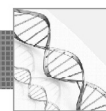
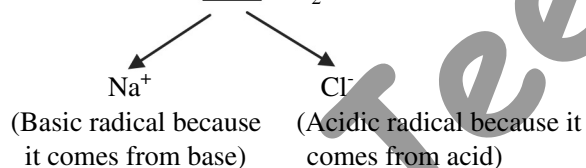
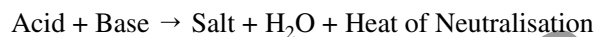


Salt Analysis

Key Concepts



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



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

Bitter almond smell

Hypochlorites (ClO^-)

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} , $[\text{Fe}(\text{CN})_6]^{4-}$
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 ₂ Cl ₂ , NH ₄ X, AlCl ₃ , HgCl ₂ , As ₂ O ₃ , Sb ₂ O ₃
b. Yellow	As ₂ S 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 ₃ O ₄
d. Black (Hot); Red brown (Cold)	Fe ₂ O 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
b. O ₂ (Rekindles a glowing splinter)	C ₂ O ₄ ⁻²
c. N ₂	Nitrates, permanganate, Dichromate, chlorate
(ii) Colourless gas with odour	Ammonium Nitrate
a. NH ₃ (Characteristic smell, turns nessler's solution brown and turns red litmus blue)	NH ₄ ⁺
b. H ₂ S (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 ₂ Cr ₂ O 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)

CH₃COO⁻

(iii) Coloured gas

a. NO₂ (Reddish brown, turns ferrous sulphate solution brownish black)

NO₂⁻ or NO₃⁻

b. Br₂ (Reddish brown turns starch paper orange-red or yellow, turns starch iodide paper blue)

Br⁻

c. Cl₂ (Greenish yellow, turns starch iodide paper blue, bleaches moist litmus paper, bleaches indigo solution)

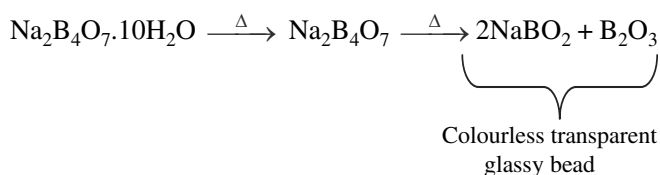
Cl⁻

d. I₂ (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:

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 ($(\text{NH}_4)_2\text{S}_2$) as well as in colourless $(\text{NH}_4)_2\text{S}$ 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 $(\text{NH}_4)_2\text{S}$ except SnS	HgS PbS CuS } Black Bi_2S_3 } CdS (Yellow) As_2S_3 } Yellow As_2S_5 } Sb_2S_3 } Orange Sb_2S_5 } Sb_2S_5 (Brown) SnS_2 (Yellow)
iii	NH_4Cl + NH_4OH	Fe^{3+} , Al^{3+} , Cr^{3+}	$\text{Al}(\text{OH})_3$ (Gelatinous White) $\text{Fe}(\text{OH})_3$ (Reddish Brown) $\text{Cr}(\text{OH})_3$ (Green)
iv	NH_4Cl + NH_4OH + H_2S in warm solution (or, excess $(\text{NH}_4)_2\text{S}$)	Co^{2+} , Ni^{2+} , Zn^{2+} , Mn^{2+}	ZnS (White) MnS (Buff or Pink) of flesh colour CoS } Black NiS }

v	NH_4Cl + $(\text{NH}_4)_2\text{CO}_3$	Ca^{2+} , Sr^{2+} , Ba^{2+}	CaCO_3 SrCO_3 BaCO_3 } White
vi	NH_4Cl + NH_4OH + Na_2HPO_4	Mg^{2+}	$\text{Mg}(\text{NH}_4)\text{PO}_4$ (White)
Zero	NaOH or $\text{Ca}(\text{OH})_2$ (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 $\text{MnO}_2 \cdot \text{H}_2\text{O}$.
- (d) $(\text{NH}_4)_2\text{SO}_4$ 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, $(\text{NH}_4)_2\text{CO}_3$ 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:

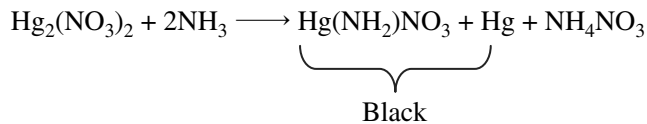


(NH_4Cl) (NaOH)

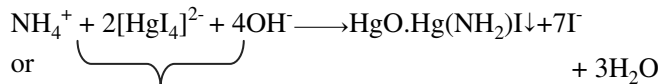
Ammonia gas can be identified, if

- By its characteristics smell.
- By formation of white fumes of NH_4Cl with HCl .
 $\text{NH}_3 + \text{HCl} \longrightarrow \text{NH}_4\text{Cl} \uparrow$ (white fumes)
- 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.



2. With Nessler's reagent:



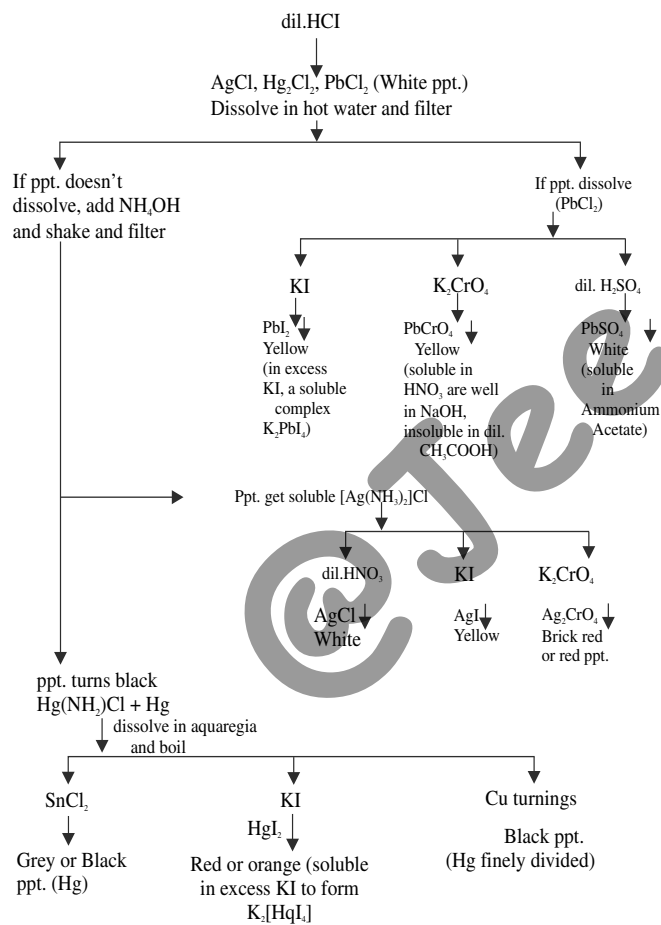
NH₃ Nessler's reagent

Brown ppt.

