

Transition Elements

LEVEL - I

- If the d-d transition of a compound requires orange radiation, then the colour of the compound would be
 - orange
 - blue
 - red
 - green.
- In the first transition series, the elements which do not exhibit variable oxidation state is /are
 - Zn only
 - Sc only
 - Sc and Zn
 - Sc, Zn and Ti.
- A substance which is not paramagnetic is
 - $\text{Cr}(\text{ClO}_4)_3$
 - KMnO_4
 - TiCl_3
 - VOBr_2 .
- Disproportionation is shown by
 - $\text{Cr}(\text{OH})_2$
 - MnO_4^-
 - $\text{Cr}(\text{OH})_3$
 - Mn^{3+} .
- The calculate value of magnetic moment of ${}_{23}\text{V}^{3+}$ is
 - 1.73 Bohr magneton
 - 2.83 Bohr magneton
 - 3.87 Bohr magneton
 - 4.90 Bohr magneton.
- Which of the following is not a characteristic property of transition elements?
 - Formation of coloured salts
 - Variable oxidation states
 - Inert pair effect
 - Catalytic activity.
- The ability of transition elements to form coordination compounds is attributed to
 - small size of the atom or ion
 - high effective nuclear charge
 - presence of vacant orbitals to accept lone pair of electrons from ligands
 - all.
- Which of the following statements about the oxidizing property of KMnO_4 in acidic medium is not correct?
 - H_2S is oxidized to SO_4^{2-}
 - H_2S is oxidized to S
 - SO_3^{2-} gets oxidized to SO_4^{2-}
 - $\text{C}_2\text{O}_4^{2-}$ gets oxidized to CO_2 .
- The brown ring compound formed during the test of NO_3^- or NO_2^- is
 - $[\text{Fe}(\text{H}_2\text{O})_5\text{ONO}]^{2+}$
 - $[\text{Fe}(\text{H}_2\text{O})_4(\text{NO})_2]^{2+}$
 - $[\text{Fe}(\text{H}_2\text{O})_5\text{NO}]^{3+}$
 - $[\text{Fe}(\text{H}_2\text{O})_5\text{NO}]^{2+}$.
- Paramagnetism of $\text{Cr}(Z = 24)$, $\text{Mn}^{2+}(Z = 25)$ and $\text{Fe}^{3+}(Z = 26)$ are x, y and z respectively. They are in the order.
 - $x = y = z$
 - $x > y > z$

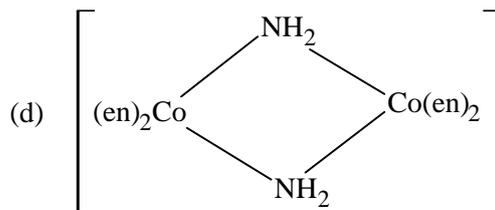
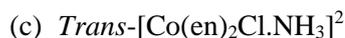
QUESTION BANK-CH-2

- (c) $x = y > z$ (d) $x > y = z$.
11. Of Cr (VI) as $\text{Cr}_2\text{O}_7^{2-}$ and CrO_4^{2-} , which is better oxidising agent?
 (a) CrO_4^{2-} , basic medium (b) $\text{Cr}_2\text{O}_7^{2-}$, basic medium
 (c) $\text{Cr}_2\text{O}_7^{2-}$, acidic medium (d) CrO_3 , basic medium.
12. When H_2O_2 is added to acidified $\text{K}_2\text{Cr}_2\text{O}_7$, the solution immediately after
 (a) turns yellow due to the formation of $\text{Cr}_2\text{O}_4^{2-}$
 (b) turns green due to formation of Cr^{3+}
 (c) turns deep blue violet due to the formation of CrO_5
 (d) turns green due to the formation of Cr_2O_3 .
13. Which of the following species is not expected to be a ligand
 (a) NO^+ (b) NH_4^+
 (c) $\text{NH}_2 - \text{NH}_3^+$ (d) CO .
14. The IUPAC name for the coordination compound $\text{Ba}[\text{BrF}_4]_2$ is
 (a) Barium tetrafluorobromate (V) (b) Barium tetrafluorobromate (III)
 (c) Barium bis (tetrafluorobromate) (III) (d) none of these.
15. The complex that violates the Sidwicks's rule of EAN is
 (a) Potassium ferrocyanide
 (b) Hexamine cobalt (III) Chloride
 (c) Tetramine copper (II) sulphate
 (d) Potassium dichlorodioxalato cobaltite (III).

