SALT ANALYSIS

INTRODUCTION:

The purpose of chemical analysis is to establish the composition of a substance. This is usually done in two distinct steps: Qualitative analysis and quantitative analysis. The qualitative analysis involves the detection of the anions and the cations present in an inorganic mixture. Sometimes the knowledge of anions present in a mixture provide important clues about the cations which may be present in a mixture and the scheme of analysis to be followed. Therefore, it is desirable to first detect the presence of anions and after that the cations.

RADICAL

A charged atom or groups of atoms which participates in chemical reactions. $CuCl_2$ + H_2SO_4 → $CuSO_4$ + HCl Base Acid Salt

Cu^{2+} SO_4^{2-} Basic radical Acidic radical

Positive radical — Basic radical Negative radical — Acid radical Valency: The magnitude of charge on a radical.

IDENTIFICATION OF ACIDIC RADICALS

Group I: This group consists of radicals which are detected by dilute H_2SO_4 or dilute HCl. These are (i) Carbonate, CO_3^{2-} (ii) Sulphite, SO_3^{2-} (iii) Sulphide, S^{2-} (iv) Acetate CH_3COO^- and (v) Nitrite, NO_2^-

Group II: This group consists of radicals which are detected by concentrated H_2SO_4. These are (i) Chloride, Cl^- (ii) Bromide, Br^- (iii) Iodide, I^- (iv) Nitrate NO_3^- and (v) Oxalate $C_2O_4^{2-}$

Group III: The radicals which do not give any characteristic gas with dilute and concentrated H_2SO_4. These are (i) Sulphate, SO_4^{2-} (ii) Phosphate, PO_4^{3-} (iii) Borate and (iv) Fluoride.

(A) Observation of Dil. HCl/H_2SO_4 + little amount of substance on slow heating

Radical	Test / Observation / Analysis	Reaction

I) CO_3^{2-} (Carbonate)	) Sharp bubbling of colourless gas (CO_2)	$Na_2CO_3 + H_2SO_4 \rightarrow Na_2SO_4 + H_2O + CO_2\uparrow$
	i) Gas turns milky to lime	$CO_2 + Ca(OH)_2 \rightarrow CaCO_3\downarrow$ (Milky) $+ H_2O$
	ii) On passing excess gas through lime water, milky colour disappears.	$CaCO_3 + CO_2 + H_2O \rightarrow Ca(HCO_3)_2$
2) SO_3^{2-} (Sulphite)	) Colourless gas (SO_2) in which very unpleasant smell of burnt sulphur	$Na_2SO_3 + H_2SO_4 \rightarrow Na_2SO_4 + H_2O + SO_2\uparrow$
	i) Gas turns green to moist acidic $K_2Cr_2O_7$ paper	$_2Cr_2O_7 + H_2SO_4 + 3SO_2 \rightarrow K_2SO_4 + Cr_2(SO_4)_3$(green) $+ H_2O$
	ii) Sulphite gives white ppt. with $BaCl_2$ which is soluble in dil. HCl	$a_2SO_3 + BaCl_2 \rightarrow 2NaCl + BaSO_3\downarrow$
3) S^{2-} (Sulphide)	) Colourless gas with rotten egg smell (H_2S)	$Na_2S + H_2SO_4 \rightarrow Na_2SO_4 + H_2S\uparrow$
	i) Gas turns black to lead acetate paper	$CH_3COO)_2Pb + H_2S \rightarrow PbS\downarrow$(black) $+ 2CH_3COOH$
	ii) Sulphide turns violet colour to sodium nitroprusside soln.	$Na_2S + Na_2[Fe(NO)(CN)_5] \rightarrow Na_4[Fe(NO)(CN)_5S]\uparrow$ (violet)
4) CH_3COO^- (Acetate)	) Vinegar smell, acetate may be	$2CH_3COONa + H_2SO_4 \rightarrow 2CH_3COOH + Na_2SO_4$ (Vinegar smell)

