Chapter 20

Principles of Qualitative Analaysis

1. Which of the following compounds is not colored yellow? **[JEE (Main)-2015]**

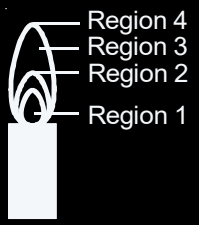
   (1) $Zn_2[Fe(CN)_6]$

   (2) $K_3[Co(NO_2)_6]$

   (3) $(NH_4)_3[As\ (Mo_3O_{10})_4]$

   (4) $BaCrO_4$

2. The hottest region of Bunsen flame shown in the figure below is **[JEE (Main)-2016]**



   (1) Region 2 (2) Region 3

   (3) Region 4 (4) Region 1

3. Sodium salt of an organic acid 'X' produces effervescence with conc. H_2SO_4. 'X' reacts with the acidified aqueous $CaCl_2$ solution to give a white precipitate which decolourises acidic solution of $KMnO_4$. 'X' is **[JEE (Main)-2017]**

   (1) CH_3COONa

   (2) $Na_2C_2O_4$

   (3) C_6H_5COONa

   (4) HCOONa

4. Hydrogen peroxide oxidises $[Fe(CN)_6]^{4-}$ to $[Fe(CN)_6]^{3-}$ in acidic medium but reduces $[Fe(CN)_6]^{3-}$ to $[Fe(CN)_6]^{4-}$ in alkaline medium. The other products formed are, respectively.

   [JEE (Main)-2018]

   (1) $(H_2O + O_2)$ and H_2O

   (2) $(H_2O + O_2)$ and $(H_2O + OH^-)$

   (3) H_2O and $(H_2O + O_2)$

   (4) H_2O and $(H_2O + OH^-)$

5. When metal 'M' is treated with NaOH, a white gelatinous precipitate 'X' is obtained, which is soluble in excess of NaOH. Compound 'X' when heated strongly gives an oxide which is used in chromatography as an adsorbent. The metal 'M' is **[JEE (Main)-2018]**

   (1) Zn (2) Ca

   (3) Al (4) Fe

6. An organic compound 'A' is oxidized with Na_2O_2 followed by boiling with HNO_3. The resultant solution is then treated with ammonium molybdate to yield a yellow precipitate

   Based on above observation, the element present in the given compound is : **[JEE (Main)-2019]**

   (1) Fluorine

   (2) Nitrogen

   (3) Phosphorus

   (4) Sulphur

7. Thermal decomposition of a Mn compound (X) at 513 K results in compound Y, MnO_2 and a gaseous product. MnO_2 reacts with NaCl and concentrated H_2SO_4 to give a pungent gas Z. X, Y and Z respectively are: **[JEE (Main)-2019]**

   (1) K_2MnO_4, $KMnO_4$ and Cl_2

   (2) K_3MnO_4, K_2MnO_4 and Cl_2

   (3) K_2MnO_4, $KMnO_4$ and SO_2

   (4) $KMnO_4$, K_2MnO_4 and Cl_2

8. A metal (A) on heating in nitrogen gas gives compound B. B on treatment with H_2O gives a colourless gas which when passed through $CuSO_4$ solution gives a dark blue-violet coloured solution. A and B respectively, are **[JEE (Main)-2020]**

   (1) Mg and Mg_3N_2

   (2) Na and Na_3N

   (3) Mg and $Mg(NO_3)_2$

   (4) Na and $NaNO_3$

9. Reaction of an inorganic sulphite X with dilute H_2SO_4 generates compound Y. Reaction of Y with NaOH gives X. Further, the reaction of X with Y and water affords compound Z. Y and Z, respectively, are

[JEE (Main)-2020]

(1) S and Na_2SO_3 (2) SO_2 and $NaHSO_3$

(3) SO_2 and Na_2SO_3 (4) SO_3 and $NaHSO_3$

10. On treating a compound with warm dil. H_2SO_4, gas X is evolved which turns $K_2Cr_2O_7$ paper acidified with dil. H_2SO_4 to a green compound Y. X and Y respectively are : **[JEE (Main)-2021]**