LEVEL - II

1. A metal is left exposed to the atmosphere for some time. It becomes coated with green basic carbonate. The metal must be
 (a) Nickel (b) Chromium
 (c) Copper (d) Zinc
2. Copper displaces the metal in the salt solution of
 (a) AgNO_3 (b) ZnSO_4
 (c) FeSO_4 (d) NiSO_4
3. Potassium permanganate acts as an oxidant in neutral, alkaline as well as acidic media. The final products obtained from it in the three conditions are, respectively
 (a) MnO_4^{2-} , Mn^{3+} and Mn^{2+} (b) MnO_2 , MnO_2 and Mn^{2+}
 (c) MnO_2 , MnO_2^+ and Mn^{3+} (d) MnO , MnO_2 and Mn^{2+}
4. Number of Cr - O bonds in dichromate ion ($\text{Cr}_2\text{O}_7^{2-}$) is
 (a) 6 (b) 7
 (c) 8 (d) 4
5. The equivalent mass of $\text{K}_2\text{Cr}_2\text{O}_7$, when it acts as oxidizing agent in acidic medium, is equal to

- (a) M/3
(c) M/6
- (b) M/2
(d) M/5
6. Which of the following compounds is (are) coloured due to charge transfer spectra and not due to d-d transitions?
(a) $\text{K}_2\text{Cr}_2\text{O}_7$
(c) CrO_3
- (b) KMnO_4
(d) All of the above
7. Chromyl chloride when dissolved in NaOH solution gives yellow solution. The yellow solution contains
(a) $\text{Cr}_2\text{O}_7^{2-}$
(c) CrO_5
- (b) CrO_4^{2-} ions
(d) Cr_2O_3
8. Copper sulphate solution reacts with KCN to give
(a) $\text{Cu}(\text{CN})_2$
(c) $\text{K}_2[\text{Cu}(\text{CN})_4]$
- (b) CuCN
(d) $\text{K}_3[\text{Cu}(\text{CN})_4]$
9. Which of the following statement(s) is (are) correct with reference to the ferrous and ferric ions?
(a) Fe^{3+} gives green colour with potassium ferricyanide
(b) Fe^{2+} gives blue colour precipitate with potassium ferricyanide
(c) Fe^{3+} gives red colour with potassium thiocyanate
(d) Fe^{2+} gives brown colour with ammonium thiocyanate
10. The lanthanide contraction is responsible for the fact that
(a) Zr and Y have almost the same radius
(c) Zr and Hf have almost the same radius
- (b) Zr and Nb have similar oxidation state
(d) Zr and Zn have same oxidation state.
11. If a multidentate ligand is cyclic in nature and there are no unfavourable steric factors, then the stability of complex is greatly enhanced. This factual statement refers to
(a) Chelate effect
(c) Macrocyclic effect
- (b) Co-ordination effect
(d) Tyndall effect
12. Among the divalent ions of first row of transition elements (Mn, Cu, Ni, Fe), the tendency to form stable complexes (as per Irving-William order) increases as
(a) $\text{Mn}^{\text{II}} > \text{Fe}^{\text{II}} > \text{Ni}^{\text{II}} > \text{Cu}^{\text{II}}$
(c) $\text{Cu}^{\text{II}} > \text{Mn}^{\text{II}} > \text{Fe}^{\text{II}} > \text{Ni}^{\text{II}}$
- (b) $\text{Mn}^{\text{II}} > \text{Cu}^{\text{II}} > \text{Ni}^{\text{II}} > \text{Fe}^{\text{II}}$
(d) $\text{Ni}^{\text{II}} > \text{Mn}^{\text{II}} > \text{Cu}^{\text{II}} > \text{Fe}^{\text{II}}$
13. Which of the following species combine to form *ferrocene*?
(a) Fe^{3+} and two molecules of cyclopentadiene
(b) Fe and two C_6H_6 molecules
(c) Fe^{2+} ion and two cyclopentadienyl ions
(d) Fe^{2+} and two C_5H_{10} molecules
14. For a complex $[\text{Co}(\text{NH}_3)_3\text{Cl}_3]$ pick up true statement?
(a) The co-ordination number of cobalt is 6
(b) The complex can exhibit *fac* and *mer* isomerism
(c) the complex can show optical isomerism
(d) Both (a) and (b)
15. Which of the following complexes is not able to exhibit optical isomerism?
(a) $[\text{Al}(\text{Ox})_3]^{3-}$
(b) $[\text{Co}(\text{EDTA})]^-$