	i) Acetate gives blood red colour with neutral $FeCl_3$ solution.	$CH_3COONa + 2FeCl_3 \rightarrow Fe(CH_3COO)_3 + 3NaCl$
5) NO_2^- (Nitrite)	) Red, brown NO_2 vapour comes out. Nitrite may be	$NaNO_2 + H_2SO_4 \rightarrow Na_2SO_4 + 2HNO_2$ $3HNO_2 \rightarrow HNO_3 + 2NO\uparrow + H_2O$ $2NO + O_2 \rightarrow 2NO_2\uparrow$
	i) Gas turns blue to iodic KI starch paper.	$KI + 2NO_2 \rightarrow 2KNO_2 + I_2$ starch + $I_2 \rightarrow$ blue colour
6) Cl^- (Chloride)	) Colourless fuming gas (HCl) with faint smell	$NaCl + H_2SO_4 \rightarrow Na_2SO_4 + 2HCl\uparrow$
	i) Chloride gives white ppt. with $AgNO_3$ which is soluble in NH_4OH	$aCl + AgNO_3 \rightarrow AgCl\downarrow + NaNO_3$ (white) $AgCl + 2NH_4OH \rightarrow Ag(NH_3)_2Cl + 2H_2O$ (soluble)
	ii) Chromyl chloride test	$NaCl + K_2Cr_2O_7 + 3H_2SO_4 \rightarrow 2CrO_2Cl_2 + 2Na_2SO_4 + K_2SO_4 + 3H_2O$ (orange red)
	a) Sodium chloride when heated with $K_2Cr_2O_7$ & conc. H_2SO_4 then orange red vapour of chromyl chloride CrO_2Cl_2 comes out.	$rO_2Cl_2 + NaOH \rightarrow Na_2CrO_4 + 2NaCl + 2H_2O$
	b) This vapour when passed with NaOH gives yellow solution (Na_2CrO_4)	$a_2CrO_4 + (CH_3COO)_2Pb \rightarrow 2CH_3COONa + PbCrO_4\downarrow$ (yellow ppt.)
	c) Acidic solution of Na_2CrO_4 gives yellow ppt. with $(CH_3COO)_2Pb$	

7) Br^- (Bromide)	) Brown vapour comes out of $[Br_2]Br^-$ or NO_2 may be	$NaBr + H_2SO_4 \rightarrow Na_2SO_4 + 2HBr$ $2HBr + H_2SO_4 \rightarrow Br_2\uparrow + SO_2\uparrow + 2H_2O$

Radical	Test / Observation / Analysis	Reaction
11) SO_4^{2-} (Sulphate)	mall amount of substance + conc.HNO_3 mixtures is heated & now adding $BaCl_2$ white ppt. comes which is insoluble in acid or base. Sulphate confirmed.	$a_2SO_4 + 2HNO_3 \rightarrow 2NaNO_3 + H_2SO_4$ $H_2SO_4 + BaCl_2 \rightarrow BaSO_4\downarrow + 2HCl$ (white)
12) PO_4^{3-} (Phosphate)	a) Small amount of substance + conc. HNO_3 mixture is heated &	a) $Na_3PO_4 + 3HNO_3 \rightarrow 3NaNO_3 + H_3PO_4$
	b) Ammonium molybdate is mixed, yellow ppt. comes which confirms the presence of phosphate.	b) $H_3PO_4 + 12(NH_4)_2MoO_4 \rightarrow 23HNO_3$ (ammonium molybdate) $\rightarrow (NH_4)_3PO_4 12MoO_3\downarrow + 12H_2O \rightarrow 21NH_4NO_3$ (ammonium phosphomolybdate (yellow ppt.))
13) BO_3^{3-} (Borate)	o small quantity of the substance (salt or mixture), add a few mL of ethyl alcohol and conc. H_2SO_4. Stir the contents with a glass rod. Heat the test tube and bring the mouth of the test tube near the flame. The formation of green-edged flame indicates the presence of borate.	$Na_3BO_3 + 3H_2SO_4 \rightarrow 2Na_2SO_4 + 2H_3BO_3$ $H_3BO_3 + 3C_2H_5OH \rightarrow (C_2H_5)_3BO_3 + 3H_2O$ (Ethyl borate)

14) F^- (Fluoride)	ake a small amount of the substance in a dry test tube and add an equal amount of sand. Mix the contents and add conc. H_2SO_4. Heat the contents and place a glass rod moistened with water over the mouth of the test tube. A waxy white deposit on the rod is formed.	NaF + H_2SO_4 → Na_2SO_4 + 2HF↑ SiO_2 + 2HF → SiF_4 + H_2O 3SiF_4 + 2H_2O → H_2SiO_3 + 2H_2SiF_6 (white)