(1) X = SO_3, Y = Cr_2O_3

(2) X = SO_3, Y = $Cr_2(SO_4)_3$

(3) X = SO_2, Y = $Cr_2(SO_4)_3$

(4) X = SO_2, Y = Cr_2O_3

11. Reagent, 1-naphthylamine and sulphanilic acid in acetic acid is used for the detection of

[JEE (Main)-2021]

(1) NO_3^- (2) N_2O

(3) NO_2^- (4) NO

12. An inorganic Compound 'X' on treatment with concentrated H_2SO_4 produces brown fumes and gives dark brown ring with $FeSO_4$ in presence of concentrated H_2SO_4. Also Compound 'X' gives precipitate 'Y', when its solution in dilute HCl is treated with H_2S gas. The precipitate 'Y' on treatment with concentrated HNO_3 followed by excess of NH_4OH further gives deep blue coloured solution, Compound 'X' is **[JEE (Main)-2021]**

(1) $Cu(NO_3)_2$ (2) $Pb(NO_2)_2$

(3) $Pb(NO_3)_2$ (4) $Co(NO_3)_2$

13. To an aqueous solution containing ions such as Al^{3+}, Zn^{2+}, Ca^{2+}, Fe^{3+}, Ni^{2+}, Ba^{2+} and Cu^{2+} was added conc. HCl, followed by H_2S.

The total number of cations precipitated during this reaction is/are : **[JEE (Main)-2021]**

(1) 2 (2) 1

(3) 3 (4) 4

14. What are the products formed in sequence when excess of CO_2 is passed in slaked lime?

[JEE (Main)-2021]

(1) CaO, $CaCO_3$ (2) $CaCO_3$, $Ca(HCO_3)_2$

(3) $Ca(HCO_3)_2$, $CaCO_3$ (4) CaO, $Ca(HCO_3)_2$

15. Which one of the following complexes is violet in colour? **[JEE (Main)-2021]**

(1) $[Fe(SCN)_6]^{4-}$ (2) $[Fe(CN)_5NOS]^{4-}$

(3) $[Fe(CN)_6]^{4-}$ (4) $Fe_4[Fe(CN)_6]_3 \cdot H_2O$

16. Consider the sulphides HgS, PbS, CuS, Sb_2S_3, As_2S_3 and CdS. Number of these sulphides soluble in 50% HNO_3 is_____. **[JEE (Main)-2021]**

17. Match List-I with List-II.

List-I (Metal Ion)	**List-II (Group in Qualitative analysis)**
(a) Mn^{2+}	(i) Group-III
(b) As^{3+}	(ii) Group-IIA
(c) Cu^{2+}	(iii) Group-IV
(d) Al^{3+}	(iv) Group-IIB

Choose the most appropriate answer from the options given below **[JEE (Main)-2021]**

(1) (a)-(iv), (b)-(ii), (c)-(iii), (d)-(i)

(2) (a)-(iii), (b)-(iv), (c)-(ii), (d)-(i)

(3) (a)-(i), (b)-(iv), (c)-(ii), (d)-(iii)

(4) (a)-(i), (b)-(ii), (c)-(iii), (d)-(iv)

18. The potassium ferrocyanide solution gives a Prussian blue colour, when added to :

[JEE (Main)-2021]

(1) $CoCl_3$ (2) $CoCl_2$

(3) $FeCl_2$ (4) $FeCl_3$

19. Given below are two statements:

Statement-I : Colourless cupric metaborate is reduced to cuprous metaborate in a luminous flame.

Statement-II : Cuprous metaborate is obtained by heating boric anhydride and copper sulphate in a non-luminous flame.

In the light of the above statements, choose the most appropriate answer from the options given below. **[JEE (Main)-2021]**

(1) Statement I is false but statement II is true

(2) Both statement I and statement II are true

(3) Both statement I and statement II are false

(4) Statement I is true but statement II is false

20. During the qualitative analysis of salt with cation y^{2+}, addition of a reagent (X) to alkaline solution of the salt gives a bright red precipitate. The reagent (X) and the cation (y^{2+}) present respectively are:

[JEE (Main)-2022]

(1) Dimethylglyoxime and Ni^{2+}
(2) Dimethylglyoxime and Co^{2+}
(3) Nessler's reagent and Hg^{2+}
(4) Nessler's reagent and Ni^{2+}

21. Which statement is **not** true with respect to nitrate ion test? **[JEE (Main)-2022]**

(1) A dark brown ring is formed at the junction of two solutions.
(2) Ring is formed due to nitroferrous sulphate complex.
(3) The brown complex is $[Fe(H_2O)_5(NO)]SO_4$.
(4) Heating the nitrate salt with conc. H_2SO_4, light brown fumes are evolved.