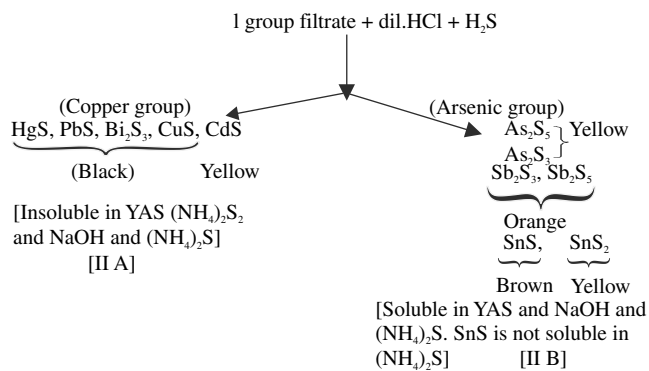
or

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

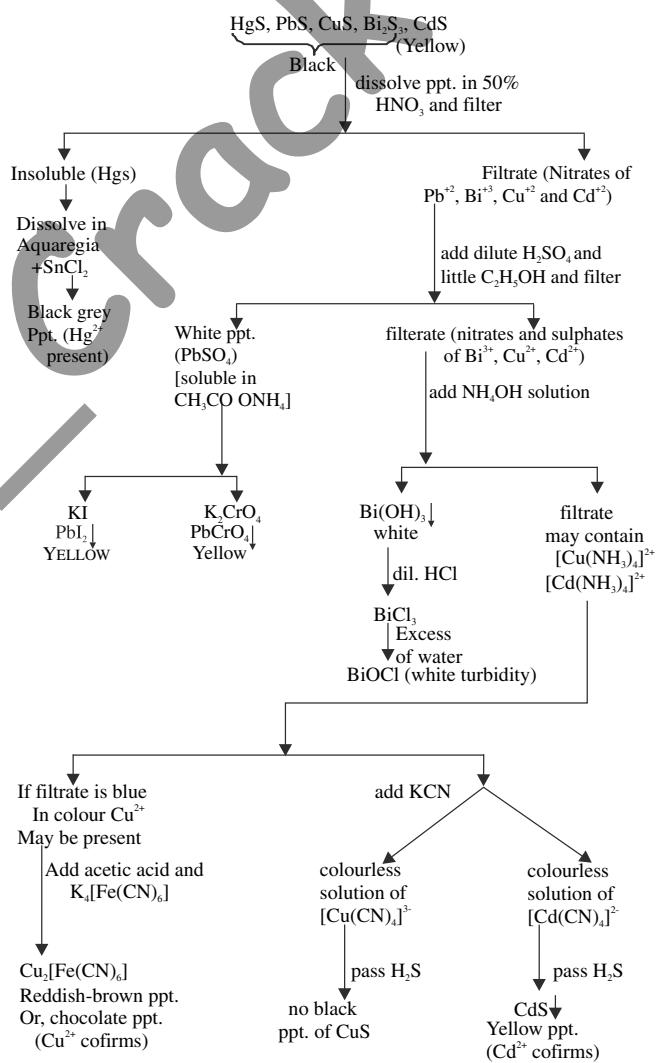
Group I

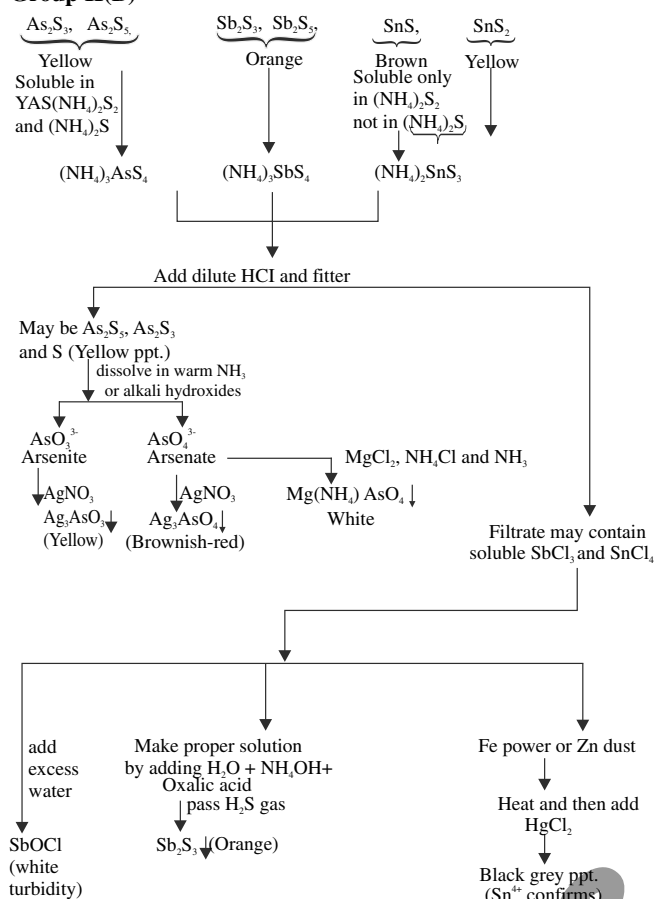
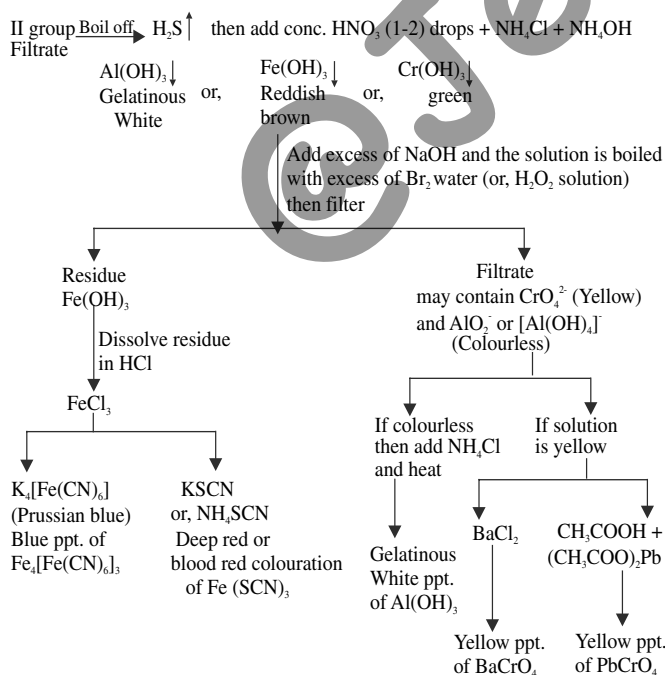
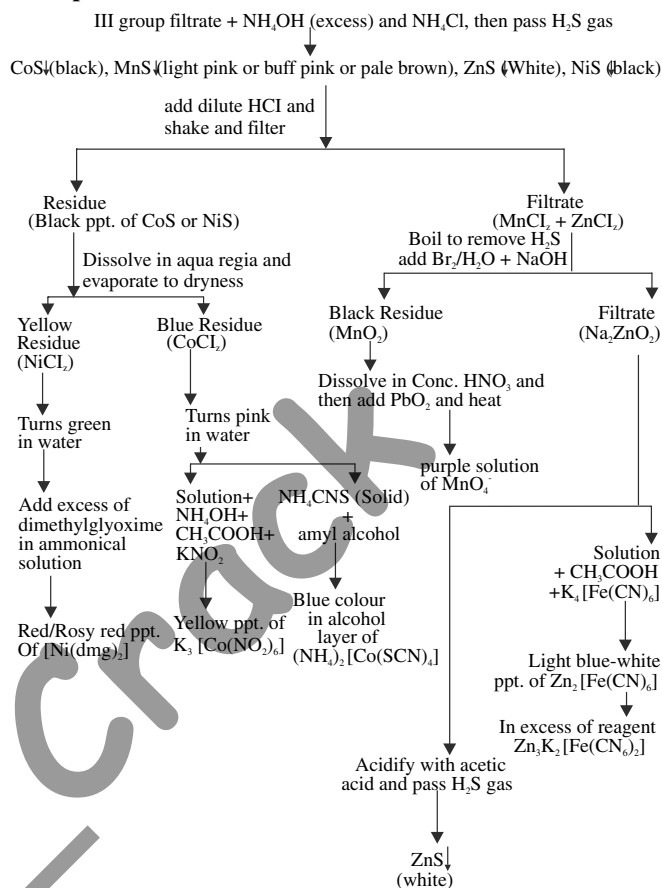
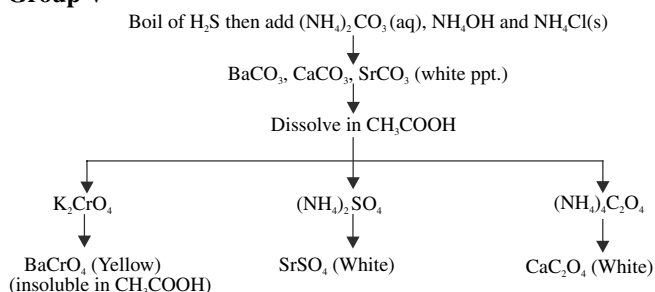


Group II



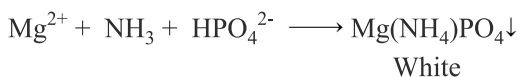
Group II (A)



Group II(B)**Group III****Group IV****Group V****Group VI****Test of Mg^{2+} :**

With Na_2HPO_4 solution:

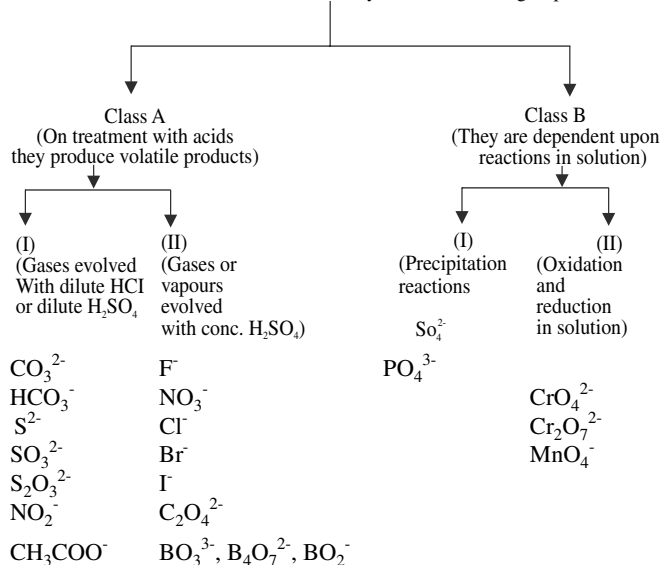
White crystalline ppt. of $\text{Mg}(\text{NH}_4)\text{PO}_4 \cdot 6\text{H}_2\text{O}$ in the presence of NH_4Cl (to prevent ppt. of $\text{Mg}(\text{OH})_2$) and NH_3 solution.



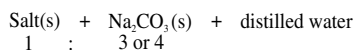
The ppt. is sparingly soluble in water, soluble in acetic acid and in mineral acids.

Classification of acidic radicals (anions):

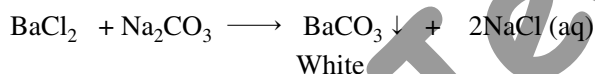
Acidic radicals can be broadly divided into two groups



Preparation sodium carbonate extract:-



Heat and filter

Residue
(Carbonates of basic radicals)Filtrate
(Sodium salts of acidic radicals
[It is known as sodium carbonate extract]
Used for identification of acidic radicals
Except: CO₃²⁻ and HCO₃⁻)

Sodium carbonate extract is used when:

- Salt is only partially soluble in water or insoluble in water.
- 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.

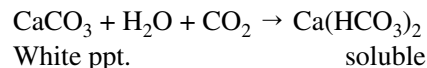
Carbonate, CO₃²⁻:

- The carbonates are decomposed with the effervescence of carbon dioxide gas.

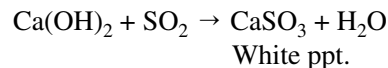
$$\text{Na}_2\text{CO}_3 + \text{H}_2\text{SO}_4 \rightarrow \text{Na}_2\text{SO}_4 + \text{CO}_2$$
- When this gas is passed through lime water, it turns milky with the formation of calcium carbonate.

$$\text{Ca(OH)}_2 + \text{CO}_2 \rightarrow \text{CaCO}_3 + \text{H}_2\text{O}$$

Lime water white ppt.
- If the CO₂, gas is passed in excess, the milky solution becomes colourless due to the formation of soluble calcium bicarbonate.



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



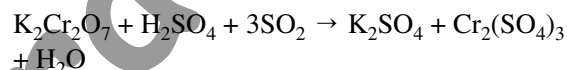
However SO₂ can be identified by its pungent odour of burning sulphur.

Sulphite, SO₃²⁻:

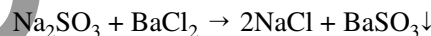
- The sulphite gives out sulphur dioxide gas, having suffocating smell of burning sulphur.



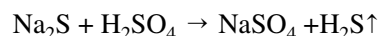
- When acidified potassium dichromate paper is exposed to the gas, it attains green colour due to the formation of chromic sulphate.



The sulphite also gives white precipitate with BaCl₂, soluble in dil. HCl

**Sulphide, S²⁻:**

- The sulphide salts form H₂S which smells like rotten eggs.

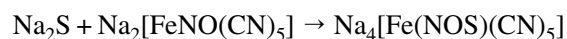


- On exposure to this gas, the lead acetate paper turns black due to the formation of lead sulphide.

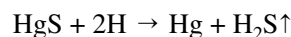
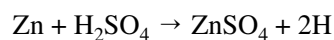
$$\text{Pb(CH}_3\text{COO)}_2 + \text{H}_2\text{S} \rightarrow \text{PbS} \downarrow + 2\text{CH}_3\text{COOH}$$

black ppt.