TEST OF BASIC RADICALS

Radicals:
GROUP I
Pb^{2+}, Ag^{+}, Hg^{2+}(ous)
Group reagent:
Dil. HCl

Radicals:
GROUP II
Hg^{2+}, Pb^{2+}, Bi^{3+}, Cu^{2+}, Cd^{2+} Group IIA
As^{3+}, Sb^{3+}, Sn^{2+}, Sn^{4+} Group IIB
Group reagent:
H_2S gas in presence of dil. HCl

Radicals:
GROUP III
Fe^{3+}, Al^{3+}, Cr^{3+}
Group reagent:
NH_4OH + NH_4Cl

Radicals:
GROUP IV
Ni^{2+}, Co^{2+}, Mn^{2+}, Zn^{2+}
Group reagent:
H_2S gas in presence of NH_4Cl & NH_4OH

Radicals:
GROUP V
Ba^{2+}, Sr^{2+}, Ca^{2+}
Group reagent:
$(NH_4)_2CO_3$ in presence of NH_4OH

Radicals:
GROUP VI
Mg^{2+}
Group reagent:
Na_2HPO_4 in presence of NH_4OH

Group No./Radical	Test / Observation / Analysis	Reaction
group Pb^{2+}, Ag^+, Hg_2^{2+}	small amount of salt + few drops of dil. HCl, white ppt. comes out which confirms the presence of Pb^{2+}, Ag^+ or Hg_2^{2+}	$bCl_2 + 2Cl^- \rightarrow [PbCl_4]^{2-}$ (soluble) $AgCl + Cl^- \rightarrow [AgCl_2]^-$ (insoluble) $Hg_2SO_4 + 2Cl^- \rightarrow Hg_2Cl_2\downarrow + SO_4^{2-}$
ote: $PbCl_2$ is soluble in hot water (but insoluble in cold water) Whereas insoluble in both AgCl & Hg_2Cl_2		
1) Pb^{2+}	"b" ion gives yellow ppt. with K_2CrO_4 & KI both separately.	$bCl_2 + K_2CrO_4 \rightarrow PbCrO_4\downarrow$ (yellow) + 2KCl
2) Hg_2^{2+}	"Hg_2" gives black ppt. with NH_3	$g_2Cl_2 + 2NH_4OH \rightarrow Hg(NH_2)Cl\downarrow + Hg\downarrow + NH_4Cl + 2H_2O$
3) Ag^+	) Ag^+ is soluble in NH_4OH (ii) Ag^+ ion gives yellow ppt. with K_2CrO_4	$g^+ + 2NH_4OH \rightarrow [Ag(NH_3)_2]^+ + 2H_2O$ $Ag^+ + I^- \rightarrow AgI\downarrow$ (yellow)
4) Cu^{2+}	) Passing H_2S in presence of HCl these gives ions	
group Hg^{2+}, Cu^{2+}, Pb^{2+}, Cd^{2+}, Bi^{3+}(IIA) As^{3+}, Sb^{3+}, Sn^{2+}(IIB) Cu^{2+}, Cd^{2+}, Bi^{3+}, Pb^{2+}, Sn^{4+}, Sb^{3+}**	ellow ppt. (CdS, As_2S_3) Orange ppt. (Sb_2S_3) Brown ppt. (SnS)	

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Radical	Test / Observation / Analysis	Reaction

