO + 4NO_2 + O_2$
Ca 20 40 (Brick-red)	$Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2$ (cold)	$2Ca + O_2 \rightarrow 2CaO$ (Basic) (Ionic)	$3Ca + N_2 \rightarrow Ca_3N_2$ (non-volatile)	$CaCO_3 \xrightarrow{900^\circ C} CO_2 + CaO$	$2Ca(NO_3)_2 \rightarrow 2CaO + 4NO_2 + O_2$
Sr 38 87 (Lithium Red)	$Sr + 2H_2O \rightarrow Sr(OH)_2 + H_2$ (cold)	$2Sr + O_2 \rightarrow 2SrO$ (Basic) (Ionic)	$3Sr + N_2 \rightarrow Sr_3N_2$ (non-volatile)	$SrCO_3 \xrightarrow{1290^\circ C} CO_2 + SrO$	$2Sr(NO_3)_2 \rightarrow 2SrO + 4NO_2 + O_2$
Ba 56 137 (Pale green / grassy green)	$Ba + 2H_2O \rightarrow Ba(OH)_2 + H_2$ (cold)	$2Ba + O_2 \rightarrow 2BaO$ (limited); $Ba + O_2 \rightarrow BaO_2$ (excess) (ionic)	$3Ba + N_2 \rightarrow Ba_3N_2$ (non-volatile)	$BaCO_3 \xrightarrow{1360^\circ C} CO_2 + BaO$	$2Ba(NO_3)_2 \rightarrow 2BaO + 4NO_2 + O_2$

Margin notes: Don't react directly with H_2; Mg → lowest B.P; $CaH_2 + 2H_2O \rightarrow Ca(OH)_2 + 2H_2$



Group IV-A Elements (Carbon Family)

Oxides	Rxn with H_2O	Rxn with base	Rxn with Acid	Tetra-halides	Rxn with H_2O
CO (v.v. slightly Acidic)	No reaction	$CO + NaOH \rightarrow HCOONa$ (sodium Methanoate)	—	CCl_4	$CCl_4 + H_2O \xrightarrow[\text{steam}]{\text{superheated (500°C)}} COCl_2 + 2HCl$ (Phosgene gas)
CO_2 (Weakly acidic)	$CO_2 + H_2O \rightarrow H_2CO_3$ (Carbonic Acid); $H^+ + HCO_3^- \leftarrow$ (bi-carbonate ion)	$CO_2 + 2NaOH \rightarrow Na_2CO_3 + H_2O$ (excess); $CO_2 + NaOH \rightarrow NaHCO_3$ (Lim)	—		
SiO_2 (Weakly acidic)	No reaction	$SiO_2 + 2NaOH \xrightarrow{\text{hot, conc.}} Na_2SiO_3 + H_2O$; $SiO_2 + CaO \xrightarrow{\Delta} CaSiO_{3(l)}$ (slag)	—	$SiCl_4$	$SiCl_4 + 2H_2O \rightarrow SiO_2 + 4HCl$
GeO (Amphoteric)	$GeO + 2H_2O \rightarrow Ge(OH)_2$	$GeO + 2NaOH \rightarrow Na_2GeO_2 + H_2O$	$GeO + 2HCl \rightarrow GeCl_2 + H_2O$	GeH_4	$GeCl_4 + 2H_2O \rightarrow GeO_2 + 4HCl$
GeO_2 Amphoteric)	No reaction	$GeO_2 + 2NaOH + 2H_2O \rightarrow Na_2[Ge(OH)_6]$	$GeO_2 + 4HCl \rightarrow GeCl_4 + 2H_2O$		
SnO Amphoteric)	$SnO + H_2O \rightarrow Sn(OH)_2$	$SnO + 2NaOH \rightarrow Na_2SnO_2 + H_2O$	$SnO + 2HCl \rightarrow SnCl_2 + H_2O$	$SnCl_4$	$SnCl_4 + 2H_2O \rightarrow SnO_2 + 4HCl$
SnO_2 Amphoteric)	No reaction	$SnO_2 + 2NaOH + 2H_2O \rightarrow Na_2[Sn(OH)_6]$	$SnO_2 + 4HCl \rightarrow SnCl_4 + 2H_2O$		
PbO (Amphoteric)	$PbO + H_2O \rightarrow Pb(OH)_2$ (Plumbous Acid)	$PbO + 2NaOH \rightarrow Na_2PbO_2 + H_2O$	$PbO + 2HCl \rightarrow PbCl_2 + H_2O$	$PbCl_4$	$PbCl_4 + 2H_2O \rightarrow PbO_2 + 4HCl$
PbO_2 (Amphoteric)	No reaction	$PbO_2 + 2NaOH + 2H_2O \rightarrow Na_2[Pb(OH)_6]$	$PbO_2 + 4HCl \rightarrow SnCl_4 + H_2O$		