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

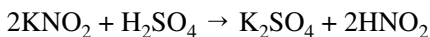


Sulphide of lead, calcium, nickel, cobalt, antimony and stannic are not decomposed with dilute H₂SO₄. Conc. HCl should be used for their test. However brisk evolution of H₂S takes place even by use of dilute H₂SO₄ if a pinch of zinc dust is added.

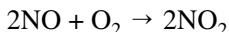
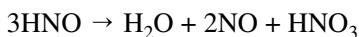
**Nitrite, NO₂⁻:**

- 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.



Nitrous acid



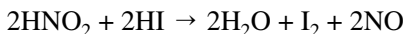
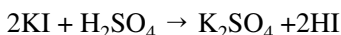
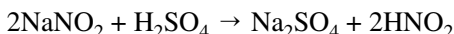
brown coloured gas

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

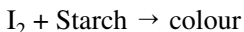


Brown ring complex

- (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.

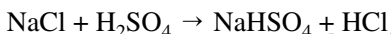


Violet
vapours



Chloride Cl^-

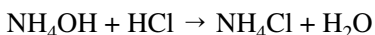
- (i) Colourless pungent fumes of hydrogen chloride are evolved.



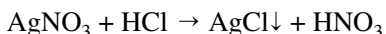
- (ii) Yellowish green chlorine gas with suffocating odour is evolved on addition of MnO_2 to the above reaction mixture.



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

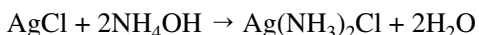


- (iv) The gas evolved or solution of chloride salt forms a curdy precipitate of silver chloride with silver nitrate solution.



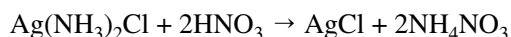
Note:

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

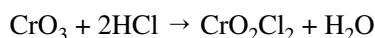
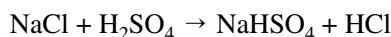


- (b) The solution having the silver complex on acidifying with dilute nitric acid gives again a

white precipitate of silver chloride.



- (c) Chromyl chloride Test: When solid chloride is heated with conc. H_2SO_4 in presence of $\text{K}_2\text{Cr}_2\text{O}_7$, deep red vapours of chromyl chloride are evolved.



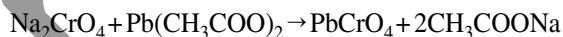
Chromyl chloride

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



Yellow colour

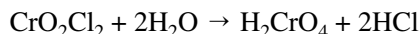
The yellow solution neutralized with acetic acid gives a yellow precipitate of lead chromate with lead acetate.



Yellow ppt.

Note:

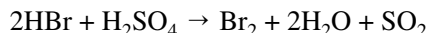
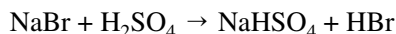
- (a) This test is not given by the chloride of mercuric, tin, silver, lead and antimony.
- (b) The chromyl chloride test is always to be performed in a dry test tube otherwise the chromyl chloride vapours will be hydrolysed in the test tube.



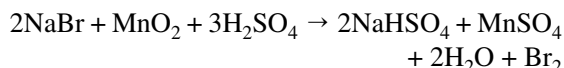
- (c) Bromides and iodides do not give this test.

Bromide, Br^- :

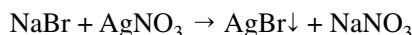
- (a) Reddish-brown fumes of bromine are formed.



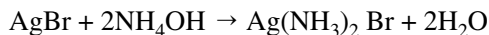
- (b) More reddish brown fumes of bromine are evolved when MnO_2 is added.



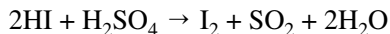
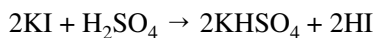
- (c) The aqueous solution of bromide or sodium carbonate extract gives pale yellow precipitate of silver bromide which partly dissolve in excess of NH_4OH forming a soluble complex.



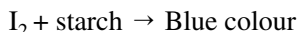
Pale yellow ppt.

**Iodide, I⁻:**

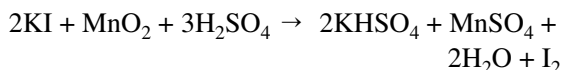
- (a) Violet vapours of iodine are evolved.



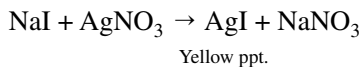
- (b) Violet vapours with starch produce blue colour.



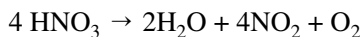
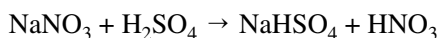
- (c) More violet vapours are evolved when MnO
- ₂
- is added.



- (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
- ₄
- OH.

**Nitrate, NO₃⁻:**

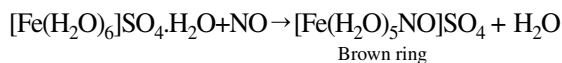
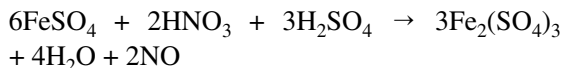
- (a) Light brown fumes of nitrogen dioxide are evolved.



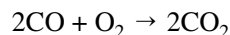
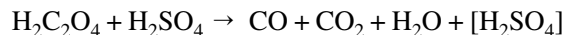
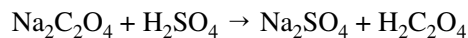
- (b) These fumes intensify when copper turnings are added.



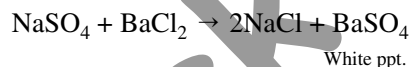
- (c)
- Ring Test:**
- An aqueous solution of salt is mixed with freshly prepared FeSO
- ₄
- solution and conc. H
- ₂
- SO
- ₄
- is poured in test tube from sides, a brown ring is formed on account of the formation of a complex at the junction of two liquids.

**Oxalate, C₂O₄⁻²:**

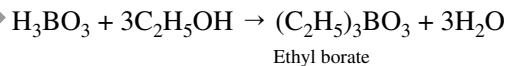
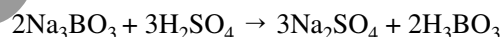
A mixture of CO and CO₂ is given off. The CO burns with blue flame.

**Sulphate, SO₄⁻²:**

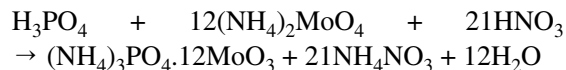
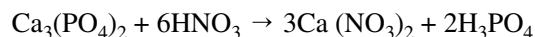
Add conc. HNO₃ to a small amount of substance or take sodium carbonate extract and then add BaCl₂ solution. A white precipitate of BaSO₄ insoluble in conc. acid is obtained.

**Borate:**

To a small quantity of the substance (salt or mixture), add few multilitres of ethyl alcohol and conc. H₂SO₄ 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.

**Phosphate:**

Add conc. HNO₃ 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.



Canary yellow ppt.

Solved Examples



1. Chemical volcano is produced on heating:

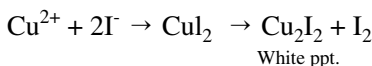
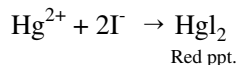
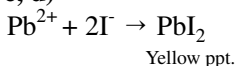
- (a) $K_2Cr_2O_7$ (b) $(NH_4)_2Cr_2O_7$
(c) $ZnCr_2O_7$ (d) K_2CrO_4

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+}

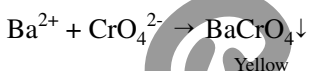
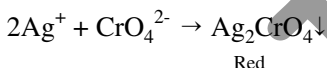
Sol. (b, c, d)



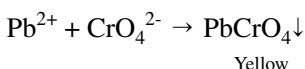
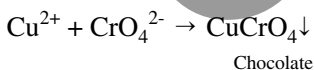
3. Name one common reagent that can form precipitate or react and differentiate the following pairs:

- (a) Ag^+ and Ba^{2+} (b) Cu^{2+} and Pb^{2+}
(c) Fe^{3+} and Cu^{2+} (d) Co^{2+} and Cu^{2+}

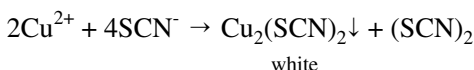
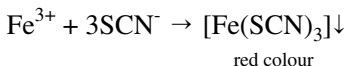
Sol. (a) $K_2Cr_2O_4$



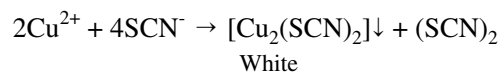
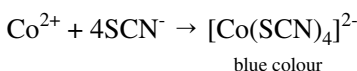
(b) K_2CrO_4



(c) NH_4SCN

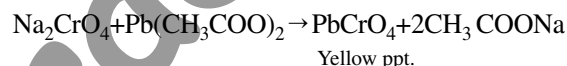
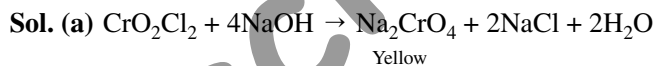


(d) NH_4SCN



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:

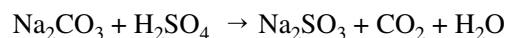
- (a) Chromyl chloride test
(b) Lassaigne's test
(c) Silver mirror test
(d) Fehling solution test



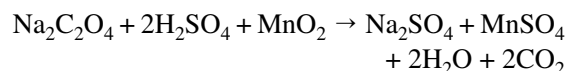
5. When an inorganic mixture was treated with excess of dil. H_2SO_4 , effervescence were produced. The solution was heated till effervescence ceased. After this a small pinch of MnO_2 were added, fresh effervescence were produced. Select the correct statements:

- (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.

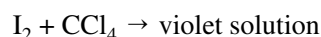
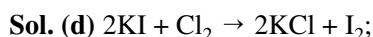


When evolution of CO_2 occurs again after adding MnO_2 , it is due to decomposition of oxalate.