g^{2+}, Pb^{2+}, Bi^{3+}, Cu^{2+}	lack ppt. (HgS, PbS, Bi_2S_3, CuS)	
ote: Obtained ppt. is differentiated by the reaction of $(NH_4)_2S_2$ which is insoluble in the ppt. obtained of II A and soluble in II B ppt.		
-A group Hg^{2+}	Hg" is soluble in aquaregia Adding $SnCl_2$ gives white ppt. obtained which turns black	$2HgS + 2HNO_3 + 6HCl \rightarrow 2HgCl_2 + 2NO\uparrow + 2S\downarrow + 4H_2O$ $2Hg^{2+} + SnCl_2 \rightarrow Sn^{4+} + Hg_2^{2+} + HgCl_2\downarrow$ $Hg_2Cl_2 + SnCl_2 \rightarrow SnCl_4 + 2Hg\downarrow$ (black)
5) Pb^{2+}	) In solution, Pb^{2+} gives hot ppt. with H_2SO_4 (ii) In solution, Pb^{2+} ion gives yellow ppt. with K_2CrO_4 & KI	$b^{2+} + H_2SO_4 \rightarrow PbSO_4\downarrow + 2H^+$ $Pb^{2+} + CrO_4^{2-} \rightarrow PbCrO_4\downarrow$ (yellow) $Pb^{2+} + 2I^- \rightarrow PbI_2\downarrow$ (yellow)
6) Cu^{2+}	) These ion gives dark blue colour with excess NH_4OH (ii) Cu^{2+} ion gives chocolate colour with $K_4Fe(CN)_6$	$Cu^{2+} + 4NH_4OH \rightarrow [Cu(NH_3)_4]^{2+} + 4H_2O$ $2Cu^{2+} + K_4Fe(CN)_6 \rightarrow Cu_2[Fe(CN)_6]\downarrow + 4K^+$ (chocolate or red brown ppt.)
7) Bi^{3+}	) Bi^{3+} ion gives white ppt. when adding water and adding HCl solution it gets clear (ii) In this solution if stannous ppt. with alkaline Na_2SnO_3	$Bi(NO_3)_3 + H_2O \rightarrow Bi(OH)(NO_3)_2 + HNO_3$ (white bismuth oxy nitrate) $Bi(OH)(NO_3)_2 + 3HCl \rightarrow BiCl_3 + 2H_2O + HNO_3$ $BiCl_3 + 3Na_2SnO_3 + 6NaOH \rightarrow$ (sodium stannite) $2Bi\downarrow + 3Na_2SnO_3 + 6NaCl + 3H_2O$ (black)
8) Cd^{2+}	) The yellow precipitate is dissolve in dil. HNO_3. To the resulting solution, NH_4OH is added slowly. A white ppt. is formed which dissolve in excess of NH_4OH. (ii) When KCN is present, in this solution a yellow ppt. appears.	$Cd^{2+} + (S^{2-}) \rightarrow CdS$(yellow) $+ H_2O + 2H^+ (NO_3)^- CdS + 2HNO_3 \rightarrow Cd(NO_3)_2 + H_2S\uparrow$ $Cd(NO_3)_2 + 2NH_4OH \rightarrow Cd(OH)_2\downarrow + 2NH_4NO_3$ (white) $Cd(OH)_2 + 2NH_4OH \rightarrow$ $Cd(NH_3)_{42} + 2H_2O$ $Cd(NH_3)_{42} + H_2S \rightarrow CdS\downarrow + 2NH_4NO_3 + 2NH_3$

-B group As^{3+}	n solution As^{3+} ion forms yellow ppt. with ammonium molybdate and HNO_3	$As^{3+} \rightarrow (H_3AsO_4) \rightarrow As^{5+}$ (in H_3AsO_4) $H_3AsO_4 + 12(NH_4)_2MoO_4 + 21HNO_3 \rightarrow (NH_4)_3[As(Mo_3O_{10})_4]\downarrow + 21NH_4NO_3 + 12H_2O$
10) Sn^{4+}	n^{4+} ion gives white ppt. which turns black in form of $HgCl_2$ with $SnCl_2$ when thusly black.	$SnCl_4 + 2HgCl_2 \rightarrow SnCl_4 + Hg_2Cl_2\downarrow$ $Hg_2Cl_2 + SnCl_2 \rightarrow SnCl_4 + 2Hg\downarrow$ (black)

