Solved Examples

JEE Main/Boards

Example 1: A colourless solid (A) liberates a brown gas (B) on acidification, a colourless alkaline gas (C) on treatment with NaOH and a colourless non-reactive gas (D) on heating. If heating of (A) is continued, it completely disappears. Identify the compounds (A) to (D).

Sol: (A) From the given data it appears to be NH_4NO_2.

This can be explained by the following reaction

With mineral acid NH_4NO_2 yields Nitrous acid which eventually gets converted to Nitric acid liberating NO.

NO with oxygen forms brown coloured NO_2 gas.

$$(1)\ \underset{(A)}{NH_4NO_2} + HCl \longrightarrow NH_4Cl + \underset{\text{Nitrous acid}}{HNO_2}$$

$$3HNO_2 \longrightarrow \underset{\text{(Nitric acid)}}{HNO_3} + H_2O + 2NO$$

$$2NO + O_2 \longrightarrow \underset{\text{(Brown gas) (B)}}{2NO_2}$$

NH_4NO_2 with NaOH gives out Sodium nitrite and ammonia gas.

$$(2)\ NH_4NO_2 + NaOH \longrightarrow NaNO_2 + \underset{\text{(C) Ammonia gas}}{NH_3}\uparrow + H_2O$$

On heating it gives off colourless Nitrogen gas and water.

$$(3)\ NH_4NO_2 \xrightarrow{\Delta} \underset{\text{Non–reactive (D)}}{N_2}\uparrow + 2H_2O$$

***** Both NO_2 and Br_2 are brown gases. How can they be identified if placed separately in two containers?**

[Hint: Water is added in both the container. Br_2 forms yellow solution whereas NO_2 forms colourless solution.]

Example 2: An aqueous solution of gas (X) shows the following reactions

(a) It turns red litmus blue.

(b) When added in excess to a copper sulphate solution, a deep blue colour is obtained.

(c) On addition of $FeCl_3$ solution, a brown ppt., soluble in dilute HNO_3 is obtained. Identify (X) and give equations for the reactions at step (b) and (c).

Sol: Gas X is soluble in water forming basic solution because it turns red litmus blue. Hence, the gas may be NH_3.

$$NH_3 + H_2O \longrightarrow NH_4OH$$

$$CuSO_4 + 4NH_4POH \longrightarrow \underset{\substack{\text{(Tetra– amine cupric}\\ \text{sulphate) Deep blue}}}{[Cu(NH_3)_4]SO_4} + 4H_2O$$

Ferric chloride gives brown ppt. of $Fe(OH)_3$

$$FeCl_3 + 3NH_4OH \longrightarrow \underset{\text{(Brown precipitate)}}{Fe(OH)_3} + 3NH_4Cl$$

Brown ppt. is soluble in HNO_3

$$Fe(OH)_3 + 3HNO_3 \longrightarrow \underset{\text{(Soluble complex)}}{Fe(NO_3)_3} + 3H_2O$$

***** NaCl on heating with conc. H_2SO_4 gives HCl whereas NaBr and NaI gives Br_2 and I_2 respectively. Why?**

[Hint: $NaCl + H_2SO_4 \longrightarrow NaHSO_4 + HCl$

$NaBr + H_2SO_4 \longrightarrow NaHSO_4 + HBr$

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

HBr and HI are reducing agent whereas H_2SO_4 is oxidising agent and thus Br_2 and I_2 are formed.]

Example 3: A compound (A) on heating with an excess of caustic soda solution liberates a gas (B) which gives white fumes on exposure of HCl. Heating it continued to expel the gas completely. The resultant alkaline solution again liberates the same gas (B) when heated with zinc powder. However the compound (A), when heated alone does not give nitrogen. Identify (A) and (B).

Sol: We all know that NH_3 with HCl gives white fumes of NH_4Cl with popping noise.

Hence it should be NH_3. Thus, compound (A) must be an ammonium salt.

Also we know that nitrates and nitrites on heating with Zn and alkali liberate NH_3 gas. Hence the compound (A) should be ammonium nitrate or nitrite

But compound (A) does not give N_2 on heating hence it may not be ammonium nitrite.

Reactions involved:

$$NH_4NO_3 + NaOH \longrightarrow NaNO_3 + H_2O + NH_3 \uparrow$$
(A)

$$NH_3 + HCl \longrightarrow NH_4Cl$$
(White fumes)

$$NaNO_3 + 8[H] \xrightarrow{Zn/NaOH} NaNO_3 + 2H_2O + NH_3 \uparrow$$

***** Why original solution is not prepared in conc. HNO_3 ?**

[Hint: HNO_3 is an oxidising agent which on decomposition gives oxygen. A yellow ppt. of sulphur is obtained in presence of HNO_3 when H_2S is passed for detecting the radicals of group II and group IV. $H_2S + 2HNO_2 \longrightarrow 2NO_2 + 2H_2O + S$ **]**

Example 4: An inorganic compound (A) shows the following reactions.

(i) It is white solid and exists as dimmer; gives fumes of (B) with wet air.

(ii) It sublimes on $180°$ C and forms monomer if heated to $400°$ C.

(iii) Its aqueous solution turns blue litmus to red.

(iv) Addition of NH_4OH and NaOH separately to a solution of (A) gives white ppt. which is however soluble in excess of NaOH.

Sol: (i) (A) is a characteristic dimerized compound which sublimes on $180°$ C and forms monomer if heated to $400°$ C and thus, (A) is $(AlCl_3)_2$ or Al_2Cl_6

$$Al_2Cl_{6(s)} \xrightarrow{180°C} Al_2Cl_{6(v)} \xrightarrow{400°C} 2AlCl_3$$

(ii) It fumes with wet air

$$Al_2Cl_6 + 6H_2O \longrightarrow 2Al(OH)_3 + 6HCl \uparrow$$
Fumes (B)

(iii) Its solution in water is acidic due to hydrolysis

$$2AlCl_3 + 6H_2O \longrightarrow 2Al(OH)_3 + 6HCl_{(aq)}$$

(iv) (A) gives white ppt. with NH_4OH, soluble in excess of NaOH.

$$Al_2Cl_6 + 6NH_4OH \longrightarrow 2Al(OH)_3 + 6NH_4Cl$$

$$Al_2Cl_6 + 6NaOH \longrightarrow 2AlOH + 6NaCl$$

Example 5: (i) Solution salt of an acid (A) is formed on boiling white phosphorus with NaOH solution.

(ii) On passing chlorine through phosphorus kept fused under water, another acid (B) is formed which on strong heating gives metaphosphoorus acid.

(iii) Phosphorus on treatment with conc. HNO_3 gives an acid (C) which ais also formed by the action of dilute H_2SO_4 on powdered phosphorite rock.

(iv) (A) on treatment with a solution of $HgCl_2$ first gives a white ppt. of compound (D) and then grey ppt. (E).

Identify (A) to (E) and write balanced chemical equations for the reactions at step (i) to (iv)

Sol: (i) $P_4 + 3NaOH + 3H_2O \longrightarrow 3NaH_2PO_2 + PH_3$
(Sodium hypophosphate)

Thus, acid (A) is H_3PO_2, i.e. , hypophosphorus acid

(ii) $2P + 3Cl_2 + 6H_2O \longrightarrow 2H_3PO_3 + 6HCl$
(Phosphorus acid)

Thus, acid (B) is H_3PO_3

(iii) $P_4 + 20HNO_3 \longrightarrow 4H_3PO_4 + 20NO_2 + 4H_2O$
(C)

$$P_4 + 10HNO_3 \longrightarrow 4H_3PO_4 + 10NO_2 + 4H_2O$$
Phoshoric acid (C)

Thus acid (C) is H_3PO_4

(iv) $H_3PO_2 + 2H_2O \longrightarrow H_3PO_4 + 4H$

$$HgCl_2 + 2H \longrightarrow Hg_2Cl_2 + 2HCl$$
(white)(D)

$$Hg_2Cl_2 + 2H \longrightarrow 2Hg + 2HCl$$
(Grey)(E)

***** During testing of Cl^- and Br^- by chloroform test, $CHCl_3$ layer first turns violet and then brown, confirming the presence of I^- and Br^- respectively. When layer turns brown then violet colour disappears or not and why?**

[Hint: Violet and brown colours are due to oxidation of I^- to I_2 and Br^- to Br_2 respectively. The violet colour of I_2 disappears when layer is brown due to formation of (IO_3^-) (iodate ion) which is colourless.]

Example 6: (i) A black coloured compound (B) is formed on passing hydrogen sulphide through the solution of a compound (A) in NH_4OH.

(ii) (B) on treatment with hydrochloric acid and potassium chlorate gives (A).

(iii) (A) on treatment with potassium cyanide gives a buff coloured ppt. which dissolves in excess of this reagent forming a compound (C).

(iv) The compound (C) is changes into a compound (D) when its aqueous solution is boiled.

(v) The solution of (A) was treated with excess of sodium bicarbonate and then with bromine water. On cooling and shaking for some time, a green colour compound (E) is formed. No change is observed on heating. Identify (A) to (E) and gives chemical equations for the reactions at steps (i) to (v).

Sol: Here it is given that a black coloured compound (B) is formed on passing hydrogen sulphide through the solution of a compound (A) in NH_4OH.

This indicates that (A) is salt of the IV group radicals $\left(Co^{2+},\ Ni^{2+} \text{or } Zn^{2+}\right)$.

Further it is given that on treatment with potassium cyanide (A) gives a buff coloured ppt. which dissolves in excess of this reagent forming a compound (C).

Which appears to be a cobalt salt ($CoCl_2$)

(i) $CoCl_2 + 2NH_4OH + H_2S \longrightarrow CoS + 2NH_4Cl + 2H_2O$
(A) (B)

(ii) $CoS + 2HCl + O \xrightarrow{(B)} CoCl_2 + H_2O + S$
(from $KClO_3$)

$2KClO_3 \longrightarrow 2KCl + 3O_2$

(iii) $CoCl_2 + 2KCN \longrightarrow Co(CN)_2 \downarrow + 2KCl$
buff coloured

$CO(CN)_2 + 4KCN \longrightarrow K_4[Co(CN)_6]$

(iv) $2K_4[CO(CN)_6] + O + H_2O \longrightarrow 2K_3[Co(CN)_6] + 2KOH$
(D)

(v) $CoCl_2 + 6NaHCO_3 \longrightarrow Na_4[Co(CO_3)_3] +$
$2NaCl + 3CO_2 + 3H_2O$

$2Na_4[Co(CO_3)_3] + 2NaHCO_3 + O \longrightarrow$

$2Na_3[Co(CO_3)_3] + 2Na_2CO_3 + H_2O$
(E)

Note: * Subquestions placed after the answers**

JEE Advanced/Boards

Example 1: (i) An ore (A) on roasting with sodium carbonate and lime in the presence of air gives two compounds, (B) and (C).

(ii) The solution of (B) in conc. HCl on treatment with potassium ferricyanide gives a blue colour or ppt. of compound (D).

(iii) The aqueous solution of (C) on treatment with conc. H_2SO_4 gives a yellow coloured compound (E).

(iv) Compound (E) when treated with KCl gives an orange-red compound (F) which is used an oxidizing reagent.

(v) The solution of (F) on treatment with oxalic acid and then with an excess of potassium oxalate gives blue crystals of compound (G).

Identify (A) to (G) and give balanced chemical equations for reactions at steps (i) to (v).

Sol: (a) Reaction (i) suggests that the ore contains Fe.

(b) Reaction (ii) and (iv) suggests that the ore also contains chromium.

Reaction (i), (iii) and (IV) are involved in the preparation of $K_2Cr_2O_7$ from chromite ore, $FeOCr_2O_3$.

Hence the given reactions can be written as below

(i) $4FeO.Cr_2O_3 + 8Na_2CO_3 + 7O_2 \xrightarrow[\text{(Rosting)}]{\text{lime}} 2Fe_2O_3 \downarrow$
Chromite ore (A) (B)

$8Na_2CrO_4 + 8CO_2 \uparrow$
(C)

(ii) $Fe_2O_3 + 6HCl \longrightarrow 2FeCl_3 + 3H_2O$

$4FeCl_3 + 3K_4[Fe(CN)_6] \longrightarrow Fe_4[Fe(CN)_6]_3 + 12KCl$
Blue (D)

(iii) $2Na_2CrO_4 + H_2SO_4 \longrightarrow Na_2Cr_6O_3 + Na_2SO_4 + H_2O$
soluble (C) Yellow colour (E)

(iv) $Na_2Cr_2O_7 + 2KCl \longrightarrow K_2Cr_2O_7 + 2NaCl$
(E) (F)

$K_2Cr_2O_7$ (F) is well known oxidizing agent.

(v) $Cr_2(C_2O_4)_3 + 3K_2C_2O_4 \longrightarrow$
$2K_3[Cr(C_2O_4)_3] + Cr_2(C_2O_4)_3$
Potassium trioxalatochromium
Blue crystals (G)

***** Chromyl chloride test for chlorides is not performed if mixture contain chlorates, why?**

[Hint: Because ClO_3^- ions react with H_2SO_4 to form chlorine dioxide (yellow greenish gas) which dissolves in H_2SO_4 forming orange-yellow solution. This solution is highly explosive.

$$3KClO_3 + 3H_2SO_4 \longrightarrow 2ClO_2 + ClO_4^- + 3SO_4^{2-} + 4H^+ + 3K^+ + H_2O\,]$$

Example 2: (i) A black mineral (A) on heating in presence of air gives a gas (B).

(ii) The mineral (A) on reaction with dilute H_2SO_4 gives a gas (C) and solution of a compound (D).

(iii) On passing gas (C) into an aqueous solution of (B) a white turbidity is obtained.

(iv) The aqueous solution of compound (D) on reaction with potassium ferricyanide gives a blue compound (E).

Identify (A) to (E) and give chemical equations for reactions at steps (i) to (iv).

