P-BLOCK (13)+(14)

13th Group

1. Orthoboric acid – H_3BO_3.
2. Borax – $Na_2B_4O_7 \cdot 10H_2O$
3. Kernite – $Na_2B_4O_7 \cdot 4H_2O$
4. Bauxite – $Al_2O_3 \cdot 2H_2O$
5. Cryolite – Na_3AlF_6
6. Atomic radius

   $B < Ga < Al < In < Tl$

7. I.P

   $B > Tl > Ga > Al > In$

8. B Al Ga In Tl
   → (+1) stability (↑)
9. Tendency to behave as L.A des down the group.
10. $BF_3 < BCl_3 < BBr_3 < BI_3$
    due to back bonding.
11. $MXl_3 \xrightarrow{H_2O} [M(OH)_4]^{\ominus}$
12. BO_3 → Acidic
    Al/Ga oxide → Amphoteric
    In/Tl oxide → basic
13. $2Al \xrightarrow{6HCl} 2Al^{+3}(aq.) + 6Cl^-(aq.) + 3H_{2(g)}$
    $2Al \xrightarrow{2NaOH} 2Na^+[Al(OH)_4]^- + 3H_{2(g)}$
    sodium tetra hydroxo aluminate (III)
14. TlI_3 → xx
15. MX_3 (X= Cl, Br, I)
    covalent in nature, can be Hydrolysed
16. BF_6^{3-} xx No d-orbitals.

BORAX

17. $Na_2[B_4O_5(OH)_4] \cdot 8H_2O$
18. $Na_2B_4O_7 + 7H_2O \longrightarrow 2NaOH + 4H_3BO_3$
19. $Na_2B_4O_7 \cdot 10H_2O \xrightarrow{\Delta} Na_2B_4O_7$ metaborate
20. $Na_2B_4O_7 \xrightarrow{\Delta} 2NaBO_2 + B_2O_3$ Boric anhydride
21. Borax bead test (For transitⁿ element)
    Borax + CoO $\xrightarrow[Pt\ wire]{on}$ $Co(BO_2)_2$ (Blue) → metal borate.

Orthoboric acid

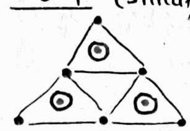
22. • sparingly soluble in cold water
    fully " " Hot "
23. $Na_2B_4O_7 + 2HCl + 5H_2O \longrightarrow 2NaCl + 4B(OH)_3$
24. $B(OH)_3$ → Monobasic acid
    → lewis acid.
25. $B(OH)_3 + H_2O \longrightarrow (B(OH)_4)^- + H_3O^+$
26. $H_3BO_3 \xrightarrow[370K(?)]{\Delta} HBO_2$ (metaboric acid) $\xrightarrow{\Delta} B_2O_3$ (boric oxide)

Diborane (B_2H_6)

27. $4BF_3 + 3LiAlH_4 \longrightarrow 2B_2H_6 + 3LiF + 3AlF_3$
28. $2NaBH_4 + I_2 \longrightarrow B_2H_6 + 2NaI + H_2$
24. $B_2H_6 + 3O_2 \longrightarrow B_2O_3 + 3H_2O$
25. $B_2H_6 + H_2O \longrightarrow 2B(OH)_3 + H_2$
26. $B_2H_6 + 2CO \longrightarrow 2BH_3 \cdot CO$ (adduct)
27. $3B_2H_6 + 6NH_3 \longrightarrow 3[BH_2(NH_3)_2]^+[BH_4]^-$
    ↓ Δ
    $2B_3N_3H_6 + 12H_2$ (inorganic benzene)
28. Banana bond → 3c – 2e⊖ bond
29. $2MH + B_2H_6 \longrightarrow 2M^+[BH_4]^-$
30. $BF_3 + NH_3 \longrightarrow F_3B \leftarrow NH_3$

14th Group

31. CO_2, SiO_2, GeO_2 → Acidic
    SnO_2, PbO_2 → amphoteric
32. CO → Neutral
    GeO → Acidic
    SnO, PbO → Amphoteric.
33. $Sn + 2H_2O \xrightarrow{\Delta} SnO_2 + 2H_2$
34. SnF_4 & PbF_4 → ionic in nature.
35. $Ge^{+4} > Ge^{+2}$
    $Pb^{+2} > Pb^{+4}$
36. $Si(OH)_4$ → silicic acid
37. Diamond
    • direction covalent bond ntl.
38. Fullerene (C_{60})
    • No dangling bonds
    • 20 – Hexagons ; 12 – Pentagons.
    • Aromatic
39. $\Delta_f H^{\ominus}$ = Graphite = 0
40. Carbon Monoxide
    $C + H_2O \xrightarrow{473-1273K} CO + H_2$ water/synthesis gas
41. $2C + O_2 + 4N_2 \xrightarrow{1273K} 2CO + 4N_2$ Producer gas
42. $SiO_2 + 2NaOH \longrightarrow Na_2SiO_3 + H_2O$
    $SiO_2 + 4HF \longrightarrow SiF_4 + 2H_2O$
43. Si–O–Si–O–Si
    O–Si–O–Si–O
    Si–O–Si–O–Si–
44. $2CH_3Cl + Si \xrightarrow{Cu\ powder} (CH_3)_2SiCl_2$
    $\downarrow -2HCl\ +2H_2O$
    $(CH_3)_2Si(OH)_2$
45. $-O-[Si(CH_3)_2-O-Si(CH_3)_2]_n-$ ⟹ silicone.
    ↓ Hydrophobic
46. SiO_4^{4-} → silicates.
47. Zeolites
    Al atom replace Si atoms in SiO_2
    eg. ZSM-5
48. Hydrate zeolite are used as ion exchanger in softening of Hard water
44. CO_2 linear SiO_2 3-d structure.
45. $Si_3O_9^{-6}$ (silicate)