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Radical	Test / Observation / Analysis	Reaction
(11)Sn^{2+}	\ turning Sn^{2+} to Sn^{4+}. After Sn^{4+} is examined by $HgCl_2$.	$SnCl_2 + HgCl_2 \rightarrow$ No reaction $3SnCl_2 + 2A^{l} \rightarrow 2AlCl_3 + 3SnCl_4$
(12)Sb^{3+}	On adding water in solution, Sb^{3+} ion forms white ppt. in the form of SbOCl which is dissolved when HCl is added.	$SbCl_3 + H_2O \rightarrow SbOCl\downarrow$ (white) + 2HCl SbOCl + 2HCl $\rightarrow SbCl_3 + H_2O$
II group Fe^{3+}, Cr^{3+} & Al^{3+}	hese ion precipitate in the form of hydroxide on adding NH_4OH & NH_4OH	$Fe^{3+} + 3OH^- \rightarrow Fe(OH)_3\downarrow$ (reddish brown ppt.) $Cr^{3+} + 3OH^- \rightarrow Cr(OH)_3\downarrow$ (green ppt.) $Al^{3+} + 3OH^- \rightarrow Al(OH)_3\downarrow$ (white ppt.)
Note: In the analysis of III group, some drops of conc. HNO_3 are also added before oxidising Fe^{2+} to Fe^{3+}		
(13) Al^{3+}	White ppt. of $Al(OH)_3$ is soluble in an excess of sodium hydroxide	$Al(OH)_3 + NaOH \rightarrow Na[Al(OH)_4] + 2H_2O$ (sodium aluminate)
(14)Cr^{3+}	(i) Solution of $Cr(OH)_3$ is acidified + Br_2 water (or in this soln. when $BaCl_2$ is added yellow ppt. is obtained)	$Br_2 + 2OH^- \rightarrow 2Br^- + H_2O + [O]$ $2Cr(OH)_3 + 2NaOH + 3O \rightarrow 2Na_2CrO_4 + 5H_2O$ $Na_2CrO_4 + BaCl_2 \rightarrow BaCrO_4\downarrow$ (yellow) + 2NaCl

(15) Fe^{3+}	(i) On addition of KSCN to Fe^{3+} solution, blood red colouration is obtained. When KSCN is added to this soln., blood red colouration is obtained. (ii) In this soln., on adding $K_4Fe(CN)_6$, prussian blue colour is obtained.	$Fe(OH)_3 + 3HCl \rightarrow FeCl_3 + 3H_2O$ $Fe^{3+} + SCN^- \rightarrow [Fe(SCN)]^{2+}$ (NCl) (blood red) $Fe^{3+} + K_4[Fe(CN)_6] \rightarrow Fe_4[Fe(CN)_6]_3\downarrow$ (KCl) (ferric ferrocyanide prussian blue)
IV group Zn^{2+}, Mn^{2+}, Ni^{2+}, Co^{2+}, Ni^{2+}	These ions in presence of NH_4OH precipitate on passing H_2S. Black ppt. (CoS, NiS) (soluble in dilute HCl) White ZnS (soluble in HCl) Pink or buff (MnS), soluble in HCl	$NiCl_2 + H_2S \rightarrow NiS\downarrow + 2HCl$
(16)Ni^{2+}	n presence of NH_4OH, Ni salt on reaction with dimethyl glyoxime (DMG) turns red ppt. of nickel dimethyl glyoxime.	$CH_3 - C = NOH + Ni^{2+} \rightarrow CH_3 - C = NONi + 2H^+$ DMG + Nickel dimethyl glyoxime (red ppt.)
(17)Co^{2+}	Cobalt salt turns blue colouration with NH_4CNS	$CoCl_2 + 4NH_4CNS \rightarrow [Co(NH_4)_4(CNS)_4]^{2+} + 2NH_4Cl$ (ammonium cobalt thiocyanate) (blue colour)

Radical	Test / Observation / Analysis	Reaction
(18)Zn^{2+}	In solution, Zn^{2+} ion turns white ppt. with NaOH which is soluble in excess NaOH	$n^{2+} + 2NaOH \rightarrow Zn(OH)_2\downarrow$ (white) + $2Na^+$ $Zn(OH)_2 + 2NaOH \rightarrow Na_2Zn(OH)_4 + 2H_2O$ (soluble zincate)
(19)Mn^{2+}	a) Mn^{2+} ion gives pink ppt. with NaOH (b) On heating turns black or brown.	$Mn^{2+} + 2NaOH \rightarrow Mn(OH)_2\downarrow + 2Na^+$ $Mn(OH)_2 + O \rightarrow MnO_2\downarrow + H_2O$ (green and black)
/ group Ba^{2+}, Sr^{2+}, Ca^{2+}	n adding $(NH_4)_2CO_3$, these precipitate in the form of carbonates.	$Ba^{2+} + (NH_4)_2CO_3 + NH_4OH \rightarrow BaCO_3\downarrow + 2NH_4^+$ $BaCO_3 + 2CH_3COOH \rightarrow Ba(CH_3COO)_2$ (soluble in CH_3COOH)

