Chapter 8

Salt Analysis

Key Concepts

Qualitative analysis involves the detection of basic radicals (cations) and acidic radicals (anions) of a salt or a mixture of salts.

Acid + Base → Salt + H_2O + Heat of Neutralisation

$HCl + NaOH \rightarrow \underline{NaCl} + H_2O$ + Heat

Na^+ (Basic radical because it comes from base)

Cl^- (Acidic radical because it comes from acid)

The systematic procedure for qualitative analysis is:

a. Preliminary tests:
   - → Physical appearance (Colour and smell)
   - → Dry heating test
   - → Flame test
   - → Borax bead test
   - → Charcoal cavity test
   - → Cobalt nitrate test

b. Wet tests for acidic radicals

c. Wet tests for basic radicals

Physical appearance (Smell):

Smell	Inference
Ammonical Smell	NH_4^+
Vinegar like Smell	CH_3COO^-
Smell like that of rotten eggs	S^{-2}
Chlorine gas smell	Hypochlorites (ClO^-)
Bitter almond smell	Cyanides

Physical appearance (Coloured substance):

Light pink	Hydrated salt of Mn
Reddish Pink	Hydrated salt of Co(II)
Red	HgO, HgI_2, Pb_3O_4
Orange – red	Sb_2S_3, Some dichromates and ferricyanides
Reddish brown	Fe_2O_3
Dark brown	PbO_2, Bi_2S_3, CdO, Ag_2O, $CuCrO_4$, SnS
Light yellow or brown	Chromates, As_2S_3, As_2S_5, AgBr, AgI, PbI_2, CdS, SnS_2, a few iodides and ferrocyanides.
Green	K_2MnO_4, Ni salts, hydrated ferrous salts, some Cu (II) Compound
Dark green	Salt of Cr(III)
Blue	Hydrated $CuSO_4$, anhydrous $CoSO_4$
Black	Sulphides of Ag^+, Cu^+, Cu^{+2}, Fe^{+2}, Ni^{+2}, Co^{+2}, Hg^{+2}, and Pb^{+2}. MnO_2, Fe_3O_4, FeO, CuO, Co_3O_4, Ni_2O_3

Physical appearance (Solution is coloured):

Green or blue	Ni^{+2}, Fe^{+2}, Cr^{+3} and Cu^{+2}
Pink	Co^{+2} and Mn^{+2}
Yellow	CrO_4^{2-}, Fe^{+3}, $[Fe(CN)_6]^{4-}$
Orange	Dichromates
Purple	Permanganates

Dry heating:

	Observation	Inference
1.	Substance decrepitates (Crackling noise)	NaCl, KI, $Pb(NO_3)_2$, $Ba(NO_3)_2$
2.	Substance Melts (or, fuses)	Alkali metal salts or salt containing water of crystallization
3.	Substance swells (due to loss of water of crystallization)	Alums, borates and Phosphates
4.	The substance Sublimes and the colour of sublimate is:-	
	a. White	Hg_2Cl_2, NH_4X, $AlCl_3$, $HgCl_2$, As_2O_3,Sb_2O_3
	b. Yellow	As_2S_3 and HgI_2 (turns red when rubbed with glass rod)
	c. Blue black and violet vapours	Iodides
5.	A residue (generally oxides) is left and its colour is:	
	a. White (Cold) and Yellow (Hot)	ZnO
	b. Reddish brown (Hot); Yellow (Cold)	PbO
	c. Black (Hot); Red (Cold)	HgO, Pb_3O_4
	d. Black (Hot); Red brown (Cold)	Fe_2O_3
	e. Original salt Blue becomes White on heating	Hydrated $CuSO_4$
6.	Gas is evolved:	Ammonium nitrate
	(i) Colourless and odourless	
	a. CO_2 (Turns lime water milky)	CO_3^{-2} $C_2O_4^{-2}$
	b. O_2 (Rekindles a glowing splinter)	Nitrates, permanganate, Dichromate, chlorate
	c. N_2	Amonium Nitrate
	(ii) Colourless gas with odour	
	a. NH_3 (Characteristic smell, turns nesseler's solution brown and turns red litmus blue)	NH_4^+
	b. H_2S (Smell of rotten eggs, turns lead acetate paper black)	S^{-2} or Hydrated S^{-2}
	c. SO_2 (suffocating or irritating smell of burning sulphur, turns acidified $K_2Cr_2O_7$ paper green)	SO_3^{2-}
	d. HCl (Pungent smell, white fumes with ammonia, white ppt with $AgNO_3$ Solution)	Hydrated Cl^-
	e. Acetic acid vapours (characteristic vinegar like smell)	CH_3COO^-
	(iii) Coloured gas	
	a. NO_2 (Reddish brown, turns ferrous sulphate solution brownish black)	NO_2^- or NO_3^-
	b. Br_2 (Reddish brown turns starch paper orange-red or yellow, turns starch iodide paper blue)	Br^-
	c. Cl_2 (Greenish yellow, turns starch iodide paper blue, bleaches moist litmus paper, bleaches indigo solution)	Cl^-
	d. I_2 (violet, turns starch paper blue)	I^-

Flame test: The chlorides of the metals are more volatile as compared to other salts and these are prepared by mixing the compounds with a little concentrated HCl. On heating in a non- luminous Bunsen flame, they are volatilized and impart a characteristic colour to the flame.

Metal	Colour of flame
Li	Crimson red
Na	Golden yellow
K	Violet/lilac
Rb	Red violet
Cs	Blue violet
Ca	Brick red
Sr	Crimson red
Ba	Apple green

Borax bead test:

$$Na_2B_4O_7.10H_2O \xrightarrow{\Delta} Na_2B_4O_7 \xrightarrow{\Delta} \underbrace{2NaBO_2 + B_2O_3}_{\text{Colourless transparent glassy bead}}$$

On heating with a coloured salt, the glassy bead forms a coloured metaborate in oxidizing flame.

Colour of bead

Metal	Oxidising flame		Reducing flame	
	Hot	Cold	Hot	Cold
Cr	Yellow	Green	Green	Green
Mn	Violet (Amethyst)	Amethyst	Colourless	Colourless
Fe	Yellowish Brown	Yellow	Green	Green
Co	Blue	Blue	Blue	Blue
Ni	Violet	Reddish-Brown	Grey	Grey
Cu	Green	Blue	Colourless	Red opaque

Solubility rules:

Ions	Solubility	Exceptions
NH_4^+, Li^+, Na^+, K^+, Rb^+, Cs^+	Soluble	None
NO_3^-, CH_3COO^-, ClO_4^-, ClO_3^-, MnO_4^-, HCO_3^-, HSO_3^-	Soluble	None
Cl^-,Br^-,I^-	Soluble	Ag^+, Pb^{+2}, Hg_2^{+2}, Cu^+
SO_4^{-2}	Soluble	Hg^{+2}, Pb^{+2}, Sr^{+2}, Ca^{+2}, Ba^{+2}
OH^-	Insoluble	Li^+, Na^+, K^+, Rb^+, Cs^+, Ca^{+2}, Sr^{+2}, Ba^{+2}
PO_4^{-3}, S^{-2}, CO_3^{-2}, SO_3^{-2}	Insoluble	NH_4^+, Li^+, Na^+, K^+, Rb^+, Cs^+

Classification of basic radicals:

Group	Group reagent	Basic radical	Precipitate and its colour
i.	Dil HCl	Pb^{2+}, Hg_2^{2+}, Ag^+	AgCl (white) $PbCl_2$ (white) Hg_2Cl_2 (white)
ii	H_2S in presence of dilute HCl	ii (a) Hg^{2+}, Pb^{2+}, Bi^{3+} Cu^{2+}, Cd^{2+} (Copper group) Their sulphides are not soluble in YAS ($(NH_4)_2S_2$) as well as in colourless $(NH_4)_2S$	HgS PbS, CuS, Bi_2S_3 } Black CdS (Yellow)
		ii (b) As^{3+},As^{5+},Sb^{3+}, Sb^{5+},Sn^{2+},Sn^{4+} (Aresenic group). Their sulphides are soluble in YAS, also they are soluble in colourless $(NH_4)_2S$ except SnS	As_2S_3, As_2S_5 } Yellow Sb_2S_3, Sb_2S_5 } Orange Sb_2S_5 (Brown) SnS_2 (Yellow)
iii	NH_4Cl + NH_4OH	Fe^{3+}, Al^{3+}, Cr^{3+}	$Al(OH)_3$ (Gelatinous White) $Fe(OH)_3$ (Reddish Brown) $Cr(OH)_3$ (Green)
iv	NH_4Cl + NH_4OH + H_2S in warm solution (or, excess $(NH_4)_2S$)	Co^{2+}, Ni^{2+}, Zn^{2+}, Mn^{2+}	ZnS (White) MnS (Buff or Pink) of flesh colour CoS, NiS } Black
v	NH_4Cl + $(NH_4)_2CO_3$	Ca^{2+}, Sr^{2+},Ba^{2+}	$CaCO_3$, $SrCO_3$, $BaCO_3$ } White
vi	NH_4Cl + NH_4OH+ Na_2HPO_4	Mg^{2+}	$Mg(NH_4)PO_4$ (White)
Zero	NaOH or $Ca(OH)_2$ (heat)	NH_4^+	NH_3 Gas

(a) From the filtrate of iind group, H_2S gas is boiled off and then one or two drop of concentrated HNO_3 is added and again boil so that if Fe^{2+} is present, it will oxidize into Fe^{3+}.

(b) iiird group radicals are precipitated as hydroxides and the addition of NH_4Cl suppresses the ionization of NH_4OH so that only iii group radicals are precipitated as hydroxides because of their low solubility products.

(c) Excess of NH_4Cl should not be added, Mn^{2+} will precipitate as $MnO_2.H_2O$.

(d) $(NH_4)_2SO_4$ cannot be used in place of NH_4Cl because SO_4^{2-} will also give the precipitate of $BaSO_4$, $SrSO_4$ etc.

(e) In acidic medium, hydroxides do not precipitate.

(f) In place of NH_4OH, NaOH can't be used because in excess of it we get soluble complexes of Al^{3+} and Cr^{3+}.

(g) In ivth group radicals NH_4OH increases the ionization of H_2S by removing H^+ from H_2S as unionized water. (Ksp values of these sulphides are very high)

(h) In vth group radicals, $(NH_4)_2CO_3$ should be added in alkaline or neutral medium. In the absence of ammonia or NH_4^+ ions, Mg^{2+} will also be precipitated.

Zero group (NH_4^+ ion):

1. Sodium hydroxide solution:
   $NH_4^+ + OH^- \longrightarrow NH_3\uparrow + H_2O$
   (NH_4Cl) ($NaOH$)

Ammonia gas can be identified, if

a. By its characteristics smell.

b. By formation of white fumes of NH_4Cl with HCl.
   $NH_3 + HCl \longrightarrow NH_4Cl\uparrow$ (white fumes)

c. By its turning moistened red litmus paper blue or turmeric paper brown.

d. By its ability to turn filter paper moistened with mercury (I) nitrate solution black.

$$Hg_2(NO_3)_2 + 2NH_3 \longrightarrow \underbrace{Hg(NH_2)NO_3 + Hg}_{\text{Black}} + NH_4NO_3$$

2. With Nessler's reagent:

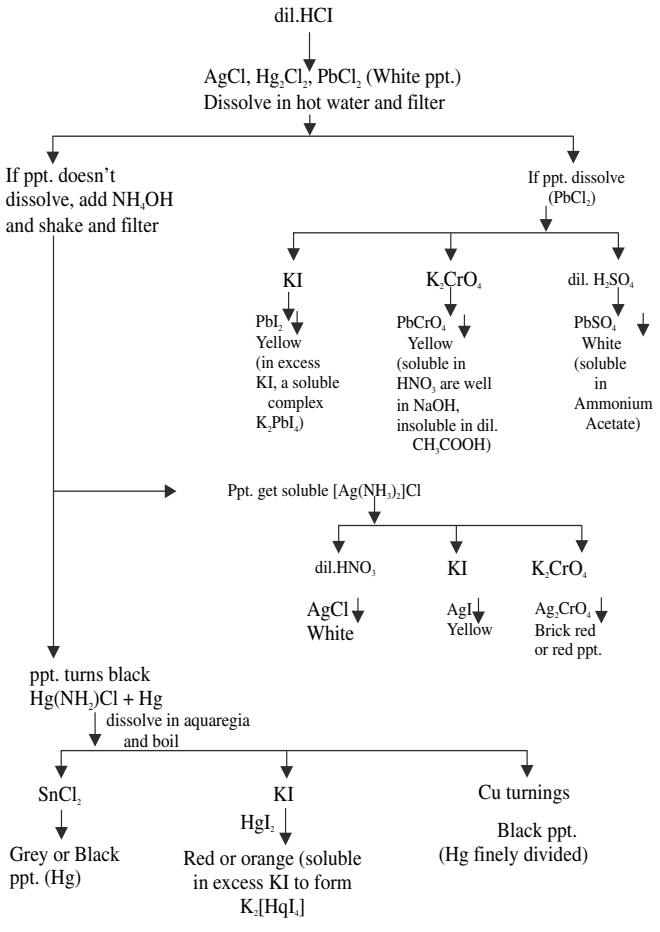
$$NH_4^+ + \underbrace{2[HgI_4]^{2-} + 4OH^-}_{\text{Nessler's reagent}} \longrightarrow HgO.Hg(NH_2)I\downarrow + 7I^- + 3H_2O$$

NH_3 Brown ppt.