Sol: Summary of the given statement can be written as:

$$\text{Gas C} + \text{Solution of D} \xleftarrow{\text{dil}H_2SO_4} \text{Black mineral}$$

$$A \xrightarrow{O_2} \text{Gas B} \xrightarrow[\text{ii) gas C}]{\text{i)}H_2O} \text{White turbidity}$$

D

$\downarrow K_3[Fe(CN)_6]$

Blue compound E

Compound D foms blue coloured solution of E by ton treatment of potassium ferricyanide.This indicates that compound D contains Fe^{2+} ion which is also the constituent ion of the compound A. Further it is given that A, is a black mineral of Fe^{2+} ion, so it has to be ferrous sulphide (FeS) which is confirmed by following reaction:

(i) $4FeS + 7O_2 \longrightarrow 2Fe_2O_3 + 4SO_2$
(A) (B)

(ii) $FeS + H_2SO_4 \longrightarrow FeSO_4 + H_2S + S$
(A) (D) (C)

(iii) a) $SO_2 + H_2O \longrightarrow H_2SO_3$

b) $2H_2S + H_2SO_3 \longrightarrow 3S + 3H_2O$
(C) Turbidity

(iv) $FeSO_4 + K_3[Fe(CN)_6] \longrightarrow KFe[Fe(CN)_6] + K_2SO_4$
(D) (E)

Example 3: A white substance A reacts with dilute H_2SO_4 to produce a colourless gas B and a colourless solution C. The reaction between B and acidified $K_2Cr_2O_7$ solution produces a green solution and a slightly coloured participate D. The substance D burns in air to produce a gas E which reacts with B to yield D and a colourless liquid. Anhydrous copper sulphate is turned blue on addition of this colourless liquid. Addition of aqueous NH_3 or NaOH to C produces first a participate which dissolves in the excess of the respective reagent to produce a clear solution in each case. Identify A, B, C, D and E. Write the equation of the reactions involved.

Sol:

$$A \xrightarrow{\text{dil}.H_2SO_4} B\uparrow + C$$
(White) (Colourless) (Colourless solution)

$\downarrow K_2Cr_2O_7/H^+$

Green solution + $D\downarrow$ (Burns in air to form E)
(Coloured)

$$E\uparrow + B\uparrow \longrightarrow D + \text{Colourless liquid} \xrightarrow{CuSO_4} \text{Blue}$$

$$C \xrightarrow[\text{or NaOH}]{\text{Aq}.NH_3} \text{Precipitate} \xrightarrow[\text{reagent}]{\text{Excess of}} \text{Clear solution}$$

The above set leads to following conclusions.

(i) Because Gas (B) is colourless and turns acidified $K_2Cr_2O_7$ solution green, it appers to be H_2S.

(ii) H_2S gas is obtained by the reaction of dil. H_2SO_4 on A, thus A must be a sulphide.

(iii) Zns sulphide is white thus it indicates that A is ZnS

$$ZnS + H_2SO_4(\text{dil}) \longrightarrow ZnSO_4 + H_2S\uparrow$$
(A) (C) (B)

$$3H_2S + K_2Cr_2O_7 \longrightarrow K_2SO_4 + Cr_2(SO_4)_3 + 7H_2O + 3S$$
(B) (green) (D)

$$S + O_2 \longrightarrow SO_2\uparrow \xrightarrow{2H_2S(B)} 2H_2S + 3S\downarrow$$
(D) (E) (Colourless liq) (D)

$\downarrow CuSO_4(\text{white})$

$CuSO_4 . 5H_2O$ (blue)

$$ZnSO_4 + 2NaOH \longrightarrow Zn(OH)_2\downarrow \xrightarrow{2NaOH} Na_2ZnO_2 + 2H_2O$$
(C) (Soluble)

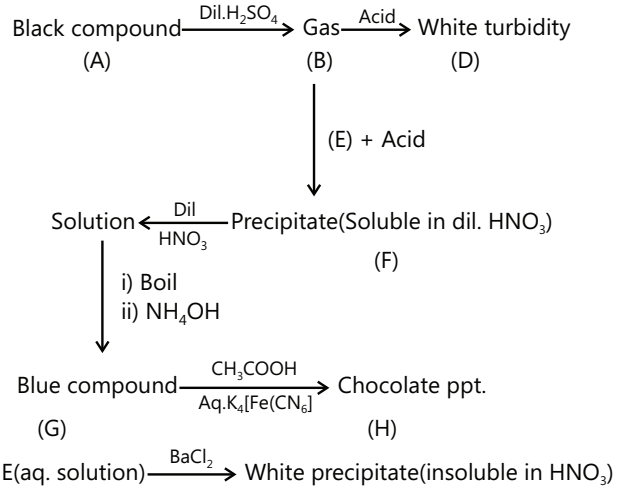
***** Before testing II group, iodide ions are separated. Why?**

[Hint: Because I^- ions react with air to form I_2 which reacts with H_2S and give white or light yellow ppt. of sulphur i.e., why I^- are removed by boiling original solution with $NaNO_2$.

$4HI + O_2 \longrightarrow 2H_2O + 2I_2$; $I_2 + H_2S \longrightarrow 2HI + S$]

Example 4: A black coloured compound (A) on reaction with dilute sulphuric acid gives a gas (B) which on passing in a solution of an acid (C) gives a white turbidity (D). Gas (B) when passed in acidified solution of a compound (E) gives a ppt. (F) soluble in dilute nitric acid. After boiling this solution when an excess of ammonium hydroxide is added, a blue coloured compound (G) is formed. To this solution on addition of acetic acid and aqueous potassium ferrocyanide a chocolate ppt. (H) is obtained. On addition of an aqueous solution of barium chloride to an aqueous solution (E), a white ppt. insoluble in HNO_3 is obtained. Identify from (A) to (H).

Sol: Summary we can draw from the given Data:



(i) Aqueous solution of compound E with $BaCl_2$ to give white ppt. which is insoluble in nitric acid indicates that the salt (E) contains SO_4^{2-} ions.

(ii) Compound (G) with potassium ferricyanide in presence of acidic acid to give chocolate ppt. (H) this indicates that (G) must contain Cu^{2+} and hence (H) has to be cupric ferricyanide, Cu_2 [Fe (CN) $_6$].

(iii) As compound (G) is derived from (F), compound (F) also contains Cu^{2+}. Further since (F) is derived from the reaction of the gas (B) and compound (E), (E) must contain Cu^{2+} ion. Ppt. of Cu^{2+} ion soluble in dilute nitric acid should be CuS; hence (F) must be CuS and thus (B) is H_2S.

(iv) According to first point compound (E) contains SO_4^{2-} hence (E) must be $CuSO_4$.

(v) Gas (B) (identified as H_2S) is obtained by the decomposition of black coloured compound (A) with dil. H_2SO_4. Hence (A) must be sulphide of Cu, Pb, Hg, and Fe. Co, Ni, etc.

Thus the various compounds from (A) to (H) and their reactions can be written as below.

$$\underset{\text{Ferrous sulphide (A)}}{FeS} + H_2SO_4 \longrightarrow \underset{\text{Hydrogen sulphide (B)}}{FeSO_4} + H_2S\uparrow$$

$$\underset{\text{Hydrogen sulphide (B)}}{H_2S} + \underset{\text{Nitric acid(C)}}{HNO_3} \longrightarrow 2H_2O + 2NO_2 + \underset{\text{Sulphur (turbidity, D)}}{S\downarrow}$$

$$\underset{\text{Copper sulphide(E)}}{CuSO_4} + \underset{\text{(B)}}{H_2S} \xrightarrow[\text{of dil.HCl}]{\text{in presence}} \underset{\text{Copper sulphide(F)}}{CuS}\downarrow + H_2SO_4$$

$$\underset{\text{(F)}}{3CuS} + 8HNO_3 \longrightarrow 3Cu(NO_3)_2 + 2NO + 3S + 4H_2O$$

$$Cu(NO_3)_2 + H_2SO_4 \longrightarrow CuSO_4 + 2HNO_3$$

$$CuSO_4 + 4NH_4OH \longrightarrow \underset{\substack{\text{Cupric ammonium sulphate}\\ \text{(blue compound (G))}}}{[Cu(NH_3)_4]SO_4} + 4H_2O$$

$$\underset{\text{(G)}}{[Cu(NH_3)_4]SO_4} + 4CH_3COOH \longrightarrow CuSO_4 + 4CH_3COONH_4$$

$$2CuSO_4 + \underset{\text{Ptassium ferrocyanide}}{K_4[Fe(CN)_6]} \longrightarrow \underset{\substack{\text{Cupric ferrocyanide}\\ \text{(Chocolate precipitate, H)}}}{Cu_2[Fe(C)_6]}\downarrow + 2K_2SO_4$$

$$\underset{\text{(E)}}{CuSO_4} + BaCl_2 \longrightarrow \underset{\substack{\text{Barium sulphate}\\ \text{(insoluble in water)}}}{BaSO_4}\downarrow + CuCl_2$$

Thus the compounds (A) to (H) are

A = Ferrous sulphide, FeS,

B = Hydrogen sulphide, H_2S,

C = Nitric acid, HNO_3

D = sulphur, S,

E = Copper sulphate, $CuSO_4$,

F= Copper sulphide, CuS,

G = Cupric ammonium sulphate, $[Cu(NH_3)_4]SO_4$

H = Cupric ferricyanide, $Cu_2[Fe(CN)_6]$

***** An original solution is prepared in conc. HCl. When diluted a while ppt. is formed. What does it indicate?**

[Hint: Formation of White ppt indicates the Presence of Sb^{+3} or Bi^{+3}. Their chlorides hydrolyse to oxychlorides in presence of excess of water.

$BiCl_3 + H_2O \longrightarrow BiOCl + 2HCl$;

$SbCl_3 + H_2O \longrightarrow SbOCl + 2HCl$]

Example 5: (i) The yellow coloured ppt. of compound (A) is formed on passing H_2S through a neutral solution of salt (B).

(ii) (A) is soluble in hot dilute HNO_3 but insoluble in yellow ammonium sulphide.

(iii) The solution of (B) on treatment with small quantity of NH_3 gives a white ppt. which become soluble in excess of its forming a compound (C).

(iv) The solution of (B) gives white ppt. with small concentration of KCN which becomes soluble in excess of this reagent forming a compound (D).

(v) The solution of (D) on treatment with H_2S gives (A).

(vi) The solution of (B) in dil. HCl on treatment with a solution of $BaCl_2$ gives a white ppt. of compound (E) which is insoluble in conc. HNO_3.

Identify (A) to (E) and give chemical equations for the reactions at steps (a) to (c) to (f)

Sol: Yellow ppt. of CdS is (A)

(i) $\underset{(B)}{CdSO_4} + H_2S \longrightarrow \underset{(A)}{CdS} + H_2SO_4$

(ii) $CdS + 2HNO_3 \longrightarrow Cd(NO_3)_2 + H_2S$
soluble

$CdS \longrightarrow$ Insoluble in yellow ammonium sulphide.

$CdSO_4 + 2NH_4OH \longrightarrow Cd(OH)_2 + (NH_4)_2SO_4$

(iii) $Cd(OH)_2 + 4NH_4OH \longrightarrow \underset{(C)}{[Cd(NH_3)_4](OH)_2} + 4H_2O$

(iv) $CdSO_2 + 2KCN \longrightarrow Cd(CN)_2 + K_2SO_4$
white

$Cd(CN)_2 + 2KCN \longrightarrow \underset{(D)\,\text{soluble}}{K_2[Cd(CN)_4]}$

(v) $K_2[Cd(CN)_4] + H_2S \longrightarrow CdS + 2KCN + 2HCN$

(vi) $CdSO_4 + BaCl_2 \longrightarrow \underset{(E)}{BaSO_4} + CdCl_2$

Example 6: A substance X dissolves in hot conc. HCl to give solution which when treated with caustic soda solution gives a white ppt. which however dissolves in excess of caustic soda solution giving a strongly solution. On heating X with sulphur, a brown powder Y is formed which dissolved on warming with yellow ammonium sulphide solution. The solution gives a grey ppt. with HCl. When X is heated in air, a white powder Z is obtained which can be dissolved in conc. H_2SO_4. When Z is fused with NaOH, extracted with hot water, then treated with mineral acid, white gelatinous ppt. is obtained. Identify X, Y, Z and give the reactions involved.

Sol:

$$X \xrightarrow{\text{conc.HCl}} \text{Solution} \xrightarrow{\text{NaOH}} \text{White ppt.} \xrightarrow{\text{NaOH}} \underset{\text{(Strongly reducing)}}{\text{Solution}}$$

$$X \xrightarrow{S} \underset{Y}{\text{Brown powder}} \xrightarrow{(NH_4)_2S} \text{Solution} \xrightarrow{\text{HCl}} \text{Grey ppt.}$$

$$X \xrightarrow[\text{heat}]{\text{air}} \underset{\text{Z(soluble only in conc.}H_2SO_4\text{)}}{\text{White powder}} \xrightarrow[\text{ii)hot water}]{\text{i)NaOH}} \text{Solution} \xrightarrow{\text{HCl}} \underset{\text{white}}{\text{Gelatinous}\downarrow}$$

(i) Solution of X (with HCl) reacts with NaOH and forms white ppt.This ppt dissolves in excess of NaOH to give solution which has strongly reducing nature. This reducing properties of this solution points out that the solution might be containing sodium stannite and here X must be tin.

(ii) The nature of X as tin is confirmed by its reaction with S forming SnS_2 which dissolves in yellow ammonium sulphide but regenerates in presence of HCl.

Thus the various reactions and nature of X, Y, and Z can be written as below.

(i) $\underset{(X)}{Sn} + 2HCl \longrightarrow SnCl_2 + H_2$

$SnCl_2 + 2NaOH \longrightarrow Sn(OH)_2 + 2NaCl$

$Sn(OH)_2 + 2NaOH \longrightarrow \underset{\substack{\text{Sodium stannite}\\\text{(Strongly reducing)}}}{Na_2SnO_2} + 2H_2O$

(ii) $Sn + 2S \longrightarrow SnS_2$

$SnS_2 + (NH_4)_2S \longrightarrow (NH_4)_2SnS_3$

$(NH_4)_2SnS_3 + 2HCl \longrightarrow SnS_2 + 2NH_4Cl + H_2S$

(iii) $Sn + O_2 \longrightarrow \underset{(Z)}{SnO_2}$ (Soluble only in conc. H_2SO_4)

$SnO_2 + 2NaOH \longrightarrow Na_2SnO_3 + H_2O$

$Na_2SnO_3 + 2HCl \longrightarrow \underset{\text{Stannic acid}}{H_2SnO_3}\downarrow + 2NaCl$

Example 7: A colourless solid A on heating gives a white solid B and a colourless gas, C; B gives off reddish brown fumes on treatment with dilute acids. On heating with NH_4Cl, B gives a colourless gas D and a residue E. The compound A also gives a colourless gas F on heating with ammonium sulphide and white residue G. Both E and G impart bright yellow colour to Bunsen flames. The gas C forms white powder with strongly heated magnesium metal. The white powder forms magnesium hydroxide with water. The gas D, on the other hand, is absorbed by heated calcium which gives off ammonia on hydrolysis. Identify the substance A to G and gives reactions for the changes involved.