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

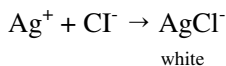
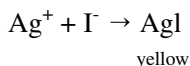
- (a) F^- ion (b) Cl^- ion
(c) Br^- ion (d) I^- ion



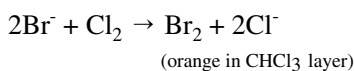
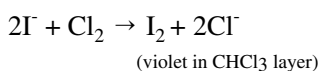
7. Name one common reagent that can precipitate or react and differentiate following pairs:

- (a) I^- and Cl^-
 (b) I^- and Br^-
 (c) SO_3^{2-} and SO_4^{2-}

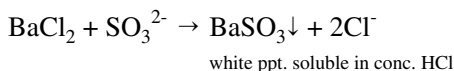
Sol. (a) AgNO_3



- (b) Cl_2 water + CHCl_3 :



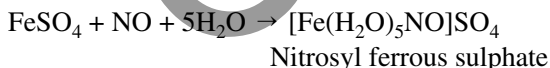
- (c) BaCl_2



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) $(\text{FeSO}_4)_2\text{NO}$
 (c) $\text{FeSO}_4(\text{NO})_2$
 (d) $[\text{Fe}(\text{H}_2\text{O})_5\text{NO}]\text{SO}_4$

Sol. (d) $\text{NaNO}_3 + \text{H}_2\text{SO}_4 \rightarrow \text{NaHSO}_4 + \text{HNO}_3$

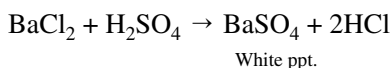


9. An inorganic compound gives a white ppt. with a solution of AgNO_3 , a white ppt. with dil. H_2SO_4 and imparts green colour to flame.

The probable compound is:

- (a) CuCl_2 (b) BaCl_2
 (c) $\text{Cu}(\text{NO}_3)_2$ (d) PbCl_2

Sol. (b) $2\text{AgNO}_3 + \text{BaCl}_2 \rightarrow 2\text{AgCl} + \text{Ba}(\text{NO}_3)_2$



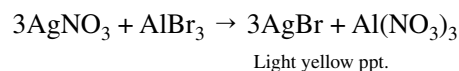
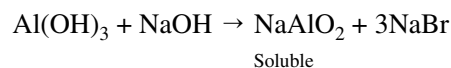
Barium imparts green colour to flame.

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) $\text{AlBr}_3 + 3\text{NaOH} \rightarrow \text{Al}(\text{OH})_3 + 3\text{NaBr}$

White ppt.



The salt is AlBr_3 .

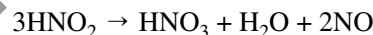
11. A compound (A) forms an unstable pale blue colour solution in water. The solution decolorizes Br_2 water and an acidified solution of KMnO_4 . The possible compound (A) is:

- (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:



and in dilute solution as:



Reaction with:

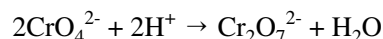
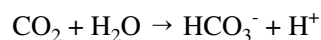
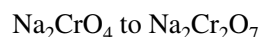
- (a) Br_2 water-
 $\text{HNO}_2 + \text{H}_2\text{O} + \text{Br}_2 \rightarrow \text{HNO}_3 + 2\text{HBr}$
 (b) $\text{KMnO}_4 + 3\text{H}_2\text{SO}_4 + 5\text{HNO}_2 \rightarrow \text{K}_2\text{SO}_4 + 2\text{MnSO}_4 + 3\text{H}_2\text{O} + 5\text{HNO}_3$

- 12.(a) If $\text{CO}_2(\text{g})$ under pressure is passed into $\text{Na}_2\text{CrO}_{4(\text{aq})}$, $\text{Na}_2\text{Cr}_2\text{O}_{7(\text{aq})}$ is formed. What is the function of the $\text{CO}_2(\text{g})$?

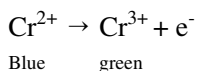
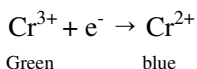
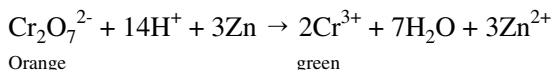
- (b) When zinc is added to acidic solution of $\text{Na}_2\text{Cr}_2\text{O}_7$. What is the colour of the solution?

- (c) In acidic solution silver (II) oxide first dissolves to produce $\text{Ag}^{2+}(\text{aq.})$ and then reduces to Ag^+ by H_2O which is oxidized to $\text{O}_2(\text{g})$. Explain?

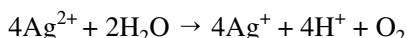
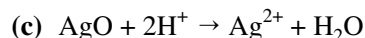
Sol. (a) CO_2 makes the solution acidic that can convert



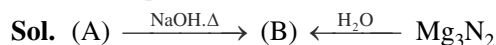
- (b) Zn reduces $\text{Cr}_2\text{O}_7^{2-}$ to Cr^{3+} (green) and then to Cr^{2+} (blue). Over a long time, Cr^{2+} is oxidised to Cr^{3+} by atmospheric O_2 and thus blue colour changes to green.



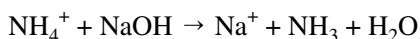
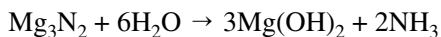
(Note: These reactions are spontaneous based on the standard reduction electrons potential values.)



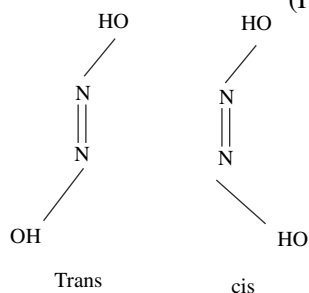
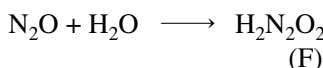
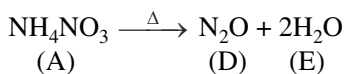
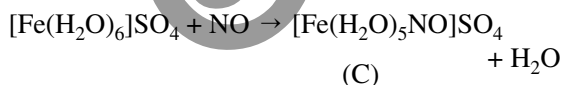
13. Colourless salt (A), on heating with sodium hydroxide, give gas (B) that can also be obtained when Mg_3N_2 reacts with H_2O . When reaction of (A) with NaOH was complete, solution obtained on reaction with FeSO_4 gave a brown coloured ring (C) between two layers. (A) on heating strongly, forms (D) 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.



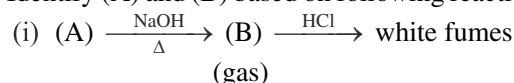
(A) has NH_4^+ ion and (B) is NH_3



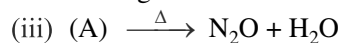
Resultant solution after NH_3 has escaped completely. It contains Na^+ and anion of (A) which also gives Ring Test of NO_3^- thus, (A) is NH_4NO_3



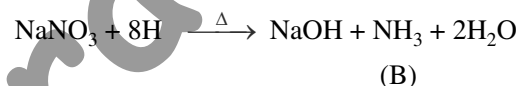
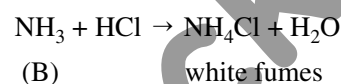
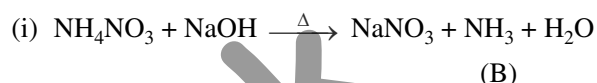
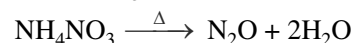
14. Identify (A) and (B) based on following reactions:



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



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



(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.

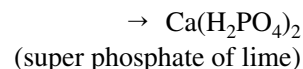
(a) The fertilizer is obtained by treating apatite with H_2SO_4 .

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

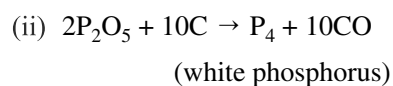
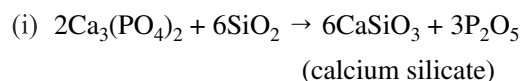
Suggest formula for apatite and explain the chemical reactions (i) and (ii)

Sol. Chemically apatite is $\text{Ca}_3(\text{PO}_4)_2$

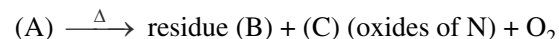
(a) When apatite is heated with $\text{H}_2\text{SO}_4(\text{s})$



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



16. (A)+tap water $\rightarrow$ white turbidity soluble in aq. NH_3



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 $\rightarrow$ 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^+

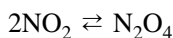
(A) also gives ring test of NO_3^-

(A) is AgNO_3



(B) (C)

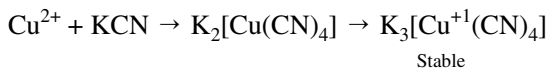
NO_2 is paramagnetic due to one unpaired electron and thus forms dimer by using unpaired electron.



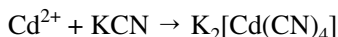
dimer (V.D. = 46)

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+}

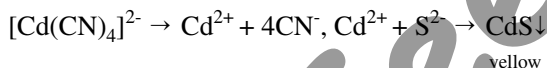


Stable



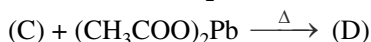
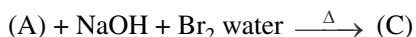
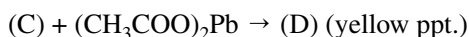
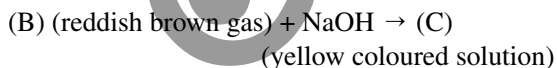
Unstable

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



yellow

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



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

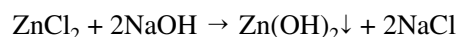
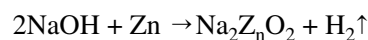
ppt. with ZnCl_2 or AlCl_3 but ppt. dissolves in excess of (A). What is (A) and explain reaction.

Sol. (A) turns red litmus blue $\Rightarrow$ (A) is basic in nature.

(A) imparts golden yellow colour in flame $\Rightarrow$ (A) has Na^+

(A) gives H_2 gas with Zn or Al $\rightarrow$ (A) is NaOH .

Explanation:



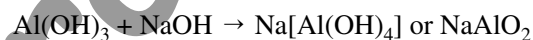
White ppt.



Sodium zincate



White ppt.