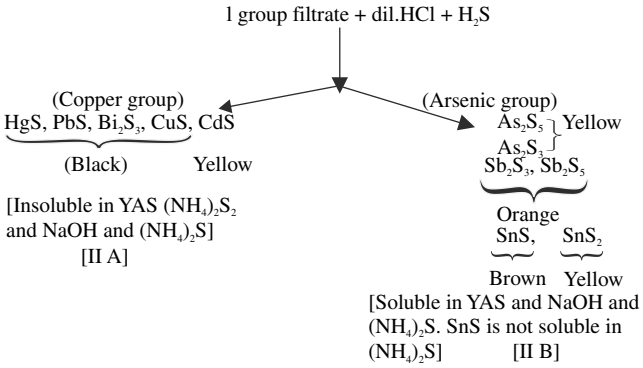
or

Brown or Yellow colouration
(Iodide of millon's base)

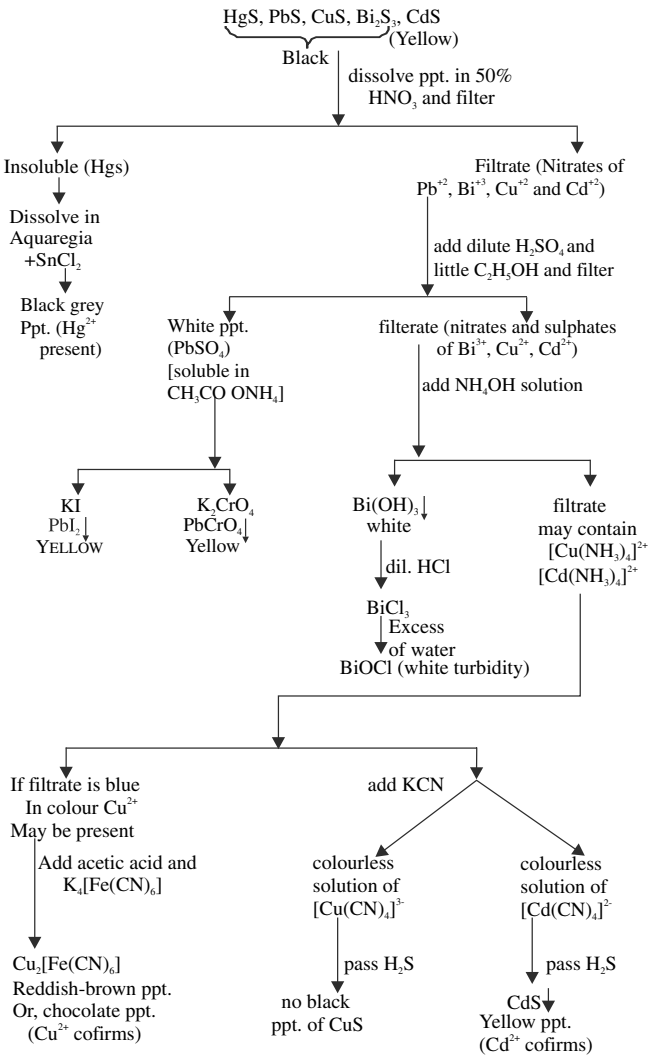
Group I



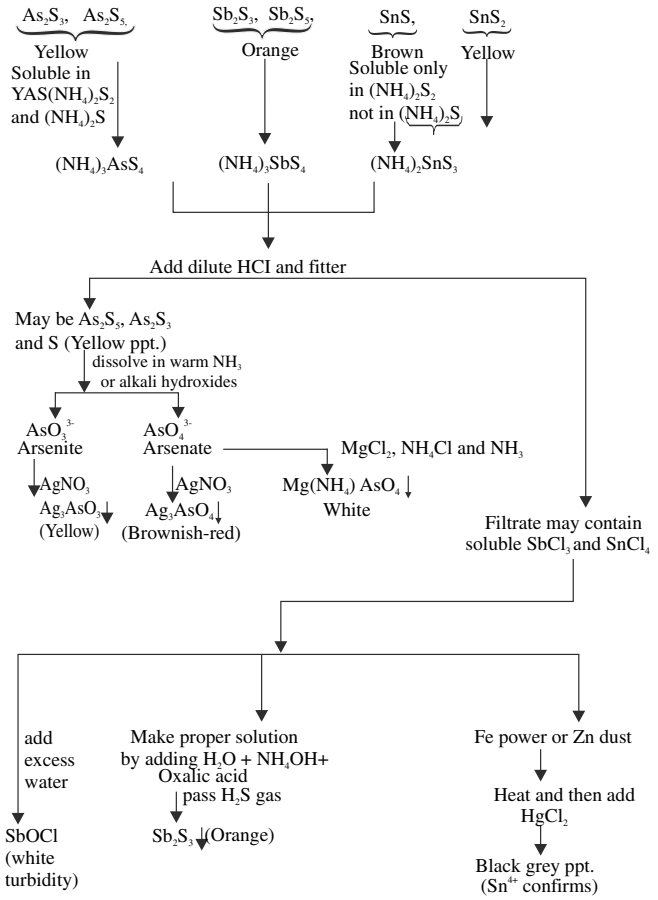
Group II



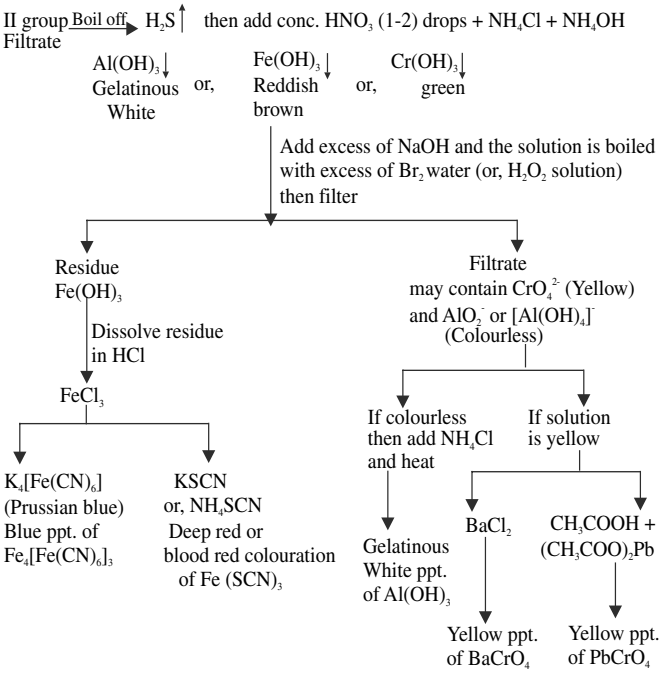
Group II (A)



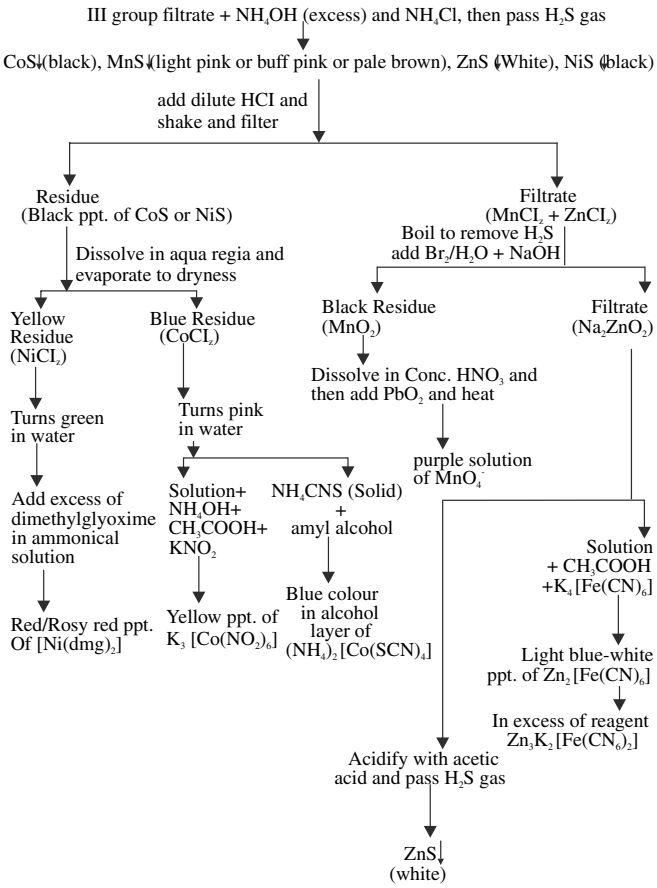
Group II(B)



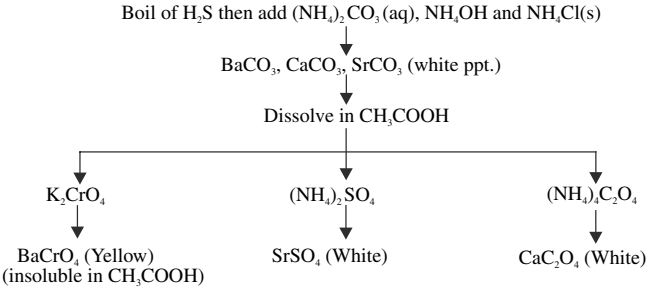
Group III



Group IV



Group V



Group VI

Test of Mg^{2+}:

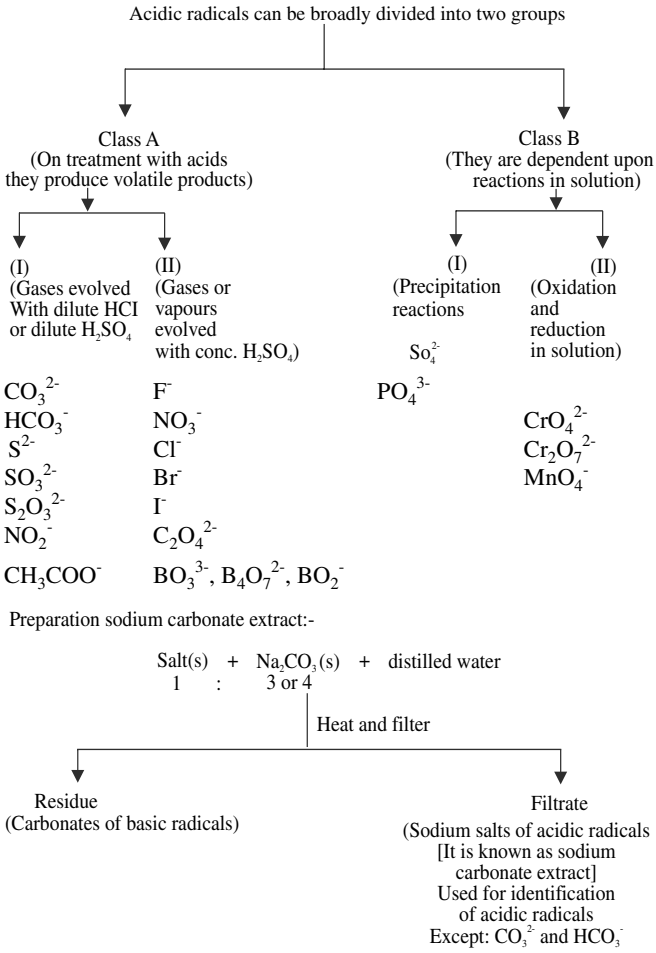
With Na_2HPO_4 solution:

White crystalline ppt. of $Mg(NH_4)PO_4.6H_2O$ in the presence of NH_4Cl (to prevent ppt. of $Mg(OH)_2$) and NH_3 solution.

$$Mg^{2+} + NH_3 + HPO_4^{2-} \longrightarrow \underset{\text{White}}{Mg(NH_4)PO_4\downarrow}$$

The ppt. is sparingly soluble in water, soluble in acetic acid and in mineral acids.

Classification of acidic radicals (anions):



Preparation sodium carbonate extract:-

$$BaCl_2 + Na_2CO_3 \longrightarrow \underset{\text{White}}{BaCO_3\downarrow} + 2NaCl\ (aq)$$

Sodium carbonate extract is used when:

a. Salt is only partially soluble in water or insoluble in water.
b. Cations interfere with the tests for acidic radicals or the coloured salt solution may be too intense in colour that the test results are not too clear.

Carbonte, CO_3^{2-}:

(i) The carbonates are decomposed with the effervescence of carbon dioxide gas.

$$Na_2CO_3 + H_2SO_4 \rightarrow Na_2SO_4 + CO_2$$

(ii) When this gas is passed through lime water, it turns milky with the formation of calcium carbonate.

$$\underset{\text{Lime water}}{Ca(OH)_2} + CO_2 \rightarrow \underset{\text{white ppt.}}{CaCO_3} + H_2O$$

(iii) If the CO_2, gas is passed in excess, the milky solution becomes colourless due to the formation of soluble calcium bicarbonate.

$$\underset{\text{White ppt.}}{CaCO_3} + H_2O + CO_2 \rightarrow \underset{\text{soluble}}{Ca(HCO_3)_2}$$

Note: Sulphur dioxide evolved from sulphites also turns lime water milky.

$$Ca(OH)_2 + SO_2 \rightarrow \underset{\text{White ppt.}}{CaSO_3} + H_2O$$

However SO_2 can be identified by its pungent odour of burning sulphur.

Sulphite, SO_3^{2-}:

(i) The sulphite gives out sulphur dioxide gas, having suffocating smell of burning sulphur.

$$CaSO_3 + H_2SO_4 \rightarrow CaSO_4 + H_2O + SO_2\uparrow$$

(ii) When acidified potassium dichromate paper is exposed to the gas, it attains green colour due to the formation of chromic sulphate.

$$K_2Cr_2O_7 + H_2SO_4 + 3SO_2 \rightarrow K_2SO_4 + Cr_2(SO_4)_3 + H_2O$$

The sulphite also gives white precipitate with $BaCl_2$, soluble in dil. HCl

$$Na_2SO_3 + BaCl_2 \rightarrow 2NaCl + BaSO_3\downarrow$$

Sulphide, S^{-2}:

(i) The sulphide salts form H_2S which smells like rotten eggs.

$$Na_2S + H_2SO_4 \rightarrow NaSO_4 + H_2S\uparrow$$

(ii) On exposure to this gas, the lead acetate paper turns black due to the formation of lead sulphide.

$$Pb(CH_3COO)_2 + H_2S \rightarrow \underset{\text{black ppt.}}{PbS\downarrow} + 2CH_3COOH$$

(iii) The sulphides also turn sodium nitroprusside solution violet (use sodium carbonate extract for this test).

$$Na_2S + Na_2[FeNO(CN)_5] \rightarrow Na_4[Fe(NOS)(CN)_5]$$

Sulphide of lead, calcium, nickel, cobalt, antimony and stannic are not decomposed with dilute H_2SO_4. Conc. HCl should be used for their test. However brisk evolution of H_2S takes place even by use of dilute H_2SO_4 if a pinch of zinc dust is added.

$$Zn + H_2SO_4 \rightarrow ZnSO_4 + 2H$$
$$HgS + 2H \rightarrow Hg + H_2S\uparrow$$

Nitrite, NO_2^-:

(i) The nitrites yield a colourless nitric oxide gas which in contact with oxygen of the air becomes

brown due to the formation of nitrogen dioxide.

$2KNO_2 + H_2SO_4 \rightarrow K_2SO_4 + 2HNO_2$

Nitrous acid

$3HNO \rightarrow H_2O + 2NO + HNO_3$

$2NO + O_2 \rightarrow 2NO_2$

brown coloured gas

(ii) On passing the gas through dilute $FeSO_4$ solution, brown colored complex salt is formed.

$FeSO_4.7H_2O + NO \rightarrow [Fe(H_2O)_5NO]SO_4 + 2H_2O$

Brown ring complex

(iii) When a mixture of iodide and nitrite is treated with dilute H_2SO_4, the iodides are decomposed giving violet vapours of iodine, which turns starch iodide paper blue.