Sol: It is advisable to summarize the given facts in the form of a chart.

$$A \xrightarrow[\text{Heat}]{(NH_4)_2SO_4} \underset{\text{Colourless residue}}{G} + \underset{\text{Colourless gas}}{F}$$

$$\underset{\text{Colourless solid}}{A} \xrightarrow{\text{Heat}} \underset{\text{Colourless solid}}{B} + \underset{\text{Colourless gas}}{C}$$

$$B \xrightarrow[\text{Heat}]{NH_4Cl} \underset{\text{Colourless residue}}{D} + \underset{\text{Residue}}{E}$$

$$B \xrightarrow{\text{Dil. HCl}} \text{Reddish brown fumes}$$

$$\underset{\text{Colourless residue}}{C} + Mg \longrightarrow \text{White powder} \xrightarrow{H_2O} Mg(OH)_2$$

$$\underset{\text{Colourless residue}}{D} + Ca\ (\text{Heated}) \xrightarrow{H_2O} NH_3$$

The above reactions lead to the following conclusions.

(A) And (D) on reaction with calcium forms a compound which on hydrolysis gives ammonia, this indicates that D must be nitrogen.

Compound (B), Residues E and G burns with yellow flame this indicates that these are sodium salts. Hence compound B (which give E) and A (which give G) must be sodium salts.

(C) The colourless solid B with dilute acid gives reddish brown fumes, the reddish brown fumes are probably of NO_2.

Hence compound B must be nitrite

(Remember: NO_3^- ions are not attacked by dil. Acids.).

Consequently, A must be compound of NO_3^- which can give NO_3^- (B) on heating.

Thus compound A is $NaNO_3$.

Reactions are as follows:

(i) $\underset{(A)}{2NaNO_3} \longrightarrow \underset{(B)}{2NaNO_2} + \underset{(C)}{N_2}\uparrow$

(ii) $\underset{(A)}{2NaNO_2} + H_2SO_4(\text{dil.}) \longrightarrow NaSO_4 + 2HNO_2$

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

$3NO + O_2 \longrightarrow \underset{\text{Reddish brown fumes}}{2NO_2}\uparrow$

(iv) $\underset{(A)}{2NaNO_3} + (NH_4)_2SO_4 \longrightarrow \underset{(G)}{Na_2SO_4} + \underset{(F)}{2NH_3}\uparrow + 2HNO_3$

(iii) $\underset{(A)}{NaNO_2} + NH_4Cl \xrightarrow{\text{heat}} \underset{(E)}{NaCl} + \underset{(D)}{N_2}\uparrow + 2H_2O$

(iv) $\underset{(A)}{2NaNO_2} + (NH_4)_2SO_4 \longrightarrow \underset{(G)}{Na_2SO_4} + \underset{(F)}{2NH_3}\uparrow + 2HNO_3$

(v) $\underset{(C)}{2Mg + O_2} \longrightarrow \underset{\text{White powder}}{2MgO}$

$MgO + H_2O \longrightarrow 2Mg(OH)_2$

(vi) $\underset{(D)}{3Ca + N_2} \longrightarrow Ca_3N_2$

$Ca_3N_2 + 6H_2O \longrightarrow 2Ca(OH)_2 + 2NH_3\uparrow$

Thus substance (A) to (G) can be represented as

(A) $NaNO_3$ (B) $NaNO_2$ (C) O_2

(D) N_2 (E) NaCl (F) NH_3 (G) Na_2SO_4

Note: * Subquestions placed after the answers**

JEE Main/Boards

Exercise 1

Q.1 Sometimes, a white ppt. is obtained even in the absence of members of Ist group on the addition of HCl. Explain it.

Q.2 Give examples and explain with equations:

(i) Two colourless solution give a black ppt. on mixing.

(ii) Two colourless solution give a red ppt. on mixing, soluble in excess of one of them.

(iii) Two colourless solutions give a white ppt. on mixing, soluble in ammonium hydroxide.

(iv) Two colourless solution give a yellow ppt. on mixing.

Q.3 What is yellow ammonium sulphide? Why is yellow ammonium sulphide and not ordinary ammonium sulphide used for the separation of II A and II B sub-groups?

Q.4 A certain inorganic compound (X) shows the following reactions:

(i) On passing H_2S through an acidified solution of (X) a brown ppt. is obtained.

(ii) The ppt. obtained at step (i) dissolve in excess of yellow ammonium sulphide.

(iii) On adding an aqueous solution of NaOH to a solution of (X), first a white ppt. is obtained which dissolves in excess of NaOH.

(iv) The aqueous solution of (X) reduce ferric chloride.

Identify the cation of (X) and give chemical equations for reactions at steps (i), (iii) and (iv)

Q.5 A mixture of the three gases A, B and C is passes first into an acidified dichromate solution when A is absorbed turning the solution green. The remainder of the gas is passed through an excess of lime water which turns milky, resulting in the absorption of B. The residual gas C is absorbed by an alkaline pyrogallol solution. However, the original gaseous mixture does not turn lead acetate paper black. Identify A, B and C.

Q.6 You are given unlabelled four packets of white substance of zinc, namely ZnO, $Zn(OH)_2$, $ZnCO_3$ and ZnS. How will you proceed to identify each of them?

Q.7 Explain, while performing qualitative analysis of basic radicals of third group, why ammonium chloride is added in excess before adding ammonium hydroxide?

Q.8 What happens when

(i) Copper sulphate is treated with excess of NH_4OH

(ii) Bismuth chloride is treated with sodium stannite in presence of NaOH

(iii) Stannous chloride is treated with mercuric chloride

(iv) Excess of water is added to concentrated solution of antimony chloride

Q.9 (i) What is the function of concentrated HNO_3 in third group?

(ii) Will you add HNO_3 in third group even if iron is given in ferric state in the mixture?

(iii) Can you use NaCl and NaOH instead of NH_4Cl and NH_4OH in third group?

Q.10 Identify compounds A to G from the following reactions

$$\text{A (white crystals)} \xrightarrow{\text{heat}} \underset{\text{solid}}{\text{B}} + \underset{\text{gas}}{\text{C}};\ \text{C} \xrightarrow[\text{solution}]{\text{KI}} I_2\ \text{A}$$

$$\text{B} \xrightarrow{HNO_3} \text{Solution D} \xrightarrow{\text{NaOH}} \underset{\text{brown}}{\text{E}\downarrow} \xrightarrow{NH_3}$$

$$\text{SolutionF} \xrightarrow{\text{H CO OH}} \text{Black precipitate}$$

Q.11 Complete the following

(i) $\text{PbS} + \underset{(A)}{\text{Acid}} \longrightarrow \underset{(B)}{\text{Gas}} \xrightarrow[C]{\text{Acid}} \underset{(D)}{\text{Yellow ppt.}}$

(ii) $A + H_2S \xrightarrow{NH_4OH} \underset{(B)}{\text{White ppt.}} + 2HCl$

$$A + NaOH \xrightarrow[(C)]{} \text{ppt.} \xrightarrow{\text{NaOH}} \underset{(D)}{\text{solution}}$$

(iii) $\text{Pbs} \xrightarrow{\text{heat in air}} A + PbS \xrightarrow{B} Pb + SO_2$

Q.12 Explain the following:

(i) Lead (Pb^{2+}) is placed in the first as well as second group of qualitative analysis.

(ii) The colour of mercurous chloride, Hg_2Cl_2 , change from white to black when treated with ammonia.

(iii) During the qualitative analysis of a mixture containing Cu^{2+} and Zn^{2+} ions, H_2S gas is passes through an acidified solution containing these ions in order to test Cu^{2+} alone. Explain briefly.

Q.13 Identify the unknown species and complete the following:

(i) $(A)+BaCl_2 \longrightarrow$ White ppt.

(ii) $NaOH+(B) \longrightarrow NH_3$ gas

(iii) $(C)+MnO_2+H_2SO_4 \longrightarrow$ Violet vapours

(iv) $(D)+K_2Cr_2O_7+H_2SO_4 \longrightarrow$ Green coloured solution

(v) $\underset{\text{Colourless solid}}{(E)} \xrightarrow{\text{Heat}}$ Yellow compound

Q.14 Fill in the blanks

(a) Lime water is used for the test of.....

(b) Acetates are..... in water.

(c) Nitrates when treated with conc. H_2SO_4 evolve..... gas.

(d) Chromyl chloride test is performed for.....

(e) Chlorides of ..... are insoluble in dilute HCl.

(f) H_2S is used as a group reagent in..... group in..... medium while in..... group in.....medium.

(g) HgS is..... in dilute HNO_3

(h) Yellow ammonium sulphide dissolves sulphides of.....

(i) Group reagent for third group radicals is.....

(j) If metal ions of group III are ppt. by NH_4Cl medium and NH_4OH without prior oxidation by concentrated HNO_3 .....is not completely ppt..

(k) colour of zinc sulphide is .....

(l) In V group, K_2CrO_4 is used for the test of.....

(m) ..... ppt. is formed when Na_2HPO_4 is added to magnesium salt in presence of NH_4OH.

(n) Ammonium thiocyanate is used in the detection of.....

Q.15 A compound on heating with an excess of caustic soda solution liberates a gas (B), which gives white fumes on exposure to HCl. Heating is continued to expel the gas completely. The resultant alkaline solution again liberates the same gas (B), when heated with zinc powder. However, the compound (A), when heated alone, does not give nitrogen. Identify (A) and (B).

Q.16 A certain metal (A) is boiled in dilute nitric acid to give a salt (B) and an oxide of nitrogen (C). An aqueous solution of (B) with brine gives a ppt. (D) which is solution in ammonium hydroxide. On adding aqueous solution of (B) to hypo solution, a white ppt. (E) is obtained. (E) on standing turns to a black compound (F). Identify (A) to (F).

Q.17 A yellow solid (A) is unaffected by acids and bases. It is not soluble in water. It dissolves slowly in hot conc. HNO_3 and a brown gas (B) is released. The solid (A) dissolves only in a boiling solution of sodium sulphite giving a clear solution (C). Acidification (C) causes a colourless gas (D) to be liberated, accompanied by an appearance of a milky ppt. (E) in the solution. Identify (A) to (E).

Q.18 State, whether the following statements are true or False:

(a) AgCl dissolve in NH_4OH.

(b) Sb_2S_3 is yellow in colour.

(c) Copper suplhate forms a violet colour with potassium ferrocyanide solution.

(d) Both phosphate and arsenic ions give yellow ppt. when heated with nitric acid and ammonium molybdate.

(e) Addition of ammonium chloride to a sodium containing ferric and magnesium ions is essential for selective precipitation of ferric hydroxide by aqueous ammonia.

(f) Ammonium sulphate can be used in place of ammonium chloride in third group.

(g) Iodine is liberated when an iodine in heated with conc. H_2SO_4.

(h) It is not necessary to use HNO_3 in the third group if ferric compound is given in a mixture.

(i) In the test of acetate radical, neutral ferric chloride is used.

(j) Nessler's reagent is the alkaline solution of K_2HgI_4.

(k) The solubility product of cadmium sulphide is highest amongst the sulphides of second group.

(l) Cobalt can be tested with dimethyl glyoxime.

(m) Cobalt salt with KNO_2 and acetic acid gives yellow ppt..

(n) The carbonates of barium, strontium and calcium are soluble in acid.

Q.19 Explain with proper reasoning.

(a) The aqueous solution of ferric chloride can not be stored. It is always acidified with hydrochloric acid.

(b) The aqueous solution of $FeCl_3$, possesses yellow colour. The colour becomes green on passing H_2S gas.

(c) The aqueous solution of $K_2Cr_2O_7$, is orange. On adding an alkali, it turns yellow.

(d) In the test of oxalate, the evolved gas burns with blue flame inly initially.

(e) Why yellow ammonium sulphide is used in group (II) sulphides separation?

(f) Why zinc sulphide is not ppt. when H_2S is passed through $ZnCl_2$ solution.

(g) $CaSO_4$ is insoluble but it is not ppt. when excess of $(NH_4)_2SO_4$ is added to $CaCl_2$.

(h) Why (NH_4Cl+NH_4OH) and not [$(NH_4)_2SO_4+NH_4OH$] is used in group (III) analysis?

(i) Why is it necessary to added few drops of conc. HNO_3 to the filtrate of group (II) before the use of NH_4Cl+NH_4OH.

(j) Why NaOH cannot be used to separate $Al(OH)_3$ and $Zn(OH)_2$?

Q.20 A certain salt (X) gives the following tests:

(i) Its aqueous solution is alkaline to litmus.

(ii) On strongly heating it swells to give glassy material.

(iii) When concentrated H_2SO_4 is added to a hot concentrated solution.

Identify the salt (X) and give the equations for the reactions.

Q.21 An aqueous solution of a gas (X) shows the following reactions.

(i) It turns red litmus blue.

(ii) When added in excess to copper sulphate solution deep blue colour is obtained.

(iii) On addition to a ferric chloride solution a brown ppt. soluble in dilute nitric acid is obtained. Identify (X) and give equations for the reactions at steps (ii) and (iii).

Exercise 2

Single Correct Choice Type

Q.1 Which of the following gives a suffocating gas when treated with dilute HCl?

(A) Carbonate (B) Sulphite

(C) Sulphate (D) Borate

Q.2 The acidic solution of a salt produces blue colour with KI starch solution. The salt may be

(A) Sulphite (B) Bromide

(C) Nitrite (D) Chloride

Q.3 Sulphite on treatment with dil, H_2SO_4 liberates a gas which

(A) Turns lead acetate paper black

(B) Burns with blue flame

(C) Smells like vinegar

(D) Turns acidified $K_2Cr_2O_7$ paper green

Q.4 A gas is evolved which burns with blue flame when the mixture is heated with conc. H_2SO_4. The mixture contains.

(A) Carbonate (B) Oxalate

(C) Nitrate (D) Nitrite

Q.5 Mercurous chloride turns black on treatment with ammonium hydroxide. This is due to the formation of

(A) $Hg(NH_2)Cl$ (B) $Hg_2Cl_2.NH_4OH$

(C) Hg and $HgNH_2Cl$ (D) $HgCl_2.NH_4OH$

Q.6 Bromine vapours turn starch iodide paper

(A) Violet (B) Blue

(C) Yellow (D) Red

Q.7 A mixture when heated with dil. H_2SO_4 does not evolve brown vapours but when heated with conc. H_2SO_4, brown vapours are obtained. The vapours when brought in contact with silver nitrate solution do not give any ppt.. The mixture contains.

(A) NO_2^- (B) NO_3^-

(C) Cr (D) Br^-

Q.8 Ammonium dichromate is used in some fireworks. The green coloured powder blown in air is due to

(A) CrO_3 (B) Cr_2O_3 (C) Cr (D) $CrO(O_2)$

Q.9 A mixture, on heating with conc. H_2SO_4 and MnO_2, liberates brown vapours of

(A) Br_2 (B) NO_2 (C) HBr (D) I_2

Q.10 A white solid is first heated with dil. H_2SO_4 and then with conc. H_2SO_4. No action was observed in wither case. The solid salt contains.