22. The number of statement(s) **correct** from the following for Copper (at. no. 29) is/are _____.

[JEE (Main)-2022]

(A) Cu(II) complexes are always paramagnetic
(B) Cu(I) complexes are generally colourless
(C) Cu(I) is easily oxidized
(D) In Fehling solution, the active reagent has Cu(I)

23. Match **List I** with **List II**.

List I (Anion)	**List II (gas evolved on reaction with dil H_2SO_4)**
A. CO_3^{2-}	I. Colourless gas which turns lead acetate paper black.
B. S^{2-}	II. Colourless gas which turns acidified potassium dichromate solution green
C. SO_3^{2-}	III. Brown fumes which turns acidified KI solution containing starch blue.
D. NO_2^-	IV. Colourless gas evolved with brisk effervescence, which turns lime water milky.

Choose the correct answer from the options given below:

[JEE (Main)-2022]

(1) A-III, B-I, C-II, D-IV (2) A-II, B-I, C-IV, D-III
(3) A-IV, B-I, C-III, D-II (4) A-IV, B-I, C-II, D-III

24. A white precipitate was formed when $BaCl_2$ was added to water extract of an inorganic salt. Further, a gas 'X' with characteristic odour was released when the formed white precipitate was dissolved in dilute HCl. The anion present in the inorganic salt is **[JEE (Main)-2022]**

(1) I^- (2) SO_3^{2-}
(3) S^{2-} (4) NO_2^-

25. Fe^{3+} cation gives a Prussian blue precipitate on addition of potassium ferrocyanide solution due to the formation of: **[JEE (Main)-2022]**

(1) $[Fe(H_2O)_6]_2[Fe(CN)_6]$
(2) $Fe_2[Fe(CN)_6]_2$
(3) $Fe_3[Fe(OH)_2(CN)_4]_2$
(4) $Fe_4[Fe(CN)_6]_3$

26. When borax is heated with CoO on a platinum loop, blue coloured bead formed is largely due to

[JEE (Main)-2022]

(1) B_2O_3 (2) $Co(BO_2)_2$
(3) CoB_4O_7 (4) $Co[B_4O_5(OH)_4]$

27. White precipitate of AgCl dissolves in aqueous ammonia solution due to formation of:

[JEE (Main)-2022]

(1) $[Ag(NH_3)_4]Cl_2$ (2) $[Ag(Cl)_2(NH_3)_2]$
(3) $[Ag(NH_3)_2]Cl$ (4) $[Ag(NH_3)Cl]Cl$

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Chapter 20

Principles of Qualitative Analaysis

1. Answer (1)

$(NH_4)_3[As(Mo_3O_{10})_4]$, $BaCrO_4$ and $K_3[Co(NO_2)_6]$ are yellow colored compounds but $Zn_2[Fe(CN)_6]$ is not yellow colored compound.

2. Answer (1)

Region "2" is the hottest region of Bunsen flame.

3. Answer (2)

$$\underset{(X)}{Na_2C_2O_4} + \underset{\text{Conc.}}{H_2SO_4} \longrightarrow Na_2SO_4 + \underset{\text{oxalic acid}}{H_2C_2O_4}$$

$$H_2C_2O_4 \xrightarrow[\substack{\Delta \\ -H_2O}]{\text{Conc. } H_2SO_4} \underbrace{CO\uparrow + CO_2\uparrow}_{\text{(effervescence)}}$$

$$\underset{(X)}{Na_2C_2O_4} + CaCl_2 \longrightarrow \underset{\text{white ppt.}}{CaC_2O_4}\downarrow + 2NaCl$$

$$2MnO_4^- + 5C_2O_4^{2-} + 16H^+ \rightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$$