46. $B(OH)_3 + NaOH \longrightarrow B(OH)_4^- Na^+$ (sp² → sp³)
    → Na_3BO_3 xx
47. $H_3BO_3 \xrightarrow{3C_2H_5OH} (C_2H_5O)_3B$. Green edge Flame
    ↓ NaOH
    $3C_2H_5OH + Na_3BO_3$
48. $B_2H_6 + NH_3 \longrightarrow B_3N_3H_6 \xrightarrow{\Delta,\ 750°C}$ BN (Hexagonal) (In Graphite)
    BN (Hexagonal) $\xrightarrow[\uparrow P]{\Delta}$ BN (cubic) (In Diamond)
49. ↑ M.P of Boron
    Boron is covalent solid
50. $N(SiH_3)_3$ → Planar.
51. $HO-B(OH)-OH$ ⟹ can form H-bond
    → sp².
52. $Tl(I)F_3$ do not exist
53. Aluminothermite process
    Al → reducing agent
54. C oxidised by conc. H_2SO_4
    $CO_2 + SO_2$ released
55. $Si(OH)_4$ (HO–Si(OH)(OH)–OH)

(56) Crystalline form of silica.
- quartz • tridymite
- cristobalite

(57) crucibles → of Graphite (→ inert to acid & base)

(58) $HCOOH \xrightarrow{H_2SO_4} CO + H_2O$

(59) Man made silicates.
→ Glass
→ cement.

(60) silicates (SiO_4^{4-})
→ Feldspar → Mica
→ zeolite → abestos.

(61) ZSM-5
Alcohols → Gasoline.

(62) $SnO_2 \rightarrow SnO_2$,
Galena → PbS

(63) Kieselguhr → Amorphous form

(64) Rn $SiCl_4$ (ex-17)

(65) ~~(So)~~ $(SiO)_n$ → not stable

Group-15 [Extra]

(1) As, Sb, Bi → found as sulphide mineral

(2) $HNO_2 + \cancel{H_2O} \rightarrow HNO_3 + NO + H_2O$

(3) B.P → NH_3, PH_3, AsH_3, SbH_3, BiH_3 ↑es
M.P → ...
NH_3 PH_3 AsH_3 SbH_3 BiH_3
195 139 156 185
$NH_3 > SbH_3 > AsH_3 > PH_3$

(4) $NH_4Cl + NaNO_2 \rightarrow N_2 + H_2O + NaCl$
small amt. of NO, HNO_3 (impurities)
removed by passing by $H_2SO_4(aq) + K_2Cr_2O_7$

(5) N_2 → non toxic, ↓ solubility in cryosurgery

(6) Ammonia
$N_2 + 3H_2 \rightleftharpoons 2NH_3$
catalyst :- $Fe + K_2O + Al_2O_3$
↳ molybdenum promotor

(7) lab Grade HNO_3.
68% by mass

(8) HNO_3 → Planar.
↳ forms → Nitroglycerin.
trinitrotoulene
Pickling of stainless steel

(9) $P_4(w)$ → translucent waxy solid
→ Poisonous.

(10) $P_4(R)$ → Iron Grey lusture
↳ Non-Poisonous.

(11) $P_4(red) \xrightarrow{873} \alpha$- Black
Monoclinic, Rhombohedral

(12) $HNO_3 + RA(X) \rightarrow X + NO$ (105 or stable)
$H_2S \rightarrow S$, $SO_2 \rightarrow SO_4^{2-}$, $I^- \rightarrow I_2$
$Sn^{+2} \rightarrow Sn^{+4}$

(13) Mg, Mn $\xrightarrow{dil.\ HNO_3}$ $MNO_2 + H_2$

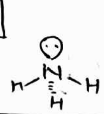
(14) N_2O, NO
OF_2 O_2F_2
NCl_3, NBr_3, NI_3] $\Delta H_f = +ve$

