Chapter

31 Analytical Chemistry

TYPE A : MULTIPLE CHOICE QUESTIONS

1. Beilstein test is used for the detection of :

(a) N_2 (b) CO_2 ***[1999]***

(c) Na (d) Cl

2. When 8.3 g copper sulphate reacts with excess of potassium iodide then the amount of iodine liberated is: ***[2000]***

(a) 42.3 g (b) 24.3 g

(c) 4.23 g (d) 2.43 g

3. The compound used for gravimetric estimation of copper(II) is: ***[2003]***

(a) $Cu(SCN)_2$ (b) Cu_2O

(c) Cu_2I_2 (d) Cu_2CO_3

4. Dimethyl glyoxime gives a red precipitate with Ni^{2+}, which is used for its detection. To get this precipitate readily, the best pH range is :***[2004]***

(a) < 1 (b) $2 - 3$

(c) $3 - 4$ (d) $9 - 11$

5. Which of the following imparts green colour to the burner flame? ***[2004]***

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

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

6. Nessler's reagent is used to detect ***[2010]***

(a) PO_4^{3-} (b) MnO_4^-

(c) NH_4^+ (d) CrO_4^{2-}

7. The reagent that can distinguish between silver and lead salt is ***[2012]***

(a) H_2S gas

(b) Hot dilute HCl solution

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

(d) NH_4Cl (solid) + $(NH_4)_2CO_3$ solution

8. A laboratory reagent imparts green colour to the flame. On heating with solid $K_2Cr_2O_7$ and conc. H_2SO_4 it evolves a red gas. Identify the reagent ***[2017]***

(a) $CaCl_2$ (b) $BaCl_2$

(c) $CuCl_2$ (d) None of these

TYPE B : ASSERTION REASON QUESTIONS

Directions for (Qs. 9-17) : These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following five responses.

(a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.

(b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.

(c) If the Assertion is correct but Reason is incorrect.

(d) If both the Assertion and Reason are incorrect.

(e) If the Assertion is incorrect but the Reason is correct.

9. **Assertion :** Potassium can be used in Lassaigne test

Reason : Potassium reacts vigorously. ***[1997]***

10. **Assertion :** During test for nitrogen with Lassaigne extract on adding $FeCl_3$ solution, sometimes a red precipitate is obtained.

Reason : Sulphur is also present ***[2001]***

11. **Assertion :** Sb (III) is not precipitated as sulphide when in its alkaline solution H_2S is passed.

Reason : The concentration of S^{2-} ion in alkaline medium is inadequate for precipitation. ***[2004]***

12. **Assertion :** Borax bead test is not suitable for Al(III).

Reason : Al_2O_3 is insoluble in water ***[2005]***

13. **Assertion :** In the iodometric titration, starch is used as an indicator.

Reason : Starch is a polysaccharide. ***[2006]***

14. **Assertion :** $K_2Cr_2O_7$ is used as a primary standard in volumetric analysis.
Reason : It has a good solubility in water. ***[2006]***

15. **Assertion :** Sb_2S_3, is not soluble in yellow ammonium sulphide.
Reason : The common ion effect due to S^{2-} ions reduces the solubility of Sb_2S_3 ***[2006]***

16. **Assertion :** Fe^{3+} can be used for coagulation of As_2S_3 sol.
Reason : Fe^{3+} reacts with As_2S_3 to give Fe_2S_3 ***[2006]***

17. **Assertion :** Change in colour of acidic solution of potassium dichromate by breath is used to test drunk drivers.
Reason : Change in colour is due to the complexation of alcohol with potassium dichromate. ***[2006]***

Directions for (Q.18) : Each of these questions contains an Assertion followed by Reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.

(a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
(b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
(c) If Assertion is correct but Reason is incorrect.
(d) If both the Assertion and Reason are incorrect.

18. **Assertion :** Cu^{2+} and Cd^{2+} are separated from each other by first adding KCN solution and then passing H_2S gas.
Reason : KCN reduces Cu^{2+} to Cu^{+} and forms a complex with it. ***[2013]***

HINTS & SOLUTIONS

Type A : Multiple Choice Questions

1. (d) Beilstein test is used for the detection of halogens. A green or blue colour in flame indicates the presence of halogen. The colour is produced due to the formation of copper halides.

2. (c) $2CuSO_4.5H_2O + 4KI \longrightarrow$

$$\underset{498g}{2CuSO_4.5H_2O} + 4KI \longrightarrow Cu_2I_2 + 2K_2SO_4 + I_2 + 10H_2O$$

$$\underset{254\,g}{Cu_2I_2} + 2K_2SO_4 + I_2 + 10H_2O$$

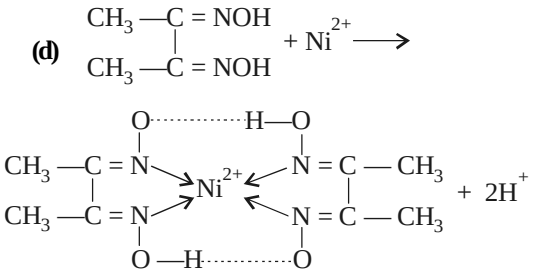
498 g of $CuSO_4$ liberate I_2 = 254 g

8.3 g of $CuSO_4$ liberate $I_2 = \frac{254}{498} \times 8.3$

$= 4.23$ g

3. (a) Gravimetrically, Cu^{2+} ions are estimated as $Cu(SCN)_2$, copper thiocyanate.