(A) Sulphide (B) Sulphite

(C) Thiosulphate (D) Sulphate

Q.11 A light yellow ppt. is formed in the second group of the qualitative analysis on passing H_2S even when no radical of second group is present. This is due to presence of ..... in the mixture:

(A) Phosphate (B) Acetate

(C) Oxalate (D) Nitrate

Q.12 On adding water to $BiCl_3$ solution in HCl, the compound formed is

(A) Bi_2O_3 (B) $Bi(OH)_3$

(C) BiOCl (D) $BiOCl_2$

Q.13 The sulphide which is insoluble in 30% HNO_3 is

(A) HgS (B) CuS (C) PbS (D) CdS

Q.14 NiS is separated from ZnS by treating with

(A) NaOH

(B) Conc.HCl

(C) Yellow ammonium sulphide

(D) Aqua-regia

Q15.Soda extract is prepared by

(A) Fusing soda and mixture and then extracting with water

(B) Dissolving $NaHCO_3$ and misture in dil. HCl

(C) Boiling Na_2CO_3 and mixture in dil. HCl

(D) Boiling Na_2CO_3 and mixture in distilled water

Q.16 When dimethyl glyoxime solution is added to an aqueous solution of nickel (II) chloride followed by ammonium hydroxide:

(A) No ppt. is obtained

(B) A blue coloured ppt. is obtained

(C) A red coloured ppt. is obtained

(D) A black coloured ppt. is obtained

Q.17 An organic salt when heated evolves a coloured gas which bleaches moist litmus paper. The evolved gas is

(A) NO_2 (B) Cl_2 (C) Br_2 (D) I_2

Q.18 Which of the following metal oxides is white in colour but becomes yellow in heating?

(A) AgO (B) Ag_2O (C) FeO (D) ZnO

Q.19 A white ppt. obtained in the analysis of a mixture becomes black on treatment with NH_4OH. It may be.

(A) $PbCl_2$ (B) AgCl (C) $HgCl_2$ (D) Hg_2Cl_2

Q.20 Which one among the following soluble in excess of NaOH?

(A) $Fe(OH)_3$ (B) $Al(OH)_3$

(C) $Cr(OH)_3$ (D) $Mn(OH)_2$

Q.21 Which compound does not dissolve in hot dil. HNO_3

(A) HgS (B) PbS (C) CuS (D) CdS

Q.22 An aqueous solution of $FeSO_4Al_2(AO_4)_3$ and chrome alum is heated with excess of Na_2O_2 and filtered. The materials obtained are

(A) A colourless filtrate and a green residue

(B) A yellow filtrate and green residue

(C) A yellow filtrate and a brown residue

(D) A green filtrate and a brown residue

Q.23 All ammonium salts liberate ammonia when

(A) Heated

(B) Heated with caustic soda

(C) Heated with H_2SO_4

(D) Heated with $HaNO_2$

Q.24 One of the following compounds gives a white ppt. with aqueous $AgNO_3$ and a green flame test.

(A) NaCl (B) KCl (C) $BaCl_2$ (D) $CaCl_2$

Q.25 Which one of the following pairs of ions cannot be separated by H_2S in dilute hydrochloric acid?

(A) Bi^{3+}, Sn^{4+} (B) Al^{3+}, Hg^{2+}

(C) $Zn^{2+}Cu^{2+}$ (D) Ni^{2+}, Cu^{2+}

Q.26 When H_2S is passes through an ammonium salt solution X, a white ppt is obtained. The X can be

(A) Cobalt salt (B) Nickel salt

(C) Manganese salt (D) Zinc salt

Q.27 The best explanation for the solubility of MnS in dil. HCl in salt

(A) Solubility product of $MnCl_2$ is less than that of MnS

(B) Concentration of Mn^{2+} is lowered by the formation of complex ions with chloride ions.

(C) Concentration of sulphide ions is lowered by oxidation to free sulphur.

(D) Concentration of sulphide ions is lowered by formation of the weak acid H_2S

Q.28 A white solid is first heated with dilute H_2SO_4 and when with concentrated. No action is observed in either case. The solid contains.

(A) Sulphide (B) Sulphide

(C) Sulphate (D) Thiosulphate

Q.29 The salt used for performing 'bead test' in qualitative inorganic analysis is

(A) $K_2SO_4.Al_2(SO_4)_3.24H_2O$

(B) $FeSO_4.(NH_4)_2SO_4.6H_2O$

(C) $Na(NH_4)HPO_4.4H_2O$

(D) $CaSO_4.2H_2O$

Q.30 The only cation present in a slightly acidic solution are Fe^{3+}, Zn^{2+} and Cu^{2+}. The reagent which when added in excess to this solution would identify and separate Fe^{3+} in one step is

(A) 2MHCl (B) 6 M NH_3

(C) 6 M NaOH (D) H_2S gas

Q.31 Concentrated aqueous sodium hydroxide can separate a mixture of

(A) Al^{3+} and Sn^{2+} (B) Al^{3+} and Fe^{3+}

(C) Al^{3+} and Zn^{2+} (D) Zn^{2+} and Pb^{2+}

Q.32 Potassium ferricyanide [potassium hexacyano ferrate (III)] has

(A) Fe(II) (B) Fe(III) (C) Cu(II) (D) Cd(II)

Q.33 Which of the following sulphate is insoluble in water?

(A) $CuSO_4$ (B) $CdSO_4$ (C) $PbSO_4$ (D) $Bi_2(SO_4)_3$

Q.34 Calcium burns in nitrogen to produce a white powder which dissolve in sufficient water to produce a gas (A) and an alkaline solution. The solution on exposure to air produces a thin solid layer of (B) on the surface. Identify the compounds A and B.

(A) C_2H_2, $CaCO_3$ (B) NH_3, $CaCO_3$

(C) NH_3, $Ca(OH)_2$ (D) CH_4, $CaCO_3$

Q.35 A gas 'X' is passed through water to form a saturated solution. The aqueous solution on treatment with silver nitrate gives a white ppt.. The saturated aqueous solution also dissolve magnesium ribbon with the evolution of a colourless gas 'Y'. Identify 'X' and 'Y'.

(A) X=CO_2, Y=Cl_2 (B) X=Cl_2, Y=CO_2

(C) X=Cl_2, Y=H_2 (D) X_2=H_2, Y=Cl_2

Previous Years' Questions

Q.1 A gas 'X' is passed through water to form a saturated solution. The aqueous solution on treatment with silver nitrate gives a white ppt.. The saturated aqueous solution also dissolves magnesium ribbon with evolution of a colourless gas 'Y'. Identify 'X' and 'Y'. ***(2002)***

Q.2 $[X]+H_2SO_4 \longrightarrow$ [Y] a colourless gas with irritating smell $[Y]+K_2Cr_2O_7+H_2SO_4 \longrightarrow$ green solution [X] and [Y] are ***(2003)***

(A) SO_3^{2-}, SO_2 (B) Cl^-, HCl

(C) S^{2-}, H_2S (D) CO_3^{2-}, CO_2

Q.3 A sodium salt of an unknown anion when treated with $MgCl_2$ gives white ppt. only on boiling. The anion is ***(2004)***

(A) SO_4^{2-} (B) HCO_3^- (C) CO_3^{2-} (D) NO_3^-

Q.4 $(NH_4)_2Cr_2O_7$ on heating gives a gas is also given by ***(2004)***

(A) Heating NH_4NO_2 (B) Heating NH_4NO_3

(C) $Mg_3N_2+H_2O$ (D) Na(comp.)+ H_2O_2

Q.5 A metal nitrate reacts with KI to give a black ppt. which on addition of excess of KI convert into orange colour solution. The cation of metal nitrate ***(2005)***

(A) Hg^{2+} (B) Bi^{3+} (C) Sm^{2+} (D) Pb^{2+}

Q.6 A solution when diluted with H_2O and boiled, it gives a white ppt. On addition of excess NH_4Cl/NH_4OH, the volume of ppt. decreases leaving behind a white gelatinous ppt. Identify the ppt which dissolves in NH_4OH/NH_4Cl. ***(2002)***

(A) $Zn(OH)_2$ (B) $Al(OH)_3$

(C) $Mg(OH)_2$ (D) $Ca(OH)_2$

(A) If both assertion and reason are true and reason is the correct explanation of assertion, then mark (a)

(B) If both assertion and reason are true but R is not the correct explanation of assertion, then mark (b)

(C) If assertion is true but reason is false, then mark (c)

(D) If both assertion and reason are false, then mark (d)

Q.7 Statement-I: A very dilute acidic solution of Cd^{2+} and Ni^{2+} gives yellow ppt. of CdS on passing H_2S.

Statement-II: Solubility product of CdS is more than that of NiS. ***(1989)***

Q.8 Statement-I: Sulphate is estimated as $BaSO_4$, not as $MgSO_4$.

Statement-II: Ionic radius of Mg^{2+} is smaller than that of Ba^{2+} ***(1998)***

Q.9 An aqueous solution $FeSO_4$. $Al_2(SO_4)_3$ and chrome alum is heated with excess of Na_2O_2 and filtered. The materials obtaining are ***(1996)***

(A) A colourless filtrate and a green residue

(B) A yellow filtrate and a green residue

(C) A yellow filtrate and a brown residue

(D) A green filtrate and brown residue

Q.10 In nitroprusside ion the iron and NO exist as Fe (II) and NO^+ rather than Fe(III) and NO. These forms can be differentiated by ***(1998)***

(A) Estimating the concentration of iron

(B) Measuring the concentration of CN

(C) Measuring the solid state magnetic moment

(D) Thermally decomposing the compound

Q.11 An aqueous solution if a substance gives a white ppt. on treatment with dilute hydrochloride acid, which dissolves on heating. When hydrogen sulphide is passed through the hot acid solution, a black ppt. is obtained. The substance is a ***(2000)***

(A) Hg_3^{2+} salt (B) Cr^{2+} salt

(C) Ag^+ salt (D) Pb^{2+} salt

JEE Advanced/Boards

Exercise 1

Q.1 An inorganic Lewis acid(X) shows the following reactions:

(i) It fumes in moist air.

(ii) The intensity of fumes increases when a rod dipped in NH_4OH is brought near to it.

(iii) An acidic solution of (X) on addition of NH_4Cl and NH_4OH gives a ppt. which dissolves in NaOH solution.

(iv) An acidic solution of (X) does not give a ppt. with H_2S. Identify (X) and give chemical equations for reactions at steps (i) to (iii).

Q.2 An aqueous solution of salt (A) gives white ppt. (B) with NaCl solution. The filtrate gives black ppt., (C) when H_2S is passed into it. Compound (B) dissolves in hot water and the solution gives a yellow ppt., (D) on treatment with sodium iodide and cooling. The compound (A) does not give any gas with dilute HCl but liberates a reddish-brown gas on heating. Identify the compounds (A) to (D).

Q.3 A mixture of two salts was treated as follows:

(a) The mixture was heated with manganese dioxide and concentrated H_2SO_4, when yellowish green gas was liberated.

(b) The mixture on heating with NaOH solution gave a gas which turn red litmus blue.

(c) Its solution in water gave blue ppt. with potassium ferricyanide and red colouration with NH_4CNS.

Q.4 An unknown inorganic compound (X) loses its water of crystallization on heating and its aqueous solution gives the following reactions.

(i) It gives a white turbidity with dilute hydrochloric acid solution.

(ii) It decolourises a solution of iodine in potassium iodide.

(iii) It gives white ppt. with silver nitrate solution which turns black on standing.

Q.5 Identify the compound (X) and give chemical equations for the reactions at steps (i), (ii) and (iii). A certain compound (X) shows the following reactions.

(i) When KI is added to an aqueous suspension of (X) containing acetic acid, iodine is liberated.

(ii) When CO_2 is passed through an aqueous suspension of (X) the turbidity transforms to a ppt..

(iii) When a paste of (X) in water is heated with ethyl alcohol a product of anesthetic use is obtained. Identify (X) and write down chemical equation for reactions at steps (i), (ii) and (iii).

Q.6 Identify the unknown species and complete the following

(i) (A) + dil.H_2SO_4 + $K_2Cr_2O_7 \rightarrow$ (B) green coloured

(A) + dil.H_2SO_4 + (C) $\rightarrow$ (B) $MnSO_4$

$(A) + O_2 \xrightarrow{H_2O} (D)$

(D) + $BaCl_2 \rightarrow$ White ppt.

(ii) $(A)\,aq. + Zn \xrightarrow{Heat} (B)\,gas$

$(A)\,aq. + (C) \xrightarrow{Heat} PH_3$

$(A)\,aq. + NH_4Cl \xrightarrow{Heat} (D)\,gas$

Q.7 (i) A black coloured compound (B) is formed on passing hydrogen sulphide through the solution of a compound (A) in NH_4OH.

(ii) (B) on treatment with hydrochloric acid and $KClO_3$ gives (A).

(iii) (A) on treatment with potassium cyanide gives a buff colored ppt. which dissolves in excess of this reagent forming a compound (C).

(iv) The compound (C) is changed into a compound (D) when its aqueous solution boiled.

(v) The solution of (A) was treated with excess of sodium bicarbonate and then with bromine water. On cooling and shaking for same time, a green colour of compound (E) is formed. No change is observed on heating.

Identify (A) to (E) and give chemical equations for the reactions at steps (a) to (e).

Q.8 A colourless solid (A) on hydrolysis produces a heavy white ppt. (B). Solid (A) gives a clear solution in conc. HCl; however, when added to large amount of water, it again gives ppt. (B). When H_2S is passed through a suspensions of (A) or (B), a brown black ppt. of (C) is obtained. Compound (A) liberates a gas (D) on treating with H_2SO_4. The gas (D) is water soluble and gives white ppt. (E) with solution of mecurous salt but not with mercuric salt. Identify (A) to (E). Also report (A), (B), (C) if (C) is orange ppt..

Q.9 Identify the unknown species and complete the following

(i) $(A) + NaOH \xrightarrow{Heat} NaCl + NH_3 + H_2O$.

(ii) $NH_3 + CO_2 + H_2O \rightarrow$ (B).

(iii) (B) + NaCl $\rightarrow$(C) + NH_4Cl.

(iv) $(C) \xrightarrow{Heat} Na_2CO_3 + H_2O + (D)$.

Q.10 Element A burns in nitrogen to give an ionic compound B. Compound B reacts with water to give C and D. A solution of C becomes 'milky' on bubbling carbon dioxide. Identify A, B, C and D.