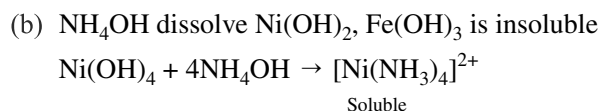


Sodium meta-aluminate

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

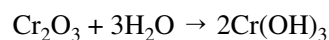
- NaOH and $\text{Fe}(\text{OH})_3$
- $\text{Ni}(\text{OH})_2$ and $\text{Fe}(\text{OH})_3$
- Cr_2O_3 and $\text{Fe}(\text{OH})_3$
- MnS and CoS
- AgCl and AgI

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



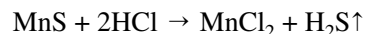
Soluble

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

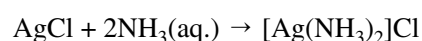


Soluble

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



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



Soluble



Exercise



LEVEL 1

- Which of the following salt on heating with conc. H_2SO_4 gives violet vapours?
 - Iodide salt
 - Nitrate salt
 - Sulphate salt
 - Bromide salt
- Salts of which of the following metal are white?
 - Zinc
 - Cobalt
 - Chromium
 - Fe
- A glassy bead formed by heating borax on a platinum wire loop is:
 - Sodium tetraborate
 - Sodium metaborate
 - Sodium metaborate and boric anhydride
 - Boric anhydride and sodium tetraborate
- An oxalate salt gives which of the following gas in dry heating test:
 - $\text{CO} + \text{CO}_2$
 - Only CO_2
 - Only CO
 - Oxalic acid vapours
- The salts of which of the following elements are generally dark green coloured?
 - Chromium
 - Copper(I)
 - Barium
 - Cobalt
- The chromyl chloride test is meant for which of the following ion?
 - Cl^- ions
 - Both Cl^- and Br^- ions
 - I^- ions
 - Cl^- and CrO_4^{2-} ions
- Which of the following gases turn lime water milky?
 - SO_2
 - CO_2
 - H_2S
 - Both (a) and (b)
- Yellow ammonium sulphide solution can be used for the separation of which of the following pair of species?
 - CuS and PbS
 - PbS and Bi_2S_3
 - Bi_2S_3 and CuS
 - CdS and As_2S_3
- Reddish-brown (chocolate) ppt. are formed by mixing solutions containing respectively:
 - Cu^{2+} and $[\text{Fe}(\text{CN})_6]^{4-}$ ions
 - Ba^{2+} and SO_4^{2-} ions
 - Pb^{2+} and I^- ions
 - Pb^{2+} and SO_4^{2-} ions
- Which of the following gives black precipitate on passing H_2S through it?
 - Acidified zinc nitrate solution
 - Ammonical barium chloride solution
 - Magnesium nitrate solution
 - Copper nitrate solution
- All ammonium salts liberate ammonia gas when:
 - Heated with water
 - Heated with caustic soda
 - Heated with H_2SO_4
 - Heated with NaNO_2
- Addition of solution containing $\text{C}_2\text{O}_4^{2-}$ ions to an aqueous solution containing Ba^{2+} , Sr^{2+} and Ca^{2+} will precipitate.
 - Ca^{+2}
 - Ca^{+2} and Sr^{2+}
 - Ba^{+2} and Sr^{2+}
 - All three
- Sodium sulphide react with sodium nitroprusside to form a purple coloured Compound. During the reaction the oxidation state of iron:
 - Changes from +2 to +3
 - Changes from +3 to +2
 - Changes from +2 to +4
 - Remains unchanged
- Which of the following sulphide is not soluble in dil HNO_3 ?
 - PbS
 - HgS
 - ZnS
 - Bi_2S_3
- Cu^{2+} ions will be reduced to Cu^+ ion by addition of an aqueous solution of:
 - KF
 - KCl
 - KI
 - KOH
- Precipitate of AgCl dissolves in liquid ammonia due to the formation of:
 - $[\text{Ag}(\text{NH}_4)_2]\text{OH}$
 - $[\text{Ag}(\text{NH}_4)_2]\text{Cl}$
 - $[\text{Ag}(\text{NH}_3)_2]\text{OH}$
 - $[\text{Ag}(\text{NH}_3)_2]\text{Cl}$

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 $\text{K}_2\text{Cr}_2\text{O}_7$ 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+} and Cd^{2+} ions in the solution?
 (a) H_2S in acidic medium
 (b) H_2S in alkaline medium
 (c) KCN solution
 (d) $\text{K}_4[\text{Fe(CN)}_6]$ solution

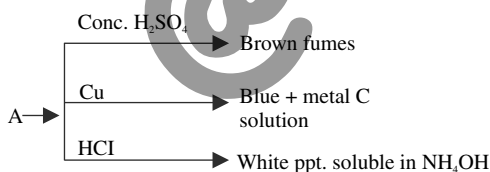


LEVEL II

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. $\text{CrCl}_3 \xrightarrow[\text{NH}_4\text{OH}]{\text{NH}_4\text{Cl}} (\text{A}) \xrightarrow[\text{H}_2\text{O}]{\text{Na}_2\text{O}_2} (\text{B}) \xrightarrow[\text{acetate}]{\text{Lead}} (\text{C})$; compound (C) is:
 (a) Na_2CrO_4 (b) $\text{Na}_2\text{Cr}_2\text{O}_7$
 (c) $\text{Cr}(\text{OH})_3$ (d) PbCrO_4
4. $2\text{Cu}^{2+} + 5\text{I}^- \longrightarrow 2\text{CuI}\downarrow + [\text{X}]$
 $[\text{X}] + 2\text{S}_2\text{O}_3^{2-} \longrightarrow 3[\text{Y}] + \text{S}_4\text{O}_6^{2-}$; 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) $\text{Na}_2\text{S}_2\text{O}_3$
 (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. $\text{A} + \text{Na}_2\text{CO}_3 \longrightarrow \text{B} + \text{C}$,
 $\text{A} \xrightarrow{\text{CO}_2} (\text{Milky}) \text{C}$
 The chemical formula of A and B are respectively:
 (a) NaOH and $\text{Ca}(\text{OH})_2$
 (b) $\text{Ca}(\text{OH})_2$ and NaOH
 (c) NaOH and CaO
 (d) CaO and $\text{Ca}(\text{OH})_2$
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) $\text{SO}_2 + \text{SO}_3$
 (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?
- Potassium thiocyanate
 - Potassium hexacyanoferrate (II)
 - Potassium pyroantimonate
 - 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?
- Pb^{2+} , Ag^+
 - Pb^{2+} , Ba^{2+}
 - Ag^+ , Cu^{2+}
 - Hg^{2+} , Ag^+
23. The reagent that can distinguish between silver and lead salt is:
- H_2S gas
 - Hot dilute HCl solution
 - NH_4Cl (solid) + NH_4OH (solution)
 - NH_4Cl (solid) + $(NH_4)_2CO_3$ (solution)
24. A yellow turbidity, sometimes appears on passing H_2S gas even in the absence of the second group radicals. Explain why?
- Sulphur is present in the mixture as an impurity
 - The fourth group radicals are precipitated as sulphides
 - The H_2S is oxidized by some acidic radical present in solution
 - The third group radicals are precipitated
25. Colourless salt (A)



The salt A can be:

- $Cu(NO_3)_2$
 - $AgBr$
 - $AgNO_3$
 - $Pb(NO_3)_2$
26. Al^{3+} , Cr^{3+} , Fe^{3+} are grouped together for qualitative analysis because:
- Their carbonates are insoluble in ammonia
 - Their hydroxides are insoluble in ammonia
 - Their sulphides are insoluble in acid
 - 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:
- Chromous ions
 - Aluminium ions
 - Barium ions
 - Iron ions
28. Dimethyl glyoxime in a suitable solvent was refluxed for 10 minutes with pure pieces of nickel sheet, it will result in:
- Red precipitate
 - Blue precipitate
 - Yellow precipitate
 - 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:
- $Mg(NO_3)_2$
 - Mg_3N_2
 - NH_3
 - 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:
- Some salt of Ni
 - Some salt of copper
 - $FeSO_4$
 - Unpredictable



LEVEL III

ONE OR MORE THAN ONE CORRECT TYPE

- Which of the following salts release reddish brown gas when heated in a dry test tube?
 - $LiNO_3$
 - KNO_3
 - $Pb(NO_3)_2$
 - $AgNO_3$
- When Borax is heated it forms a colourless glassy bead because of formation of :
 - B_2H_6
 - $NaBO_2$
 - B_2O_3
 - $Na_2B_4O_7$
- Which of the following metal chloride will give chromyl chloride test ?
 - $NaCl$
 - KCl
 - $AgCl$
 - $SbCl_3$

4. Which of the following statement(s) is/are correct with respect to bromide ions ?
- KBr on heating with MnO_2 and concentrated H_2SO_4 liberates Br_2 and SO_2 gases.
 - KBr on heating with concentrated H_2SO_4 liberates Br_2 and SO_2 gases.
 - KBr forms HBr with concentrated H_3PO_4 .
 - KBr(s) liberates Br_2 on gentle warming with concentrated H_2SO_4 and $\text{K}_2\text{Cr}_2\text{O}_7$ (s).
5. KI solution is the reagent for :
- Hg^{2+}
 - Pb^{2+}
 - Ag^+
 - Cu^{2+}
6. Which of the following cations form(s) black precipitate(s) with $\text{H}_2\text{S}(\text{g})$?
- Cu^{2+}
 - Sb^{3+}
 - Pb^{2+}
 - Bi^{3+}
7. Which of the following is/are correct for potassium ferrocyanide?
- It gives a brown precipitate with Cu^{2+} ions.
 - It gives a white precipitate of mixed salt with Ca^{2+} ions.
 - It in excess gives a bluish white/white precipitate with Zn^{2+} .
 - 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).
- NH_4NO_3
 - NH_4Cl
 - $(\text{NH}_4)_2\text{SO}_4$
 - $(\text{NH}_4)_2\text{CO}_3$
9. Which of the following statement(s) is/are correct?
- Nickel salts give rosy red precipitate with dimethyl glyoxime in excess of NH_4OH .
 - $\text{Fe}(\text{III})$ salts give red colour with potassium sulphocyanide
 - In nitroprusside, the iron and NO exist as $\text{Fe}(\text{III})$ and NO.
 - $\text{Mn}(\text{II})$ 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?
- Fe^{2+} gives brown colour with potassium ferricyanide
 - Fe^{2+} gives blue colour with potassium ferricyanide
 - Fe^{3+} gives red colour with potassium thiocyanate
 - Fe^{2+} gives brown colour with potassium thiocyanate
11. Which of the following sulphates are soluble in water ?
- CuSO_4
 - PbSO_4
 - Ag_2SO_4
 - BaSO_4
12. Which of the following substances on being heated will give a gas that turns lime water milky?
- Na_2CO_3
 - ZnCO_3
 - ZnSO_3
 - MgCO_3
13. A yellow precipitate is obtained when :
- lead acetate solution is treated with K_2CrO_4
 - $\text{Pb}(\text{NO}_3)_2$ solution is treated with K_2CrO_4
 - AgNO_3 solution treated with KI
 - H_2S is passed through a solution of CdSO_4
14. Which of the following species will be decomposed on acidification?
- $[\text{Ag}(\text{NH}_3)_2]^+$
 - $[\text{Cu}(\text{NH}_3)_4]^{2+}$
 - $[\text{Zn}(\text{OH})_4]^{2-}$
 - $[\text{Pb}(\text{OH})_4]^{2-}$