(15) ice → $H_2O(s)$
dry ice → $CO_2(s)$
white ice → $N_2O_4(s)$

(16) $\cancel{H_2O}\ HNO_2 \xrightarrow{H^+} HNO_3 + NO$

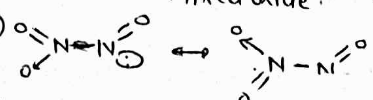
15th GROUP

1. $NaNO_3 \rightarrow$ chile salt petre
2. $KNO_3 \rightarrow$ Indian salt petre
3. $Ca_9(PO_4) \cdot CaF_2 \rightarrow$ component of "Fluorapatite" Rock
4. Except (N) all show Allotropy
5. (N) $\xrightarrow{+5 \downarrow,\ +3 \uparrow}$ (Bi) → only comp in +5 BiF_5 (inert pair effect)
6. Bi forms metallic bond in elemental state
7. N–N < P–P [∵ interelectronic repulsn] (B.S)
8. oxides
   - N, P → Acidic; As, Sb → Amphoteric; Bi → basic
9. $NF_3 + H_2O \longrightarrow$ xx [-nt d-orbital]
10. (NF_3) → only stable trihalide of (N)
11. (BiF_3) → ionic in Nature
    - all other trihalides are covalent
12. $NH_4Cl + NaNO_2 \rightarrow N_2$
13. $(NH_4)_2Cr_2O_7 \xrightarrow{\Delta} N_2 + Cr_2O_3$
14. $Ba(N_3)_2 \xrightarrow{\Delta} Ba + 3N_2$
15. (N_2) used in iron industry (inert atm.) • cryosurgery.
16. (Ammonia)
    - $NH_2-\overset{O}{\overset{\|}{C}}-NH_2 + H_2O \rightarrow (NH_4)_2CO_3 \rightleftharpoons 2NH_3$
17. $N_2 + 3H_2 \rightleftharpoons 2NH_3$
18. weak base

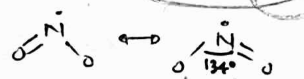


19. $ZnSO_4 + NH_4OH \longrightarrow Zn(OH)_2 + (NH_4)_2SO_4$ (white ppt)
20. $FeCl_3 + NH_4OH \rightarrow Fe_2O_3 \cdot xH_2O + NH_4Cl$ (Brown ppt)
21. Detection of metal ion
    - $Cu^{+2} + 4NH_3 \rightarrow [Cu(NH_3)_4]^{+2}$ (Blue → deep Blue)
    - $Ag^+ + Cl^- \longrightarrow AgCl$ (colourless → white ppt)
    - $AgCl + 2NH_3 \longrightarrow [Ag(NH_3)_2]Cl$
22. $NH_3(l) \rightarrow$ Refrigerant
23. (NH_3) scheme:
    - $NH_4Cl \xrightarrow{Alkali} NH_3$
    - $NH_3 \xrightarrow{Ag^+} [Ag(NH_3)_2]^+$; $NH_3 \xrightarrow{Cu^{+2}} [Cu(NH_3)_4]^{+2}$
    - $Be_3N_2, Ca_3N_2, AlN, Li_3N, Mg_3N_2 \xrightarrow{H_2O} M(OH) + NH_3$
    - $NH_3 \xrightarrow{NaClO}$ N_2H_4 (NH_3 e) (NH₂–NH₂); N_2 (NaClO e)

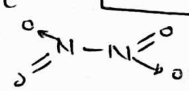
24. $\overset{+1}{N_2O}$ (Nitrous oxide) → support comb.
    - laughing (Gas)
    - $NH_4NO_3 \xrightarrow{\Delta} N_2O$
    - Metal nitrate → N_2O
    - $H_2N_2O_2 \xrightarrow{\Delta} N_2O$
    - Fe, Zn $\xrightarrow{dil.\ HNO_3} N_2O$
    - $N_2O \xrightarrow{\Delta} N_2 + O_2$
    - $NO \xrightarrow{\Delta} N_2O$
25. N_2O → $N{=}N{=}O \leftrightarrow N{\equiv}N{-}O$
26. $\overset{+2}{NO}$
    - Neutral (gas)
    - $N_2 + O_2 \xrightarrow{electric\ arc} NO$
    - dil. HNO_3 CHAPA → NO
    - $NO \xrightarrow{FeSO_4} [\overset{+1}{Fe}(H_2O)_5\overset{+1}{NO}]$
    - $NO \xrightarrow{O_2} NO_2$
    - $NO \xrightarrow{20\text{–}50°C} N_2O + NO_2$
27. N_2O_3 (solid)
    - (Blue)
    - Acidic
    - $N_2O_3 \rightleftharpoons 2\dot{N}O + \dot{N}O_2$
    - $HNO_2 \xleftarrow{H_2O} N_2O_3 \longleftarrow 2NO + N_2O_4$
    - Mixed oxide.
28.



29. $NO_2 \rightarrow$ Diamagnetic (at low temp.)
    - $N_2O_5 \xrightarrow{\Delta} NO_2$
    - Sn $\xrightarrow{HNO_3} NO_2$
    - $Pb(NO_3)_2$ or Heavy metal Nitrate $\xrightarrow{\Delta\Delta,\ 673K} NO_2$ + PbO + (O_2)
    - R.A $\xrightarrow{HNO_3} NO_2$
    - Non metal (P_4, S, I_2) $\xrightarrow{HNO_3} NO_2$
    - CHAPA Fe Zn $\xrightarrow{conc.\ HNO_3} NO_2$
30. $\overset{+4}{NO_2} \rightarrow$ (Brown Gas), Acidic

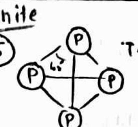


31. $\overset{+4}{N_2O_4}$ → white ice
    - colourless
    - Acidic
    - (Solid)
    - $N_2O_4 \underset{cool}{\overset{\Delta}{\rightleftharpoons}} NO_2$