Q.11 An inorganic compound (A) in its aqueous solution produced a white ppt. With NaOH, which gets dissolved in excess of NaOH. The aqueous solution of (A) also produced white ppt. With NH_4OH which also dissolved in excess of NH_4OH. Also its aqueous solution produced light yellow ppt. with $AgNO_3$ solution, soluble in dil. HNO_3, identify (A).

Q.12 (i) An aqueous solution of a compound (A) is acidic towards litmus and (A) is sublimed at about $300°C$.

(ii) (A) on treatment with an excess of NH_4SNC gives a red coloured compound (B) and on treatment with a solution of $K_4[Fe(CN)_6]$ gives a blue coloured compound (C). (iii) (A) on heating with excess of $K_2Cr_2O_7$ in presence of concentrated H_2SO_4 evolves deep red vapours of (D).

(iv) On passing the vapours of (D) into a solution of NaOH and then adding the solutions of acetic acid and lead acetate, a yellow ppt. of compound (E) is obtained.

Identify (A) to (E) and give chemical equations for the reactions at steps (ii) to (iv).

Q.13 An aqueous solution of gas (X) gives the following reactions.

(i) It decolourizes on acidified $K_2Cr_2O_7$ solution.

(ii) On boiling it with H_2O_2, cooling it and then adding an aqueous solution of $BaCl_2$ a ppt. insoluble in dilute hydrochloric acid is obtained.

(iii) On passing H_2S in the solution, a white turbidity is obtained.

Identify (X) and gives equations for the reactions at steps (i),(ii) and (iii).

Q.14 A colourless solid A, when placed into water, produces a heavy white ppt. B. Solid A gives a clear solution in conc. HCl; however when added to large amount of water, it again gives ppt. of B which dissolves in dilute HCl. When H_2S is passed through the suspension of A or B, a brown black ppt. (C) is obtained. Compound A liberates a gas D with conc. H_2SO_4. The gas D is water soluble and gives white ppt. E with solution of mercurous salts but not with mercuric salts. Identify A to E.

Q.15 (i) A blue coloured compound (A) on heating gives two products, (B) and (C).

(ii) A metal (D) is deposited on passing hydrogen through heated (B).

(iii) The solution of (B) in HCl on treatment with $K_4Fe(CN)_6$ gives a chocolate brown coloured ppt. of compound (E).

(iv) (C) turns lime water milky which disappears on continuous passage of (C) forming a compound (F). Identify (A) to (F) and give chemical equations for the reactions at steps (i) to (iv).

Q.16 (i) An inorganic compound (A) is formed on passing a gas (B) through a concentrated liquor containing sodium sulphide and sodium sulphite.

(ii) On adding (A) in to a dilute solution of silver nitrate, a white ppt. appears which quickly changes into black coloured compound (C).

(iii) On adding two or three drops of ferric chloride into the excess of solution of (A), a violet coloured compound (D) is formed. This colour disappears quickly.

(iv) On adding a solution of (A) into the solution of cupric chloride, a white ppt. is first formed which dissolves on adding excess of (A) forming a compound (E). Identify (A) to (E) and give chemical equations for the reactions at steps (i) to (iv).

Q.17 A metal chloride (X) shows the following reactions:

(i) When H_2S is passed in an acidified aqueous solution of (X), a black ppt. is obtained.

(ii) The ppt. obtained at step (i) is not soluble in yellow ammonium sulphide.

(iii) When a solution of stannous chloride is added to an aqueous solution of (X) a white ppt. is obtained which turns grey on addition of more of stannous chloride.

(iv) When an aqueous solution of KI is added to an aqueous solution of (X) a red ppt. is obtained which dissolves on addition of excess of KI.

Identify (X) and write down the equations for the reactions at steps (i), (iii) and (iv).

Q.18 A well known orange crystalline compound (A) when burnt imparts violet colour of fame. (A) on treating with (B) and conc. H_2SO_4 gives red gas (C) which gives red yellow solution (D) with alkaline H_2SO_4 gives red gas (C) which gives red yellow solution (D) with alkaline water. (D) on treating with acetic acid and lead acetate gives yellow ppt. (E). (B) sublimes on heating. Also on heating (B) NaOH, gas (F) is formed which gives white fumes with HCl. What are (A) to (F)?

Q.19 Complete and balance the following chemical equations:

(i) $Au + HCl + HNO_3 \rightarrow ..... + ... + H_2O$

(ii) $C + HNO_3(conc.) \rightarrow CO_2 + ... + H_2O$

(iii) $Sn + KOH(hot) + H_2O \rightarrow ..... + ...$

(iv) $Cu(OH)_2 + NH_4NO_3 + NH_4OH_{(aq)} \rightarrow ..... + H_2O$

Q.20 A gaseous mixture containing (X), (Y) and (Z) gases, when passed into acidified $K_2Cr_2O_7$ solution, gas (X) was absorbed and the solution was turned green. The remainder gas mixture was then pass through lime water, which turns milky by absorbing gas (Y). The residual gas when passed through alkaline pyrogallol solution, it turned black. Identify gas (X), (Y) and (Z) and explain the reaction involved.

Exercise 2

Single Correct Choice Type

Q.1 Which compound does not dissolve in hot dil. HNO_3 ?

(A) HgS (B) PbS (C) CuS (D) CdS

Q.2 An aqueous solution of $FeSO_4Al_2(SO_4)_3$ and chrome alum is heated with excess of Na_2SO_3 and filtered. The materials obtained are

(A) A colorless filtrate and a green residue

(B) A yellow filtrate and a green residue

(C) A yellow filtrate and a brown residue

(D) A green filtrate and a brown residue

Q.3 Magnesium carbonate does not ppt. with the carbonates of group V radicals in presence of NH_4OH and NH_4Cl because

(A) $MgCO_3$ is soluble in water.

(B) $MgCO_3$ is soluble in NH_4OH

(C) $MgCO_3$ is soluble in NH_4Cl

(D) $MgCO_3$ is soluble in $(NH_4)_2CO_3$

Q.4 The extent of splitting in d-orbitals is more when the chromium in the solution is in

(A) +1 oxidation state (B) +2 oxidation state

(C) +3 oxidation state (D) +6 oxidation state

Assertion Reasoning Type

(A) If both assertion and reason are true and reason is the correct explanation of assertion, then mark (A)

(B) If both assertion and reason are true but reason is not the correct explanation of assertion, then mark (B)

(C) If assertion is true but reason is false, then mark (C)

(D) If both assertion and reason are false, then mark (D)

Q.5 Assertion: Ammonium phosphomolybdate is a yellow coloured ppt.

Reason: Yellow colour of compound is due to ammonium ions.

Q.6 Assertion: Ring test for nitrates is performed from the water extract of the salt.

Reason: All nitrates are generally soluble in water.

Q.7 Assertion: In the analysis of group III-radicals NaOH can also be used as group reagent.

Reason: NaOH can be used only in the presence of NaCl as ppt. agent for group III.

Q.8 Assertion: In charcoal cavity test in intimate mixture of salt and Na_2CO_3 is heated on a charcoal block.

Reason: Charcoal cavity test is meant only for coloured salts

Q.9 Assertion: Match-stick test is meant for all sulphur containing radicals.

Reason: Match-stick test is not given by Na_2S.

Q.10 Assertion: CdS and As_2S_3 both have yellow colour.

Reason: CdS and As_2S_3 can be separated by yellow ammonium sulphide.

Comprehension Type

The following observation were made on Na_2CrO_4 and $Na_2Cr_2O_7$.

(A) When CO_2 was passed over Na_2CrO_4, then $Na_2Cr_2O_7$ was formed.

(B) When Zn is added to acidic solution of $Na_2Cr_2O_7$, the colour changes from orange to green, then to blue and then back to green.

(C) Na_2CrO_4 when added to a nitrate salt solution gave a yellow coloured ppt. which after separation and drying followed by flame test gave a green coloured flame.

Q.11 What is the function of CO_2 in the first observation?

(A) Acts as an oxidising agent

(B) Acts as a reducing agent

(C) Produces chromium and oxygen

(C) Makes the solution acidic

Q.12 The reason for the colour $Na_2Cr_2O_7$ solution to first change from orange to green on adding Zn is because

(A) Zn is reducing agent and changes Cr^{+4} to Cr^{+3}

(B) Zn is a reducing agent and changes Cr^{+6} to Cr^{+3}

(C) Zn is a reducing agent and it reduces Cr^{+6} to Cr^{+2}

(D) None of these

Q.13 The second change in colour in the solution that is from green to blue is due to the conversation of

(A) Cr^{+3} to Cr^{+1} (B) Cr^{+3} to Cr

(C) Cr^{+3} to Cr^{+2} (D) Cr^{+3} to Cr^{+4}

Q.14 The nitrate salt which gives a yellow ppt. with Na_2CrO_4 and yellow ppt. gives green flame with bunsen burner

(A) Pb^{2+} (B) Ca^{2+} (C) Mg^{2+} (D) Ba^{2+}

Previous Years' Questions

Q.1 $MgSO_4$ on reaction with NH_4OH and Na_2HPO_4 forms a white crystalline ppt. What is its formula? ***(2006)***

(A) $Mg(NH_4)PO_4$ (B) $Mg_3(PO_4)_2$

(C) $MgCl_2 . MgSO_4$ (D) $MgSO_4$

Q.2 A solution of metal ion when treated with KI gives a red ppt. which dissolves in excess KI 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 ppt. The metal ion is ***(2007)***

(A) Pb^{2+} (B) Hg^{2+} (C) Cu^{2+} (D) Co^{2+}

Q.3 Passing H_2S gas into a mixture of Mn^{2+}, Ni^{2+}, Cu^{2+}, and Hg^{2+} ions in an acidified aqueous solution ppt. ***(2011)***

(A) CuS and HgS (B) MnS and CuS

(C) MnS and NiS (D) NiS and HgS

Q.4 The reagents, NH_4Cl and aqueous NH_3 will ppt. ***(1991)***

(A) Ca^{2+} (B) Al^{3+} (C) Bi^{3+} (D) Mg^{2+}

(E) Zn^{2+}

Q.5 Which of the following statement (s) is (are) correct with reference to the ferrous and ferric ions? ***(1998)***

(A) Fe^{3+} gives brown colour with potassium ferricyanide

(B) Fe^{2+} gives blue ppt. with potassium ferricyanide

(C) Fe^{3+} gives red colour with potassium ferricyanide

(D) Fe^{2+} gives brown colour with ammonium thiocyanate

Q.6 A solution of colourless salt H on boiling with excess NaOH produces a non-flammable gas. The gas evolution ceases after sometime. Upon addition of Zn dust to the same solution, the gas evolution restarts. The colourless salt (s) H is (are) ***(2008)***

(A) NH_4NO_3 (B) NH_4NO_2

(C) NH_4Cl (D) $(NH_4)_2SO_4$

Paragraph 1: 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 colouration 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 ppt.. The ppt. 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 formation of Z.

Q.7 The compound X, is ***(2009)***

(A) $NaNO_3$ (B) NaCl (C) Na_2SO_4 (D) Na_2S

Q.8 The compound Y, is ***(2009)***

(A) $MgCl_2$ (B) $FeCl_2$ (C) $FeCl_3$ (D) $ZnCl_2$

Q.9 The compound Z, is **(2009)**

(A) $Mg_2[Fe(CN)_6]$ (B) $Fe[Fe(CN)_6]$

(C) $Fe_4[Fe(CN)_6]_3$ (D) $K_2Zn_3[Fe(CN)_6]_2$

Q.10 $Fe^{3+} \xrightarrow{SCN^-(excess)}$ Blood red (A)

$\xrightarrow{F^-(excess)}$ Colourless (B)

Identify A and B. (a) Write IUPAC name of A and B.

(b) Find out spin only magnetic moment of B. ***(2005)***

Q.11

B (White fumes having smell) $\xleftarrow{\text{Moist air}}$ MCl_4 (M = (Transition element colourless) $\xrightarrow{Zn}$ A (Purple Colour)

Identify the metal M and hence, MCl_4. Explain the difference in colours of MCl_4 and A. ***(2005)***

Paragraph 2: An aqueous solution of a mixture of two inorganic salts, when treated with dilute HCl, gave a precipitate (P) and a filtrate (Q). The precipitate P was found to dissolve in hot water. The filtrate (Q) remained unchanged, when treated with H_2S in a dilute mineral acid medium. However, it gave a precipitate (R) with H_2S in anammoniacal medium. The precipitate R gave a coloured solution (S), when treated with H_2O_2 in an aqueous NaOH medium.

Q.12 The precipitate **P** contains ***(2013)***

(A) Pb^{2+} (B) Hg^{2+} (C) Ag^{+} (D) Hg^{2+}

Q.13 The coloured solution **S** contains ***(2013)***

(A) $Fe_2(SO_4)_3$ (B) $CuSO_4$

(C) $ZnSO_4$ (D) Na_2CrO_4

Q.14 The reagent(s) that can selectively precipitate S^{2-} from a mixture of S^{2-} and SO_4^{2-} in aqueous solution is (are) ***(2016)***

(A) $CuCl_2$ (B) $BaCl_2$

(C) $Pb(OOCCH_3)_2$ (D) $Na_2[Fe(CN)_5NO]$

Q.15 In the following reaction sequence in aqueous solution, the species X, Y and Z, respectively, are ***(2016)***

$$S_2O_3^{2-} \xrightarrow{Ag^+} \underset{\text{Clear solution}}{X} \xrightarrow{Ag^+} \underset{\text{White precipitate}}{Y} \xrightarrow{\text{With time}} \underset{\text{Black precipitate}}{Z}$$

(A) $[Ag(S_2O_3)_2]^{3-}, Ag_2S_2O_3, Ag_2S$

(B) $[Ag(S_2O_3)_2]^{5-}, Ag_2S_2O_3, Ag_2S$

(C) $[Ag(SO_3)_2]^{3-}, Ag_2S_2O_3, Ag$

(D) $[Ag(SO_3)_3]^{3-}, Ag_2S_2O_4, Ag$

MASTERJEE Essential Questions

JEE Main/Boards

Exercise 1

Q.2 Q.3 Q.10

Q.19 (f,i)

Exercise 2

Q.2 Q.7 Q.15

Q.24 Q.30

Previous Years' Questions

Q.2 Q.6

JEE Advanced/Boards

Exercise 1

Q.1 Q.4 Q.6

Q.11 Q.15 Q.18

Exercise 2

Q.5

Previous Years Questions

Q.5 Q.10 Q.11

Answer Key

JEE Main/Boards

Exercise 2

Single Correct Choice Type

Q.1 B	**Q.2** C	**Q.3** D	**Q.4** B	**Q.5** C	**Q.6** B
Q.7 B	**Q.8** B	**Q.9** A	**Q.10** D	**Q.11** A	**Q.12** C
Q.13 A	**Q.14** B	**Q.15** D	**Q.16** C	**Q.17** A	**Q.18** D
Q.19 D	**Q.20** B	**Q.21** A	**Q.22** C	**Q.23** B	**Q.24** C
Q.25 A	**Q.26** D	**Q.27** D	**Q.28** C	**Q.29** C	**Q.30** B
Q.31 B	**Q.32** B	**Q.33** C	**Q.34** B	**Q.35** C	

Previous Years Questions

Q.1 X-Cl_2, Y-H_2	**Q.2** A	**Q.3** B	**Q.4** A	**Q.5** B	**Q.6** A
Q.7 C	**Q.8** B	**Q.9** C	**Q.10** C	**Q.11** D	

JEE Advanced/Boards

Exercise 2

Single Correct Choice Type

Q.1 A	**Q.2** C	**Q.3** C	**Q.4** D

Assertion Reasoning Type

Q.5 C	**Q.6** A	**Q.7** D	**Q.8** C	**Q.9** C	**Q.10** B

Comprehension Type

Q.11 D	**Q.12** B	**Q.13** C	**Q.14** D

Previous Years Questions

Q.1 A	**Q.2** B	**Q.3** A	**Q.4** B, C	**Q.5** B, C	**Q.6** A, B
Q.7 D	**Q.8** C	**Q.9** B	**Q.12** A	**Q.13** D	**Q.14** A, C
Q.15 A					

Solutions

JEE Main/Boards

Exercise 1

Single Correct Choice Type

Sol 1: It due to the formation of $PbCl_2$.