$2NaNO_2 + H_2SO_4 \rightarrow Na_2SO_4 + 2HNO_2$

$2KI + H_2SO_4 \rightarrow K_2SO_4 + 2HI$

$2HNO_2 + 2HI \rightarrow 2H_2O + I_2 + 2NO$

Violet vapours

I_2 + Starch $\rightarrow$ colour

Chloride Cl^-

(i) Colourless pungent fumes of hydrogen chloride are evolved.

$NaCl + H_2SO_4 \rightarrow NaHSO_4 + HCl$

(ii) Yellowish green chlorine gas with suffocating odour is evolved on addition of MnO_2 to the above reaction mixture.

$NaCl + H_2SO_4 \rightarrow NaHSO_4 + HCl$

$MnO_4 + 4HCl \rightarrow MnCl_2 + 2H_2O + Cl_2$

(iii) The gas evolved forms white fumes of ammonium chloride with NH_4OH.

$NH_4OH + HCl \rightarrow NH_4Cl + H_2O$

(iv) The gas evolved or solution of chloride salt forms a curdy precipitate of silver chloride with silver nitrate solution.

$AgNO_3 + HCl \rightarrow AgCl\downarrow + HNO_3$

Note:

(a) The curdy precipitate of AgCl dissolves in ammonium hydroxide forming a complex salt.

$AgCl + 2NH_4OH \rightarrow Ag(NH_3)_2Cl + 2H_2O$

(b) The solution having the silver complex on acidifying with dilute nitric acid gives again a white precipitate of silver chloride.

$Ag(NH_3)_2Cl + 2HNO_3 \rightarrow AgCl + 2NH_4NO_3$

(c) Chromyl chloride Test: When solid chloride is heated with conc. H_2SO_4 in presence of $K_2Cr_2O_7$, deep red vapours of chromyl chloride are evolved.

$NaCl + H_2SO_4 \rightarrow NaHSO_4 + HCl$

$K_2Cr_2O_7 + 2HCl \rightarrow 2KHSO_4 + 2CrO_3 + H_2O$

$CrO_3 + 2HCl \rightarrow CrO_2Cl_2 + H_2O$

Chromyl chloride

These vapours on passing through NaOH solution form the yellow solution due to the formation of sodium chromate.

$CrO_2Cl_2 + 4NaOH \rightarrow Na_2CrO_4 + 2NaCl + 2H_2O$

Yellow colour

The yellow solution neutralized with acetic acid gives a yellow precipitate of lead chromate with lead acetate.

$Na_2CrO_4 + Pb(CH_3COO)_2 \rightarrow PbCrO_4 + 2CH_3COONa$

Yellow ppt.

Note:

(a) This test is not given by the chloride of mercuric, tin, silver, lead and antimony.

(b) The chromyl chloride test is always to be performed in a dry test tube otherwise the chromyl chloride vapours will be hydrolysed in the test tube.

$CrO_2Cl_2 + 2H_2O \rightarrow H_2CrO_4 + 2HCl$

(c) Bromides and iodides do not give this test.

Bromide, Br^-:

(a) Reddish-brown fumes of bromine are formed.

$NaBr + H_2SO_4 \rightarrow NaHSO_4 + HBr$

$2HBr + H_2SO_4 \rightarrow Br_2 + 2H_2O + SO_2$

(b) More reddish brown fumes of bromine are evolved when MnO_2 is added.

$2NaBr + MnO_2 + 3H_2SO_4 \rightarrow 2NaHSO_4 + MnSO_4 + 2H_2O + Br_2$

(c) The aqueous solution of bromide or sodium carbonate extract gives pale yellow precipitate of silver bromide which partly dissolve in excess of NH_4OH forming a soluble complex.

$NaBr + AgNO_3 \rightarrow AgBr\downarrow + NaNO_3$

Pale yellow ppt.

$AgBr + 2NH_4OH \rightarrow Ag(NH_3)_2\,Br + 2H_2O$

Iodide, I^-:

(a) Violet vapours of iodine are evolved.

$2KI + H_2SO_4 \rightarrow 2KHSO_4 + 2HI$

$2HI + H_2SO_4 \rightarrow I_2 + SO_2 + 2H_2O$

(b) Violet vapours with starch produce blue colour.

I_2 + starch $\rightarrow$ Blue colour

(c) More violet vapours are evolved when MnO_2 is added.

$2KI + MnO_2 + 3H_2SO_4 \rightarrow 2KHSO_4 + MnSO_4 + 2H_2O + I_2$

(d) Aqueous solution of the iodide or sodium carbonate extract gives yellow precipitate of AgI with silver nitrate solution which does not dissolve in NH_4OH.

$NaI + AgNO_3 \rightarrow AgI + NaNO_3$

Yellow ppt.

Nitrate, NO_3^-:

(a) Light brown fumes of nitrogen dioxide are evolved.

$NaNO_3 + H_2SO_4 \rightarrow NaHSO_4 + HNO_3$

$4\,HNO_3 \rightarrow 2H_2O + 4NO_2 + O_2$

(b) These fumes intensify when copper turnings are added.

$Cu + 4HNO_3 \rightarrow Cu(NO_3)_2 + 2NO_2 + 2H_2O$

(c) **Ring Test:** An aqueous solution of salt is mixed with freshly prepared $FeSO_4$ solution and conc. H_2SO_4 is poured in test tube from sides, a brown ring is formed on account of the formation of a complex at the junction of two liquids.

$NaNO_3 + H_2SO_4 \rightarrow NaHSO_4 + HNO_3$

$6FeSO_4 + 2HNO_3 + 3H_2SO_4 \rightarrow 3Fe_2(SO_4)_3 + 4H_2O + 2NO$

$[Fe(H_2O)_6]SO_4.H_2O + NO \rightarrow [Fe(H_2O)_5NO]SO_4 + H_2O$

Brown ring

Oxalate, $C_2O_4^{-2}$:

A mixture of CO and CO_2 is given off. The CO burns with blue flame.

$Na_2C_2O_4 + H_2SO_4 \rightarrow Na_2SO_4 + H_2C_2O_4$

$H_2C_2O_4 + H_2SO_4 \rightarrow CO + CO_2 + H_2O + [H_2SO_4]$

$2CO + O_2 \rightarrow 2CO_2$

Sulphate, SO_4^{-2}:

Add conc. HNO_3 to a small amount of substance or take sodium carbonate extract and then add $BaCl_2$ solution. A white precipitate of $BaSO_4$ insoluble in conc. acid is obtained.

$NaSO_4 + BaCl_2 \rightarrow 2NaCl + BaSO_4$

White ppt.

Borate:

To a small quantity of the substance (salt or mixture), add few multilitres of ethyl alcohol and conc. H_2SO_4 and 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.

$2Na_3BO_3 + 3H_2SO_4 \rightarrow 3Na_2SO_4 + 2H_3BO_3$

$H_3BO_3 + 3C_2H_5OH \rightarrow (C_2H_5)_3BO_3 + 3H_2O$

Ethyl borate

Phosphate:

Add conc. HNO_3 to a small amount of substance or take sodium carbonate extract, heat and then add ammonium molybdate. A canary yellow precipitate of ammonium phosphomolybdate is formed.

$Ca_3(PO_4)_2 + 6HNO_3 \rightarrow 3Ca\,(NO_3)_2 + 2H_3PO_4$

$H_3PO_4 + 12(NH_4)_2MoO_4 + 21HNO_3 \rightarrow (NH_4)_3PO_4.12MoO_3 + 21NH_4NO_3 + 12H_2O$

Canary yellow ppt.

Solved Examples

1. Chemical volcano is produced on heating:

(a) $K_2Cr_2O_7$ (b) $(NH_4)_2Cr_2O_7$

(c) $ZnCr_2O_7$ (d) K_2CrO_4

Sol. (b) On heating $(NH_4)_2Cr_2O_7$, N_2 is given out with Cr_2O_3 powder at higher rate giving a look artificial volcano.

2. Which of the following ions forms(s) ppt. with KI:

(a) Mg^{2+} (b) Pb^{2+}

(c) Hg^{2+} (d) Cu^{2+}

Sol. (b, c, d)

$$Pb^{2+} + 2I^- \rightarrow \underset{\text{Yellow ppt.}}{PbI_2}$$

$$Hg^{2+} + 2I^- \rightarrow \underset{\text{Red ppt.}}{HgI_2}$$

$$Cu^{2+} + 2I^- \rightarrow CuI_2 \rightarrow \underset{\text{White ppt.}}{Cu_2I_2} + I_2$$

3. Name one common reagent that can form precipitate or react and differentiate the following pairs:

(a) Ag^+ and Ba^{2+} (b) Cu^{2+} and Pb^{2+}

(c) Fe^{3+} and Cu^{2+} (d) Co^{2+} and Cu^{2+}

Sol. (a) $K_2Cr_2O_4$

$$2Ag^+ + CrO_4^{2-} \rightarrow \underset{\text{Red}}{Ag_2CrO_4}\downarrow$$

$$Ba^{2+} + CrO_4^{2-} \rightarrow \underset{\text{Yellow}}{BaCrO_4}\downarrow$$

(b) K_2CrO_4

$$Cu^{2+} + CrO_4^{2-} \rightarrow \underset{\text{Chocolate}}{CuCrO_4}\downarrow$$

$$Pb^{2+} + CrO_4^{2-} \rightarrow \underset{\text{Yellow}}{PbCrO_4}\downarrow$$

(c) NH_4SCN

$$Fe^{3+} + 3SCN^- \rightarrow \underset{\text{red colour}}{[Fe(SCN)_3]}\downarrow$$

$$2Cu^{2+} + 4SCN^- \rightarrow \underset{\text{white}}{Cu_2(SCN)_2}\downarrow + (SCN)_2$$

(d) NH_4SCN

$$Co^{2+} + 4SCN^- \rightarrow \underset{\text{blue colour}}{[Co(SCN)_4]^{2-}}$$

$$2Cu^{2+} + 4SCN^- \rightarrow \underset{\text{White}}{[Cu_2(SCN)_2]}\downarrow + (SCN)_2$$

4. In which of the following tests, Cl^- ion is tested by observing the colour of a precipitate which does not contain Cl^- ions at all:

(a) Chromyl chloride test

(b) Lassaigne's test

(c) Silver mirror test

(d) Fehling solution test

Sol. (a) $CrO_2Cl_2 + 4NaOH \rightarrow \underset{\text{Yellow}}{Na_2CrO_4} + 2NaCl + 2H_2O$

$$Na_2CrO_4 + Pb(CH_3COO)_2 \rightarrow \underset{\text{Yellow ppt.}}{PbCrO_4} + 2CH_3COONa$$

5. When an inorganic mixture was treated with excess of dil. H_2SO_4, effervescence were produced. The solution was heated till effervescence ceased. After this a small pinch of MnO_2 were added, fresh effervescence were produced. Select the correct statements:

(a) Mixture contains CO_3^{2-} ions

(b) Mixture contains $C_2O_4^{2-}$ ions

(c) Mixture contains SO_3^{2-} ions

(d) Mixture contains CO_3^{2-} and $C_2O_4^{2-}$

Sol. (d) Effervescence on heating the mixture with dil. H_2SO_4, it is due to decomposition of carbonate.

$$Na_2CO_3 + H_2SO_4 \rightarrow Na_2SO_3 + CO_2 + H_2O$$

When evolution of CO_2 occurs again after adding MnO_2, it is due to decomposition of oxalate.

$$Na_2C_2O_4 + 2H_2SO_4 + MnO_2 \rightarrow Na_2SO_4 + MnSO_4 + 2H_2O + 2CO_2$$

6. Few drops of a salt solution are shaken with chloroform, chlorine water. Chloroform layer becomes violet. The solution contains:

(a) F^- ion (b) Cl^- ion

(c) Br^- ion (d) I^- ion

Sol. (d) $2KI + Cl_2 \rightarrow 2KCl + I_2$;

$I_2 + CCl_4 \rightarrow$ violet solution

7. Name one common reagent that can precipitate or react and differentiate following pairs:

(a) I^- and Cl^-

(b) I^- and Br^-

(c) SO_3^{2-} and SO_4^{2-}

Sol. (a) $AgNO_3$

$$Ag^+ + I^- \rightarrow \underset{\text{yellow}}{AgI}$$

$$Ag^+ + Cl^- \rightarrow \underset{\text{white}}{AgCl^-}$$

(b) Cl_2 water + $CHCl_3$:

$$2I^- + Cl_2 \rightarrow I_2 + 2Cl^-$$
(violet in $CHCl_3$ layer)

$$2Br^- + Cl_2 \rightarrow Br_2 + 2Cl^-$$
(orange in $CHCl_3$ layer)

(c) $BaCl_2$

$$BaCl_2 + SO_3^{2-} \rightarrow \underset{\text{white ppt. soluble in conc. HCl}}{BaSO_3\downarrow} + 2Cl^-$$

$$BaCl_2 + SO_4^{2-} \rightarrow \underset{\text{white ppt. insoluble in conc. HCl}}{BaSO_4\downarrow} + 2Cl^-$$

8. During qualitative test of nitrate radical, a brown ring is formed. The ring formed is due to the formation of:

(a) $FeSO_4NO$

(b) $(FeSO_4)_2NO$

(c) $FeSO_4(NO)_2$

(d) $[Fe(H_2O)_5NO]SO_4$

Sol. (d) $NaNO_3 + H_2SO_4 \rightarrow NaHSO_4 + HNO_3$

$$6FeSO_4 + 2HNO_3 + 2H_2SO_4 \rightarrow 2Fe_2(SO_4)_3 + 2NO + 4H_2O$$

$$FeSO_4 + NO + 5H_2O \rightarrow \underset{\text{Nitrosyl ferrous sulphate}}{[Fe(H_2O)_5NO]SO_4}$$

9. An inorganic compound gives a white ppt. with a solution of $AgNO_3$, a white ppt. with dil. H_2SO_4 and imparts green colour to flame.

The probable compound is:

(a) $CuCl_2$ (b) $BaCl_2$

(c) $Cu(NO_3)_2$ (d) $PbCl_2$

Sol. (b) $2AgNO_3 + BaCl_2 \rightarrow 2AgCl + Ba(NO_3)_2$

$$BaCl_2 + H_2SO_4 \rightarrow \underset{\text{White ppt.}}{BaSO_4} + 2HCl$$

Barium imparts green colour to flame.