4. Answer (3)

$$[Fe(CN)_6]^{4-} + \frac{1}{2}H_2O_2 + H^+ \longrightarrow [Fe(CN)_6]^{3-} + H_2O$$

$$[Fe(CN)_6]^{3-} + \frac{1}{2}H_2O_2 + OH^{\ominus} \longrightarrow [Fe(CN)_6]^{4-} + H_2O + \frac{1}{2}O_2$$

5. Answer (3)

$$Al^{3+} \xrightarrow{NaOH} \underset{\text{White gelatinous ppt.}}{Al(OH)_3}\downarrow \xrightarrow[NaOH]{\text{Excess}} \underset{\substack{\text{Sodium meta}\\ \text{aluminate}\\ \text{(soluble)}}}{NaAlO_2}$$

$$2Al(OH)_3 \xrightarrow{\text{Strong heating}} Al_2O_3 + 3H_2O$$

Al_2O_3 is used in column chromatography.

6. Answer (3)

Phosphorus is detected in the form of canary yellow ppt on reaction with ammonium molybdate.

7. Answer (4)

$$\underset{(X)}{2KMnO_4} \xrightarrow{513K} \underset{(Y)}{K_2MnO_4} + MnO_2 + \underset{\text{gas}}{O_2}$$

$$MnO_2 + 4NaCl + 4\underset{\text{Conc.}}{H_2SO_4} \longrightarrow MnCl_2 + 4NaHSO_4 + \underset{\substack{(Z)\\ \text{pungent gas}}}{Cl_2} + 2H_2O$$

8. Answer (1)

$$\underset{(A)}{3Mg} + N_2 \xrightarrow{\Delta} \underset{(B)}{Mg_3N_2} \xrightarrow{H_2O} \underset{\text{(Colourless gas)}}{2NH_3} + 3Mg(OH)_2$$

$$\downarrow \frac{1}{2}CuSO_4$$

$$\frac{1}{2}[Cu(NH_3)_4]SO_4$$

dark blue coloured

9. Answer (2)

$X = Na_2SO_3$

$$\underset{(X)}{SO_3^{2-}} + H_2SO_4 \rightarrow [H_2SO_3] \rightarrow H_2O + \underset{(Y)}{SO_2}$$

$$SO_2 + 2NaOH \rightarrow \underset{(X)}{Na_2SO_3} + H_2O$$

$$Na_2SO_3 + SO_2 + H_2O \rightarrow 2NaHSO_3$$

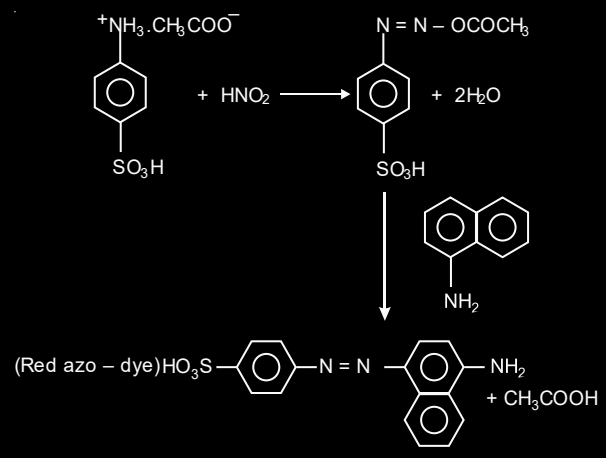
10. Answer (3)

$$SO_2 + K_2Cr_2O_7 + \text{dil. } H_2SO_4 \rightarrow SO_3 + \underset{\text{(green)}}{Cr_2(SO_4)_3}$$

11. Answer (3)

1-naphthyl amine and sulphanilic acid in acetic acid is used for the detection of NO_2^-

$$NO_2^- + CH_3COOH \longrightarrow HNO_2 + CH_3COO^-$$



12. Answer (1)

$$Cu(NO_3)_2 \xrightarrow{H_2SO_4} NO_2\uparrow$$
(X)

$$\xrightarrow[\text{conc. } H_2SO_4]{FeSO_4} [Fe(H_2O)_5NO]^{2+}$$

$$Cu(NO_3)_2 \xrightarrow[H_2S]{\text{dil. HCl}} CuS$$
(X) (Y)

$$CuS \xrightarrow{HNO_3} Cu(NO_3)_2 + S + NO\uparrow + H_2O$$
(Y)

$$Cu(NO_3)_2 \xrightarrow{NH_4OH} [Cu(NH_3)_4]^{2+}$$
Deep blue coloured solution

13. Answer (2)

Only group I and group II cations will get precipitated.