Sol.2 (i) Lead salt + sulphide $\rightarrow$ PbS (black)

E.g $Pb(CH_3COO)_2 + Na_2S \rightarrow PbS + 2CH_3COONa$

(ii) $HgCl_2 + 2KI \rightarrow \underset{\text{red}}{HgI_2} + KCl$

$HgI_2 + KCl \rightarrow K_2HgI_4$ (soluble)

(iii) $AgNO_3 + NaCl \rightarrow \underset{\text{white}}{AgCl} + NaNO_3$

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

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

Sol 3: Yellow ammonia sulphide.

YAS = yellow ammonium sulphide $(NH_4)_2 S_X$

The group II A and II B elements are differentiated on the basis of their solubility in YAS.

The group 2A elements are insoluble in YAS and 2B elements soluble in YAS, whereas they are all insoluble in sulphides.

Sol 4: X + H_2S + acid gas $\rightarrow$ Brown ppt.

Brown ppt $\rightarrow$ soluble in YAS

$X + NaOH \rightarrow$ white ppt $\xrightarrow[NaOH]{\text{excess}}$ soluble

$X(aq) + FeCl_3 \rightarrow FeCl_2 + \ldots\ldots$.

X is a group 2B salt which gives a brown sulphide $\therefore$ X is Sn^{+2}

$SnCl + NaOH \rightarrow Sn(OH)_2 + 2NaCl$

$Sn(OH)_2 + 2NaOH \rightarrow Na_2SnO_2$

(Strongly reducing)

$Sn^{+2} + 2FeO_3 \rightarrow Sn^{4+} + 2FeCl_2$

Sol 5: $A + K_2Cl_2O_7 \rightarrow$ Green soluble

$A = SO_2/H_2S$

$B + Ca(OH)_2 \rightarrow$ White ppt

$\therefore B = CO_2$

C + Alkaline pyrogallol $\rightarrow$ Absorbed

$\therefore C = O_2$

A + B + C + Lead acetate $\rightarrow$ Does not turn black

$\therefore A = SO_2$; $B = CO_2$; $C = O_2$

Sol 6: ZnO, $Zn(OH)_2$, $ZnCO_3$ and ZnS

$Zn(OH)_2 \xrightarrow{\Delta} H_2O + ZnO$

(Yellow when hot

white when cold)

$ZnCO_3 \rightarrow CO_2 + ZnO$

$\downarrow$

$Ca(OH)_2 \longrightarrow CaCO_3$

(turns lime water milky)

$ZnO \xrightarrow{\Delta}$ no gas

$ZnS \xrightarrow{\Delta}$ with dil H_2SO_4 gives H_2S

Sol 7: To decrease the conc. of (OH^-) ion in solution as if (NH_4^+) ion, conc. is high. Due to common ion effect, the conc. of OH^- ions is maintained low.

Sol 8: (i) $CuSO_4 + 2NH_4OH \rightarrow Cu(OH)_2 + (NH_4)_2SO_4$

$Cu(OH)_2 + (NH_4)_2 SO_4 + \underset{\text{excess}}{2NH_4OH} \rightarrow Cu(NH_3)_4 SO_4 + 2H_2O$

(ii) $BiCl_3 + 2Na_2SnO_2 + 6NaOH \rightarrow 2Bi + 3Na_2SnO_3 + 6NaCl + 3H_2O$

(iii) $2HgCl_2 + SnCl_2 \rightarrow Hg_2Cl_2 + SnCl_4$

$HgCl_2 + SnCl_2 \rightarrow 2Hg + SnCl_4$

(iv) $SbCl_3 + H_2O \rightarrow SbOCl + 2HCl$

Sol 9: Conc. HNO_3 is added for the

(i) Oxidation of metal to its highest oxidation state

(ii) No

(iii) No. NaOH is a strong base

$\therefore$ It has high conc of OH^- ions.

Sol 10: A(White crystals) $\xrightarrow{\Delta}$ $\underset{\text{solid}}{B} + \underset{\text{gas}}{C}$

$C \xrightarrow[\text{Sol}]{KI} I_2$

$B \xrightarrow{HNO_3}$ solution D $\xrightarrow{NaOH}$

$\underset{\text{brown}}{E} \uparrow$ Sol F $\xrightarrow{HCOOH}$ Black ppt

$A = AgNO_3 \xrightarrow{\Delta} Ag + NO_2 + \frac{1}{2}O_2$

$Ag \xrightarrow{HNO_3} D = AgNO_3$

$O_2 \xrightarrow{KI} I_2$

$AgNO_3 \xrightarrow{NaOH} \underset{\text{low}}{E} \downarrow$

$E = AgO$

$AgO \xrightarrow{NH_3} F = [Ag(NH_3)_2OH]$

Sol 11: (i)PbS + Acid $\rightarrow \underset{B}{Gas} \xrightarrow{Acid} \underset{D}{Yellow\ ppt.}$

Acid (A) : dil HCl of H_2SO_4

$B = H_2S$

C = conc. HNO_3

D = S (yellow ppt)

(ii) $A + H_2S \xrightarrow{NH_4OH}$ White ppt. + 2HCl

$A = ZnCl_2 + H_2S \xrightarrow{NH_4OH} ZnS + 2HCl$

$ZnCl_2 + NaOH \rightarrow Zn(OH)_2 \xrightarrow{NaOH} Na_2ZnO_2$

(iii) $PbS \xrightarrow[\text{air}]{\Delta \text{ in}} A + PbS \rightarrow Pb + SO_2$

A = PbO

Sol 12: (i) $PbCl_2$ is formed after Ist group partly soluble in water and hence Pb^{2+} ions pass to the first group filtrate, i. e. to the II group and is detected in the test for IInd group as well.

(ii) $\underset{\text{white}}{Hg_2Cl_2} \xrightarrow{NH_4OH} Hg(NH_2)Cl + \underset{\text{Black}}{Hg}$

(iii) K_{sp} (CuS) < K_{sp} (ZnS)

Ionisation of H_2S is further suppressed in presence of acid (common ion effect).

$\therefore$ So, when H_2S gas is passed through acidified solution contain Cu^{2+} and Zn^{2+} only. Cu^{2+} ions will precipitate out due to low conc, of S^{2-} ion.

Sol 13: (a) $A + BaCl_2 \rightarrow$ White ppt

$A = H_2SO_4$ or some sulphate

(b) $NaOH + B \rightarrow NH_3(g)$

$B = NH_4^+$ salt

(c) $C + MnO^-_4 + H_2SO_4 \rightarrow$ Violet vapours

C = iodide

(d) $D + K_2Cr_2O_7 + H_2SO_4 \rightarrow$ Green soluble

D = Some reducing agent

(e) $E \xrightarrow{\Delta}$ Yellow component

E = ZnO

Sol 14: (a) CO_3^{2-}

(b) Soluble

(c) NO_2

(d) Chloride ions

(e) Ist group (Pb^{2+} Ag^+ Hg^+)

(f) II group $\rightarrow$ Acidic medium

IV group $\rightarrow$ Alkaline medium

(g) Insoluble

(h) Group IIB

(i) NH_4OH

(j) Fe (iron)

(k) White

(l) $Ba^{2+}\uparrow$

(m) White

(n) Co^{2+} + Fe^{3+} ion

Sol 15: $A \xrightarrow[NaOH]{\Delta} B \uparrow + C$

$B \xrightarrow{HCl}$ white green $\therefore$ $B = NH_3$

$C \xrightarrow{Zn} B$

$A \xrightarrow{\Delta}$ No N_2 ; $A = NH_4NO_2$

Sol 16: $A = AgNO_3$

$Ag + DilHNO_3 \rightarrow AgNO_3 + NO$

$AgNO_3 + Brine \rightarrow AgCl$

$AgCl \xrightarrow{NH_4OH} Ag(NH)_3Cl$

$AgNO_3 + H_2S_2O_3 \rightarrow Ag_2S_2O_3$

$Ag_2S_2O_3 \rightarrow Ag_2S$

$\therefore$ A = Ag B = $AgNO_3$

C = NO D = AgCl

E = $Ag_2S_2O_3$ F = Ag_2S

Sol 17:

A = sulphur

$S \xrightarrow{\text{hot conc } HNO_3} \underset{\text{(brown)}}{NO_2} + H_2SO_4$

$S \xrightarrow{Na_2SO_3} Na_2S_2O_3$ (C)

$Na_2S_2O_3$ (acidified) $\rightarrow \underset{\text{white}}{Na_2S_4O_6} + NaOH$

Sol 18: (a) $AgCl \xrightarrow{NH_4OH} \underset{\text{(soluble)}}{Ag(NH_3)_2Cl}$

true

(b) Sb_2S_3 (is orange in colour) false

(c) $CuSO_4 + K_4FeCN_6 \rightarrow \underset{\text{choclote ppt}}{CuFeCN_6} + K_2SO_4$

False

(d) True

(e) True

(f) False, sulphates of V group radicals will be precipitated

(g) $I^- \xrightarrow{\text{conc. } H_2SO_4} I_2$ true

(h) False IInd group ferric salts are reduced as H_2S. Hence it is always necessary to use HNO_3 in IIIrd grp.

(i) True $3(CH_3COO^-)_2Ca + FeCl_3 \rightarrow 2Fe(CH_3COO)_3 + 3CaCl_2$

(j) K_2HgI_4 alkaline true

(k) True

(l) False Ni can be tested with dimethyl glyoxime as it forms a colored complex.

(m) Co^{2+} + KNO_3 + acetic acid $\rightarrow$ Yellow ppt.

$CoCl_2 + KNO_3 \rightarrow K_3[Co(NO_2)_6]$

Yellow

(n) $BaCO_3$, $SnCO_3$, $CaCO_3$ are soluble in acid to give corresponding sulphates or chloride. True

Sol 19: (a) $FeCl_3$ is a salt of weak base and a strong acid. It readily hydrolyses to form $Fe(OH)_3$

$FeCl_3 + 3H_2O \rightleftharpoons Fe(OH)_3 + 3HCl$

addition of HCl prevents hydrolysis

(b) $\underset{\text{yellow}}{FeCl_3} + H_2S \rightarrow \underset{\text{green}}{2FeCl_2} + 2HCl + S$

Due to the reduction of $FeCl_3$, the colour changes.

(c) $K_2Cr_2O_7$ + alkali $\rightarrow CrO_4^{2-} + H_2O$

the dichromate changes to yellow colored chromate.

(d) CO is evolved along with CO_2. CO_2 burns with blue flame while CO_2 prevents burning

$H_2C_2O_4 \xrightarrow{\Delta} H_2O + CO + CO_2$

CO diffuses faster than CO_2. Once CO burns with blue flame, it is put off by CO_2 which diffuse later.

(e) YAS possess excess free sulphur. It combines with group 2B sulphide which convert it and forms Sulphates from soluble complex will $(NH_4)_2S$

E.g: $SnS + S \rightarrow SnS_2$

$SnS_2 + (NH_4)_2S \rightarrow (NH_4)_2SnS_3$

(f) Reaction of $ZnCl_2$ with H_2S produces HCl which dissolve ZnS.

(g) $CaSO_4 \xrightarrow[(NH_4)_2]{\text{dissolves}}$ forming a stable complex

$CaSO_4 + (NH_4)_2 \rightarrow (NH_4)_2\,Ca(SO_4)_2$

(h) Presence of SO_4^{2-} brings preicipitation of group V ion such as Ca^{2+}, Ba^{2+} etc.

(i) Adding of conc. HNO_3 serves 2 purposes

(1) It precipitates the dissolved H_2S

(2) It convert $Fe^{2+} \rightarrow Fe^{3+}$ ions

(j) $Al(OH)_3$ and $Zn(OH)_2$ dissolve in NaOH

$Al(OH)_3 + NaOH \rightarrow \underset{\text{soluble}}{NaAlO_2} + 2H_2O$

$Zn(OH)_2 + 2NaOH \rightarrow \underset{\text{soluble}}{Na_2ZnO_2} + 2H_2O$

Sol 20: X (aq) $\xrightarrow{\Delta}$ Alkaline

A $\xrightarrow{\Delta}$ Swells to give glassy material

X $\xrightarrow{\text{Conc, } H_2SO_4}$ Crystals

X is an alkali metal salt and as it swells up to give a glassy mass, it may be borax.