10. An inorganic salt in its a solution produced a white ppt. with NaOH which dissolves in excess of NaOH, Also its a solution produced light yellow ppt. with $AgNO_3$, sparingly soluble in NH_4OH the probable salt is:

Sol. (a) $AlBr_3 + 3NaOH \rightarrow \underset{\text{White ppt.}}{Al(OH)_3} + 3NaBr$

$$Al(OH)_3 + NaOH \rightarrow \underset{\text{Soluble}}{NaAlO_2} + 3NaBr$$

$$3AgNO_3 + AlBr_3 \rightarrow \underset{\text{Light yellow ppt.}}{3AgBr} + Al(NO_3)_3$$

The salt is $AlBr_3$.

11. A compound (A) forms an unstable pale blue colour solution in water. The solution decolorizes Br_2 water and an acidified solution of $KMnO_4$. The possible compound (A) is:

(a) HNO_2 (b) HNO_3

(c) N_2O_5 (d) None of these

Sol. (a) HNO_2 is pale blue in colour due to dissolution of N_2O_3. In conc. solution it decomposes as:

$$2HNO_2 \rightarrow NO + NO_2 + H_2O$$

and in dilute solution as:

$$3HNO_2 \rightarrow HNO_3 + H_2O + 2NO$$

Reaction with:

(a) Br_2 water-

$$HNO_2 + H_2O + Br_2 \rightarrow HNO_3 + 2HBr$$

(b) $KMnO_4 + 3H_2SO_4 + 5HNO_2 \rightarrow K_2SO_4 + 2MnSO_4 + 3H_2O + 5HNO_3$

12.(a) If $CO_2(g)$ under pressure is passed into $Na_2CrO_{4(aq.)}$, $Na_2Cr_2O_{7(aq.)}$ is formed. What is the function of the $CO_2(g)$?

(b) When zinc is added to acidic solution of $Na_2Cr_2O_7$. What is the colour of the solution?

(c) In acidic solution silver (II) oxide first dissolves to produce Ag^{2+} (aq.) and then reduces to Ag^+ by H_2O which is oxidized to $O_2(g)$. Explain?

Sol. (a) CO_2 makes the solution acidic that can convert Na_2CrO_4 to $Na_2Cr_2O_7$

$$CO_2 + H_2O \rightarrow HCO_3^- + H^+$$

$$2CrO_4^{2-} + 2H^+ \rightarrow Cr_2O_7^{2-} + H_2O$$

(b) Zn reduces $Cr_2O_7^{2-}$ to Cr^{3+} (green) and then to Cr^{2+} (blue). Over a long time, Cr^{2+} is oxdised to Cr^{3+} by atmospheric O_2 and thus blue colour changes to green.

$Cr_2O_7^{2-} + 14H^+ + 3Zn \rightarrow \underset{\text{green}}{2Cr^{3+}} + 7H_2O + 3Zn^{2+}$
Orange

$\underset{\text{Green}}{Cr^{3+}} + e^- \rightarrow \underset{\text{blue}}{Cr^{2+}}$

$\underset{\text{Blue}}{Cr^{2+}} \rightarrow \underset{\text{green}}{Cr^{3+}} + e^-$

(Note: These reactions are spontaneous based on the standard reduction electrons potential values.)

(c) $AgO + 2H^+ \rightarrow Ag^{2+} + H_2O$

$4Ag^{2+} + 2H_2O \rightarrow 4Ag^+ + 4H^+ + O_2$

13. Colourless salt (A), on heating with sodium hydroxide, give gas (B) that can also be obtained when Mg_3N_2 reacts with H_2O. When reaction of (A) with NaOH was complete, solution obtained on reaction with $FeSO_4$ gave a brown coloured ring (C) between two layers. (A) on heating strongly, forms (D) and (E). (D) and (E) reacting together forming a dibasic acid (F) that exists as cis and trans isomers. Identify (A) to (F) and explain reactions.

Sol. (A) $\xrightarrow{NaOH.\Delta}$ (B) $\xleftarrow{H_2O}$ Mg_3N_2

(A) has NH_4^+ ion and (B) is NH_3

$Mg_3N_2 + 6H_2O \rightarrow 3Mg(OH)_2 + 2NH_3$

$NH_4^+ + NaOH \rightarrow Na^+ + NH_3 + H_2O$

Resultant solution after NH_3 has escaped completely. It contains Na^+ and anion of (A) which also gives Ring Test of NO_3^- thus, (A) is NH_4NO_3

$NH_4NO_3 + NaOH \xrightarrow{\Delta} NH_3\uparrow + NaNO_3 + H_2O$

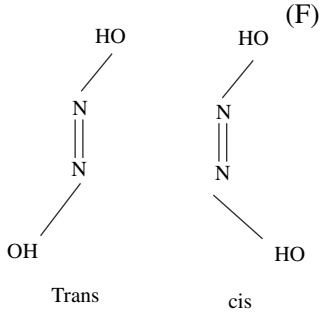
$NaNO_3 + H_2SO_4 \rightarrow NH_3\uparrow + NaHSO_4 + HNO_3$

$2HNO_3 \rightarrow H_2O + 3NO + 3O$

$[Fe(H_2O)_6]SO_4 + NO \rightarrow \underset{(C)}{[Fe(H_2O)_5NO]SO_4} + H_2O$

$\underset{(A)}{NH_4NO_3} \xrightarrow{\Delta} \underset{(D)}{N_2O} + \underset{(E)}{2H_2O}$

$N_2O + H_2O \longrightarrow \underset{(F)}{H_2N_2O_2}$



Trans cis

14. Identify (A) and (B) based on following reactions:

(i) (A) $\xrightarrow[\Delta]{NaOH}$ (B) $\xrightarrow{HCl}$ white fumes (gas)

(ii) After (B) is expelled completely, resultant alkaline solution again gives gas (B) on heating with zinc.

(iii) (A) $\xrightarrow{\Delta}$ $N_2O + H_2O$

Sol. By (iii) (A) gives N_2O, H_2O on heating hence (A) is NH_4NO_3

$NH_4NO_3 \xrightarrow{\Delta} N_2O + 2H_2O$

(i) $NH_4NO_3 + NaOH \xrightarrow{\Delta} \underset{(B)}{NaNO_3} + NH_3 + H_2O$

$NH_3 + HCl \rightarrow NH_4Cl + H_2O$

(B) white fumes

(ii) $2NaOH + Zn \xrightarrow{\Delta} Na_2ZnO_2 + 2H$

$NaNO_3 + 8H \xrightarrow{\Delta} \underset{(B)}{NaOH} + NH_3 + 2H_2O$

(NH_3 gas is obtained due to reduction of NO_3^- to NH_3)

15. A mineral popularly known as apatite is used to prepare a fertilizer, which provides phosphorus element to the soil.

(a) The fertilizer is obtained by treating apatite with H_2SO_4.

(b) When heated with silica and coke, it yields white phosphorus and calcium silicate.

Suggest formula for apatite and explain the chemical reactions (i) and (ii)

Sol. Chemically apatite is $Ca_3(PO_4)_2$

(a) When apatite is heated with H_2SO_4(s)

$\rightarrow \underset{\text{(super phosphate of lime)}}{Ca(H_2PO_4)_2}$

(b) When apatite mineral is heated with silica (SiO_2) and coke (C), white phosphorus is obtained as follows:

(i) $2Ca_3(PO_4)_2 + 6SiO_2 \rightarrow \underset{\text{(calcium silicate)}}{6CaSiO_3} + 3P_2O_5$

(ii) $2P_2O_5 + 10C \rightarrow \underset{\text{(white phosphorus)}}{P_4} + 10CO$

16. (A)+tap water → white turbidity soluble in aq. NH_3

(A) $\xrightarrow{\Delta}$ residue (B) + (C) (oxides of N) + O_2

aq. (A) gives brown ring on adding $FeSO_4$ and conc. H_2SO_4. (C) is paramagnetic and forms

dimer of vapour density 46. Identify (A), (B) and (C) and explain reactions.

Sol. (A)+tap water → white turbidity soluble in a NH_3. Tap water has Cl^- and turbidity is soluble in a NH_3 hence, turbidity is of AgCl

(A) has Ag^+

(A) also gives ring test of NO_3^-

(A) is $AgNO_3$

$$\underset{\text{(A)}}{2AgNO_3} \rightarrow \underset{\text{(B)}}{2Ag} + \underset{\text{(C)}}{2NO_2} + O_2$$

NO_2 is paramagnetic due to one unpaired electron and thus forms dimer by using unpaired electron.

$$2NO_2 \rightleftarrows N_2O_4$$

dimer (V.D. = 46)

17. If Cu^{2+} and Cd^{2+} both are present, it is difficult to analyse. Outline a scheme to analyse in a mixture.

Sol. KCN forms complex with Cu^{2+} and Cd^{2+}

$$Cu^{2+} + KCN \rightarrow K_2[Cu(CN)_4] \rightarrow \underset{\text{Stable}}{K_3[Cu^{+1}(CN)_4]}$$

$$Cd^{2+} + KCN \rightarrow \underset{\text{Unstable}}{K_2[Cd(CN)_4]}$$

When H_2S gas is passed unstable complex of Cd^{2+} gives yellow ppt.

$$[Cd(CN)_4]^{2-} \rightarrow Cd^{2+} + 4CN^-,\ Cd^{2+} + S^{2-} \rightarrow \underset{\text{yellow}}{CdS\downarrow}$$

18. Identify (A), (B), (C) and (D) and explain reactions.

(A) (green coloured salt) + $K_2Cr_2O_7$ + conc. $H_2SO_4 \xrightarrow{\Delta}$ (B)

(B) (reddish brown gas) + NaOH → (C) (yellow coloured solution)

(C) + $(CH_3COO)_2Pb$ → (D) (yellow ppt.)

(A) + NaOH + Br_2 water $\xrightarrow{\Delta}$ (C)

(C) + $(CH_3COO)_2Pb \xrightarrow{\Delta}$ (D)

Sol. (A):$CrCl_3$

(B): CrO_2Cl_2 [by chromyl-chloride test of Cl^-]

(C): Na_2CrO_4

(D): $PbCrO_4$

19. (A), an important laboratory reagent, turns red litmus blue, imparts golden yellow colour in flame and is a good precipitating agent. (A) reacts with Zn or Al forming H_2 gas. (A) gives white ppt. with $ZnCl_2$ or $AlCl_3$ but ppt. dissolves in excess of (A). What is (A) and explain reaction.

Sol. (A) turns red litmus blue ⇒ (A) is basic in nature.

(A) imparts golden yellow colour in flame ⇒ (A) has Na^+

(A) gives H_2 gas with Zn or Al → (A) is NaOH.

Explanation:

$$2NaOH + Zn \rightarrow Na_2Z_nO_2 + H_2\uparrow$$

$$2NaOH + 2H_2O + 2Al \rightarrow 2NaAlO_2 + 3H_2\uparrow$$

$$ZnCl_2 + 2NaOH \rightarrow \underset{\text{White ppt.}}{Zn(OH)_2\downarrow} + 2NaCl$$

$$Zn(OH)_2 + 2NaOH \rightarrow \underset{\text{Sodium zincate}}{Na_2[Zn(OH)_4]} \text{ or } Na_2ZnO_2$$

$$AlCl_3 + 3NaOH \rightarrow \underset{\text{White ppt.}}{Al(OH)_3\downarrow} + 3NaCl$$

$$Al(OH)_3 + NaOH \rightarrow \underset{\text{Sodium meta-aluminate}}{Na[Al(OH)_4]} \text{ or } NaAlO_2$$

20. What single reagent solution (including H_2O) could be used to effect the separation of the following of solids?

a. NaOH and $Fe(OH)_3$
b. $Ni(OH)_2$ and $Fe(OH)_3$
c. Cr_2O_3 and $Fe(OH)_3$
d. MnS and CoS
e. AgCl and AgI

Sol. (a) H_2O can dissolve NaOH, $Fe(OH)_3$ remains insoluble in water.

(b) NH_4OH dissolve $Ni(OH)_2$, $Fe(OH)_3$ is insoluble

$$Ni(OH)_4 + 4NH_4OH \rightarrow \underset{\text{Soluble}}{[Ni(NH_3)_4]^{2+}}$$

(c) Excess of NaOH can dissolve Cr_2O_3 but $Fe(OH)_3$ remains insoluble.

$$Cr_2O_3 + 3H_2O \rightarrow 2Cr(OH)_3$$

$$Cr(OH)_3 + NaOH \rightarrow \underset{\text{Soluble}}{Na[Cr(OH)_4]}$$

(d) Dilute HCl dissolves MnS soluble while CoS remains insoluble.

$$MnS + 2HCl \rightarrow MnCl_2 + H_2S\uparrow$$

(e) A NH_3 would dissolve AgCl while AgI remains insoluble

$$AgCl + 2NH_3(aq.) \rightarrow \underset{\text{Soluble}}{[Ag(NH_3)_2]Cl}$$

Exercise

LEVEL 1

1. Which of the following salt on heating with conc. H_2SO_4 gives violet vapours?

(a) Iodide salt (b) Nitrate salt

(c) Sulphate salt (d) Bromide salt

2. Salts of which of the following metal are white?

(a) Zinc (b) Cobalt

(c) Chromium (d) Fe

3. A glassy bead formed by heating borax on a platinum wire loop is:

(a) Sodium tetraborate

(b) Sodium metaborate

(c) Sodium metaborate and boric anhydride

(d) Boric anhydride and sodium tetraborate

4. An oxalate salt gives which of the following gas in dry heating test:

(a) $CO + CO_2$ (b) Only CO_2

(c) Only CO (d) Oxalic acid vapours

5. The salts of which of the following elements are generally dark green coloured?

(a) Chromium (b) Copper(I)

(c) Barium (d) Cobalt

6. The chromyl chloride test is meant for which of the following ion?

(a) Cl^- ions (b) Both Cl^- and Br^- ions

(c) I^- ions (d) Cl^- and CrO_4^{2-} ions

7. Which of the following gases turn lime water milky?

(a) SO_2 (b) CO_2

(c) H_2S (d) Both (a) and (b)

8. Yellow ammonium sulphide solution can be used for the separation of which of the following pair of species?

(a) CuS and PbS (b) PbS and Bi_2S_3

(c) Bi_2S_3 and CuS (d) CdS and As_2S_3

9. Reddish-brown (chocolate) ppt. are formed by mixing solutions containing respectively:

(a) Cu^{2+} and $[Fe(CN)_6]^{4-}$ ions

(b) Ba^{2+} and SO_4^{2-} ions

(c) Pb^{2+} and I^- ions

(d) Pb^{2+} and SO_4^{2-} ions

10. Which of the following gives black precipitate on passing H_2S through it?

(a) Acidified zinc nitrate solution

(b) Ammonical barium chloride solution

(c) Magnesium nitrate solution

(d) Copper nitrate solution

11. All ammonium salts liberate ammonia gas when:

(a) Heated with water

(b) Heated with caustic soda

(c) Heated with H_2SO_4

(d) Heated with $NaNO_2$

12. Addition of solution containing $C_2O_4^{2-}$ ions to an aqueous solution containing Ba^{2+}, Sr^{2+} and Ca^{2+} will precipitate.