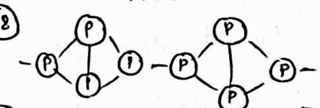


32. $\overset{+5}{N_2O_5}$ (Most acidic)
    - colourless
    - Acidic
    - (Solid)
    - $N_2O_5 \xrightarrow{O_3} \dot{N}O_3 + O_2$
    - $HNO_3 \xrightarrow{P_4O_{10}} N_2O_5$ (निर्जलन)
    - $N_2O_5 \xrightarrow{H_2O} HNO_3$
    - $N_2O_5 \xrightarrow{Na} NO_2 + NaNO_3$
33. (HNO_3)
    - $4NH_3 + 5O_2 \xrightarrow[\Delta]{Pt/Rh\ Gauge} 4NO \xrightarrow{O_2} NO_2 \xrightarrow{H_2O} HNO_3$
    - $(N_2 + O_2 \rightarrow NO - NO_2 \xrightarrow{H^+} HNO_3)$
34. Non metal $+ HNO_3 \longrightarrow$ oxy acid $+ NO_2$ (Test O.S)
    - exceptⁿ $I_2 + 10HNO_3 \rightarrow HIO_3$ (+5)
35. CHAPA Fe Zn $\xrightarrow{conc.\ HNO_3}$ metal Nitrate + NO_2
36. CHAPA $\xrightarrow{dil\ HNO_3}$ Metal Nitrate + NO
37. Fe Zn $\xrightarrow{dil.\ HNO_3}$ Metal Nitrate + N_2O

38. Fe, Zn, Sb + $\underline{v.v\ dil\ HNO_3} \rightarrow NH_4NO_3$ + M.Nitrate (NH_3)
39. Uses! – Pickling of stainless steel
40. Brown Ring Test
    - Test of (NO_3^- (Nitrate) ion.
    - Fe^+, NO^+; $[\overset{+1}{Fe}(H_2O)_5\overset{+1}{NO}]$
    - $4s^13d^6 \rightleftharpoons 3d^7$, n=3, Sp^3d^2
41. PARI (Pt, Au, Rh, Ir) $\xrightarrow{HNO_3}$ xx
    - $\xrightarrow{Aqua\ Regia}$ → Au → Au^{3+} [$AuCl_4$]$^-$
42. Aqua Regia $HNO_3 + HCl$ (1 : 3)
43. white phosphorus → least stable
    - Insoluble in water
    - soluble in CS_2
    - show (chemiluminescence)
44. R
    - $P_4 + 3NaOH + 3H_2O \longrightarrow PH_3 + 3NaH_2PO_2$ (white; Sodium Hypo phosphite)
45. Tetrahedral . unstable



46. $P_4 + SO_2 \rightarrow P_4O_6$ → white fumes
47. Red Phosphorus
    - P_4(white) $\xrightarrow[\Delta]{573\ K}$ P_4(red)
    - Insoluble in water & CS_2
    - less reactive
48.



49. Black Phosphorus → most stable, → Max. density
    - P_4(red) $\xrightarrow{803K}$ α-Black P_4
    - P_4(white) $\xrightarrow[HP]{473K}$ β-Black P_4
50. $P_4(R) \xrightarrow[limited]{Cl_2} PCl_3 \xrightarrow{H_2O} H_3PO_3$; $PCl_3 \xrightarrow{SO_3} SO_2 + POCl_3$
51. Phosphine (PH_3) → not inflammable when pure
    - $PH_4I \xrightarrow{KOH} PH_3$
    - $Ca_3P_2 \xrightarrow{H_2O/HCl} PH_3$ (P_2H_4 makes flammable)
    - $PH_3 \xrightarrow{Cu^{+2}}$ Cu + H_3PO_4
    - $PH_3 \xrightarrow{Ag^+}$ (Ag) + H_2SO_4 Black ppt
    - $PH_3 \xrightarrow{\overset{+2}{CuSO_4}} \overset{+2}{Cu_3P_2} + H_2SO_4$
    - $PH_3 \xrightarrow{HgCl_2} Hg_3P_2 + HCl$
    - $P_4 + 3NaOH$ (white) → PH_3 (inert atm. of CO_2)
52. Holme's signal (sp. combustⁿ of PH_3); in smoke screen
53. Ions $\xrightarrow{PH_3}$ Acid (↓ O.S) + ion का Natural form

(54) **Phosphorus trichloride** → colourless oily liq.

$PCl_3 \xrightarrow{H_2O} H_3PO_3 + HCl$ (white fumes)

$PCl_3 \xrightarrow{CH_3COOH} CH_3COCl$

$PCl_3 \xrightarrow{C_2H_5OH} R-Cl$

$P_4 \xrightarrow{Cl_2} PCl_3$

$P_4 \xrightarrow{SOCl_2} PCl_3$

(55) **Phosphorus Pentachloride**

PCl_5 (solid) → $[PCl_4]^{\oplus}[PCl_6]^{\ominus}$

$P_4 \xrightarrow{SOCl_2} PCl_5$

P_4 (white) $+ Cl_2 \rightarrow PCl_5$

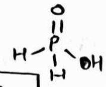
$PCl_5 \xrightarrow{H_2O} POCl_3 \xrightarrow{H_2O} H_3PO_4$