$\therefore$ X is borax

$Na_2B_4O_7 + 7H_2O \rightarrow 2NaOH + 4H_3BO_3$

$Na_2B_4O_7 . 10H_2O \rightarrow Na_2B_4O_7 + 10H_2O$

$Na_2B_4O_7 \xrightarrow{\Delta} 2NaBO_2 + B_2O_3$

glassy mass

$Na_2B_4O_7 + H_2SO_4 + 5H_2O \rightarrow Na_2SO_4 + 4H_3BO_3$

weak acid

Sol 21: X(aq) $\rightarrow$ Red litmus blue

$\therefore$ X is basic

$X \xrightarrow[CuSO_4]{excess}$ Deep blue colour

$X + FeCl_3 \longrightarrow$ Brown ppt (Soluble in dil. HNO_3)

$\therefore$ X must be NH_3 as $X + CuSO_4 \rightarrow$ Deep blue solution

$CuSO_4 + 4NH_3 \rightarrow Cu(OH)_3 + 3NH_4Cl$

$3NH_3 + 3H_2O + FeCl_3 \rightarrow Fe(OH)_3 + 3NH_4Cl$

$Fe(OH)_3 + 3HNO_3 \rightarrow Fe(NO_3)_3 + H_2O$

Exercise 2

Single Correct Choice Type

Sol 1: (B) Sulphite + HCl $\rightarrow$ S (Suffocating)

Sol 2: (C) $CuNO_3$ + KI(Starch) $\rightarrow$ blue

Sol 3: (D) SO_3^- + dil $H_2SO_4 \rightarrow SO_2$

$\downarrow$

$K_2Cr_2O_7$

Green

Sol 4: (B) Oxalate $(C_2O_4^{2-}) \xrightarrow{\Delta}$ $CO + CO_2$

$\downarrow$

burns with blue flame

Sol 5: (C) $Hg_2Cl_2 + NH_4OH \rightarrow Hg + [HgNH_2Cl]$

$\downarrow$

Black

Sol 6: (B) Br_2 + KI $\rightarrow$ Blue

Sol 7: (B) X + dil. $H_2SO_4 \xrightarrow{\Delta}$ do not evolve brown vapour

X+conc. $H_2SO_4 \xrightarrow{\Delta}$ brown vapours

$\downarrow AgNO_3$

no ppt.

Brown vapours = NO_2

X $\rightarrow$ Nitrate NO_3^-

Sol 8: (B) $(NH_4)_2Cr_2O_7 \rightarrow Cr_2O_3$

Sol 9: (A) Only brown gas was Br_2

Sol 10: (D)

White solid + dil $H_2SO_4 \longrightarrow$ } No action observed

$\downarrow$ Conc. H_2SO_4, Δ } No action observed

Salt contains sulphate

Sol 11: (A) IInd group MS (is yellow)

When no radical of group II is present

$\because$ Phosphate is present in mix.

Sol 12: (C) $BiCl_3 + H_2O \rightarrow BiOCl$

Sol 13: (A) HgS is insoluble in dil. HNO_3

Sol 14: (B) NiS and ZnS are seperated by Conc. HCl

ZnS dissolved in dil HCl

Where $ZnS + 2HCl \rightarrow ZnCl_2 + H_2S$

NiS is insoluble in dil HCl.

Sol 15: (D) Heating Na_2CO_3 mix in distilled water.

Sol 16: (C) Dimethyl glyoxime + Ni $\rightarrow$ Red coloured complex ppt.

Sol 17: (A) NO_2 bleaches moist litmus paper.

Sol 18: (D) $\underset{\text{white}}{ZnO} \xrightarrow{\Delta} \underset{\text{yellow}}{ZnO}$

Sol 19: (D) White ppt + $NH_4OH \rightarrow$ black

Compound is Hg_2Cl_2

$Hg_2Cl_2 + NH_4OH \rightarrow Hg + \left[HgNH_2Cl\right]$

Sol 20: (B) $Al(OH)_3 + NaOH$ (excess) $\rightarrow Na[Al(OH)_4]$
Soluble complex

Sol 21: (A) HgS does not dissolve in hot dil. HNO_3.

Sol 22: (C) An aqueous solution of $FeSO_4Al_2(AO_4)_3$ and chrome alum is heated with excess of Na_2O_2 and filtered. The materials obtained are a yellow filtrate and a brown residue

Sol 23: (B) $NH_4^+(salt) + NaOH \xrightarrow{\Delta} NH_3$

Sol 24: (C) Green frame $\therefore$ Cation is Ba^{2+}

$BaCl_2 + 2Ag^+ \rightarrow \underset{\text{White}}{2AgCl} + Ba^{2+}$

Sol 25: (A) Bi and Sn both belong to IInd group. Both give precipitate.

Sol 26: (D) $H_2S + NH_4OH + X \rightarrow$ White ppt.

$ZnCl_2$

$\therefore$ X = Zinc salt

Sol 27: (D) Conc. of S^{2-} ion is covered by formation of weak acid H_2S.

Sol 28: (C) A white solid is first heated with dilute and when with concentrated. No action is observed in either case. The solid contains sulphate.

Sol 29: (C) Bead's test's salt is $Na(NH_4)HPO_4.4H_2O$

Sol 30: (B) To separate Fe from Zn and Cu, use excess NH_3

Sol 31:(B) Al and Fe can be separated by NaOH excess

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

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

Sol 32: (B) $K_4[Fe(CN)_6]$, Fe^{+3} ferricyanide

Sol 33: (C) $PbSO_4$ is water insoluble.

Sol 34: (B) $Ca + N_2 \rightarrow Ca_3N$

$Ca_3N + 6H_2O \rightarrow 3Ca(OH)_2 + NH_3$

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

$\therefore$ gas = NH_3 and solid = $CaCO_3$

Sol 35: (C) $X + H_2O \rightarrow$ Saturated solution

$X(ag) + AgNO_3 \rightarrow$ White ppt. AgCl

$X(ag) + Mg \rightarrow$ Colourless gas $MgCl_2$

$X = Cl_2$; $Y = H_2$

Previous Years' Questions

Sol 1: $Cl_2 + H_2O \longrightarrow \underset{\text{'X'}}{HCl + HOCl}$

$HCl + AgNO_3 \longrightarrow AgCl\downarrow$ (White) $+ HNO_3$

$2HCl + Mg \longrightarrow MgCl_2 + \underset{y}{H_2(g)\uparrow}$ Y

Sol 2: (A) $\underset{X}{SO_3^{2-}} + H_2SO_4 \longrightarrow \underset{Y}{SO_2}\uparrow + H_2O + SO_4^{2-}$

SO_2 is a colourless gas with irritating odour.

$SO_2 + K_2Cr_2O_7 + H_2SO_4 \longrightarrow K_2SO_4 + \underset{\text{Green solution}}{Cr_2(SO_4)_3} + H_2O$

Sol 3: (B) A sodium salt of an unknown anion when treated with MgCl gives white precipitate ($MgCO_3$) only on boiling. Hence, the action must be HCO_3^- ion.

$MgCl_2 + 2NaHCO_3 \xrightarrow{\Delta} MgCO_3 + 2NaCl + H_2O + CO_2$

Sol 4: (A) Both $(NH_4)_2Cr_2O_7$ and NH_4NO_2 on heating gives nitrogen gas.

Sol 5: (B) $Bi^{3+} + 3I^- \longrightarrow \underset{\text{Black}}{BiI_3}\downarrow \xrightarrow[\text{Excess}]{I^-} \underset{\text{Orange solution}}{[BiI_4]^-}$

Sol.6: (A) $Zn^{2+} + 2H_2O \longrightarrow \underset{\text{White}}{Zn(OH)_2}\downarrow + 2H^+$

Sol 7: (C) Cation Cd^{2+} belongs to group II white Ni^{2+} belongs to group I of analytical group. Group II radicals are precipitated by passing $H_2S(g)$ through acidic solution of salt but radicals of group III are precipitated by passing $H_2S(g)$ in NH_3/NH_4Cl buffer solution of salt due to greater solubility products of later salts.

Sol 8: (B) As $MgSO_4$ is soluble in water, so not used for estimation of SO_4^{2-} ion.

Sol 9: (C) Yellow filtrate contain CrO_5 and brown residue contain Fe_2O_3.

Sol 10: (C) Fe(II) and Fe(III) will have different values of magnetic moment due to different number of unpaired electrons in their d-orbitals.

Sol 11: (D) $PbCl_2$ is soluble in hot water and PbS (black) is formed on passing H_2S(g) through acidic solution.

JEE Advanced/Boards

Exercise 1

Sol 1: X (Lewis acid $\rightarrow$ fumes in moist air)

X + $NH_4OH \rightarrow$ fumes intensity increases

X (acidic) + NH_4Cl + $NH_4OH \rightarrow$ ppt $\rightarrow$ soluble in NaOH

X + $H_2S \rightarrow$ No ppt.

X is some chloride as its fumes increases in presence of NH_4OH

X + NH_4Cl + $NH_4OH \rightarrow$ ppt $\rightarrow$ soluble in NaOH

$\therefore$ X = $AlCl_3$ or $ZnCl_2$

But X is a Lewis acid $\therefore$ X = $AlCl_3$

Sol 2: A(aq) $\xrightarrow{NaCl}$ B (ppt) + O solution

C $\xrightarrow{H_2S}$ Black ppt

B $\xrightarrow{\text{hot water+Na } I_2}$ Yellow ppt.

A $\xrightarrow[\Delta]{\text{dil. HCl}}$ X no gas reddish brown gas

A = $Pb(NO_3)_2$

B = $PbCl_2$

Pb $\xrightarrow{H_2S}$ PbS (black)

Pb^{2+} + KI $\rightarrow$ PbI_2 yellow

Sol 3: Salt + MgO_2 $\xrightarrow{\text{Conc. } H_2SO_4}$ Yellow greenish gas

Mix + NaOH $\xrightarrow{\Delta}$ Red litmus blue

X (aq) $\rightarrow$ Blue ppt $K_4(Fe_3CN_3)$

and let NH_4CNS

Mix $\xrightarrow{K_2HgI_4}$ brown ppt.

The mixture contains Fe^{+2} and Fe^{+3} (from NH_4^+) (from test b and d) and Cl^- from test A.

$\therefore$ The reactions are Cl^- + MgO $\xrightarrow{\text{Conc, } H_2SO_4}$ Cl_2

$NH_4^+ + NaOH \xrightarrow{\Delta} NH_3$

$Fe^{+2} \rightarrow K_4FeCN_3$

$Fe^{+3} \rightarrow$ Blue ppt will be K_4FeCN_6

NH_3 $\xrightarrow{K_2HgI_4}$ Brown ppt.

Sol 4: X . nH_2O $\xrightarrow{\Delta}$ X + nH_2O

X(aq) $\xrightarrow{\text{with dil HCl}}$ White turns brown

KI + X $\rightarrow$ Decolourises

Ag NO_3 + X $\rightarrow$ White ppt

$\downarrow$ black or strong

X containing $S_2O_3^{2-}$ as it decolourises I^- which also coincides with the other 2 statement I and (II)

hence the compound is $Na_2S_2O_3$. $5H_2O$

$Na_2S_2O_3 . 5H_2O \xrightarrow{\Delta} Na_2S_2O_3 + 5H_2O\uparrow$

(i) $Na_2S_2O_3$ + 2HCl $\rightarrow$ 2NaCl + H_2O

+ SO_2 + S (Turbidity)

(ii) $2Na_2S_2O_3 + I_2 \rightarrow Na_2S_4O_6$ + 2NaI

(iii) $Na_2S_2O_3$ + $2AgNO_3 \rightarrow Ag_2S_2O_3\downarrow$ + $2NaNO_3$

White ppt.

$Ag_2S_2O_3$ + $H_2O \rightarrow Ag_2S\downarrow$ + H_2SO_4

Black

Sol 5: X + CH_3COO^- + KI $\rightarrow$ I_2

CO_2 + aq(X) $\rightarrow$ ppt.

X (H_2O) + ethyl alcohol $\rightarrow$

Product = Ester

X = $CaOCl_2$ bleaching powder

(i) $CaOCl_2$ + $CH_3COOH \rightarrow (CH_3COO)_2$ Ca + Cl_2 + H_2O

2KI + $Cl_2 \rightarrow$ 2KCl + I_2

(ii) $CaOCl_2$ + $CO_2 \rightarrow CaCO_3$ + Cl_2

(iii) $CaOCl_2$ + $H_2O \rightarrow Ca(OH)_2$ + Cl_2

$C_2H_5OH + Cl_2 \rightarrow CH_3CHO + 2HCl$

$CH_3CHO + 3Cl_2 \rightarrow CCl_3CHO + 3HCl$

$CCl_3CHO + 2Ca(OH)_2 \rightarrow CHCl_3 + (HCOO)_2Ca$

Sol 6: A = SO_2

SO_2 + dil. H_2SO_4 + $K_2Cr_2O_7 \rightarrow K_2SO_4 + Cr_2(SO_4)_3$

SO_2 + dil. H_2SO_4 + $KMnO_4 \rightarrow MnSO_4$

$SO_2 + O_2 \rightarrow H_2SO_4$

$H_2SO_4 + BaCl_2 \rightarrow BaSO_4$

A = SO_2

B = $Cr_2(SO_4)_3$

C = $KMnO_4$

D = H_2SO_4

Sol 7: (i)A(aq) + Zn $\xrightarrow{\text{heat}}$ B

A(aq) + C $\xrightarrow{\text{heat}}$ PH_3

A(aq) + $NH_4Cl \rightarrow$ (D) gas

(ii) A = NaOH/KOH C = P_4

B = H_2 D = NH_3

CO : CoS

↓ ↓

A + H_2S $\xrightarrow{NH_4OH}$ B (black)

B CoS + HCl + $KClO_3 \rightarrow A(CoCl_2)$

$\underset{(COCl_2)}{A}$ + KCN buff coloured ppt.

A

↓ Excess reagent

$\underset{Co(CN)_6}{C}$

$\underset{COCl_2}{A}$ (aq) $\xrightarrow{\Delta}$ B

A + $NaHCO_3$ (excess) $\rightarrow \xrightarrow[H_2O]{Br_2}$

A = $CoCl_2$

B = CoS

C = $K_4[Co(CN)_6]$

E = $2Na_3Co(CO_3)_3$ Green

$CoCl_2 + H_2S + NH_4OH \rightarrow$ CoS (black)

$CoS + HCl + KClO_3 \rightarrow CoCl_2$

$CoCl_2 + KCN \rightarrow K_3[Co(CN)_6]$

$CoCl_2 + NaHCO_3 \rightarrow Na_4Co(CO_3)_3 + H_2O + 3CO_2$

$Br_2 + H_2O \rightarrow HBr + O$

$2Na_4Co(CO_3)_3 + H_2O + O \rightarrow 2Na_3Co(CO_3)_3 + NaOH$

sod. cobalt carbonate (green)

Sol 8: A + H_2O $\xrightarrow{\Delta}$ White ppt. (B)

A + conc. HCl $\rightarrow$ Clear solution

↓ Excess H_2O

B precipitate

A/B $\xrightarrow{H_2S}$ Brown / Black ppt. (C)

A + $H_2SO_4 \rightarrow$ D

D + Hg^+(Salt) $\rightarrow$ White E

$\therefore$ D = Cl_2, E = Hg_2Cl_2

A = $BiCl_3$, B = BiOCl, C = BiS

D = HCl, E = Hg_2Cl_2

$BiCl_3 + H_2O \rightarrow Bi(OH)_3 + 2HCl$

$Bi(OH)_3$ + HCl $\rightarrow$ Clear $BiCl_3$

$BiCl_3 + H_2O$ (Excess) $\rightarrow$ BiOCl

$BiCl_3 + H_2S \rightarrow$ BiS (Brownish black)

D = HCl and E = Hg_2Cl_2

Sol 9: A = NH_4Cl

B = NH_4HCO_3

C = $NaHCO_3$

$NH_4CO_3 + NaCl \rightarrow NaHCO_3 + NH_4Cl$

$NaHCO_3 \xrightarrow{\Delta} Na_2CO_3 + H_2O + CO_2$

D = CO_2.