$\therefore$ Only Cu^{2+} gets precipitated here.

14. Answer (2)

$$CO_2 + \underset{\text{(slaked lime)}}{Ca(OH)_2} \rightarrow CaCO_3\downarrow$$

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

15. Answer (2)

$[Fe(CN)_6]^{4-}$ – Pale yellow

$[Fe(CN)_6]^{3-}$ – Yellow

$Fe(SCN)_3$ – Red colouration

$[Fe(CN)_5(NOS)]^{4-}$ – Violet colour

16. Answer (4)

Except HgS and Sb_2S_3 rest of the compounds are soluble in 50% HNO_3

17. Answer (2)

Metal ion	Group in qualitative analysis
Mn^{2+}	Group-IV
As^{3+}	Group-IIB
Cu^{2+}	Group-IIA
Al^{3+}	Group-III

18. Answer (4)

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

19. Answer (3)

Statement-I : Cupric metaborate is blue in colour

Hence statement-I is false

Statement-II : $CuSO_4 + B_2O_3 \rightarrow Cu(BO_2)_2$

cupric metaborate is obtained instead of cuprous metaborate.

Hence statement-II is false

20. Answer (1)

On addition of dimethylglyoxime to alkaline solution of Ni^{+2}, a bright red ppt. is obtained.

$Ni^{+2} + 2dmg \rightarrow [Ni(dmg)_2]^{+2}$ (Bright red ppt)

21. Answer (2)

Brown ring test

$$NO_3^- + 3Fe^{+2} + 4H^+ \rightarrow NO + 3Fe^{+3} + 2H_2O$$

$$[Fe(H_2O)_6]^{2+} NO \rightarrow \underset{\text{Brown ring}}{[Fe(H_2O)_5NO]^{2+}} H_2O$$

22. Answer (3)

(A) Cu(II) complexes are always paramagnetic as they have one unpaired electron due to d^9 configuration of Cu(II)

(B) Cu(I) complexes are generally colourless due to d^{10} configuration.

(C) Cu(I) is easily oxidised to Cu^{+2} in aqueous solution

$2Cu^+ \rightarrow Cu^{+2} + Cu$

Cu^{+1} disproportionates to Cu^{+2} and Cu

($E^{\circ}_{cell} > 0$ for this cell reaction in aqueous solution)

In Fehling's solution, active reagent has Cu(II) which is reduced to Cu(I) on reaction with aldehydes.

Hence (D) statement is incorrect

23. Answer (4)

CO_3^{2-} : On action of dil sulphuric acid, CO_2 gas is released which turns lime water milky.

S^{2-} : On action of dil sulphuric acid, H_2S gas is released which turns lead acetate paper black.

SO_3^{2-} : On action of dil H_2SO_4, SO_2 gas is evolved which turns acidified potassium dichromate solution green.

NO_2^- : On action of dil H_2SO_4, NO_2 gas is evolved which turns KI solution containg starch blue.

24. Answer (2)

Anion is SO_3^{-2}

$$BaSO_3 \xrightarrow{\text{dil HCl}} \underset{X(gas)}{SO_2}\uparrow$$

Gas is released with smell of burning sulphur.

25. Answer (4)

$Fe^{+3} + K_4[Fe(CN)_6] \rightarrow Fe_4[Fe(CN)_6]_3$

Prussian blue ppt

26. Answer (2)

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

$B_2O_3 + CoO \rightarrow Co(BO_2)_2$

Cobalt metaborate

(blue coloured)

27. Answer (3)

$$AgCl + 2NH_3 \rightarrow \left[Ag(NH_3)_2\right]Cl$$

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