$PCl_5 \xrightarrow{\Delta} PCl_3 + Cl_2$

$PCl_5 \xrightarrow{Sn} SnCl_4$

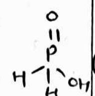
$PCl_5 \xrightarrow{Ag} AgCl + PCl_3$

(56) $H_3\overset{+1}{P}O_2$ ⇒ Hypophosphorus (Phosphinic)



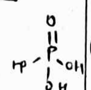
$P_4(W) + \text{Alkali} \longrightarrow H_3PO_2$

(57) H_3PO_3 → orthophosphorus (Phosphonic) or Phosphorous acid (+3)



$P_2O_3 + H_2O \longrightarrow H_3PO_3$

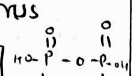
(58) $H_3\overset{+5}{P}O_4$ → orthophosphoric or Phosphoric acid



$P_4O_{10} + H_2O \longrightarrow H_3PO_4$

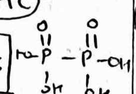
(59) $H_4\overset{+3}{P_2}O_5$ → Pyrophosphorus

$PCl_3 + H_3PO_3 \longrightarrow H_4P_2O_5$



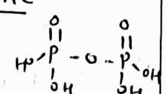
(60) $H_4P_2O_6$ → Hypophosphoric*

$P_4(R) + \text{Alkali} \rightarrow H_4P_2O_6$



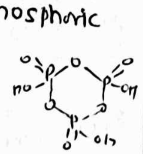
(61) $H_4P_2O_7$ Pyrophosphoric

$H_3PO_4 \xrightarrow{\Delta} H_4P_2O_7$



(62) $(HPO_3)_3$ – cyclotrimetaphosphoric acid

$H_3PO_3 + Br_2 \longrightarrow (HPO_3)_3$



(63) Reducing Nature ∝ No. of P-H bonds

(64) $H_3PO_3 \xrightarrow{\Delta} H_3PO_4 + PH_3$

(65) $AgNO_3 + H_3\overset{+1}{P}O_2 \xrightarrow{H_2O} 4Ag + HNO_3 + H_3\overset{+5}{P}O_4$

(66) HI in purificatⁿ of PH_3

(67) oxides of Nitrogen involved in ozone depletⁿ

(68) $PF_5 + XeF_2 \rightarrow [XeF]^+[PF_6]^{\ominus}$

(69) $XeF_2 + PF_5 \rightarrow [XeF]^+[PF_6]^-$

$XeF_4 + SbF_5 \rightarrow [XeF_3]^+[SbF_6]^-$

$XeF_6 + MF \rightarrow [XeF_7]^-[M]^+$ — F acceptor Rxn

(70) F_2 is S.O.A than Cl_2

→ ~~low enthalpy~~ ↓ B.D.E of F_2

↑ ΔHhyd. of $F^{\ominus}$

(71) $4I^{\ominus} + 4H^+ + O_2 \rightleftharpoons 2I_2 + 2H_2O$

(72) Halides M.P

HI > HF > HBr > HCl

222 190 185 159 K

(73) Hydride Halide B.P

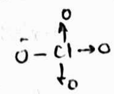
HF > HI > HBr > HCl

293 238 206 189

(74) (Cl_2) discovered by Scheele [1774]

↳ elementary nature by Davy [1810]

(75) ClO_4^-



(76) α-Black → Monoclinic / Rhombohedral

(77) $PH_3(aq.) \xrightarrow{h\nu} P(red) + H_2$

(78) $PH_3 + P_2H_6 + H_2 \xrightarrow{\text{liquid} \atop \text{freeze}} (PH_3 + P_2H_4) + H_2(l)$ (liquify)

$KI + H_2O + PH_3 \xleftarrow{KOH} PH_4I \leftarrow HI$

(79) Will-o-the wasp P → burning of $P_2H_4 + H_2$

(80) $PH_3 \xrightarrow{Cl_2} PCl_3 + HCl$

$PH_3 \xrightarrow{Cl_2 (excess)} PCl_5 + HCl$

(81) $PH_3 + O_2 \rightarrow P_4O_{10} \xrightarrow{H_2O}$ ~~H_3PO~~ HPO_3

(82) $PH_3 + AgNO_3 \rightarrow (Ag_3P \cdot AgNO_3) + HNO_3$ (intermediate)

$Ag_3P \cdot AgNO_3 + H_2O \rightarrow Ag\downarrow$ (black) $+ HNO_3 + H_3PO_3$

(83) N P As Sb Bi

M.P → ↓ (1089, 1260 ...)

B.P ↑↑

(84) $H_2 + Cl_2 \rightarrow HCl$

$H_2S + Cl_2 \rightarrow HCl + S$

$C_{10}H_{16} + Cl_2 \rightarrow HCl + C$

$S_8 + 4Cl_2 \rightarrow 4S_2Cl_2$

(85) $XX' + H_2O \rightarrow HX' + HOX$ (X → Halogen)

(86) XX_3 → T Shape

XX_5 → Square Pyramidal

XX_7 → Pentagonal Bipy.

(87) XX' → Fluorinating agents

(88) $U(s) + 3ClF_3 \rightarrow UF_6 + 3ClF$ (OR BrF_3) — enrichment of U^{235}

(17) B.P & M.P ↑es down the group

(18) $XeF_4 + SiO_2 \rightarrow SiF_4 + XeOF_4$

(19) KrF_2

18th Group

(1) He, Ne in • Pitch blende • Monazite • cleveite (not in atm.)