(a) Ca^{+2} (b) Ca^{+2} and Sr^{2+}

(c) Ba^{+2} and Sr^{2+} (d) All three

13. Sodium sulphide react with sodium nitroprusside to form a purple coloured Compound. During the reaction the oxidation state of iron:

(a) Changes from +2 to +3

(b) Changes from +3 to +2

(c) Changes from +2 to +4

(d) Remains unchaged

14. Which of the following sulphide is not soluble in dil HNO_3?

(a) PbS (b) HgS

(c) ZnS (d) Bi_2S_3

15. Cu^{2+} ions will be reduced to Cu^+ ion by addition of an aqueous solution of:

(a) KF (b) KCl

(c) KI (d) KOH

16. Precipitate of AgCl dissolves in liquid ammonia due to the formation of:

(a) $[Ag(NH_4)_2]OH$

(b) $[Ag(NH_4)_2]Cl$

(c) $[Ag(NH_3)_2]OH$

(d) $[Ag(NH_3)_2]Cl$

17. On adding a solution of CrO_4^{2-} ions to an aqueous solution containing Ba^{2+}, Sr^{2+} and Ca^{2+} ions. The precipitate obtained first of all will be:

(a) $CaCrO_4$ (b) $SrCrO_4$

(c) $BaCrO_4$ (d) A mixture of all the three

18. Brown ring test is used to detect:

(a) Iodide (b) Nitrate

(c) Iron (d) Bromide

19. When sodium thiosulphate solution is shaken with iodine, thiosulphate is changed to:

(a) Sulphite ion

(b) Sulphate ion

(c) Tetrathionate ion

(d) Sulphide ion

20. Reaction of $K_2Cr_2O_7$ with NaCl and conc. H_2SO_4 gives:

(a) $CrCl_3$ (b) $CrOCl_2$

(c) CrO_2Cl_2 (d) Cr_2O_3

21. Which of the following gives blood red colour with KCNS?

(a) Cu^{2+} (b) Fe^{3+}

(c) Al^{3+} (d) Zn^{2+}

22. Which of the following imparts green colour to the Bunsen's flame?

(a) $B(OMe)_3$ (b) Na(OMe)

(c) $Al(OPr)_3$ (d) $Sn(OH)_2$

23. The aqueous solutions of which of the following pairs of salts will give yellow precipitate separately with aqueous solutions of barium bromide?

(a) K_2CrO_4, $AgNO_3$ (b) $AgNO_3$, K_2SO_4

(c) K_2CrO_4, K_2SO_4 (d) $AgNO_3$, Na_2CO_3

24. An aqueous solution is prepared by dissolving a mixture containing $ZnCl_2$, $CdCl_2$ and $CuCl_2$. H_2S gas is now passed through the aqueous solution of salt to form black ppt. The ppt. contains:

(a) CdS, CuS (b) CdS, CuS, ZnS

(c) CuS, ZnS (d) Only CuS

25. Which of the following compound will turn black on adding NH_4OH to it?

(a) Lead chloride

(b) Silver chloride

(c) Mercurous chloride

(d) Barium chloride

26. Among the pair of species given below which react with each other on mixing their aqueous solutions to give yellow precipitate:

(I) KI and Silver nitrate

(II) KI and Lead (II) nitrate

(III) KI and KBr

(IV) KI and I_2

(a) I, II (b) II, III

(c) I, II, IV (d) Only I

27. Which salt would give a colourless gas having pungent smell with hot dil. H_2SO_4 and at the same time it will decolourise bromine water?

(a) Na_2SO_4 (b) $NaHSO_4$

(c) Na_2SO_3 (d) Na_2CO_3

28. Which of the following contains colourless gases which form white fumes on coming in contact with each other?

(a) SO_2, HCl (b) Cl_2, NH_3

(c) HCl, NH_3 (d) CO, Cl_2

29. Red vapour obtained by heating a mixture of KCl and potassium dichromate is passed through dil. Sodium hydroxide solution. The colour of the solution so obtained is:

(a) Bright red (b) Yellow

(c) green (d) Scarlet

30. Which of the following reagent can help in the separation of Cu^{2+} an Cd^{2+} ions in the solution?

(a) H_2S in acidic medium

(b) H_2S in alkaline medium

(c) KCN solution

(d) K_4 [$Fe(CN)_6$] solution

LEVEL II

1. $Fe(OH)_3$ can be separated from $Al(OH)_3$ by addition of:

(a) $BaCl_2$ (b) Dil. HCl

(c) NaOH solution (d) NH_4Cl and NH_4OH

2. An aqueous solution of a substance, on treatment with dilute HCl, gives a white precipitate soluble in hot water. When H_2S is passed through the hot acidic solution, a black precipitate is formed. The substance is:

(a) Hg_2^{2+} salt (b) Cu^{2+} salt

(c) Ag^+ salt (d) Pb^{2+} salt

3. $CrCl_3 \xrightarrow[NH_4OH]{NH_4Cl} (A) \xrightarrow[H_2O]{Na_2O_2} (B) \xrightarrow[acetate]{Lead} (C)$; compound (C) is:

(a) Na_2CrO_4 (b) $Na_2Cr_2O_7$

(c) $Cr(OH)_3$ (d) $PbCrO_4$

4. $2Cu^{2+} + 5I^- \longrightarrow 2CuI\downarrow + [X]$

$[X] + 2S_2O_3^{2-} \longrightarrow 3[Y] + S_4O_6^{2-}$; X and Y are:

(a) I_3^- and I^- (b) I_2 and I_3^-

(c) I_2 and I^- (d) I_3^- and I_2

5. Which of the following reagents can separate a mixture of AgCl and AgI?

(a) KCN (b) $Na_2S_2O_3$

(c) HNO_3 (d) NH_3

6. $FeSO_4$ is used in the brown ring test for a nitrate. What is the oxidation state of Fe in the compound responsible for the brown colour of the ring?

(a) 0 (b) +1

(c) + 2 (d) + 3

7. In an alkaline solution, sodium nitroprusside gives a violet colour with:

(a) S^{2-} (b) SO_3^{2-}

(c) SO_4^{2-} (d) NO_2^-

8. Which of the following sulphides is white?

(a) CdS (b) PbS

(c) ZnS (d) SnS

9. A white sublimate substance, that turns black on treatment with an NH_3 solution can be:

(a) Hg_2Cl_2 (b) $HgCl_2$

(c) As_2O_3 (d) NH_4Cl

10. Which of the following pairs of cations can be separated by adding NH_4Cl and NH_4OH to the mixture and then passing H_2S through it?

(a) Fe^{3+}, Al^{3+} (b) Cr^{3+}, Ni^{2+}

(c) Al^{3+}, Cr^{3+} (d) Fe^{3+}, Cr^{3+}

11. Which of the following pairs of sulphides are insoluble in dilute HCl?

(a) CoS and NiS (b) CoS and MnS

(c) NiS and MnS (d) NiS and ZnS

12. On heating, a salt gives a gas which turns lime water milky and an acidified dichromate solution green. The salt may be:

(a) carbonate (b) sulphide

(c) sulphate (d) sulphite

13. Which of the following has the highest value of K_p?

(a) $BeCO_3$ (b) $MgCO_3$

(c) $CaCO_3$ (d) $BaCO_3$

14. $A + Na_2CO_3 \longrightarrow B + C$,

$A \xrightarrow{CO_2} (Milky)\ C$

The chemical formula of A and B are respectively:

(a) NaOH and $Ca(OH)_2$

(b) $Ca(OH)_2$ and NaOH

(c) NaOH and CaO

(d) CaO and $Ca(OH)_2$

15. Which of the following salt on heating with concentrated H_2SO_4, coloured vapours do not evolve?

(a) NaBr (b) $NaNO_3$

(c) CaF_2 (d) KI

16. A salt made of bi-bivalent ions X and Y each of which is capable of decolourising acidified $KMnO_4$. The salt is likely to be:

(a) Ferric oxalate (b) Ferrous oxalate

(c) Ferrous sulphate (d) Stannic chloride

17. When concentrated H_2SO_4 is added to dry KNO_3, brown fumes are evolved. These fumes are due to:

(a) SO_2 (b) $SO_2 + SO_3$

(c) NO (d) NO_2

18. Freshly prepared chlorine water is added to the aqueous solution of some halide salt containing some CS_2. After shaking the contents, a violet colour appeared in CS_2 layer. The halide ion in solution is:

(a) Iodide (b) Bromide

(c) Chloride (d) Iodide as well as bromide.

19. For the confirmatory tests of acid radicals, sodium carbonate extract is prepared because:

(a) All anions react with Na

(b) Na is more reactive

(c) Na_2CO_3 is water soluble

(d) Sodium salts of almost all anions are water soluble.

20. In the precipitation of the radicals of iron group in qualitative analysis, NH_4Cl is added before adding NH_4OH. This causes:

(a) Decrease in the concentration of OH^- ions

(b) Removal of PO_4^{3-} ions

(c) Increase in the concentration of Cl^- ions

(d) Increase in the concentration of NH_4^+ ions

21. The aqueous solution of which of the following reagent will give Prussian blue coloured ppt. with an aqueous solution containing iron (III) ions?

(a) Potassium thiocyanate

(b) Potassium hexacyanoferrate (II)

(c) Potassium pyroantimonate

(d) All of these

22. Aqueous solution of salt A gives yellow precipitate with aqueous solution of K_2CrO_4. which of the following series of cation may be present in A?

(a) Pb^{2+}, Ag^+ (b) Pb^{2+}, Ba^{2+}

(c) Ag^+, Cu^{2+} (d) Hg^{2+}, Ag^+

23. The reagent that can distinguish between silver and lead salt is:

(a) H_2S gas

(b) Hot dilute HCl solution

(c) NH_4Cl (solid) + NH_4OH (solution)

(d) NH_4Cl (solid) + $(NH_4)_2\,CO_3$ (solution)

24. A yellow turbidity, sometimes appears on passing H_2S gas even in the absence of the second group radicals. Explain why?

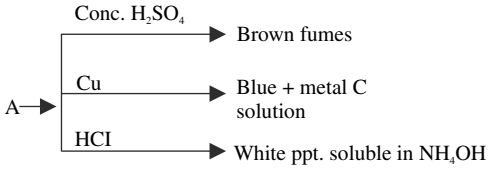
(a) Sulphur is present in the mixture as an impurity

(b) The fourth group radicals are precipitated as sulphides

(c) The H_2S is oxidized by some acidic radical present in solution

(d) The third group radicals are precipitated

25. Colourless salt (A)



The salt A can be:

(a) $Cu(NO_3)_2$ (b) AgBr

(c) $AgNO_3$ (d) $Pb(NO_3)_2$

26. Al^{3+}, Cr^{3+}, Fe^{3+} are grouped together for qualitative analysis because:

(a) Their carbonates are insoluble in ammonia

(b) Their hydroxides are insoluble in ammonia

(c) Their sulphides are insoluble in acid

(d) They belong to same group of periodic table

27. On addition of aqueous NaOH to a salt solution, a white gelatinous precipitate is formed, which dissolves in excess alkali. The salt solution contains:

(a) Chromous ions

(b) Aluminium ions

(c) Barium ions

(d) Iron ions

28. Dimethyl glyoxime in a suitable solvent was refluxed for 10 minutes with pure pieces of nickel sheet, it will result in:

(a) Red precipitate

(b) Blue precipitate

(c) Yellow precipitate

(d) No precipitate

29. A metal X on heating in nitrogen gas gives Y. Y on treatment with H_2O gives a colourless gas which when passed through $CuSO_4$ solution gives a blue colour. Y is:

(a) $Mg(NO_3)_2$ (b) Mg_3N_2

(c) NH_3 (d) MgO

30. A light green coloured salt (X) does not react with dilute and conc. H_2SO_4. Its aqueous solution becomes dark brown when sodium nitrite solution is added to it. X can be:

(a) Some salt of Ni (b) Some salt of copper

(c) $FeSO_4$ (d) Unpredictable

LEVEL III

ONE OR MORE THAN ONE CORRECT TYPE

1. Which of the following salts release reddish brown gas when heated in a dry test tube?

(a) $LiNO_3$ (b) KNO_3

(c) $Pb(NO_3)_2$ (d) $AgNO_3$

2. When Borax is heated it forms a colourless glassy bead because of formation of :

(a) B_2H_6 (b) $NaBO_2$

(c) B_2O_3 (d) $Na_2B_4O_7$

3. Which of the following metal chloride will give chromyl chloride test ?

(a) NaCl (b) KCl

(c) AgCl (d) $SbCl_3$

4. Which of the following statement(s) is/are correct with respect to bromide ions ?

(a) KBr on heating with MnO_2 and concentrated H_2SO_4 liberates Br_2 and SO_2 gases.

(b) KBr on heating with concentrated H_2SO_4 liberates Br_2 and SO_2 gases.

(c) KBr forms HBr with concentrated H_3PO_4.

(d) KBr(s) liberates Br_2 on gentile warming with concentrated H_2SO_4 and $K_2Cr_2O_7$(s).

5. KI solution is the reagent for :

(a) Hg^{2+} (b) Pb^{2+}

(c) Ag^{+} (d) Cu^{2+}

6. Which of the following cations form(s) black precipitate(s) with H_2S(g)?

(a) Cu^{2+} (b) Sb^{3+}

(c) Pb^{2+} (d) Bi^{3+}

7. Which of the following is/are correct for potassium ferrocyanide?

(a) It gives a brown precipitate with Cu^{2+} ions.

(b) It gives a white preciptate of mixed salt with Ca^{2+} ions.

(c) It in excess gives a bluish white/white precipitate with Zn^{2+}

(d) It develops a deep red colouration with Fe^{3+}.

8. The following can be used to regulate the concentration of OH^- ions for the scheme of basic radical analysis (III group).

(a) NH_4NO_3 (b) NH_4Cl

(c) $(NH_4)_2SO_4$ (d) $(NH_4)_2CO_3$

9. Which of the following statement(s) is/are correct?

(a) Nickel salts give rosy red precipitate with dimethyl glyoxime in excess of NH_4OH.

(b) Fe(III) salts give red colour with potassium sulphocyanide

(c) In nitroprusside, the iron and NO exist as Fe(III) and NO.

(d) Mn(II) salts give white precipitate with NaOH which turns brown on adding Br_2 water.