LEVEL - III

1. Which compound is formed when excess of KCN is added to aqueous solution of CuSO_4 ?
 (a) $\text{Cu}(\text{CN})_2$ (b) $\text{K}_2[\text{Cu}(\text{CN})_4]$
 (c) $\text{K}[\text{Cu}(\text{CN})_2]$ (d) $\text{K}_3[\text{Cu}(\text{CN})_4]$
2. Compound that is both paramagnetic and coloured is
 (a) $\text{K}_2\text{Cr}_2\text{O}_7$ (b) $(\text{NH}_4)_2[\text{TiCl}_6]$
 (c) VOSO_4 (d) $\text{K}_3[\text{Cu}(\text{CN})_4]$
3. The only cations present in a slightly acidic solution are Fe^{3+} , Zn^{2+} and Cu^{2+} . The reagent that when added in excess to this solution would identify and separate Fe^{3+} in one step is
 (a) 2 M HCl (b) 6 M NH_3
 (c) 6 M NaOH (d) H_2S gas
4. Which of the following statement(s) is (are) correct when a mixture of NaCl and $\text{K}_2\text{Cr}_2\text{O}_7$ is gently warmed with conc. H_2SO_4 ?
 (a) A green colour vapour is evolved
 (b) The vapour when passed into NaOH solution gives a yellow solution of Na_2CrO_4
 (c) Chlorine gas is evolved
 (d) Chromyl chloride is formed
5. In the standardization of $\text{Na}_2\text{S}_2\text{O}_3$ using $\text{K}_2\text{Cr}_2\text{O}_7$ by iodometry, the equivalent mass of $\text{K}_2\text{Cr}_2\text{O}_7$ is
 (a) (Molecular weight)/2 (b) (Molecular weight)/6
 (c) (Molecular weight)/3 (d) Same as molecular weight
6. The chemical composition of 'slag' formed during smelting process in the extraction of copper is
 (a) $\text{Cu}_2\text{O} + \text{FeS}$ (b) FeSiO_3
 (c) CuFeS_2 (d) $\text{Cu}_2\text{S} + \text{FeO}$
7. The equivalent mass of MnSO_4 is half of its molecular mass when it is converted to
 (a) Mn_2O_3 (b) MnO_2
 (c) MnO_4^- (d) MnO_4^{2-}
8. The aqueous solution of the following salts will be coloured in the case of
 (a) $\text{Zn}(\text{NO}_3)_2$ (b) LiNO_3
 (c) $\text{Co}(\text{NO}_3)_2$ (d) Potash alum
9. The number of moles of KMnO_4 that will be needed to react completely with one mole of ferrous oxalate in acidic solution is