4. (d)



The reaction indicates that protons are released during reaction. Hence a basic medium is needed to facilitate the reaction. Thus the best pH range is 9-11. If medium is kept acidic then nitrogen atom of the ligand will start donating lone pair to H^+ ion of the acid and not to central metal ion.

5. (a) In the qualitative analysis of BO_3^{3-}, mixture is heated with conc. H_2SO_4 and little alcohol when trialkyl borate, R_3BO_3 or $B(OR)_3$ is formed.

$$2BO_3^{3-} + 3H_2SO_4 \rightarrow 2H_3BO_3 + 3SO_4^{2-}$$

$$H_3BO_3 + 3ROH \rightarrow R_3BO_3 + 3H_2O$$

The vapours of trialkyl borate, $B(OMe)_3$ impart green colour to the burner flame

6. (c) Nessler's reagent ($K_2[HgI_4]$) is used for the detection and quantitative determination of ammonia (or NH_4^+) in solution. It gives a yellow colour or brown precipitate of oxydimercuric ammonium iodide $\left(O\begin{matrix}Hg\\Hg\end{matrix}NH_2I\right)$ even with concentra-tion as low as 1 part per million of NH_3.

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

8. (b) The reagent is $BaCl_2$ which imparts green colour to flame. $BaCl_2$ forms chromyl chloride (which is red in colour), when treated with $K_2Cr_2O_7$ and conc. H_2SO_4.

$$2BaCl_2 + K_2Cr_2O_7 + 3H_2SO_4 \longrightarrow$$

$$K_2SO_4 + 2BaSO_4 + \underset{\text{Chromyl chloride (red gas)}}{2CrO_2Cl_2} + 3H_2O$$

Type B : Assertion Reason Questions

9. (e) Potassium is not used in Lassaigne's test because of its higher reactivity.

10. (a) Due to presence of sulphur, sodium thiocyanate is produced which produces blood red coloured precipitate with Fe^{3+} ion.

$$Na + C + S + N \xrightarrow{\Delta} NaSCN$$

$$Fe^{3+} + 3NaSCN \longrightarrow Fe(SCN)_3 + 3Na^+.$$

11. (d) Sb (III), placed in II group of qualitative analysis is precipitated as Sb_2S_3 by passing H_2S in presence of HCl which decreases ionisation of H_2S (due to common ion effect). This is done to avoid precipitation of metals of higher groups.

$$H_2S \rightleftharpoons 2H^+ + S^{2-}$$

$$HCl \rightleftharpoons H^+ + Cl^-$$

Thus when Sb(III) is precipitated by low concentration of H_2S, it will easily be

precipitated when concentration of S^{2-} is high, i.e., by H_2S in presence of alkali.

$$H_2S \rightleftharpoons 2H^+ + S^{2-}$$

$$H^+ + OH^- \rightleftharpoons H_2O$$

Thus here both assertion and reason are false.

12. (b) Metals form coloured compound (metaborates) with borax. On the basis of colour of metaborates, we can identify the metal. Aluminium does not form coloured metaborate, so this test is not valid for Al^{3+} ion. Al_2O_3 is insoluble in water but it is not explanation of A

13. (b) Starch is used as an indicator because it forms blue coloured complex with iodine. Starch is a polysaccharide but this is not explanation of A.

14. (c) $K_2Cr_2O_7$ is used as primary standard in volumetric analysis because its standard solution can be prepared. A is true but R is wrong.

15. (d) Antimony sulphide (Sb_2S_3) is soluble in yellow ammonium sulphide forming ammonium thioantimonate.

$$Sb_2S_3 + 3(NH_4)_2S + 2S \longrightarrow 2(NH_4)_3SbS_4$$

The common ion effect due to S^{2-} ion does not reduce the solubility of Sb_2S_3. So both *A* as well as *R*, are false.

16. (c) Fe^{3+} can be used to coagulate As_2S_3 as sol of As_2S_3 is negatively charged due to adsorption of S^{2-} ions. The positive charge of Fe^{3+} ion neutralises the negative charge of sol particles. Reason as given in the question does not explain A.

17. (c) A is true but R is wrong because change in colour of potassium dichromate is due to oxidation of alcohol by dichromate.

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

$$C_2H_5OH + O \longrightarrow CH_3COOH$$

18. (b) KCN forms complexes with Cu^+ and Cd^{2+} as $K_3[Cu(CN)_4]$ and $K_2[Cd(CN)_4]$ respectively. On passing H_2S, only Cd^{2+} complex is decomposed to give yellow CdS precipitate.