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 $\text{K}_2\text{Cr}_2\text{O}_7$ 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 $(\text{CH}_3\text{COO})_2\text{Pb}$

15. The colourless inorganic compound (A) is:

- $\text{Ba}(\text{NO}_3)_2$
- BaCl_2
- CuCl_2
- CrBr_3

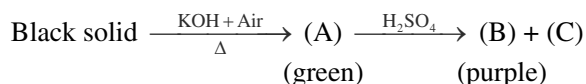
16. The liberated gas vapour (C) is:

- Br_2
- NO_2
- CrO_2Cl_2
- Cl_2

17. The yellow ppt. formed when (D) reacts with CH_3COOH and $(\text{CH}_3\text{COO})_2\text{Pb}$ is:

- PbI_2
- PbCrO_4
- BaCrO_4
- AgBr

Passage # 2 (Q. 18 to 20)



- (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 $\text{K}_2\text{Cr}_2\text{O}_7$ 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 $\text{K}_2[\text{HgI}_4]$, 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) $\text{Hg}(\text{NH}_2)\text{I}$
- (c) HgO (d) $\text{HgO} \cdot \text{Hg}(\text{NH}_2)\text{I}$

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) $\text{Ba}_3(\text{PO}_4)_2$ (b) $\text{Sr}_3(\text{PO}_4)_2$
- (c) $\text{Ca}_3(\text{PO}_4)_2$ (d) $\text{MgNH}_4\text{PO}_4 \cdot 6\text{H}_2\text{O}$

INTEGER VALUE TYPE QUESTIONS

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

- (a) $(\text{NH}_4)_2\text{SO}_4$, (b) $(\text{NH}_4)_2\text{CO}_3$,
- (c) NH_4Cl , (d) NH_4NO_3 ,
- (e) $(\text{NH}_4)_2\text{Cr}_2\text{O}_7$

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

- (a) $\text{NaBr} + \text{AgNO}_3 \longrightarrow$
- (b) $\text{NaI} + \text{AgNO}_3 \longrightarrow$
- (c) $\text{NaBr} + \text{Pb}(\text{NO}_3)_2 \longrightarrow$
- (d) $\text{NaI} + \text{Pb}(\text{NO}_3)_2 \longrightarrow$

- (e) $\text{Na}_2\text{S} + \text{Cd}(\text{CH}_3\text{COO})_2 \longrightarrow$
 (f) $\text{K}_2\text{CrO}_4 + \text{Pb}(\text{CH}_3\text{COO})_2 \longrightarrow$
 (g) $\text{K}_2\text{CrO}_4 + (\text{CH}_3\text{COO})_2\text{Ba} \longrightarrow$
 (h) $\text{K}_2\text{CrO}_4 + \text{AgNO}_3 \longrightarrow$
 (i) $\text{NaBr} + \text{Cl}_2$ 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 qualitative analysis of given 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) $\text{IO}_3^- + \text{SO}_2 + \text{starch} \longrightarrow$
(B)	Rotten egg smell	(b) $\text{SO}_2 + \text{MnO}_4^- \longrightarrow$
(C)	Colourless solution	(c) $\text{Zn} + \text{NaOH} + \text{SO}_2 \longrightarrow$
(D)	Blue color	(d) $\text{CO}_2 + \text{Ca}(\text{OH})_2 \longrightarrow$

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. $[\text{X}] + \text{H}_2\text{SO}_4 \longrightarrow [\text{Y}]$ a colourless gas with irritating smell; $[\text{Y}] + \text{K}_2\text{Cr}_2\text{O}_7 + \text{H}_2\text{SO}_4 \longrightarrow$ green solution. $[\text{X}]$ and $[\text{Y}]$ 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 forms 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) $\text{Al}(\text{OH})_3$ (b) $\text{Zn}(\text{OH})_2$
 (c) $\text{Mg}(\text{OH})_2$ (d) $\text{Ca}(\text{OH})_2$

[IIT-2006]

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

(a) $[\text{Cu}(\text{CN})_4]^{2-}$
 (b) Cu^{2+} get reduced to form $[\text{Cu}(\text{CN})_4]^{3-}$
 (c) $\text{Cu}(\text{CN})_2$
 (d) CuCN

[IIT-2006]

6. $\text{MgSO}_4 + \text{NH}_4\text{OH} + \text{Na}_2\text{HPO}_4 \longrightarrow$ white crystalline precipitate. The formula of crystalline precipitate is:

(a) $\text{MgCl}_2 \cdot \text{MgSO}_4$ (b) MgSO_4
 (c) $\text{Mg}(\text{NH}_4)\text{PO}_4$ (d) $\text{Mg}(\text{PO}_4)_2$

[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) $(\text{NH}_4)_2\text{SO}_4$

[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 addition of the reagent. Similarly, treatment 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) $\text{Mg}_2[\text{Fe}(\text{CN})_6]$ (b) $\text{Fe}[\text{Fe}(\text{CN})_6]$
 (c) $\text{Fe}_4[\text{Fe}(\text{CN})_6]_3$ (d) $\text{K}_2\text{Zn}_3[\text{Fe}(\text{CN})_6]_2$

12. The equilibrium, $2\text{Cu}^I \rightleftharpoons \text{Cu}^0 + \text{C}^{II}$ 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) $\text{Zn}(\text{NO}_3)_2$
 (c) $\text{Al}(\text{NO}_3)_3$ (d) $\text{Pb}(\text{NO}_3)_2$

15. The final solution contains:

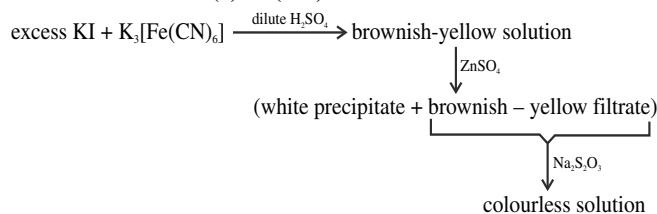
(a) $[\text{Pb}(\text{NH}_3)_4]^{2+}$ and $[\text{CoCl}_4]^{2-}$
 (b) $[\text{Al}(\text{NH}_3)_4]^{3+}$ and $[\text{Cu}(\text{NH}_3)_4]^{2+}$
 (c) $[\text{Ag}(\text{NH}_3)_2]^+$ and $[\text{Cu}(\text{NH}_3)_4]^{2+}$
 (d) $[\text{Ag}(\text{NH}_3)_2]^+$ and $[\text{Ni}(\text{NH}_3)_6]^{2+}$

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 $\text{Zn}_3[\text{Fe}(\text{CN})_6]_2$

- (c) Addition of filtrate 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) NO₂
 (c) N₂O (d) N₂O₄

[JEE Advanced - 2013]

19. Upon treatment with ammoniacal H₂S, 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 H₂S in a dilute mineral acid medium. However, it gave a precipitate (R) with H₂S in an ammoniacal medium. The precipitate (R) gave a coloured solution (s), when treated with H₂O₂ in an aqueous NaOH medium.

[JEE Advanced - 2013]

20. The precipitate P contains:

- (a) Pb²⁺ (b) Hg₂²⁺
 (c) Ag⁺ (d) Hg²⁺

21. The coloured solution S contains:

- (a) Fe₂(SO₄)₃ (b) CuSO₄
 (c) ZnSO₄ (d) Na₂CrO₄

22. Among PbS, CuS, HgS, MnS, Ag₂S, NiS, CoS,

Bi₂S₃ and SnS₂, 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 H₂S gas in presence of dilute HCl, is (are):

- (a) Ba²⁺, Zn²⁺ (b) Bi³⁺, Fe³⁺
 (c) Cu²⁺, Pb²⁺ (d) Hg²⁺, Bi³⁺

[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⁺, Ca²⁺ and HCO₃⁻ ions we get a precipitate of K₂Ca(CO₃)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) (NH₄)₂Cr₂O₇ (b) HgI₂
 (c) HgO (d) Pb₃O₄

[AIEEE - 2003]

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

- (a) Zn₂[Fe(CN)₆] (b) K₃[Co(NO₂)₆]
 (c) (NH₄)₃[As(Mo₃O₁₀)₄] (d) BaCrO₄

[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)

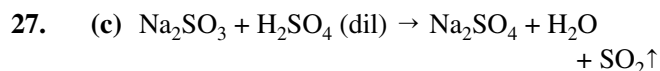
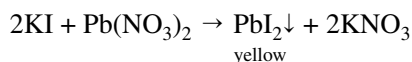
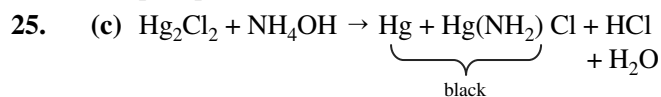
Hints and Solutions



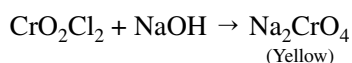
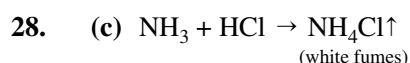
LEVEL I