- (a) $\frac{3}{5}$ (b) $\frac{2}{5}$
 (c) $\frac{4}{5}$ (d) 1
10. Amongst the following ions which one has the highest paramagnetism?
 (a) $[\text{Cr}(\text{H}_2\text{O})_6]^{3+}$ (b) $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$
 (c) $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$ (d) $[\text{Zn}(\text{H}_2\text{O})_6]^{2+}$
11. The geometry of $\text{Ni}(\text{CO})_4$ and $\text{Ni}(\text{PPh}_3)_2\text{Cl}_2$ are
 (a) both square planar (b) tetrahedral and square planar
 (c) both tetrahedral (d) square planar and tetrahedral
12. Mixture containing 0.02 mol of $[\text{Co}(\text{NH}_3)_5\text{SO}_4] \text{ Br}$ and 0.02 mol of $[\text{Co}(\text{NH}_3)_5\text{Br}]\text{SO}_4$ was dissolved in water to get 2L of solution of
 1L of X + Excess of $\text{AgNO}_3 \longrightarrow$ Y mol of ppt
 1L of X + Excess of $\text{BaCl}_2 \longrightarrow$ Z mol of ppt
 Y and Z are respectively
 (a) 0.01, 0.01 (b) 0.02, 0.01
 (c) 0.01, 0.02 (d) 0.02, 0.02
13. In the process of extraction of gold
 Roasted gold ore + $\text{CN}^- (\text{aq}) + \text{H}_2\text{O} \xrightarrow{\text{O}_2} [\text{H}] + [\text{OH}]$
 $[\text{X}] + \text{Zn} \longrightarrow [\text{Y}] + \text{Au}$
 $[\text{X}]$ and $[\text{Y}]$ are respectively
 (a) $[\text{Au}(\text{CN})_2]^-$, $[\text{Zn}(\text{CN})_4]^{2-}$ (b) $[\text{Au}(\text{CN})_4]^{3-}$, $[\text{Zn}(\text{CN})_4]^{2-}$
 (c) $[\text{Au}(\text{CN})_2]^-$, $[\text{Zn}(\text{CN})_6]^{4-}$ (d) $[\text{Au}(\text{CN})_4]^-$, $[\text{Zn}(\text{CN})_4]^{2-}$
14. The spin magnetic moment of cobalt in the compound $\text{Hg}[\text{Co}(\text{SCN})_4]$ is
 (a) $\sqrt{3}$ (b) $\sqrt{8}$
 (c) $\sqrt{15}$ (d) $\sqrt{24}$
15. The species having tetrahedral shape among the following is
 (a) $[\text{PdCl}_4]^{2-}$ (b) $[\text{Ni}(\text{CN})_4]^{2-}$
 (c) $[\text{Pd}(\text{CN})_4]^{2-}$ (d) $[\text{NiCl}_4]^{2-}$

Answers**Transition Elements****LEVEL – I**

- | | | | | | |
|----|---|-----|---|-----|---|
| 1. | b | 6. | c | 11. | c |
| 2. | c | 7. | d | 12. | c |
| 3. | b | 8. | a | 13. | b |
| 4. | d | 9. | d | 14. | b |
| 5. | b | 10. | d | 15. | c |

LEVEL – II

- | | | | | | |
|----|---|-----|---|-----|---|
| 1. | c | 6. | d | 11. | c |
| 2. | a | 7. | b | 12. | a |
| 3. | b | 8. | d | 13. | c |
| 4. | c | 9. | c | 14. | d |
| 5. | c | 10. | c | 15. | c |

LEVEL – III

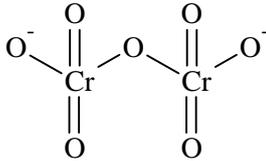
- | | | | | | |
|----|---|-----|---|-----|---|
| 1. | d | 6. | b | 11. | c |
| 2. | c | 7. | b | 12. | a |
| 3. | b | 8. | c | 13. | a |
| 4. | b | 9. | a | 14. | c |
| 5. | b | 10. | b | 15. | d |