10. Which statement(s) is/are correct with reference to the ferrous and ferric ions?

(a) Fe^{2+} gives brown colour with potassium ferricyanide

(b) Fe^{2+} gives blue colour with potassium ferricyanide

(c) Fe^{3+} gives red colour with potassium thiocyanate

(d) Fe^{2+} gives brown colour with potassium thiocyanate

11. Which of the following sulphates are soluble in water ?

(a) $CuSO_4$ (b) $PbSO_4$

(c) Ag_2SO_4 (d) $BaSO_4$

12. Which of the following substances on being heated will give a gas that turns lime water milky?

(a) Na_2CO_3 (b) $ZnCO_3$

(c) $ZnSO_3$ (d) $MgCO_3$

13. A yellow precipitate is obtained when :

(a) lead acetate solution is treated with K_2CrO_4

(b) $Pb(NO_3)_2$ solution is treated with K_2CrO_4

(c) $AgNO_3$ solution treated with KI

(d) H_2S is passed through a solution of $CdSO_4$

14. Which of the following species will be decomposed on acidification?

(a) $[Ag(NH_3)_2]^+$ (b) $[Cu(NH_3)_4]^{2+}$

(c) $[Zn(OH)_4]^{2-}$ (d) $[Pb(OH)_4]^{2-}$

PASSAGE BASED QUESTIONS

Passage # 1 (Q. 15 to 17)

A colourless inorganic compound (A) imparts a green colour to the flame. Its solution gives a white ppt. (B) with H_2SO_4. When heated with $K_2Cr_2O_7$ and conc. H_2SO_4, a brown red vapour/gas (C) is formed. The gas/vapour when passed through aqueous NaOH solution, it turns into a yellow solution (D) which forms yellow precipitate (E) with CH_3COOH and $(CH_2COO)_2Pb$

15. The colourless inorganic compound (A) is:

(a) $Ba(NO_3)_2$ (b) $BaCl_2$

(c) $CuCl_2$ (d) $CrBr_3$

16. The liberated gas vapour (C) is:

(a) Br_2 (b) NO_2

(c) CrO_2Cl_2 (d) Cl_2

17. The yellow ppt. formed when (D) reacts with CH_3COOH and $(CH_2COO)_2$ Pb is:

(a) PbI_2 (b) $PbCrO_4$

(c) $BaCrO_4$ (d) AgBr

Passage # 2 (Q. 18 to 20)

$$\text{Black solid} \xrightarrow[\Delta]{KOH + Air} \underset{\text{(green)}}{(A)} \xrightarrow{H_2SO_4} \underset{\text{(purple)}}{(B) + (C)}$$

(i) KI on reaction with alkaline solution of (B) changes into a compound (D).

(ii) The colour of the compound (B) disappears on treatment with the acidic solution of $FeSO_4$

(iii) With cold conc. H_2SO_4 compound (B) gives (E), which being explosive decomposes to yield (F) and oxygen.

18. Nature of compound (E) is:

(a) Acidic oxide

(b) Basic oxide

(c) Amphoteric oxide

(d) Neutral oxide

19. Colour of the solution obtained, when ferrous sulphate reacts with acidic solution of (B):

(a) Colourless (b) Pink

(c) Green (d) Yellow

20. Which of the following options is correct ?

(a) (C) and (F) are same compounds having same colour.

(b) (C) and (F) are different compounds having same colour.

(c) Compound (B) forms similar compound (E) with hot and conc. H_2SO_4.

(d) Compound (A) does not give same type of reaction in acidic and neutral medium.

Passage # 3 (Q. 21 to 23)

When a crystalline compound X is heated with $K_2Cr_2O_7$ and concentrated H_2SO_4, a reddish brown gas A is evolved. On passing A into caustic soda, a yellow solution of B is formed. A yellow precipitate of C is obtained when a solution of B is neutralised with acetic acid and then treated with a lead acetate solution. When X is heated with NaOH, a colourless gas is evolved which, when passed into a solution of $K_2[HgI_4]$, gives a reddish brown precipitate of D.

21. Compound (X) is:

(a) NH_4Br (b) NH_4Cl

(c) NH_4NO_2 (d) NH_4NO_3

22. If the solution B is colourless, which of the following ions would not be present in the solid X?

(a) Cl^- (b) Br^-

(c) NO_3^- (d) NO_2^-

23. Which of the following is the composition of the brown precipitate (D)?

(a) HgI_2 (b) $Hg(NH_2)I$

(c) HgO (d) $HgO.Hg(NH_2)I$

Passage # 4 (Q. 24 to 26)

(i) A white solid mixture of two salts containing a common cation is insoluble in water. It dissolved in dilute HCl producing some gases (with effervescence) that turns an acidified dichromate solution green. After the gases are passed through the acidified dichromate solution, the emerging gas turns baryta water milky.

(ii) On treatment with dilute HNO_3, the white solid gives a solution which does not directly give a precipitate with a $BaCl_2$ solution but gives a white precipitate when warmed with H_2O_2 and then treated with $BaCl_2$ solution.

(iii) The solution of the mixture in dilute HCl, when treated with NH_4Cl, NH_4OH and an Na_2HPO_4 solution, gives a white precipitate.

24. The gases evolved in (i) are:

(a) CO_2 and HCl (b) SO_2 and CO_2

(c) SO_2 and H_2S (d) NH_3 and CO_2

25. The white precipitate obtained in (ii) indicates the presence of a:

(a) carbonate (b) sulphide

(c) sulphite (d) chloride

26. The white precipitate obtained in (iii) consists of:

(a) $Ba_3(PO_4)_2$ (b) $Sr_3(PO_4)_2$

(c) $Ca_3(PO_4)_2$ (d) $MgNH_4PO_4.6H_2O$

INTEGER VALUE TYPE QUESTIONS

27. How many compounds liberate NH_3 on heating from the following?

(a) $(NH_4)_2 SO_4$, (b) $(NH_4)_2 CO_3$,

(c) NH_4Cl, (d) NH_4NO_3,

(e) $(NH_4)_2 Cr_2O_7$

28. How many of the following reactions give yellow ppt.

(a) $NaBr + AgNO_3 \longrightarrow$

(b) $NaI + AgNO_3 \longrightarrow$

(c) $NaBr + Pb(NO_3)_2 \longrightarrow$

(d) $NaI + Pb(NO_3)_2 \longrightarrow$

(e) $Na_2S + Cd(CH_2COO)_2 \longrightarrow$

(f) $K_2CrO_4 + Pb(CH_3COO)_2 \longrightarrow$

(g) $K_2CrO_4 + (CH_3COO)_2Ba \longrightarrow$

(h) $K_2CrO_4 + AgNO_3 \longrightarrow$

(i) $NaBr + Cl_2$ water (excess) $\longrightarrow$

29. An aqueous solution contains Hg_2^{2+}, Hg^{2+}, Pb^{2+}, Ag^+, Bi^{3+} and Cd^{2+}. Out of these, how many ions will produce white precipitate with dilute HCl?

30. aq.$CuSO_4$ decolourizes on addition of KCN due to formation of complex (A). In complex "A".

(i) Number of d-orbital in hybridisation is/are "a"

(ii) Geometry of complex (b) :

(iii) Coordination number of Cu is "c". then find 8a + 7b + 5c.

(1) represents linear geometry

(2) represents tetrahedral geometry

(3) represents octahedral geometry

(4) represents square planer geometry

31. How many of the following pairs of ions can be separated by H_2S in dilute HCl?

(a) Bi^{3+} and Sn^{4+}, (b) Al^{3+} and Hg^{2+},

(c) Cd^{2+} and Zn^{2+}, (d) Fe^{3+} and Cu^{2+},

(e) As^{3+} and Sb^{3+}

Match the column type questions

32. Match the reagent which are used in qualitatiive analysis of gtiven anions :

	Column I	**Column II**
(A)	$AgNO_3$ solution	(a) CO_3^{2-}
(B)	$BaCl_2$ solution	(b) Cl^-
(C)	$PbNO_3$ solution	(c) S^{2-}
(D)	Acidified $KMnO_4$ solution	(d) NO_2^-

33.

	Column I	**Column II**
(A)	White turbidity	(a) $IO_3^- + SO_2$ + starch $\longrightarrow$
(B)	Rotten egg smell	(b) $SO_2 + MnO_4^- \longrightarrow$
(C)	Colourless solution	(c) $Zn + NaOH + SO_2 \longrightarrow$
(D)	Blue color	(d) $CO_2 + Ca(OH)_2 \longrightarrow$

34.

	Column I	**Column II**
(A)	Bi^{3+} give(s) black precipitate with	(a) H_2S (saturated solution in water)
(B)	Cu^{2+} give(s) black precipitate with	(b) Potassium thiocyanate solution
(C)	Zn^{2+} give(s) white precipitate with	(c) Potassium iodide solution
(D)	Ag^+ give(s) white precipitate with	(d) Potassium ferrocyanide solution

PREVIOUS YEARS' QUESTIONS FOR JEE (MAIN AND ADVANCED)

1. [X] + $H_2SO_4 \longrightarrow$ [Y] a colourless gas with irritating smell; [Y] + $K_2Cr_2O_7$ + $H_2SO_4 \longrightarrow$ green solution. [X] and [Y] is:

(a) SO_3^{2-}, SO_2 (b) Cl^-, HCl

(c) S^{2-}, H_2S (d) CO_3^{2-}, CO_2

[IIT-2003]

2. A dilute aqueous solution of a sodium salt froms white precipitate with $MgCl_2$, only after boiling. The anion of the sodium salt is:

(a) HCO_3^- (b) CO_3^{2-}

(c) NO_3^- (d) SO_4^{2-}

[IIT-2004]

3. The species present in solution when CO_2 is dissolved in water are:

(a) CO_2, H_2CO_3, HCO_3^-, CO_3^{2-}

(b) HCO_3^-, CO_3^{2-}

(c) CO_3^{2-}, HCO_3^-

(d) CO_2, H_2CO_3

[IIT-2006]

4. A white precipitate is obtained when a solution is diluted with H_2O and boiled. On addition of excess NH_4Cl/ NH_4OH, the volume of precipitate decreases leaving behind a white gelatinous precipitate. Identify the precipitate which dissolves in ammonia solution or NH_4Cl.

(a) $Al(OH)_3$ (b) $Zn(OH)_2$

(c) $Mg(OH)_2$ (d) $Ca(OH)_2$

[IIT-2006]

5. In blue solution of copper sulphate excess of KCN is added then solution becomes colourless due to the formation of:

(a) $[Cu(CN)_4]^{2-}$

(b) Cu^{2+} get reduced to form $[Cu(CN)_4]^{3-}$

(c) $Cu(CN)_2$

(d) CuCN

[IIT-2006]

6. $MgSO_4 + NH_4OH + Na_2HPO_4 \longrightarrow$ white crystalline precipitate. The formula of crystalline precipitate is:

(a) $MgCl_2.\ MgSO_4$ (b) $MgSO_4$

(c) $Mg(NH_4)PO_4$ (d) $Mg(PO_4)_2$

[IIT-2006]

7. A solution of a metal ion when treated with KI gives a red precipitate which dissolves in excess KI to give a colourless solution. Moreover, the solution of metal ion on treatment with a solution of cobalt (II) thiocyanate gives rise to a deep blue crystalline precipitate. The metal ion is:

(a) Pb^{2+} (b) Hg^{2+}

(c) Cu^{2+} (d) Co^{2+}

[IIT-2007]

8. A solution of colourless salt H on boiling with excess NaOH produces a non-flammable gas. The gas evolution ceases after some time. Upon addition of Zn dust to the same solution, the gas evolution restarts. The colourless salts(s) H is (are):

(a) NH_4NO_3 (b) NH_4NO_2

(c) NH_4Cl (d) $(NH_4)_2SO_4$

[IIT-2008]

Passage # 1 (Q. 9 to 11)

p-Amino-N, N-dimethylaniline is added to a strongly acidic solution of X. The resulting solution is treated with a few drops of aqueous solution of Y to yield blue coloration due to the formation of methylene blue. Treatment of the aqueous solution of Y with the reagent potassium hexacyanoferrate(II) leads to the formation of an intense blue precipitate. The precipitate dissolves on excess additon of the reagent. Similarly, treatement of the solution of Y with the solution of potassium hexacyanoferrate(III) leads to a brown colouration due to the formation of Z.

[IIT-2009]

9. The compound X is:

(a) $NaNO_3$ (b) NaCl

(c) Na_2SO_4 (d) Na_2S

10. The compound Y is:

(a) $MgCl_2$ (b) $FeCl_2$

(c) $FeCl_3$ (d) $ZnCl_2$

11. The compound Z is:

(a) $Mg_2[Fe(CN)_6]$ (b) $Fe[Fe(CN)_6]$

(c) $Fe_4[Fe(CN_6]_3$ (d) $K_2Zn_3[Fe(CN)_6]_2$

12. The equilibrium, $2Cu^{I} \rightleftarrows Cu^{0} + C^{II}$ in aqueous medium at 25°C shifts towards the left in the presence of:

(a) NO_3^- (b) Cl^-

(c) SCN^- (d) CN^-

[IIT-2011]

Passage # 2 (Q. 13 to 15)

When a metal rod M is dipped into an aqueous colourless concentrated solution of compound N the solution turns light blue. Addition of aqueous NaCl to the blue solution gives a white precipitate O. Addition of aqueous NH_3 dissolves O and give an intense blue solution.