(20) Ba^{2+}	Give Ba^{2+} ion in solution (i) Yellow ppt. with K_2CrO_4 (ii) White ppt. with $(NH_4)_2SO_4$ (iii) white ppt. with $(NH_4)_2CO_3$	$a^{2+} + K_2CrO_4 \rightarrow BaCrO_4\downarrow$ (yellow) + $2K^+$ $Ba^{2+} + (NH_4)_2SO_4 \rightarrow BaSO_4\downarrow$ (white) + $2NH_4^+$ $Ba^{2+} + (NH_4)_2CO_3 \rightarrow BaCO_3\downarrow$ (white) + $2NH_4^+$
(21) Ca^{2+}	(i) On test in $(NH_4)_2CO_3$ gives white precipitate Ca^{2+} ion gives white ppt. only with $(NH_4)_2C_2O_4$	$Ca^{2+} + (NH_4)_2CO_3 \rightarrow CaCO_3\downarrow + 2NH_4^+$ $Ca^{2+} + (NH_4)_2C_2O_4 \rightarrow CaC_2O_4\downarrow + 2NH_4^+$ (white ppt.)
Note: The order of fruit is same as above Ba^{2+}, Sr^{2+}, Ca^{2+}		
/I group (22) Mg^{2+}	Mg^{2+} ion gives white ppt. with $NH_4OH + Na_2HPO_4$	$Mg^{2+} + NH_4OH + Na_2HPO_4 \rightarrow MgNH_4PO_4\downarrow$ (white) + $2Na^+ + H_2O$
Zero group	(a) NH_4^+ ion when it is mix or reacting with soda lime (NaOH), gives smell of NH_3 (b) Gas evolved (NH_3) gives white fume with HCl (c) On passing NH_4^+ through Nessler's reagent [K_2HgI_4/NaOH], brick colour is obtained. (d) Brown ppt. is obtained with mercurous nitrate is present.	(a) $NH_4Cl + NaOH \rightarrow NaCl + NH_3\uparrow + H_2O$ (b) $NH_3 + HCl \rightarrow NH_4Cl\uparrow$ (white fume) (c) $Hg(NO_3)_2 + 2NH_3 \rightarrow Hg + Hg(NH_2)NO_3 + NH_4NO_3$ (black) (d) $2K_2HgI_4 + 4KOH + NH_3Cl \rightarrow$ (Nessler's reagent) $Hg + HgNH_2I + 7KI + KCl + 4H_2O$ (iodide solution brown ppt.)

BORAX BEAD TEST:

On heating borax the colourless glassy bead formed consists of sodium metaborate and boric anhydride.

$Na_2B_4O_7.10H_2O \rightarrow Na_2B_4O_7 \rightarrow 2NaBO_2 + B_2O_3$ (Heat) (Glassy bead)

On heating with a coloured salt, the glassy bead forms a coloured metaborate in oxidizing flame. $CuSO_4 \rightarrow CuO + SO_3$ $CuO + B_2O_3 \rightarrow Cu(BO_2)_2$ Copper metaborate (Blue)

Colour of The bead in:

Metal	Oxidizing-flame	Reducing-flame
	Hot	Cold
Copper	Green	Blue
Manganese	Green-yellow	Light-yellow
Chromium	Green	Green
Cobalt	Blue	Blue
Nickel	Violet	Brown

PHYSICAL APPEARANCE OR INORGANIC SALT

S. No.	INORGANIC SALT	COLOUR
1.	Cu^{2+}	Blue
2.	Cr^{3+}	Dark green
3.	Fe^{2+}	Green
4.	Fe^{3+}	Yellow or Brown

5.	Mn^{2+}	Light Pink
6.	Co^{2+}	Pink
7.	Ni^{2+}	Green or Blue
8.	HgO, HgI_2, Pb_3O_4	Red

ACTION OF HEAT

1. Except (Na, K, Rb and Cs) all carbonates on heating decomposes to give CO_2. $Li_2CO_3 \longrightarrow Li_2O + CO_2\uparrow$ $MgCO_3 \longrightarrow MgO + CO_2\uparrow$

2. Generally all carbonates decomposes to give carbonate and CO_2. $2NaHCO_3 \longrightarrow Na_2CO_3 + H_2O + CO_2$

3. Generally halides are stable on heating but some halides decompose. $2KClO_3 \longrightarrow 2KCl + 3O_2\uparrow$

   $MgCl_2.6H_2O \longrightarrow MgO + 2HCl\uparrow + 5H_2O$

4. Nitrates decompose on heating. $Hg_2Cl_2 \longrightarrow HgCl_2 + Hg$ $NaN_3 \longrightarrow Na + 3/2\ N_2\uparrow$

   $NH_4NO_3 \longrightarrow N_2O + 2H_2O$ $NaNO_3 \longrightarrow NaNO_2 + O_2$ (except Li)