1. (a) Γ ions are oxidized by H_2SO_4 to violet coloured I_2 .
2. (a) Due to electronic configuration of Zn^{+2} is $[\text{Ar}] 4s^0 3d^{10}$, salts of zinc are white (colourless).
3. (c) $\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O} \xrightarrow{\text{Strong heating}} \underbrace{2\text{NaBO}_2 + \text{B}_2\text{O}_3}_{\text{glassy bead}} + 10\text{H}_2\text{O}$
4. (a) Dry heating of oxalate salts 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 ($\text{Ca}(\text{OH})_2$) milky.
 $\text{Ca}(\text{OH})_2 + \text{CO}_2 \rightarrow \text{CaCO}_3 \downarrow + \text{H}_2\text{O}$
 $\text{Ca}(\text{OH})_2 + \text{SO}_2 \rightarrow \text{CaSO}_3 \downarrow + \text{H}_2\text{O}$
 White
8. (d) As_2S_3 is soluble in YAS (yellow ammonium sulphide) whereas CdS is not.
9. (a) $2\text{Cu}^{2+} + [\text{Fe}(\text{CN})_6]^{4-} \rightarrow \text{Cu}_2[\text{Fe}(\text{CN})_6]$
 Chocolate ppt.
10. (d) $\text{Cu}(\text{NO}_3)_2 + \text{H}_2\text{S} \rightarrow \text{CuS} \downarrow + 2\text{HNO}_3$
 Black
11. (b) $\text{NH}_4^+ + \text{NaOH} \rightarrow \text{NH}_3 + \text{H}_2\text{O} + \text{Na}^+$
12. (d) All the three ions will precipitate as their respective oxalates.
13. (d) $\text{Na}_2\text{S} + \text{Na}_2[\text{Fe}(\text{CN})_5\text{NO}] \rightarrow \text{Na}_4[\text{Fe}(\text{CN})_5(\text{NOS})]$
 Sodium nitroprusside $^{+2}$
 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) Γ ion acts as good reducing agent.
 $2\text{Cu}^{2+} + 4\Gamma^- \rightarrow \text{Cu}_2\text{I}_2 + \text{I}_2$
16. (d) $\text{AgCl} + \text{NH}_3 \rightarrow [\text{Ag}(\text{NH}_3)_2]\text{Cl}$
 Soluble complex
17. (c) BaCrO_4 is precipitated first.
18. (b) Brown ring test is used to detect nitrate ion.
19. (c) $\text{I}_2 + \text{S}_2\text{O}_3^{2-} \rightarrow \Gamma^- + \text{S}_4\text{O}_6^{2-}$
20. (c) $\text{NaCl} + \text{K}_2\text{Cr}_2\text{O}_7 + \text{H}_2\text{SO}_4 \rightarrow \text{NaHSO}_4 + \text{KHSO}_4 + \text{H}_2\text{O} + \text{CrO}_2\text{Cl}_2$
 CrO_2Cl_2 is chromyl chloride.
21. (b) $\text{FeCl}_3 + \text{KCNS} \rightarrow \text{Fe}(\text{SCN})\text{Cl}_2 + \text{KCl}$
 Blood red
22. (a) $\text{H}_3\text{BO}_3 + 3\text{MeOH} \rightarrow \text{B}(\text{OMe})_3 + 3\text{H}_2\text{O}$
 Methyl borate, $\text{B}(\text{OMe})_3$ burns with green flame.
23. (a) $\text{Ba}^{+2} + \text{K}_2\text{CrO}_4 \rightarrow \text{BaCrO}_4 \downarrow + 2\text{K}^+$
 Yellow
 $\text{AgNO}_3 + \text{Br}^- \rightarrow \text{AgBr} \downarrow + \text{NO}_3^-$
 yellow
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.



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

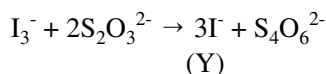
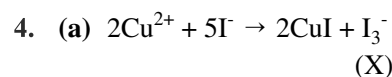
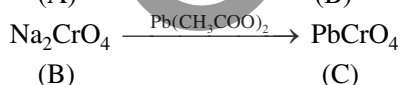
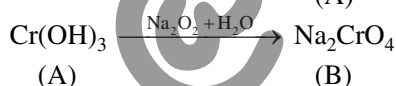
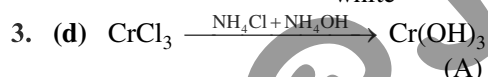
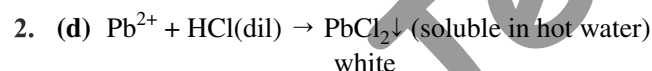


30. (c) Both form colourless complex with KCN but complex of Cd^{2+} unstable. Complex of Cd^{+2} form yellow precipitate of CdS with H_2S .

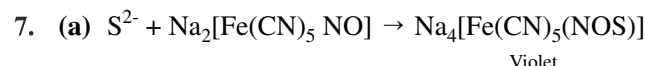
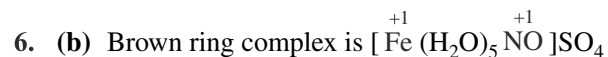


LEVEL II

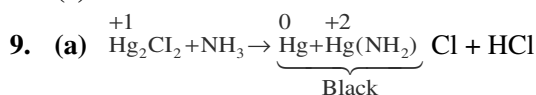
1. (c) $\text{Al}(\text{OH})_3$ dissolves in excess NaOH while $\text{Fe}(\text{OH})_3$ does not dissolve in NaOH .



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

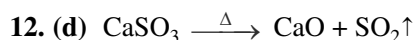


8. (c) ZnS is white in colour.



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 .

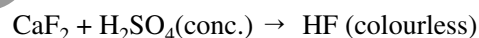
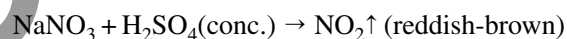
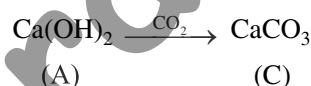
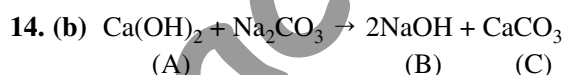


SO_2 gas turns lime water milky and an acidified dichromate solution green.

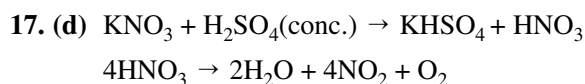
13. (a) Order of thermal stability:



BeCO_3 easily decomposes into $\text{BeO} + \text{CO}_2$

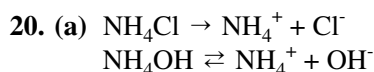


16. (b) Ferrous oxalate consists of Fe^{2+} and $\text{C}_2\text{O}_4^{2-}$ each of which is capable of reducing MnO_4^- to Mn^{2+} ions.

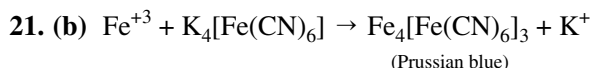


18. (a) Cl_2 oxidizes I^- ions to I_2 which dissolves in CS_2 to give violet colour.

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



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

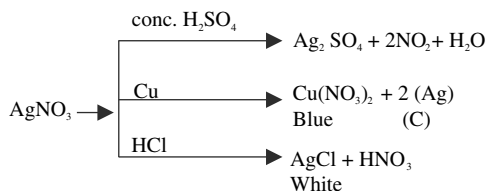


22. (b) Both Pb^{2+} and Ba^{2+} gives yellow precipitate with aqueous solution of K_2CrO_4 .

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

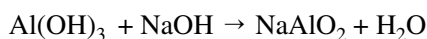
24. (c) Radicals such as NO_3^- oxidize H_2S to S which appears as turbidity.

25. (c) A is AgNO_3

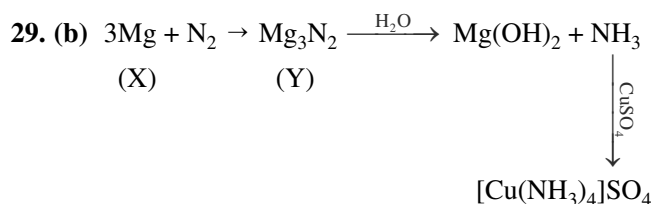


26. (b) The hydroxides of these cations are insoluble in ammoniacal solution.

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



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

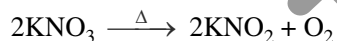
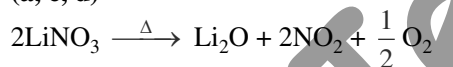


30. (c) FeSO_4 solution gives black-brown colour with NaNO_2

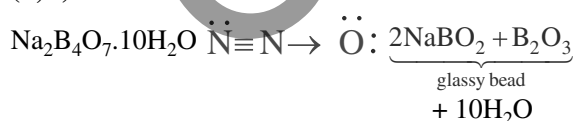


LEVEL III

1. (a, c, d)



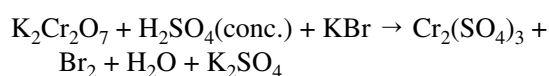
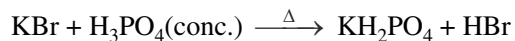
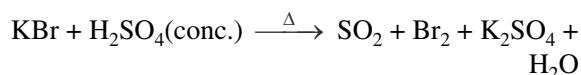
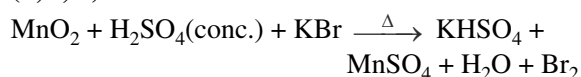
2. (b, c)



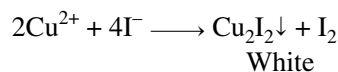
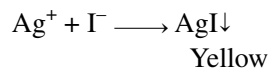
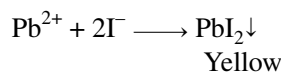
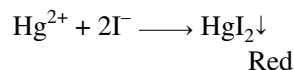
3. (a, b)

NaCl and KCl give chromyl chloride test.

4. (b, c, d)



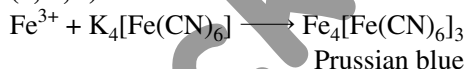
5. (a, b, c, d)



6. (a, c, d)



7. (a, b, c)



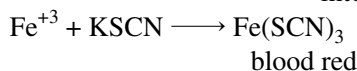
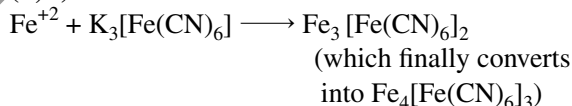
8. (a, b)

$(\text{NH}_4)_2\text{SO}_4$ and $(\text{NH}_4)_2\text{CO}_3$ 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)

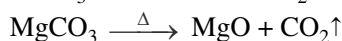
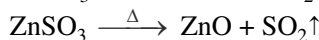
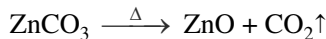


11. (a, c)

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.



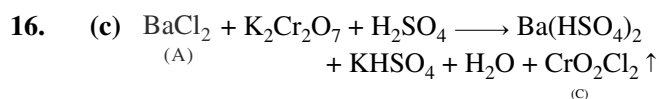
13. (a, b, c, d)

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^- .