[IIT-2011]

13. The metal rod M is:

(a) Fe (b) Cu

(c) Ni (d) Co

14. The compound N is:

(a) $AgNO_3$ (b) $Zn(NO_3)_2$

(c) $Al(NO_3)_3$ (d) $Pb(NO_3)_2$

15. The final solution contains:

(a) $[Pb(NH_3)_4]^{2+}$ and $[CoCl_4]^{2-}$

(b) $[Al(NH_3)_4]^{3+}$ and $[Cu(NH_3)_4]^{2+}$

(c) $[Ag(NH_3)_2]^{+}$ and $[Cu(NH_3)_4]^{2+}$

(d) $[Ag(NH_3)_2]^{+}$ and $[Ni(NH_3)_6]^{2+}$

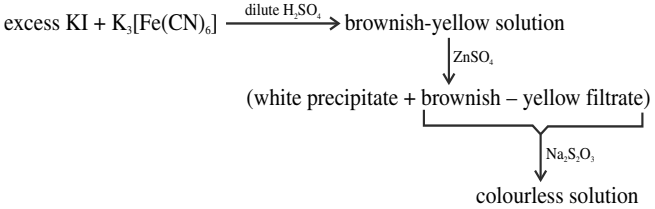
16. Passing H_2S gas into a mixture of Mn^{2+}, Ni^{2+}, Cu^{2+} and Hg^{2+} ions in an acidified aqueous solution precipitates:

(a) CuS and HgS (b) MnS and CuS

(c) MnS and NiS (d) NiS and HgS

[IIT-2011]

17. For the given aqueous reaction which of the statement(s) is (are) true?



(a) The first reaction is a redox reaction

(b) White precipitate is $Zn_3[Fe(CN)_6]_2$

(c) Addition of filerate to starch solution gives blue colour

(d) White precipitates is soluble in NaOH solution

[IIT-2012]

18. Concentrated nitric acid, upon long standing, turns yellow-brown due to the formation of:

(a) NO (b) NO_2

(c) N_2O (d) N_2O_4

[JEE Advanced - 2013]

19. Upon treatment with ammoniacal H_2S, the metal ion that precipitates as a sulphide is:

(a) Fe(III) (b) Al(III)

(c) Mg(II) (d) Zn(II)

[JEE Advanced - 2013]

Passage # 3 (Q. 20 and 21)

An aqueous solution of a mixture of two inorganic salts, when treated with dilute HCl, gave a precipitate (P) and a filtrate (Q). The precipitate P was found to dissolve in hot water. The filtrate (Q) remained unchanged, when treated with H_2S in a dilute mineral acid medium. However, it gave a precipitate (R) with H_2S in an ammonical medium. The precipitate (R) gave a coloured solution (s), when treated with H_2O_2 in an aqueous NaOH medium.

[JEE Advanced - 2013]

20. The precipitate P contains:

(a) Pb^{2+} (b) Hg_2^{2+}

(c) Ag^+ (d) Hg^{2+}

21. The coloured solution S contains:

(a) $Fe_2(SO_4)_3$ (b) $CuSO_4$

(c) $ZnSO_4$ (d) Na_2CrO_4

22. Among PbS, CuS, HgS, MnS, Ag_2S, NiS, CoS, Bi_2S_3 and SnS_2, the total number of BLACK coloured sulphide is **[JEE Advanced - 2014]**

23. The pair(s) of ions where BOTH the ions are precipitated upon passing H_2S gas in presence of dilute HCl, is (are):

(a) Ba^{2+}, Zn^{2+} (b) Bi^{3+}, Fe^{3+}

(c) Cu^{2+}, Pb^{2+} (d) Hg^{2+}, Bi^{3+}

[JEE Advanced - 2015]

24. Which one of the following statement is correct?

(a) From a mixed precipitate of AgCl and AgI, ammonia solution dissolves only AgCl.

(b) Ferric ions gave a deep green precipitate on adding potassium ferrocyanide solution

(c) On boiling a solution having K^+, Ca^{2+} and HCO_3^- ions we get a precipitate of $K_2Ca(CO_3)_2$.

(d) Manganese salts give a violet borax bead test in the reducing flame

[AIEEE - 2013]

25. A red solid is insoluble in water. However it becomes soluble if some KI is added to water. Heating the red solid in a test tube results in liberation of some violet coloured fumes and droplets of a metal appear on the cooler parts of the test tube. The red solid is

(a) $(NH_4)_2Cr_2O_7$ (b) HgI_2

(c) HgO (d) Pb_3O_4

[AIEEE - 2003]

26. Which of the following compounds is not coloured yellow?

(a) $Zn_2[Fe(CN)_6]$ (b) $K_3[Co(NO_2)_6]$

(c) $(NH_4)_3[As(Mo_3O_{10})_4]$ (d) $BaCrO_4$

[JEE Main - 2015]

Answer Key

LEVEL I

1. (a)	2. (a)	3. (c)	4. (a)	5. (a)	6. (a)	7. (d)	8. (d)	9. (a)	10. (d)
11. (b)	12. (d)	13. (d)	14. (b)	15. (c)	16. (d)	17. (c)	18. (b)	19. (c)	20. (c)
21. (b)	22. (a)	23. (a)	24. (d)	25. (c)	26. (a)	27. (c)	28. (c)	29. (b)	30. (c)

LEVEL II

1. (c)	2. (d)	3. (d)	4. (a)	5. (d)	6. (b)	7. (a)	8. (c)	9. (a)	10. (b)
11. (a)	12. (d)	13. (a)	14. (b)	15. (c)	16. (b)	17. (d)	18. (a)	19. (d)	20. (a)
21. (b)	22. (b)	23. (b)	24. (c)	25. (c)	26. (b)	27. (b)	28. (d)	29. (b)	30. (c)

LEVEL III

1. (a, c, d)	2. (b, c)	3. (a,b)	4. (b,c,d)	5. (a, b, c, d)	6. (a, c, d)	7. (a, b, c)	8. (a, b)
9. (a, b, d)	10. (b,c)	11. (a, c)	12. (b, c, d)	13. (a,b, c, d)	14. (a, b, c, d)	15. (b)	16. (c)
17. (b)	18. (a)	19. (d)	20. (a)	21. (b)	22. (a)	23. (d)	24. (b)
25. (c)	26. (d)	27. (3)	28. (7)	29. (3)	30. (34)	31. (3)	

32. A → a,b,c,d; B → a; C → a,b,c; D → b,c,d
33. A → d; B → c; C → b; D → a
34. A → a,c; B → a,b; C → a,d; D → b,d

PREVIOUS YEARS' QUESTIONS FOR JEE (MAIN AND ADVANCED)

1. (a)	2. (a)	3. (a)	4. (b)	5. (b)	6. (c)	7. (b)	8. (a, b)	9. (d)	10. (c)
11. (b)	12. (b, c, d)	13. (b)	14. (a)	15. (c)	16. (a)	17. (a, c, d)	18. (b)	19. (d)	20. (a)
21. (d)	22. (7)	23. (c, d)	24. (a)	25. (b)	26. (a)				

Hints and Solutions

LEVEL I

1. **(a)** I^- ions are oxidized by H_2SO_4 to violet coloured I_2.

2. **(a)** Due to electronic configuration of Zn^{+2} is [Ar] $4s^0 3d^{10}$, salts of zinc are white (colourless).

3. **(c)** $Na_2B_4O_7.10H_2O \xrightarrow{\text{Strong heating}} \underbrace{2NaBO_2 + B_2O_3}_{\text{galssy bead}} + 10H_2O$

4. **(a)** Dry heating of oxalate slats give CO and CO_2.

5. **(a)** Chromium salts are in general green in colour.

6. **(a)** Chromyl chloride test is applied for the detection of Cl^- ion.

7. **(d)** Both CO_2 and SO_2 turn limewater ($Ca(OH)_2$) milky.

$Ca(OH)_2 + CO_2 \rightarrow CaCO_3\downarrow + H_2O$

$Ca(OH)_2 + SO_2 \rightarrow \underset{\text{White}}{CaSO_3\downarrow} + H_2O$

8. **(d)** As_2S_3 is soluble in YAS (yellow ammonium sulphide) whereas CdS is not.

9. **(a)** $2Cu^{2+} + [Fe(CN)_6]^{4-} \rightarrow \underset{\text{Chocolate ppt.}}{Cu_2[Fe(CN)_6]}$

10. **(d)** $Cu(NO_3)_2 + H_2S \rightarrow \underset{\text{Black}}{CuS\downarrow} + 2HNO_3$

11. **(b)** $NH_4^+ + NaOH \rightarrow NH_3 + H_2O + Na^+$

12. **(d)** All the three ions will precipitate as their respective oxalates.

13. **(d)** $Na_2S + Na_2[\overset{+2}{Fe}(CN)_5NO] \rightarrow \underset{\text{Sodium nitroprusside}}{Na_4[\overset{+2}{Fe}(CN)_5(NOS)]}$

There is no change in oxidation state of Fe.

14. **(b)** HgS is not soluble in dil. HNO_3. HgS is soluble in aqua regia.

15. **(c)** I^- ion acts as good reducing agent.

$2Cu^{2+} + 4I^- \rightarrow Cu_2I_2 + I_2$

16. **(d)** $AgCl + NH_3 \rightarrow \underset{\text{Soluble complex}}{[Ag(NH_3)_2]Cl}$

17. **(c)** $BaCrO_4$ is precipitated first.

18. **(b)** Brown ring test is used to detect nitrate ion.

19. **(c)** $I_2 + S_2O_3^{-2} \rightarrow I^- + S_4O_6^{-2}$

20. **(c)** $NaCl + K_2Cr_2O_7 + H_2SO_4 \rightarrow NaHSO_4 + KHSO_4 + H_2O + CrO_2Cl_2$

CrO_2Cl_2 is chromyl chloride.

21. **(b)** $FeCl_3 + KCNS \rightarrow \underset{\text{Blood red}}{Fe(SCN)Cl_2} + KCl$

22. **(a)** $H_3BO_3 + 3MeOH \rightarrow B(OMe)_3 + 3H_2O$

Methyl borate, $B(OMe)_3$ burns with green flame.

23. **(a)** $Ba^{+2} + K_2CrO_4 \rightarrow \underset{\text{Yellow}}{BaCrO_4\downarrow} + 2K^+$

$AgNO_3 + Br^- \rightarrow \underset{\text{yellow}}{AgBr\downarrow} + NO_3^-$

24. **(d)** All three Zn^{+2}, Cd^{+2} and Cu^{+2} form precipitate with H_2S but ZnS is white and

CdS is yellow in colour. The only black precipitate is CuS.

25. **(c)** $Hg_2Cl_2 + NH_4OH \rightarrow \underbrace{Hg + Hg(NH_2)Cl}_{\text{black}} + HCl + H_2O$

26. **(a)** $KI + AgNO_3 \rightarrow \underset{\text{yellow}}{AgI\downarrow} + KNO_3$

$2KI + Pb(NO_3)_2 \rightarrow \underset{\text{yellow}}{PbI_2\downarrow} + 2KNO_3$

27. **(c)** $Na_2SO_3 + H_2SO_4\,(dil) \rightarrow Na_2SO_4 + H_2O + SO_2\uparrow$

SO_2 is a colourless gas having pungent smell and it will decolourise bromine water.

28. **(c)** $NH_3 + HCl \rightarrow \underset{\text{(white fumes)}}{NH_4Cl\uparrow}$

29. **(b)** $K_2Cr_2O_7 + KCl + H_2SO_4 \rightarrow \underset{\text{(Red)}}{CrO_2Cl_2\uparrow}$

$CrO_2Cl_2 + NaOH \rightarrow \underset{\text{(Yellow)}}{Na_2CrO_4}$

30. **(c)** Both form colourless complex with KCN but complex of Cd^{+2} unstable. Complex of Cd^{+2} form yellow precipitate of CdS with H_2S.

LEVEL II

1. **(c)** $Al(OH)_3$ dissolves in excess NaOH while $Fe(OH)_3$ does not dissolves in NaOH.

2. **(d)** $Pb^{2+} + HCl(dil) \rightarrow \underset{\text{white}}{PbCl_2\downarrow}$ (soluble in hot water)

3. **(d)** $\underset{}{CrCl_3} \xrightarrow{NH_4Cl + NH_4OH} \underset{\text{(A)}}{Cr(OH)_3}$

$\underset{\text{(A)}}{Cr(OH)_3} \xrightarrow{Na_2O_2 + H_2O} \underset{\text{(B)}}{Na_2CrO_4}$

$\underset{\text{(B)}}{Na_2CrO_4} \xrightarrow{Pb(CH_3COO)_2} \underset{\text{(C)}}{PbCrO_4}$

4. **(a)** $2Cu^{2+} + 5I^- \rightarrow \underset{\text{(X)}}{2CuI} + I_3^-$

$I_3^- + 2S_2O_3^{2-} \rightarrow 3I^- + \underset{\text{(Y)}}{S_4O_6^{2-}}$

5. **(d)** AgCl forms soluble complex with NH_3 while AgI does not form soluble complex with NH_3.

6. **(b)** Brown ring complex is $[\overset{+1}{Fe}(H_2O)_5\overset{+1}{NO}]SO_4$

7. **(a)** $S^{2-} + \underset{\text{Violet}}{Na_2[Fe(CN)_5NO]} \rightarrow Na_4[Fe(CN)_5(NOS)]$

8. **(c)** ZnS is white is colour.

9. **(a)** $\overset{+1}{Hg_2Cl_2} + NH_3 \rightarrow \underbrace{\overset{0}{Hg} + \overset{+2}{Hg(NH_2)}Cl}_{\text{Black}} + HCl$

10. **(b)** Fe^{+3}, Al^{+3} and Cr^{+3} are III group basic radicals while Ni^{+2} is IV group basic radical.

11. **(a)** CoS and NiS, both are insoluble in dilute HCl while ZnS and MnS are soluble in dilute HCl.

12. **(d)** $CaSO_3 \xrightarrow{\Delta} CaO + SO_2\uparrow$

SO_2 gas turns lime water milky and an acidified dichromate solution green.

13. **(a)** Order of thermal stability:

$BeCO_3 < MgCO_3 < CaCO_3 < BaCO_3$

$BeCO_3$ easily decomposes into $BeO + CO_2$

14. **(b)** $\underset{\text{(A)}}{Ca(OH)_2} + Na_2CO_3 \rightarrow 2\underset{\text{(B)}}{NaOH} + \underset{\text{(C)}}{CaCO_3}$

$\underset{\text{(A)}}{Ca(OH)_2} \xrightarrow{CO_2} \underset{\text{(C)}}{CaCO_3}$

15. **(c)** $NaBr + H_2SO_4(conc.) \rightarrow Br_2\uparrow$ (reddish-brown)

$NaNO_3 + H_2SO_4(conc.) \rightarrow NO_2\uparrow$ (reddish-brown)

$CaF_2 + H_2SO_4(conc.) \rightarrow$ HF (colourless)

$KI + H_2SO_4(conc.) \rightarrow I_2\uparrow$ (violet)

16. **(b)** Ferrous oxalate consists of Fe^{2+} and $C_2O_4^{2-}$ each of which is capable of reducing MnO_4^- to Mn^{2+} ions.

17. **(d)** $KNO_3 + H_2SO_4(conc.) \rightarrow KHSO_4 + HNO_3$

$4HNO_3 \rightarrow 2H_2O + 4NO_2 + O_2$

18. **(a)** Cl_2 oxidizes I^- ions to I_2 which dissolves in CS_2 to give violet colour.

19. **(d)** All sodium salts (except $NaHCO_3$) are soluble in water.

20. **(a)** $NH_4Cl \rightarrow NH_4^+ + Cl^-$

$NH_4OH \rightleftarrows NH_4^+ + OH^-$

NH_4Cl controls the concentration of OH^- ions by suppressing the ionization of NH_4OH due to common ion effect.