(2) $^{226}_{88}Ra \rightarrow ^{222}_{86}Rn + ^{4}_{2}He$

(3) ΔHeg

Ne > Ar = Kr > Xe > Rn > He

(4) sparingly soluble in water

(5) Have ↓ M.P & B.P b/co2 of weak dispersⁿ forces

(6) (He) has lowest B.P (4.2K)

↳ can diffuse through → Rubber → Glass

(7) $[O_2^{\oplus}PtF_6^{\ominus}]$ → By Neil Bartlett → Is basis of formation of Xe fluoride

↳ red comp. b/c I.E of O_2 & Xe is equal

(8) $[Xe^{\oplus}PtF_6^{\ominus}]$ → Red comp. (Xe / PtF_6)

(9) $Xe(e) + F_2 \xrightarrow{673K, 1bar} XeF_2(s)$

(10) $Xe + F_2 \xrightarrow{873K, 7bar} XeF_4(s)$ (1 : 5)

(11) $Xe + 3F_2 \xrightarrow{573K, 60-70bar} XeF_6(s)$ (1 : 20)

(12) $XeF_4 + O_2F_2 \xrightarrow{143K} XeF_6 + O_2$

(13) Hydrolysis (complete)

• $XeF_2 + H_2O \rightarrow Xe + HF + O_2$

• $XeF_4 + H_2O \rightarrow Xe + XeO_3 + HF + O_2$

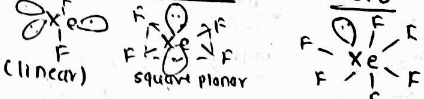
• $XeF_6 + H_2O \rightarrow XeO_3 + 4HF$

(14) Hydrolysis (Partial) No O_2

• $XeF_6 + H_2O \rightarrow XeOF_4 + 2HF$

• $XeF_6 + 2H_2O \rightarrow XeO_2F_2 + 4HF$

(15) • XeF_2 • XeF_4 XeF_6



• $XeOF_4$ • XeO_3

→ square pyramidal → colourless → volatile

• colourless • explosive.

(16) (He) → in gas cooled Nuclear reactors

→ cryogenic agent

→ with dil oxygen

(Ne) in discharge tubes

(Ar) → provide inert atm.

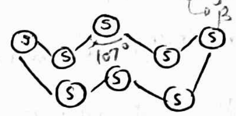
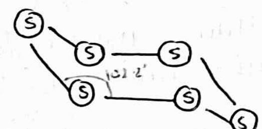
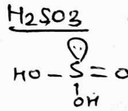
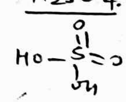
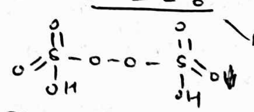
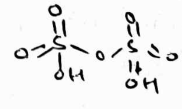
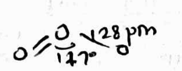
GROUP 16

1. Gypsm → $CaSO_4 \cdot 2H_2O$
2. Epson salt → $MgSO_4 \cdot 7H_2O$
3. Baryte → $BaSO_4$
4. Galena → PbS
5. zinc Blende → ZnS
6. copper pyrite → $CuFeS_2$ (fool's Gold)
7. O_2 → 90K, S_8 → 118K } due to Atomicity
8. (Po) • radioactive • $T_{1/2}$ = 13.8 days
9. Acidic Nature
   • Ies down the Grp.
   • $H_2O < H_2S < H_2Se < H_2Te < H_2Po$
10. Thermal stability
    $T.S \propto \frac{1}{size}$
11. Reducing Nature (hydrides)
    Ies down the Grp.
12. SO_2 → redusing
    TeO_2 → oxidising
13. Reducing property
    $SO_2 > SeO_2 > TeO_2$ → oxidising Ies
14. Halides
    • only Hexafluorides stable
15. SF_4 → Gas
    SeF_4 → liq.
    TeF_4 → solid
16. $2Se_2Cl_2 \rightarrow SeCl_4 + 3Se$

Oxygen → O16, O17, O18 stable

17. $2KClO_3 \xrightarrow[MnO_2]{\Delta} 2KCl + 3O_2$ — ↓ Ies rxn temp.
18. chlorates, Nitrates, Permanganate } $\xrightarrow{\Delta}$ O_2
19. Metals oxide $\xrightarrow{\Delta}$ metal + O_2 (low in electrochemical series)
20. • $Ag_2O \rightarrow Ag + O_2$
    • $HgO \rightarrow Hg + O_2$
    • $Pb_3O_4 \rightarrow PbO + O_2$
    • $PbO_2 \rightarrow PbO + O_2$
21. $2H_2O_2 \xrightarrow{MnO_2} H_2O + O_2$
22. Isotopes ^{16}O, ^{17}O, ^{18}O } stable; O_2 Paramagnetic