Day:

Date:

PbO (Amphoteric) | $PbO + H_2O \rightarrow Pb(OH)_2$ (Plumbous Acid) | $PbO + 2NaOH \rightarrow Na_2PbO_2 + H_2O$ | $PbO + 2HCl \rightarrow PbCl_2 + H_2O$ | $PbCl_4$ | $PbCl_4 + 2H_2O \rightarrow$

PbO_2 (Amphoteric) | No reaction | $PbO_2 + 2NaOH \rightarrow$ | $PbO_2 + HCl \rightarrow$

Group VII-A Elements (Halogens)

Element	State	E·N	Oxidizing Strength	Acidic Strength	Reducing strength	E·A	Displacement rxns
F	Gaseous state	4.0	F_2	HF	F^-	F	
Cl	Gas	3.0	Cl_2	HCl	Cl^-	Cl	$2NaCl + H_2SO_4 \rightarrow Na_2SO_4 + 2HCl$
Br	Heavy liquid	2.8	Br_2	HBr	Br^-	Br	$2NaBr + H_2SO_4 \rightarrow Na_2SO_4 + 2H$ $2HBr + H_2SO_4 \rightarrow Br_2 + SO_2 + H_2O$
I	Solid	2.5	I_2	HI	I^-	I	$8NaI + 4H_2SO_4 \rightarrow 4Na_2SO_4 + 8HI$ $8HI + H_2SO_4 \rightarrow 4I_2 + H_2S + 4H_2O$

Date:

Day:

Points to remember:

→ Similar types anions:

Nitrate	NO_3^-	Aluminate	AlO_2^-
Nitrite	NO_2^-	Zincate	ZnO_2^{-2}
Nitride	N^{-3}	chromate	CrO_4^{-2}
Azide	N_3^-	Silicate	SiO_3^{-2}
Sulphate	SO_4^{-2}	bisulphate	HSO_4^-
Sulphite	SO_3^{-2}	bi sulphite	HSO_3^-
Sulphide	S^{-2}	bisulphide	HS^-
Carbonate	CO_3^{-2}	bicarbonate	HCO_3^-
carbide	C^{-2}		
Manganate	MnO_4^{-2}	Chromate	CrO_4^{-2}
Permanganate	MnO_4^-	dichromate	$Cr_2O_7^{-2}$
Oxide	O^{-2}	Phosphate	PO_4^{-3}
Peroxide	O_2^{-1}	Phosphite	HPO_3^{-2}
Superoxide	$O_2^{-1/2}$	Phosphide	P^{-3}
		hypophosphite	$H_2PO_2^-$
hydroxide	OH^-		
hydride	H^-		

Solubility (down the group)	Oxides	Hydroxides	Carbonates	Sulphates	Nitrates
	increase	increase	decrease	decrease	All are water soluble

Thermal stability increase down the group

- $Be(OH)_2$ – insoluble
- $Mg(OH)_2$ – sparingly soluble
- $Ba(OH)_2$ – soluble

$BeSO_4$ > $MgSO_4$ > fairly soluble

- BeO – insoluble
- MgO – insoluble
- CaO – soluble

$CaSO_4$ - slightly soluble

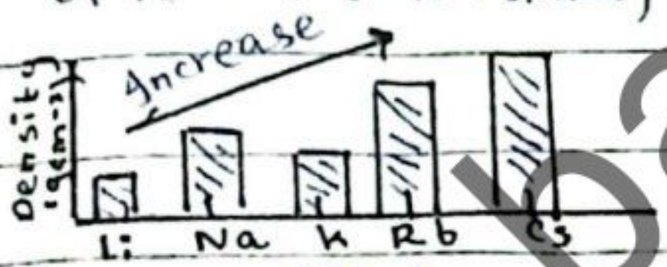
$SrSO_4$ - insoluble

EXCEPTIONS

Day: Date:

Group I-A:

- density K < Na (4-Orbital in K)
- He (2372 kJ/mol) → Maximum Ionization Energy
- Cs (376 kJ/mol) → Min / least Ionization Energy
- Diagonal relation Li < Mg
- Cs → Metallic Character (Excellent)
  → strongest reducing agent in solid state
  → least E.N in periodic table (0.7)
- LiCl → heat of Sol exothermic
  Other Alkali metals → heat of solution endothermic
- Na = 186pm Na+ 102 pm
  1.54 A° 0.95 A°
  ↓
  I.E = +496 KJ/mol
- Li → strongest Reducing agent in aqeous solution
- least electronegative elements
- Low M.P & B.P
- Hydration energy of H → (-1075 kJ/mol)

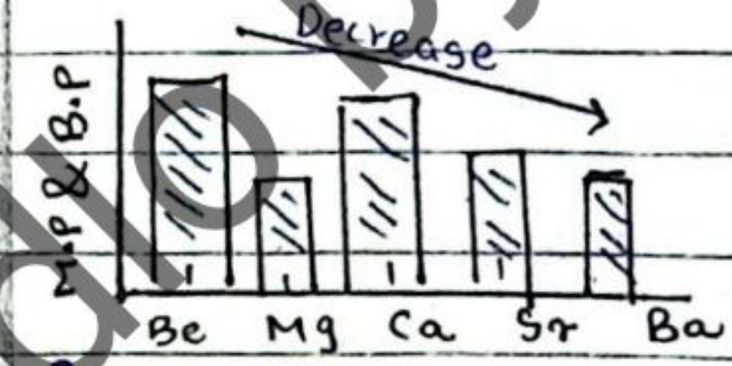


Group IV-A:

- Sn → lowest M.P.
- C , Si , Ge , Sn , Pb
  non-metals Metalloid Metals
  → Metallic character increases down the grp
- $Ge^{+2} < Sn^{+2} < Pb^{+2}$
- $Ge^{+4} > Sn^{+4} > Pb^{+4}$ (inert pair effect (↓))
- $Pb^{+2} > Pb^{+4}$
- M^{+2} → ionic (Fajan's rule)
- M^{+4} → covalent
- CO_2 → μ = 0 (non-polar)
- CO → μ ≠ 0 (polar)
- Oxides of Ge, Sn, Pb → Amphoteric

Group II-A:

- Mg → least M.P & B.P
- Ionization Energy of Mg → (+738, +1451, +7730 kJ/mol)
- Ionization Energy of Ra > Ba (-509 kJ/mol) (-503 kJ/mol)
- BeO → Amphoteric
  other → basic
- Be_3N_2 → volatile
  other → non-volatile
- Ba → forms both normal & per-oxides.
- Be → Only alkaline Earth metal which reacts with Alkalis
  ↓
  only 4 water of crystalization
  Be_2C → CH_4
  other → C_2H_2



Group III-A:

- I.E → B > Tl > Ga > Al > In

B	Al	Ga	In	Tl
801	577	579	558	589

Increase (Poor shielding effect of "d") Increase (Poor shielding effect of "f")

- Ga → lowest M.P
  Ga < In < Tl < Al < B
- Al → used in themite process

Trend of shielding effect

(S) > P > d > (F)
S.E strong S.E. weak

Group VII-A:

- F > Cl > Br > I (E.N) (4.0, 3.0, 2.8, 2.5)
- F < Cl > Br > I (E.A) (-328, -349)
- HF < HCl > HBr > HI
  Dec in bond-enthalpy →
- $F_2 > Cl_2 > Br_2 > I_2$ (Oxidizing strength)
- HF < HCl < HBr < HI (Acidic strength)
- $F^- < Cl^- < Br^- < I^-$ (Reducing strength)