Hints & Solutions**Transition Elements****LEVEL – I**

3. Mn in KMnO_4 has +7 oxidation state. Its electronic configuration would be $3d^5 4s^2$. For +7 oxidation state, Mn has no unpaired electrons. Hence, it is diamagnetic.
4. $2\text{Mn}^{3+} \longrightarrow \text{Mn}^{2+} + \text{Mn}^{4+}$
5. The electronic configuration of ${}_{23}\text{V}^{3+}$ is $3d^2$. It contains two unpaired electrons. Hence $\mu_B \mu_B = \sqrt{2(2+2)} = 2.83$.
10. Number of unpaired electrons in Cr, Mn^{2+} and Fe^{3+} are 6, 5 and 5 respectively.
11. $\text{CrO}_4^{2-} + 4\text{H}_2\text{O} + 3\text{e}^- \longrightarrow \text{Cr}(\text{OH})_3 + 5\text{OH}^-$, $E^\circ = -0.13\text{V}$
 $\text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+_{(\text{aq.})} + 6\text{e}^- \longrightarrow 2\text{Cr}^{3+}_{(\text{aq.})} + 7\text{H}_2\text{O}$, $E^\circ = 1.33\text{V}$.
12. $\text{Cr}_2\text{O}_7^{2-} + 4\text{O}_2^{2-} + 10\text{H}^+ \longrightarrow 2\text{CrO}_5$ (deep blue) + $5\text{H}_2\text{O}$

13. N in NH_4^+ has no lone pair of electrons which it can donate to metal atom.
15. EAN of Cu in $[\text{Cu}(\text{NH}_3)_4]^{2+} = 29 - 2 + 4 \times 2 = 35$ in stead of 36.

LEVEL - II

1. $2\text{Cu} + \text{H}_2\text{O} + \text{CO}_2 + \text{O}_2 \longrightarrow \text{Cu}(\text{OH})_2 \cdot \text{CuCO}_3$
Green mass
2. Ag is less reactive than Cu because it lies beneath Cu in electrochemical series.
3. In neutral and alkaline medium
 $\text{MnO}_4^- + 2\text{H}_2\text{O} + 3\text{e}^- \longrightarrow \text{MnO}_2 + 4\text{OH}^-$
 In acidic medium
 $\text{MnO}_4^- + 8\text{H}^+ + 5\text{e}^- \longrightarrow \text{Mn}^{2+} + 4\text{H}_2\text{O}$
4. Dichromate ion

 There are 8 Cr - O bonds.
5. $\text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ + 6\text{e}^- \longrightarrow 2\text{Cr}^{3+} + 7\text{H}_2\text{O}$

$$E = \frac{\text{M. mass}}{\text{Change in O.N.}} = \frac{M}{6}$$
6. $\text{K}_2\text{Cr}_2\text{O}_7$, KMnO_4 and CrO_3 are coloured due to formation of charge transfer transitions.
7. $\text{CrO}_2\text{Cl}_2 + 4\text{NaOH} \longrightarrow \text{Na}_2\text{CrO}_4 + 2\text{NaCl} + 2\text{H}_2\text{O}$
8. $\text{Cu}^{2+} + 2\text{KCN} \longrightarrow \text{Cu}(\text{CN})_2 + 2\text{K}^+$
 $2\text{Cu}(\text{CN})_2 \longrightarrow 2\text{CuCN} + (\text{CN})_2$
 $\text{CuCN} + 3\text{KCN} \longrightarrow \text{K}_3[\text{Cu}(\text{CN})_4]$
9. $\text{Fe}^{3+} + 3\text{KCNS} \longrightarrow 3\text{K}^+ + \text{Fe}(\text{CNS})_3$
Blood red
10. A gradual systematic decrease is called lanthanide contraction.
11. It is a factual statement about macrocyclic effect.
12. The order given in choice (a) is in accordance with Irving-William order.
13. Ferrocene is made of Fe^{2+} and two $(\text{C}_5\text{H}_5)^-$ ions.
14. Co-ordination no. of Co in $[\text{Co}(\text{NH}_3)_3\text{Cl}_3]$ is 6. The complex pertains to formula MA_3X_3 and can show *fac* (facial)-*mer* (meridional) isomerism.
15. *Trans*- $[\text{Co}(\text{en})_2\text{Cl.NH}_3]$ does not possess chiral structure.