23. metal/Non metal + O_2 → Metal/N.M oxide (Yes o.s)
24. $SO_2 + O_2 \xrightarrow{V_2O_5} SO_3$
25. $4HCl + O_2 \xrightarrow{CuCl_2} 2Cl_2 + 2H_2O$
26. simple oxides
    • MgO, Al_2O_3
27. Mixed
    • Pb_3O_4 • Fe_3O_4 • Co_3O_4
28. Neutral
    • CO, • NO • N_2O
29. Amphoteric
    • Al_2O_3
30. $3O_2 \rightarrow 2O_3$ — OZONE → Pale blue Gas, Dark blue liq., violet-black solid
31. Quantitative method for estimating O_3 Gas
    $O_3 + KI$ (excess) $\xrightarrow[PH=9.2]{\text{Borate buffer}}$ I_2 (O_2, dry bleaching)
    ($NO + O_3 \rightarrow NO_2 + O_2$) Titrated Against standard sol. of Thiosulphate ($S_2O_3^{2-}$)
32. (SO_2 1.2 Ways)
    • $S + O_2 \rightarrow SO_2$
    • $SO_3^{2-} + 2H^+ \rightarrow H_2O + O_2$
    • $4FeS_2 + 11O_2 \rightarrow 2Fe_2O_3 + 8SO_2$
33. Ply soluble in water
34. $2NaOH + SO_2 \rightarrow Na_2SO_3 + H_2O$ → $H_2O + SO_2$ & $NaHSO_3$.
35. $SO_2 + Cl_2 \xrightarrow{C} SO_2Cl_2$
36. $2SO_2 + O_2 \xrightarrow{V_2O_5} 2SO_3$
37. $2Fe^{+3} + SO_2 + 2H_2O \rightarrow 2Fe^{+2} + SO_4^{2-} + 4H^+$
38. $5SO_2 + 2MnO_4^- + 2H_2O \rightarrow 5SO_4^{2-} + 4H^+ + 2Mn^{+2}$
39. SO_2 → Angular
40. • contact Process से H_2SO_4 बनता है।
41. i) S_8/sulphide ore $\xrightarrow{\Delta}$ SO_2
    ii) $SO_2 \xrightarrow{V_2O_5} SO_3$
    iii) $SO_3 + H_2SO_4 \rightarrow H_2S_2O_7$ (oleum)
42. $H_2S_2O_7 + H_2O \rightarrow H_2SO_4$
43. H_2SO_4
    • low volatility
    • strong Acidic character
    • strong Affinity for water
    • Ability to act as an oxidising Agent

44. Uses. Petroleum refining
    → making of → pigments, Paints, dyes stuff
    → Nitrocellulose prod.
45. $CaF_2 + H_2SO_4 \rightarrow CaSO_4 + 2HF$
46. Rhombic sulphur (α-sulphur) (mp. 385.8K)
    • Yellow color
    • s.p Gravity = 2.06
    • soluble in CS_2
    • Partial soluble → (benzene), R-OH, R-OR
    • insoluble → H_2O
47. Monoclinic sulphur (β-sulphur) (m.p 393K)
    • S.G → 1.98
    • soluble → CS_2
48. Transition temp.
    369K at this both form are stable
49. α-sulphur (stable) → 369K → β-sulphur (stable)
50. S_8

51. S_6

52. S_2 → Paramagnetic
53. H_2SO_3 sulphurous Acid (+4)

54. H_2SO_4 sulphuric acid (+6)

55. $H_2S_2O_8$ Peroxodisulphuric acid → Marshalls acid

56. $H_2S_2O_7$ Pyrosulphuric acid → oleum

57. sulphur hydrides:
    a) SH_2 b) SH_4 c) SH_3 d) SH_5
58. 
59. H_2SO_4 (conc.) + Cu → $CuSO_4 + SO_2 + H_2O$
    + S → $SO_2 + H_2O$
    + C → $CO_2 + SO_2 + H_2O$

17th GROUP

(1) Fluorspar → CaF_2

(2) cryolite → Na_3AlF_6

(3) carnalite → $KCl.MgCl_2.6H_2O$

(4) $\Delta_{eg}H$ of $F_2 < Cl_2$ due to
- small size
- interelectronic repulsn

(5)

F	Cl	Br	I
Gases		liq.	solid
React with water		sparingly soluble in water	soluble in organic solvents

(6)
- F_2 → Yellow
- Cl_2 → Greenish Yellow
- Br_2 → Red
- I_2 → Voilet

(7) $2F_2 + 2H_2O \rightarrow 4HF + O_2$

$3F_2 + 3H_2O \rightarrow 6HF + O_3$ (ozonised oxygen)

$I_2 + H_2O \rightleftharpoons$ XX

(8) Most Rxn of (F) are exothermic (ΔH = -ve)

(9) HF ⇒ H_2F_2 (l) [∵ H-Bonding] B.P of $H_2O > H_2F_2$

(10) stability of Halide Hydride

HF > HCl > HBr > HI (Reducing)

(11) OF_2 Thermally stable

(12) stability of oxide

I > Cl > Br

(13) O_2F_2 → oxidises Plutonium → PuF_6

Rxn used to remove Plutonium as PuF_6 from spent Nuclear fuel.