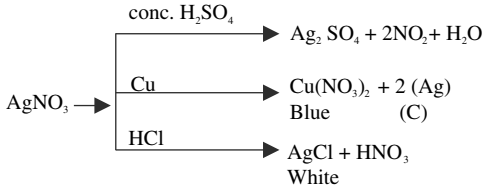
21. **(b)** $Fe^{+3} + K_4[Fe(CN)_6] \rightarrow \underset{\text{(Prussian blue)}}{Fe_4[Fe(CN)_6]_3} + K^+$

22. **(b)** Both Pb^{2+} and Ba^{2+} gives yellow precipitate with aqueous solution of K_2CrO_4.

23 **(b)** Hot HCl will produce precipitate of AgCl with Ag^+ only. $PbCl_2$ will not precipitate because it is soluble in hot solution.

24. (c) Radicals such as NO_3^- oxidize H_2S to S which appears as turbidity.

25. (c) A is $AgNO_3$



26. (b) The hydroxides of these cations are insoluble in ammonical solution.

27. (b) $Al^{+3} + 3OH^- \rightarrow Al(OH)_3$ (white gelatinous precipitate)

$Al(OH)_3 + NaOH \rightarrow NaAlO_2 + H_2O$

28. (d) DMG gives rose red precipitate with Ni^{+2} but not with Ni metal.

29. (b) $3Mg + N_2 \rightarrow \underset{(X)}{Mg_3N_2} \xrightarrow{H_2O} \underset{(Y)}{Mg(OH)_2 + NH_3}$

$\downarrow CuSO_4$

$[Cu(NH_3)_4]SO_4$

30. (c) $FeSO_4$ solution gives black-brown colour with $NaNO_2$

LEVEL III

1. (a, c, d)

$2LiNO_3 \xrightarrow{\Delta} Li_2O + 2NO_2 + \frac{1}{2}O_2$

$2KNO_3 \xrightarrow{\Delta} 2KNO_2 + O_2$

$2Pb(NO_3) \xrightarrow{\Delta} 2PbO + 4NO_2 + O_2$

$2AgNO_3 \xrightarrow{\Delta} Ag_2O + 2NO_2 + \frac{1}{2}O_2$

2. (b, c)

$Na_2B_4O_7.10H_2O \xrightarrow{\dot{N}\equiv N \rightarrow \dot{O}:} \underbrace{2NaBO_2 + B_2O_3}_{\text{glassy bead}} + 10H_2O$

3. (a, b)

NaCl and KCl give chromyl chloride test.

4. (b, c, d)

$MnO_2 + H_2SO_4(conc.) + KBr \xrightarrow{\Delta} KHSO_4 + MnSO_4 + H_2O + Br_2$

$KBr + H_2SO_4(conc.) \xrightarrow{\Delta} SO_2 + Br_2 + K_2SO_4 + H_2O$

$KBr + H_3PO_4(conc.) \xrightarrow{\Delta} KH_2PO_4 + HBr$

$K_2Cr_2O_7 + H_2SO_4(conc.) + KBr \rightarrow Cr_2(SO_4)_3 + Br_2 + H_2O + K_2SO_4$

5. (a, b, c, d)

$Hg^{2+} + 2I^- \longrightarrow \underset{\text{Red}}{HgI_2\downarrow}$

$Pb^{2+} + 2I^- \longrightarrow \underset{\text{Yellow}}{PbI_2\downarrow}$

$Ag^+ + I^- \longrightarrow \underset{\text{Yellow}}{AgI\downarrow}$

$2Cu^{2+} + 4I^- \longrightarrow \underset{\text{White}}{Cu_2I_2\downarrow} + I_2$

6. (a, c, d)

Cus, PbS, $Bi_2S_3 \longrightarrow$ black

$Sb_2S_3 \longrightarrow$ Orange

7. (a, b, c)

$Fe^{3+} + K_4[Fe(CN)_6] \longrightarrow \underset{\text{Prussian blue}}{Fe_4[Fe(CN)_6]_3}$

8. (a, b)

$(NH_4)_2SO_4$ and $(NH_4)_2CO_3$ can not be used to regulate the concentration of OH^- ions for III group basic radicals. Ba^{+2}(V group) can form precipitate $BaSO_4$ and $BaCO_3$.

9. (a, b, d)

In nitroprusside, the iron and NO exist as Fe(II) and NO^+.

10. (b, c)

$Fe^{+2} + K_3[Fe(CN)_6] \longrightarrow \underset{\text{(which finally converts into } Fe_4[Fe(CN)_6]_3)}{Fe_3[Fe(CN)_6]_2}$

$Fe^{+3} + KSCN \longrightarrow \underset{\text{blood red}}{Fe(SCN)_3}$

11. (a, c)

$CuSO_4$ and Ag_2SO_4 are water soluble.

12. (b, c, d)

CO_2 and SO_2 both gas can turn lime water milky.

$ZnCO_3 \xrightarrow{\Delta} ZnO + CO_2\uparrow$

$ZnSO_3 \xrightarrow{\Delta} ZnO + SO_2\uparrow$

$MgCO_3 \xrightarrow{\Delta} MgO + CO_2\uparrow$

13. (a, b, c, d)

$PbCrO_4$, AgI, CdS are yellow precipitate.

14. (a, b, c, d)

All complex will decompose on acidification.

15. (b) Compound (A) imparts a green colour to the flame. It implies that cation of compound is Ba^{+2}. This compound gives chromyl chloride test. It implies that anion of the compound is Cl^-.

16. (c) $\underset{(A)}{BaCl_2} + K_2Cr_2O_7 + H_2SO_4 \longrightarrow Ba(HSO_4)_2 + KHSO_4 + H_2O + \underset{(C)}{CrO_2Cl_2}\uparrow$

17. **(b)** Yellow precipitate (E) is $PbCrO_4$.

18. **(a)** $MnO_2 \xrightarrow[\Delta]{KOH + Air} \underset{(A)}{K_2MnO_4} \xrightarrow{H_2SO_4} \underset{(B)}{KMnO_4} + \underset{(C)}{MnO_2}$

$KMnO_4 + H_2SO_4$ (cold and conc.) $\longrightarrow Mn_2O_{7\,(E)}$

Mn_2O_7 is an acidic oxide

19. **(d)** $KMnO_4 + H_2SO_4 + FeSO_4 \longrightarrow$

$MnSO_4 + Fe_2(SO_4)_3 + H_2O + K_2SO_4$

Colourless Yellow

20. **(a)** (C) and (F) both are MnO_2

21. **(b)** Compound (X) gives chromyl chloride test and it also reacts with nesseler's reagent hence, (X) is NH_4Cl.

22. **(a)** If Br^- is present in (X) then Br_2 vapours are evolved which forms colourless NaBr + NaOBr/$NaBrO_3$ with NaOH.

If NO_3^- or NO_2^- is present in (X) then NO_2 gas is evolved which forms $NaNO_3$ and $NaNO_2$ with NaOH.

23. **(d)** $\underset{(X)}{NH_4Cl} + NaOH \rightarrow NH_3\uparrow$

$NH_3 + K_2HgI_4 + OH^- \rightarrow \underset{(D)}{HgO.Hg(NH_2)I}\downarrow$

24. **(b)** White solid consists of $MgCO_3$ and $MgSO_3$. With dilute HCl, this solid produces CO_2 and SO_2 gases.

25. **(c)** White precipitate in (ii) is $BaSO_4$.
It indicates presence of a sulphite.

26. **(d)** $MgCl_2 + NH_4OH + Na_2HPO_4 \rightarrow \underset{(white)}{Mg(NH_4)PO_4.6H_2O}\downarrow$

27.

$(NH_4)_2SO_4 \xrightarrow{\Delta} NH_3 + H_2SO_4$

$(NH_4)_2CO_3 \xrightarrow{\Delta} NH_3 + CO_2 + H_2O$

$NH_4Cl \xrightarrow{\Delta} NH_3 + HCl$

$(NH_4)_2Cr_2O7_4 \xrightarrow{\Delta} N_2 + Cr_2O_3 + H_2O$

$NH_4NO_3 \xrightarrow{\Delta} N_2O + H_2O$

28.

$NaBr + AgNO_3 \rightarrow AgBr$ (yellow)

$NaI + AgNO_3 \rightarrow AgI$ (yellow)

$NaI + Pb(NO_3)_2 \rightarrow PbI_2$ (yellow)

$Na_2S + Cd(CH_3COO)_2 \rightarrow CdS$ (yellow)

$K_2CrO_4 + Pb(CH_3COO)_2 \rightarrow PbCrO_4$ (yellow)

$K_2CrO_4 + (CH_3COO)_2Ba \rightarrow BaCrO_4$ (yellow)

$NaBr + Cl_2$ water (excess) $\rightarrow BrCl$ (yellow)

29. Hg_2Cl_2, $PbCl_2$, AgCl (all are white precipitate)

30. $CuSO_4(aq) + KCN_{(excess)} \rightarrow K_3[\overset{sp^3}{Cu}(CN)_4]$ (Tetrahedral)

$a = 0 ; b = 2 ; c = 4$

$8a + 7b + 5c = 34$

31. **(c)**

Al^{3+} (group III)	and	Hg^{2+} (group II)
Cd^{2+} (group II)	and	Zn^{2+} (group IV)
Fe^{3+} (group III)	and	Cu^{2+} (group II)
Bi^{3+} (group II)	and	Sn^{4+} (group II)
As^{3+} (group II)	and	Sb^{3+} (group II)

32. (A → a,b,c,d; B → a; C → a,b,c; D → b,c,d)

33. (A → d; B → c; C → b; D → a)

34. (A → a,c; B → a,b; C → a,d ; D → b,d)

PREVIOUS YEARS' QUESTIONS FOR JEE (MAIN AND ADVANCED)

1. **(a)** $\underset{[X]}{SO_3^{2-}} + H_2SO_4 \longrightarrow \underset{[Y]}{SO_2}$

$SO_2 + K_2Cr_2O_7 + H_2SO_4 \longrightarrow \underset{(green)}{Cr_2(SO_4)_2} + K_2SO_4 + H_2O$

2. **(a)** $NaHCO_3 + MgCl_2 \xrightarrow{\Delta} \underset{(white)}{MgCO_3}\downarrow$

3. **(a)** $CO_2 + H_2O \longrightarrow \underset{(H^+,\, HCO_3^-,\, CO_3^{2-})}{H_2CO_3}$

4. **(b)** $Zn(OH)_2 + NH_3(solution) \longrightarrow \underset{\text{Soluble complex}}{[Zn(NH_3)_4]^{2+}}$

5. **(b)** $\overset{+2}{Cu}SO_4 + KCN(excess) \longrightarrow K_3[\overset{+1}{Cu}(CN)_4]$

6. **(c)** $MgSO_4 + NH_4OH + Na_2HPO_4 \longrightarrow \underset{\text{White}}{Mg(NH_4)PO_4}$

7. **(b)** $Hg^{2+} + KI \longrightarrow \underset{\text{red}}{HgI_2}\downarrow$

$HgI_2 + KI(excess) \longrightarrow \underset{\text{Soluble}}{K_2[HgI_4]}$

try

8. **(a,b)** $NH_4NO_3 + NaOH \longrightarrow NH_3 + NaNO_3$

$NaNO_3 + Zn\ dust \longrightarrow NH_3 + Na_2ZnO_2$

$NH_4NO_2 + NaOH \longrightarrow NH_3 + NaNO_3$

$NaNO_2 + Zn\ dust \longrightarrow NH_3 + Na_2ZnO_2$

9. **(d)** p-Amino-N, N-dimethylaniline + $\underset{(X)}{Na_2S}$ + $\underset{(Y)}{FeCl_3} \longrightarrow$ Methylene blue

$FeCl_3 + K_4[Fe(CN)_6] \longrightarrow Fe_4[Fe(CN)_6]_3$

(Y) blue

$FeCl_3 + K_4[Fe(CN)_6] \longrightarrow Fe[Fe(CN)_6]$

(Y) (Z)

10. **(c)** $FeCl_3$

11. **(b)** $Fe[Fe(CN)_6$

12. **(b, c, d)**

With Cl^-, SCN^-, CN^- ions the more stable oxidation state of Cu is +1.

13. **(b)** $Cu + AgNO_3 \rightarrow Ag + Cu(NO_3)_2$

(M) (N) light blue

$AgNO_3 + NaCl \rightarrow AgCl\downarrow$

White

(O)

$AgCl + NH_3 \rightarrow [Ag(NH_3)_2]^+$

$Cu(NO_3)_2 + NH_3 \rightarrow [Cu(NH_3)_4]^{2+}$

14 **(a)** $AgNO_3$

15. **(c)** $[Ag(NH_3)_2]^+$ and $[Cu(NH_3)_4]^{2+}$

16. **(a)** CuS and HgS

Cu^{2+} and Hg^{2+} are II group radicals.

17. **(a, c, d)**

$K_3[\overset{+3}{Fe}(CN)_6] + KI_{(excess)} \rightarrow K_4[\overset{+2}{Fe}(CN)_6] + KI_3$

(Brownish yellow solution)

$K_4[Fe(CN)_6] + ZnSO_4 \rightarrow K_2Zn_3[Fe(CN)_6]_2$ or $K_2Zn[Fe(CN)_6]$

white ppt.

$I_3^- + 2Na_2S_2O_3 \rightarrow Na_2S_4O_6 + 2NaI + I_2$

(Brownish yellow filtrate) Clear solution (Turns starch solution blue)

$K_2Zn[Fe(CN)_6]$ reacts with NaOH as,

$K_2Zn[Fe(CN)_6] + NaOH \longrightarrow \underset{\text{Soluble}}{[Zn(OH)_4]^{2-}} + [Fe(CN)_6]^{4-}$

18. **(b)** $4HNO_3 \xrightarrow{h\upsilon} 2H_2O + 4NO_2\uparrow + O_2\uparrow$

19. **(d)** Zn^{+2} is IV group radical.

20. **(a)** $PbCl_2$ is soluble in hot water.

21. **(d)** Q is group III radical

$\underset{(Q)}{Cr(OH)_3} + H_2O_2 + NaOH \longrightarrow \underset{\text{yellow solution}}{Na_2CrO_4\ (s)}$

22. PbS, CuS, HgS, Ag_2S, NiS, CoS (Black)

MnS (buff or pink)

SnS_2(yellow coloured)

Bi_2S_3(brown/black coloured)

23. **(c, d)**

Cu^{2+}, Pb^{2+}, Hg^{2+} and Bi^{3+}, all are group II radicals.

24 **(a)** AgI does not dissolve in NH_3.

25. **(b)** $HgI_2 + 2KI \rightarrow \underset{\text{Soluble}}{K_2[HgI_4]}$

26. **(a)** $Zn_2[Fe(CN)_6]$ is white in colour.