17. (b) Yellow precipitate (E) is PbCrO_4 .
18. (a) $\text{MnO}_2 \xrightarrow[\Delta]{\text{KOH} + \text{Air}} \text{K}_2\text{MnO}_4 \xrightarrow{\text{H}_2\text{SO}_4} \text{KMnO}_4 + \text{MnO}_2$
 (A) (B) (C)
 $\text{KMnO}_4 + \text{H}_2\text{SO}_4$ (cold and conc.) $\longrightarrow \text{Mn}_2\text{O}_7$ (E)
 Mn_2O_7 is an acidic oxide
19. (d) $\text{KMnO}_4 + \text{H}_2\text{SO}_4 + \text{FeSO}_4 \longrightarrow \text{MnSO}_4 + \text{Fe}_2(\text{SO}_4)_3 + \text{H}_2\text{O} + \text{K}_2\text{SO}_4$
 Colourless Yellow
20. (a) (C) and (F) both are MnO_2
21. (b) Compound (X) gives chromyl chloride test and it also reacts with nessler's reagent hence, (X) is NH_4Cl .
22. (a) If Br^- is present in (X) then Br_2 vapours are evolved which forms colourless $\text{NaBr} + \text{NaOBr}/\text{NaBrO}_3$ 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) $\text{NH}_4\text{Cl} + \text{NaOH} \rightarrow \text{NH}_3 \uparrow$
 (X)
 $\text{NH}_3 + \text{K}_2\text{HgI}_4 + \text{OH}^- \rightarrow \text{HgO} \cdot \text{Hg}(\text{NH}_2)\text{I} \downarrow$
 (D)
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) $\text{MgCl}_2 + \text{NH}_4\text{OH} + \text{Na}_2\text{HPO}_4 \rightarrow \text{Mg}(\text{NH}_4)\text{PO}_4 \cdot 6\text{H}_2\text{O} \downarrow$
 (white)
27. $(\text{NH}_4)_2\text{SO}_4 \xrightarrow{\Delta} \text{NH}_3 + \text{H}_2\text{SO}_4$
 $(\text{NH}_4)_2\text{CO}_3 \xrightarrow{\Delta} \text{NH}_3 + \text{CO}_2 + \text{H}_2\text{O}$
 $\text{NH}_4\text{Cl} \xrightarrow{\Delta} \text{NH}_3 + \text{HCl}$
 $(\text{NH}_4)_2\text{Cr}_2\text{O}_7 \xrightarrow{\Delta} \text{N}_2 + \text{Cr}_2\text{O}_3 + \text{H}_2\text{O}$
 $\text{NH}_4\text{NO}_3 \xrightarrow{\Delta} \text{N}_2\text{O} + \text{H}_2\text{O}$
28. $\text{NaBr} + \text{AgNO}_3 \rightarrow \text{AgBr}$ (yellow)
 $\text{NaI} + \text{AgNO}_3 \rightarrow \text{AgI}$ (yellow)
 $\text{NaI} + \text{Pb}(\text{NO}_3)_2 \rightarrow \text{PbI}_2$ (yellow)
 $\text{Na}_2\text{S} + \text{Cd}(\text{CH}_3\text{COO})_2 \rightarrow \text{CdS}$ (yellow)
 $\text{K}_2\text{CrO}_4 + \text{Pb}(\text{CH}_3\text{COO})_2 \rightarrow \text{PbCrO}_4$ (yellow)
 $\text{K}_2\text{CrO}_4 + (\text{CH}_3\text{COO})_2\text{Ba} \rightarrow \text{BaCrO}_4$ (yellow)
 $\text{NaBr} + \text{Cl}_2$ water (excess) $\rightarrow \text{BrCl}$ (yellow)
29. $\text{Hg}_2\text{Cl}_2, \text{PbCl}_2, \text{AgCl}$ (all are white precipitate)
30. $\text{CuSO}_4(\text{aq}) + \text{KCN}_{(\text{excess})} \rightarrow \text{K}_3[\text{Cu}(\text{CN})_4]$
 (Tetrahedral)
 $a = 0 ; b = 2 ; c = 4$
 $8a + 7b + 5c = 34$
31. (c)
- | | | |
|------------------|-----|------------------|
| Al^{3+} | and | Hg^{2+} |
| (group III) | | (group II) |
| Cd^{2+} | and | Zn^{2+} |
| (group II) | | (group IV) |
| Fe^{3+} | and | Cu^{2+} |
| (group III) | | (group II) |
| Bi^{3+} | and | Sn^{4+} |
| (group II) | | (group II) |
| As^{3+} | and | Sb^{3+} |
| (group II) | | (group II) |
32. (A $\rightarrow$ a,b,c,d; B $\rightarrow$ a; C $\rightarrow$ a,b,c; D $\rightarrow$ b,c,d)
33. (A $\rightarrow$ d; B $\rightarrow$ c; C $\rightarrow$ b; D $\rightarrow$ a)
34. (A $\rightarrow$ a,c; B $\rightarrow$ a,b; C $\rightarrow$ a,d; D $\rightarrow$ b,d)

PREVIOUS YEARS' QUESTIONS FOR JEE (MAIN AND ADVANCED)

1. (a) $\text{SO}_3^{2-} + \text{H}_2\text{SO}_4 \longrightarrow \text{SO}_2$
 [X] [Y]
 $\text{SO}_2 + \text{K}_2\text{Cr}_2\text{O}_7 + \text{H}_2\text{SO}_4 \longrightarrow \text{Cr}_2(\text{SO}_4)_2 + \text{K}_2\text{SO}_4$
 (green) + H_2O
2. (a) $\text{NaHCO}_3 + \text{MgCl}_2 \xrightarrow{\Delta} \text{MgCO}_3 \downarrow$
 (white)
3. (a) $\text{CO}_2 + \text{H}_2\text{O} \longrightarrow \text{H}_2\text{CO}_3$
 ($\text{H}^+, \text{HCO}_3^-, \text{CO}_3^{2-}$)
4. (b) $\text{Zn}(\text{OH})_2 + \text{NH}_3(\text{solution}) \longrightarrow [\text{Zn}(\text{NH}_3)_4]^{2+}$
 Soluble complex
5. (b) $\text{Cu}^{+2}\text{SO}_4 + \text{KCN}(\text{excess}) \longrightarrow \text{K}_3[\text{Cu}(\text{CN})_4]$
 $+1$
6. (c) $\text{MgSO}_4 + \text{NH}_4\text{OH} + \text{Na}_2\text{HPO}_4 \longrightarrow \text{Mg}(\text{NH}_4)\text{PO}_4$
 White
7. (b) $\text{Hg}^{2+} + \text{KI} \longrightarrow \text{HgI}_2 \downarrow$
 red
 $\text{HgI}_2 + \text{KI}(\text{excess}) \longrightarrow \text{K}_2[\text{HgI}_4]$
 Soluble

8. (a,b) $\text{NH}_4\text{NO}_3 + \text{NaOH} \longrightarrow \text{NH}_3 + \text{NaNO}_3$
 $\text{NaNO}_3 + \text{Zn dust} \longrightarrow \text{NH}_3 + \text{Na}_2\text{ZnO}_2$
 $\text{NH}_4\text{NO}_2 + \text{NaOH} \longrightarrow \text{NH}_3 + \text{NaNO}_2$
 $\text{NaNO}_2 + \text{Zn dust} \longrightarrow \text{NH}_3 + \text{Na}_2\text{ZnO}_2$
9. (d) p-Amino-N, N-dimethylaniline + Na_2S + $\text{FeCl}_3 \longrightarrow$ Methylene blue (X)
 (Y) $\text{FeCl}_3 + \text{K}_4[\text{Fe}(\text{CN})_6] \longrightarrow \text{Fe}_4[\text{Fe}(\text{CN})_6]_3$ blue
 (Y) $\text{FeCl}_3 + \text{K}_4[\text{Fe}(\text{CN})_6] \longrightarrow \text{Fe}[\text{Fe}(\text{CN})_6]$ (Z)
 (Y) (Z)
10. (c) FeCl_3
11. (b) $\text{Fe}[\text{Fe}(\text{CN})_6]$
12. (b, c, d)
 With Cl^- , SCN^- , CN^- ions the more stable oxidation state of Cu is +1.
13. (b) $\text{Cu} + \text{AgNO}_3 \rightarrow \text{Ag} + \text{Cu}(\text{NO}_3)_2$
 (M) (N) light blue
 $\text{AgNO}_3 + \text{NaCl} \rightarrow \text{AgCl} \downarrow$
 White
 (O)
 $\text{AgCl} + \text{NH}_3 \rightarrow [\text{Ag}(\text{NH}_3)_2]^+$
 $\text{Cu}(\text{NO}_3)_2 + \text{NH}_3 \rightarrow [\text{Cu}(\text{NH}_3)_4]^{2+}$
14. (a) AgNO_3
15. (c) $[\text{Ag}(\text{NH}_3)_2]^+$ and $[\text{Cu}(\text{NH}_3)_4]^{2+}$
16. (a) CuS and HgS
 Cu^{2+} and Hg^{2+} are II group radicals.
17. (a, c, d)
 $\text{K}_3[\text{Fe}(\text{CN})_6] + \text{KI}_{(\text{excess})} \rightarrow \text{K}_4[\text{Fe}(\text{CN})_6]^{+2} + \text{KI}_3$
 (Brownish yellow solution)
 $\text{K}_4[\text{Fe}(\text{CN})_6] + \text{ZnSO}_4 \rightarrow \text{K}_2\text{Zn}_3[\text{Fe}(\text{CN})_6]_2$
 or $\text{K}_2\text{Zn}[\text{Fe}(\text{CN})_6]$
 white ppt.
 $\text{I}_3^- + 2\text{Na}_2\text{S}_2\text{O}_3 \rightarrow \text{Na}_2\text{S}_4\text{O}_6 + 2\text{NaI} + \text{I}_2$
 (Brownish yellow filtrate) Clear solution (Turns starch solution blue)
 $\text{K}_2\text{Zn}[\text{Fe}(\text{CN})_6]$ reacts with NaOH as,
 $\text{K}_2\text{Zn}[\text{Fe}(\text{CN})_6] + \text{NaOH} \longrightarrow [\text{Zn}(\text{OH})_4]^{2-} + [\text{Fe}(\text{CN})_6]^{4-}$
 Soluble
18. (b) $4\text{HNO}_3 \xrightarrow{h\nu} 2\text{H}_2\text{O} + 4\text{NO}_2 \uparrow + \text{O}_2 \uparrow$
19. (d) Zn^{+2} is IV group radical.
20. (a) PbCl_2 is soluble in hot water.
21. (d) Q is group III radical
 $\text{Cr}(\text{OH})_3 + \text{H}_2\text{O}_2 + \text{NaOH} \longrightarrow \text{Na}_2\text{CrO}_4 (\text{s})$
 (Q) yellow solution
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) $\text{HgI}_2 + 2\text{KI} \rightarrow \text{K}_2[\text{HgI}_4]$
 Soluble
26. (a) $\text{Zn}_2[\text{Fe}(\text{CN})_6]$ is white in colour.