(14) Chlorine oxides

Cl_2O (ClO_2) Cl_2O_6 Cl_2O_7

ClO_2 or Cl_2O_4 → Bleaching agent for paper pulp, water treatment

(15) Bromine oxides

Br_2O BrO_2 BrO_3 [exist at low temp.] [S.O.A]

least stable Halogen oxides

[Mid Row anomally]

(16) Iodine oxides

I_2O_4 I_2O_5 I_2O_7

- Good oxidising agent
- used in estimatn of CO

(17) Chlorine

$MnO_2 + 4HCl \rightarrow MnCl_2 + Cl_2 + 2H_2O$ (NaCl + H_2SO_4)

(18) $2KMnO_4 + 16HCl \rightarrow 2KCl + 2MnCl_2 + 8H_2O + 5Cl_2$

(19) Deacons Process

$4HCl + O_2 \xrightarrow[723K]{CuCl_2/Cu_2Cl_2} 2Cl_2 + 2H_2O$

17th GROUP

(20) Cl_2 soluble in water. → 2-5 times heavier than air

(21) $8NH_3 + 3Cl_2 \rightarrow 8NH_4Cl + N_2$ (e) white fumes

(22) $NH_3 + 3Cl_2 \rightarrow NCl_3 + 3HCl$ (e)

(23) $2NaOH + Cl_2 \rightarrow NaCl + NaOCl + H_2O$ (cold, dil) sodium hypochlorite

(24) $6NaOH + Cl_2 \rightarrow NaCl + NaClO_3 + 3H_2O$ (hot + conc.) sodium chlorate

(25) $2Ca(OH)_2 + 2Cl_2 \rightarrow Ca(OCl)_2 + CaCl_2 + H_2O$

(26) Bleaching Powder

$Ca(OCl)_2 \cdot CaCl_2 \cdot Ca(OH)_2 \cdot 2H_2O$

(27) Cl_2 (water) standing → HOCl + HCl

Yellow color → No color

(28) HOCl Gives [O]

responsible for
- oxidising
- Bleaching Nature

(29) Cl oxidise

$Fe^{+2} \rightarrow Fe^{+3}$ $SO_2 \rightarrow SO_3$

S^{+4} (in SO_2) $\rightarrow S^{+6}$ $I_2^0 \rightarrow IO_3^-$

(30) $I_2 + 6H_2O + 5Cl_2 \rightarrow 2HIO_3 + 10HCl$

(31) Phosgene ($COCl_2$)

Tear Gas (CCl_3NO_2)

Mustard Gas ($ClCH_2-CH_2S-CH_2-CH_2Cl$)

(32) $Cl_2 + H_2O \rightarrow 2HCl + (O)$

colored subs. + (O) → colourless

(33) Bleaching effect is permanent.

(34) $NaCl + H_2SO_4 \xrightarrow{420K} NaHSO_4 + HCl$

(35) $NH_3 + HCl \rightarrow NH_4Cl$ white fumes

(36) HCl(g) can be dried by passing through conc. H_2SO_4.

(37) HCl freeze as white crystalline solid.

(38) Aqua Regia Action

$M + H^+ + NO_3^- + Cl^- \rightarrow MCl_x + NO + H_2O$

M = Au, Pt HCl : HNO_3 3 : 1

(39) HCl(g) → Hydrogen chloride

HCl(aq.) → Hydrochloric acid.

(40) Hydrochloric acid decomposes salts of weaker acid

(41) carbonate or HCO_3^- $\xrightarrow{HCl}$ salt + H_2O + CO_2 (Na_2CO_3, $NaHCO_3$)

(42) sulphite (Na_2SO_3) $\xrightarrow{HCl}$ salt + H_2O + SO_2

(43) HOF → Fluoric Acid or Hypofluorous Acid (only)

(44) Fe (Finely powder) + 2HCl → $FeCl_2$ + (H_2)

liberatn of H_2 prevent formatn of $FeCl_3$

(45)
- X^{+1} → Hypohalous Acid
- X^{+3} → Halous acid
- X^{+5} → Halic acid
- X^{+7} → perHalic acid

(46)
- HOCl → Hypochlorous acid
- $HClO_2$ → chlorous acid
- $HClO_3$ → chloric acid
- $HClO_4$ → Perchloric acid

(47) Interhalogen comp. → covalent → diamagnetic

- $Cl_2 + F_2 \rightarrow 2ClF$ (equal, gas) — XX'_3 (large, small)
- $Cl_2 + 3F_2 \rightarrow 2ClF_3$ (e)
- $I_2 + Cl_2 \rightarrow 2ICl$ (equal)
- $I_2 + 3Cl_2 \rightarrow 2ICl_3$ (e)
- $Br_2 + 3F_2 \rightarrow 2BrF_3$ (diluted with water)
- $Br_2 + 5F_2 \rightarrow 2BrF_5$

XX' Hypohalite, XX'_3 Halite, XX'_5 Halate, XX'_7 Perhalate

(48) BrF_3 — T-shaped, planar

(49) B.D.E

$Cl_2 > Br_2 > F_2 > I_2$

M.P & B.P of XX' comp.

(50) Boiling Point of Halides

M.P, B.P — M.P (HI > HF > HBr > HCl)

HF > HI > HBr > HCl

(51) Bond length

X_2 ~~>~~ XX' ~~>~~ $F_2 > XX' > X_2$

(52) Reactivity

$F_2 > XX' > X_2$ MP&BP $XX' > X_2$