   $2KNO_3 \longrightarrow K_2O + 2NO_2\uparrow + O_2$ Important

   $2Mg(NO_3)_2 \longrightarrow 2MgO + 4NO_2\uparrow + O_2$ $2Cu(NO_3)_2 \longrightarrow 2CuO + 4NO_2\uparrow + O_2\uparrow$ (except Hg all bivalent nitrates) $Hg(NO_3)_2 \longrightarrow Hg + 2NO_2\uparrow + O_2$

5. Silver salts on heating gives Ag. $Ag_2CO_3 \longrightarrow 2Ag + CO_2\uparrow + O_2$

   $2AgNO_3 \longrightarrow 2Ag + 2NO_2\uparrow + O_2$

CHARACTERISTIC FLAME COLOUR

(1) Na → yellow glow (6) Cu^{2+}, BO_3^{3-} → blue or green (2) K → violet (7) Ba → golden yellow (3) Ca → violet (8) Pb → violet red (4) Sr → crimson (9) As → blue (5) Cs → crimson red (10) Ba → apple green

Note: (1) Be & Mg don't give flame test. (2)Colorless white salt don't possess Cu, Ni, Co, Fe, Mn, Cr etc. (3)White substances which swell are alum, borate and phosphate.

SUBLIMATION ACTION OF A SUBSTANCE AND COLOUR

White: $HgCl_2$, Hg_2Cl_2, As_2O_3, Sb_2O_3 Yellow: $AsCl_3$ and Hg_2 halides Brown: HgO, I_2, Bi_2O_3 Black, black and violet: Iodides Red: As, Sb, Hg sulphide and iodides.

1. Physical appearance of inorganic salts

S No.	Salt	Colour
1	MnO_2, Fe_2O_3, CuO, CoO_3, NiO_2, sulphides of Al^{3+}, Cu^{2+}, Cr^{3+}, Fe^{3+}, Fe^{2+}, Hg^{2+}	Black
2	Hydrated Cu^{2+} salts	Blue
3	HgO, HgI_2, Pb_3O_4	Red
4	Cr^{3+}, Cr^{2+}, Ni^{2+}, hydrated Fe^{2+} salts	Green
	Hydrated Mn^{2+} salt	Light Pink
	MnO, $K_2Cr_2O_7$, Sb_2S_3, ferricyanides	Orange
	Hydrated Fe^{3+} salts	| Brown

	Chromates, AgBr, AgI, PbI_2, CdS	Yellow
	CaO, Fe_2O_3, PbO_2, $CaCrO_4$	Dark brown

2. Group I : Anions which liberate gases with dil. HCl or dil. H_2SO_4. (CO_3^{2-}, HCO_3^-, SO_3^{2-}, S^{2-}, NO_2^-)

3. Group II : Gases or acid vapours evolved with conc. H_2SO_4 (Cl^-, Br^-, I^-, NO_3^-).

4. Group III : Anions which do not liberate any gas with dil. HCl or conc. H_2SO_4. They are detected by precipitation (SO_4^{2-}, PO_4^{3-}).

5. White cations : Pb^{2+}, Zn^{2+}, Hg^{2+} with dil. HCl white ppt occurs.

6. Group I : Cations : Pb^{2+}, Ag^+, Hg_2^{2+}. Pb^{2+} soluble in hot water. Ag^+ soluble in NH_4OH gives $(Ag(NH_3)_2)^+$, green ppt. ($Cr(OH)_3$) and brown ppt ($Fe(OH)_3$).

7. Group III cations : Ni^{2+}, Co^{2+} gives black ppt. with NH_4OH (excess) and H_2S gas.

8. Group IV cations : Na^+, K^+, NH_4^+, Mg^{2+}. Na^+ gives buff ppt. and Zn^{2+} gives white ppt.

9. Group V cations : Ba^{2+}, Sr^{2+}, Ca^{2+} with $(NH_4)_2CO_3$, NH_4OH (excess) and $(NH_2)_2CO_3$ gives white ppt.