LEVEL - III

1. $\text{CuSO}_4 + 2\text{KCN} \longrightarrow \text{Cu}(\text{CN})_2 + \text{K}_2\text{SO}_4$
 $\text{Cu}(\text{CN})_2 \longrightarrow 2\text{CuCN} + (\text{CN})_2$; $\text{CuCN} + 3\text{KCN} \longrightarrow \text{K}_3[\text{Cu}(\text{CN})_4]$
2. VOSO_4 has VO^{+2} or vanadium ($Z = 23$) in +4 oxidation state i.e., has one unpaired electron.
4. $\text{K}_2\text{Cr}_2\text{O}_7 + 4\text{NaCl} + 6\text{H}_2\text{SO}_4 \longrightarrow 2\text{CrO}_2\text{Cl}_2 + 6\text{NaHSO}_4 + 3\text{H}_2\text{O}$
5. The reaction involved is
 $\text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ + 6\text{e}^- \longrightarrow 2\text{Cr}^{3+} + 7\text{H}_2\text{O}$
 It involves 6e^- change therefore the equivalent weight of $\text{K}_2\text{Cr}_2\text{O}_7$ is $\frac{\text{MW}}{6}$

6. $\text{FeO} + \text{SiO}_2 \longrightarrow \text{FeSiO}_3$
7. $\text{Eq. mass} = \frac{\text{M. Mass}}{\text{Change in O.N.}}$
 $\overset{+2}{\text{Mn}}\text{SO}_4 \longrightarrow \overset{+4}{\text{Mn}}\text{O}_2$
 Change in O.N = 2.
7. $\text{Eq. mass} = \frac{\text{M. Mass}}{\text{Change in O.N.}}$
 $\overset{+2}{\text{Mn}}\text{SO}_4 \longrightarrow \overset{+4}{\text{Mn}}\text{O}_2$
 Change in O.N = 2.
8. Co in $\text{Co}(\text{NO}_3)_2$ has unpaired electrons in d-orbitals causing d-d transitions.
9. $2\text{KMnO}_4 + 3\text{H}_2\text{SO}_4 \longrightarrow \text{K}_2\text{SO}_4 + 2\text{MnSO}_4 + 3\text{H}_2\text{O} + 5[\text{O}]$
10. $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$ has highest number of unpaired electrons (4) hence, it has highest paramagnetism.
11. Both the complexes are tetrahedral in nature
12. 1L of solution X contains 0.01 mol of $[\text{Co}(\text{NH}_3)_5\text{SO}_4] \text{ Br}$ and gives 0.01 mol of Br^- ions and thus 0.01 mol of AgBr (Y). Similarly 1L of solution X has 0.01 mol of SO_4^{2-} ions and thus, will form 0.01 mol of BaSO_4 (Z).
13. $\text{Gold ore} + \text{CN}^- + \text{H}_2\text{O} \xrightarrow{\text{O}_2} [\text{Au}(\text{CN})_2]^-$
(X) soluble
 $2[\text{Au}(\text{CN})_2]^- + \text{Zn} \longrightarrow [\text{Zn}(\text{CN})_4]^{2-} + 2\text{Au}$
[Y]
14. The O.N. of Co in the given complex is +2 Co^{2+} ($3d^7$ configuration) has three unpaired electrons in this complex. Thus, its magnetic moment is $\sqrt{3(3+2)} = \sqrt{15}\text{B.M.}$
15. In $[\text{NiCl}_4]^{2-}$ O.N of Ni is +2 and its configuration is $3d^8$. It assumes sp^3 hybrid state in bonding and thus, has tetrahedral shape.