Sol 10: A + $N_2 \rightarrow$ B

B = $H_2O \rightarrow$ C + D

C + $CO_2 \rightarrow$ Milky sol^n

$\therefore$ C = $Ca(OH)_2$

A = Ca

B = Ca_3N_2

C = $Ca(OH)_2$

D = NH_3

Sol 11: A(aq) + NaOH → White ppt

↓ Excess NaOH

Dissolves

$A(aq) + NH_4OH \rightarrow$ White ppt

↓ Excess NH_4OH

Dissolves

$AgNO_3 + A \rightarrow$ Yellow ppt.

$\xrightarrow{\text{dil } HNO_3}$ Solution

$\therefore A = AlBr_3$.

Sol 12: A(acidic) → Sublimes at 300°C

$A + \underset{\text{Excess}}{NH_4SNC} \rightarrow \underset{\text{Red compound}}{B}$

$A + K_4FeCN_6 \rightarrow$ Blue compound

$(C) = Fe_4(Fe(CN)_6)_3$

$\therefore A = Fe$

$A + K_2Cr_2O_7 + \text{conc. } H_2SO_4 \rightarrow D$

(Deep red vapour) $2CrO_2Cl_2$

$\therefore Cl$

$D + NaOH + CH_3COOH +$

$Pb(CH_3COO)_2$ ↓ E

Yellow

$\therefore A = FeCl_3$ $B = Fe(SCN)_3$

$C = Fe_4[Fe(CN)_6]_3$ $D = CrO_2Cl$

$E = PbCrO_4$

$\therefore$ Reactions are

$FeCl_3 + NH_4SNC \rightarrow Fe(SCN)_3$

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

$FeCl_3 + K_2Cr_2O_7 + H_2SO_4 \rightarrow 2CrO_2Cl_2 + Fe_2(SO_4)_3$

$CrO_2Cl_2 + NaOH + CH_3COOH + Pb(CH_3COO)_2 \rightarrow PbCrO_4 + CH_3COONa$

Sol 13: $R + K_2Cr_2O_7 \rightarrow$ Decolourises

$X + H_2O_2 \rightarrow +$ Aq. $BaCl_2 \rightarrow$ A ppt

↓ Soluble in dil HCl

$H_2 + X \rightarrow$ Turbidity

According to the reaction $X = SO_2$

$K_2Cr_2O_7 + 4H_2SO_4 \rightarrow K_2SO_4 + Cr_2(SO_4)_3 + 4H_2O + 3O$

$H_2O + SO_2 + O \rightarrow H_2SO_4$

$H_2O_2 + SO_2 \rightarrow H_2SO_4$

$H_2SO_4 + BaCl_2 \rightarrow BaSO_4 + 2HCl$

$H_2S + SO_2 \rightarrow 3S\downarrow + 2H_2O$

Sol 14: Refer theory.

Sol 15: $A \xrightarrow{\Delta} B + C$

$B + H_2 \rightarrow D$ (Metal)

$[B + HCl + K_4Fe(CN)_6] \rightarrow \underset{(E)}{\text{Chocolate ppt.}}$

$C + Ca(OH)_2 \rightarrow$ Milkiness $\xrightarrow[\text{excess C}]{}$ Clear solution (F)

$E = Cu_2[Fe(CN)_6]$

$\therefore$ A is a copper compound

$C = CO_2/SO_2$

$F = CaHCO_3/Ca$

$A = CuSO_4$

$B = SO_2 + CuO$

$CuSO_4 \rightarrow 2CuO + SO_2$

$CuO + H_2 \rightarrow Cu$

$CuO + K_4Fe(CN)_6 = Cu_2[Fe(CN)_6]$

$SO_2 + Ca(OH)_2 \rightarrow CaSO_4 \rightarrow CaS_2O_3$

Sol 16: B + conc. liquor + NaS + $NaSO_2 \rightarrow A$

A + Dil $AgNO_3 \rightarrow$ White ppt. → C (Black)

$FeCl_3 + A \rightarrow$ Violet coloured D (Disappear)

$A + CuCl_2 \rightarrow$ White ppt. ↓ Excess

E

A contains $S_2O_3^{2-}$ ion from (ii) and A = $Na_2S_2O_3$

SO_2 + conc. EtOH + NaS + $NaSO_2 \rightarrow Na_2S_2O_3$

$Na_2S_2O_3$ + dil $AgNO_3 \rightarrow Ag_2S_2O_3$

White ppt.

↓

AgS (Black)

$FeCl_3 + 3Na_2S_2O_3 \rightarrow Fe_2(S_2O_3)_3 + 3NaCl$

Violet

$CuCl_2 + Na_2S_2O_3 \rightarrow NH_4[Cu_6(S_2O_3)_5]$

Sol 17: MCl

MCl + H_2S (acidified) → black ppt

(not soluble in YAS)

∴ MS is group IIA

$SnCl_2$+X → White ppt. $\xrightarrow[\text{Excess}]{SnCl_2}$ Grey

KI + X → Red ppt. $\xrightarrow[KI]{\text{Excess}}$ Dissolve

Acc. To these facts, X = $HgCl_2$

$HgCl_2 + H_2S \xrightarrow{H^+} \underset{\text{Black}}{HgS} + 2HCl$

$2HgCl_2 + SnCl_2 \rightarrow \underset{\text{White}}{Hg_2Cl_2} + SnCl_4$

$HgCl_2 + SnCl_2 \rightarrow \underset{\text{Grey}}{Hg}\downarrow + SnCl_4$

$HgCl_2 + 2KI \rightarrow \underset{\text{Red}}{HgI_2} + 2KCl$

$Hg\ I_2 + 2KI \rightarrow K_2HgI_4$

Sol 18: A $\xrightarrow{\Delta}$ Violet colour flame

∴ A contains Cr

A + B + conc. $H_2SO_4 \rightarrow$ C (Red gas)

C + alk $H_2SO_4 \rightarrow$ Red yellow solution D

D + $CH_3COOH \rightarrow$ Yellow ppt.

B + NaOH → F (fumes)

∴ F = NH_3

B = NH_4Cl

C = CrO_2Cl_2

D = Na_2CrO_4

E = $PbCrO_4$

A = $K_2Cr_2O_7$

Sol 19: (i) Au + HCl + $HNO_3 \rightarrow HAuCl_4 + 3NO_2 + 3H_2O$

(ii) C + 4HNO_3 (conc) → CO + $4NO_2$ + $2H_2O$

(iii) Sn + 2KOH (hot) + $H_2O \rightarrow K_2SnO_3 + 2H_2$

(iv) $Cu(OH)_2 + 2NH_4NO_3 + 2NH_4OH \rightarrow Cu(NH_3)_4(NO_3)_2 + 4H_2O$

Sol 20: $K_2Cr_2O_7$ + (Mix) → X absorbed solution

green solution

(Y + Z) + Ca(OH) → Milky

(Z) Alkali pyragallol → Black

∴ Z = O_2, Y = CO_2 X = SO_2

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

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

(iii) O_2 + Pyragallol → Absorbed

Exercise 2

Single Correct Choice Type

Sol 1: (A) Theoretical : HgS does not dissolve in hot dil. HNO_3.

Sol 2: (C) $FeSO_4$. $Al_2(SO_4)$ and chrome alum + Na_2SO_3 $\xrightarrow{\Delta}$ (C) a yellow filtrate and brown residue.

Sol 3: (C) $MgCO_3$ is soluble in NH_4Cl forming $MgCl_2$.

Sol 4: (D) Excess of splitting ∝ oxidation state.

Assertion Reasoning Type

Sol 5: (C) Yellow colour of compound is not due to NH_4^+ ion (as NH_4^+ ion does not impart colour to its molecules).

Sol 6: (A) (A) Both statements are true.

Sol 7: (D) both statements are false as NaOH will react with salt and not form ether hydroxide.

Sol 8: (C) Charcoal cavity test can only be used for non coloured salt,.

Sol 9: (C) All S containing molecules give match state test.

Sol 10: (B) Both Statement true but reason does not explain assertion.

Comprehension Type

Sol 11-14: (D, B, C, D)

(a) $Na_2CrO_4 + CO_2 \rightarrow Na_2Cr_2O_7$

(b) Zn + acidic $Na_2Cr_2O_7 \rightarrow$ Green Cr_2O_3

Orange

Burn ↓ Green

CO_2 acts to make the solution acidic

$H_2O + CO_2 \rightarrow H_2CO_3$

Zn is the reducing agent

Cr^{+6} to Cr^{+3}

Cr^{+3} to Cr^{+2} (blue in colour)

Previous Years' Questions

Sol 1: (A) $MgSO_4 + NH_4OH + Na_2HPO_4 \longrightarrow \underset{\text{white}}{Mg(NH_4)PO_4\downarrow} + Na_2SO_4 + H_2O$

Sol 2: (B) $Hg^{2+} + 2I^- \longrightarrow HgI_2$ (red)

$HgI_2 + 2KI \longrightarrow \underset{\text{soluble}}{K_2[HgI_4]}$

$Hg^{2+} + Co(SCN)_2 \longrightarrow \underset{\text{blue}}{Co[Hg(SCN)_4]}$

Sol 3: (A) In acidic medium, H_2S is very feebly ionized giving very small concentration of sulphide ion for precipitation. Therefore, the most insoluble salts CuS and HgS are precipitated only.

Sol 4: (B, C) Both Al^{3+} and Bi^{3+} are precipitated as their hydroxides.

Sol 5: (B, C) The blue precipitate of Fe^{2+} ion with potassium ferricyanide is due to formation of Turnbull's blue $KFe[Fe(CN)_6]$.

$Fe^{2+} + K_3[Fe(CN)_6] \longrightarrow KFe[Fe(CN)_6] + 2K^+$

The red colour of Fe^{3+} ion with potassium thiocyanate is due to formation of $[Fe(SCN)_3]$.

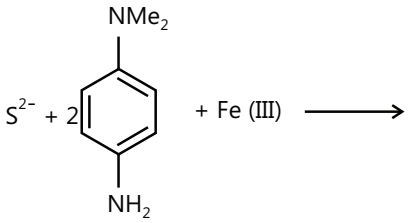
$Fe^{3+} + 3KSCN \longrightarrow \underset{\text{red coloured}}{[Fe(SCN)_3]} + 3K^+$

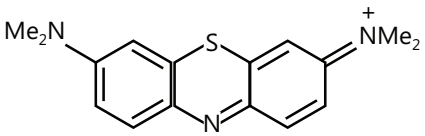
Sol 6: (A, B) $NH_4NO_3 + NaOH \longrightarrow NaNO_3 + NH_3 + H_2O$

$NH_4NO_2 + NaOH \longrightarrow NaNO_2 + NH_3 + H_2O$

Sol 7: (D) **Sol 8: (C)** **Sol 9: (B)**

The comprehension describing methylene-blue test.





Blue solution

Therefore,

1. X is Na_2S
2. Y is $FeCl_3$
3. Compound Z is $Fe[Fe(CN)_6]$

Sol 10: (a) $Fe^{3+} + 3SCN^- \longrightarrow \underset{A}{[Fe(SCN)_3]}$ (blood red colouration)

$Fe(SCN)_3 + F^- \text{(excess)} \longrightarrow \underset{B}{[FeF_6]^{3-}} + 3SCN^-$

(b) Magnetic moment (μ_s) = $\sqrt{n(n+2)}$ BM

= $\sqrt{3S}$ BM

= 5.92 BM

Sol 11: $\underset{\text{colourless}}{MCl_4} \xrightarrow{Zn}$ Purple coloured compound (A)

$\underset{\text{tr. metal}}{M} \xrightarrow[\text{air}]{\text{moist}} B$ (white fumes)

$\Rightarrow$ M = Ti, A=$[Ti(H_2O)_6]^{3+}$; B = TiO_2

Ti (IV) contains no d-electron, while d-d transition of single electron of Ti (III) will cause colour change.

Sol 12: (A) $Pb^{+2} + 2HCl \rightarrow PbCl_2 \xrightarrow[Water]{Hot} Soluble$

Sol 13: (D)

$Pb^{+2} + 2HCI \rightarrow PbCI_2 \xrightarrow[Water]{Hot} Soluble$

$Cr^{+3} \xrightarrow[Ammxmiacal]{H_2S} Cr(OH)_3 \downarrow$

$Cr(OH)_3 \xrightarrow[H_2O_3]{NaOH} \underset{Yellow\ solution}{Na_2CrO_4}$

Sol 14: (A, C) (A) $CuCI_2 + S^{-2} \rightarrow \underset{Black\,ppt}{CuS} \downarrow + 2CI^-$

$CuCI_2 + SO_4^{2-} \rightarrow No.\ ppt$

(B) $BaCI_2 + S^{-2} \rightarrow \underset{No.ppt}{BaS} + 2CI^-$

$BaCI_2 + SO_4^{-2} \rightarrow \underset{White\ ppt}{BaSO_4} \downarrow 2CI^-$

(C) $Pb(OAc)_2\, SO^{-2} \rightarrow \underset{(Black\ ppt)}{PbS \downarrow} + 2CH_3 - COO^-$

$Pb(OAc)_2 + S^{-2} \rightarrow \underset{Black\ ppt}{PbSO_4} \downarrow + 2CH_3 - COO^-$

PbS can be selective ppt out first as K_{sp} s much less than K_{sp} of $PbSO_4$

K_{sp} of $PBS = 3 \times 10^{-28}$

K_{sp} of $PbSO_4 = 25 \times 10^{-8}$

(D) $Na_2\left[Fe(CN)_5 NO\right] + S^{-2} \rightarrow \underset{Purple\ Colour}{\left[Fe(CN)_5 NOS\right]}$

$Na_2\left[Fe(CN)_5 NO\right] + SO_4^{2-} \rightarrow No.\ ppt$

Sol 15: (A)

$S_2O^{2-}_3 \xrightarrow{Ag^+} \underset{(X)}{\left[Ag(S_2O_3)_2\right]^{3-}}$

$\xrightarrow{Ag^+} \underset{(Y)}{Ag_2S_2O_3} \rightarrow \underset{(Z)}{Ag_2S}(Black\ \ ppt)$