



## CHEMISTRY

### BOOKS - VIKRAM PUBLICATION ( ANDHRA PUBLICATION)

### D AND F- BLOCK ELEMENTS AND CO-ORDINATION COMPOUNDS

#### Textual Examples

1. On what ground can you say that scandium ( $Z = 21$ ) is a transition element but zinc ( $Z = 30$ ) is not ?



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2. Why do the transition elements exhibit higher enthalpies of atomisation ?

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3. Name a transition element which does not exhibit variable oxidation states.

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4. Why is  $Cr^{2+}$  reducing and  $Mn^{3+}$  oxidizing even though both have the same  $d^4$  electronic configuration.

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5. How would you account for the increasing oxidising power in the series  $VO_2^+ < Cr_2O_7^{2-} < MnO_4^-$  ?

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6. For the first row transition metals the  $E^0$  values are:

$E^0$	V	Cr	Mn	Fe	Co	Ni	Cu
$(M^+ / M)$	-1.18	-0.91	-1.18	-0.44	-0.28	-0.25	+0.34

Explain the irregularity in the above values.

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7. Why is the  $E^0$  value for the  $Mn^{3+} / Mn^{2+}$  couple much more positive than that for  $Cr^{3+} / Cr^{2+}$  or  $Fe^{3+} / Fe^{2+}$  ? Explain.

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8. Calculate the magnetic moment of a divalent ion in aqueous solution if its atomic number is 25

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9. What is meant by 'disproportionation' of an oxidation state ?  
Give an example.

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10. Name a member of the lanthanoid series which is well known to exhibit +4 oxidation state.

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11. On the basis of the following observations made with aqueous solutions, assign secondary valencies to metals in the following compounds.

Formula	Moles of AgCl precipitated per mole of the compounds with excess AgNO <sub>3</sub>
(i) PdCl <sub>2</sub> · 4NH <sub>3</sub>	2
(ii) NiCl <sub>2</sub> · 6H <sub>2</sub> O	2
(iii) PtCl <sub>4</sub> · 2HCl	0
(iv) CoCl <sub>3</sub> · 4NH <sub>3</sub>	1
(v) PtCl <sub>2</sub> · 2NH <sub>3</sub>	0

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12. Write the formulas for the follow co-ordination compounds

Tetraammineaquachloro cobalt (III) chloride

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**13.** Write the formulas for the follow co-ordination compounds

Potassium tetrahydrozincate (II)

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**14.** Write the formulas for the follow co-ordination compounds

Potassium trioxalatoaluminate (III)

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**15.** Write the formulas for the follow co-ordination compounds

Dichlorobis (ethane-1, 2-diamine) cobalt (III)

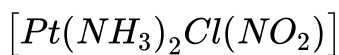
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16. Write the formulas for the follow co-ordination compounds

Tetracarbonylnickel (0)

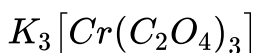
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17. Write the IUPAC names of the follow coordination compounds.



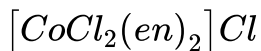
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18. Write the IUPAC names of the follow coordination compounds.



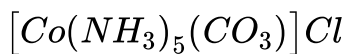
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19. Write the IUPAC names of the follow coordination compounds.



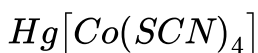
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20. Write the IUPAC names of the follow coordination compounds.



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21. Write the IUPAC names of the follow coordination compounds.



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22. Why is geometrical isomerism not possible in tetrahedral complexes having two different types of unidentate ligands Co-ordinated with the central metal ion ?

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23. Draw structures of geometrical isomers of  $[Fe(NH_3)_2(CN)_4]^-$

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24. Out of the following two Co-ordination entities which is chiral (optically active)?

a) cis-  $[CrCl_2(ox)_2]^{3-}$    b) trans-  $[CrCl_2(ox)_2]^{3-}$

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25. The spin only magnetic moment of  $[MnBr_4]^{2-}$  is 5.9 BM.

Predict the geometry of the complex ion ?

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### Very Short Answer Questions

1. What are transition elements ? Give examples.

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2. Which elements of 3d, 4d, and 5d series are not regarded as transition elements and why ?

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3. Why are d-block elements called transition elements ?

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4. Write the general electronic configuration of transition elements.

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5. In what way is the electronic configuration of transition elements different from non transition elements ?

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6. Write the electronic configuration of chromium (Cr) and copper (Cu).



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7. Why do transition elements exhibit characteristic properties ?

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8. Scandium is a transition element. But Zinc is not. Why ?

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9. Even though silver has  $d^{10}$  configuration, it is regarded as a transition element. Why?

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10. Write the electronic configuration of  $Co^{2+}$  and  $Mn^{2+}$ .



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11. Why are  $Mn^{2+}$  compounds more stable than  $Fe^{2+}$  towards oxidation to their +3 state?



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12. Which metal in the first series of transition metals exhibits + 1 oxidation state most frequently and why ?



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13. Why do transition elements exhibit more than one oxidation state (variable oxidation states) ?



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14. Though Sc is a transition element, it does not exhibit variable oxidation state. Why ?

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15. Why is it difficult to obtain  $M^{3+}$  oxidation state in Ni, Cu and Zn ?

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16. Why is  $Cr^{2+}$  reducing and  $Mn^{3+}$  oxidizing even though both have the same  $d^4$  electronic configuration.

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17. Although Cr, Mo and W belong to the same group (group 6) Cr (VI) is a strong oxidizing agent while Mo (VI) and W (VI) are not.

Why ?

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18. What do you infer from the fact that  $M^{3+} / M^{2+}$  standard electrode potential of Mn is comparatively higher and that of Fe is comparatively lower ?

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19. Transition elements have high melting points. Why ?

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20. Among the first transition series (3d series) Chromium has highest melting point. Why?

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21. Compared to s-block elements, the transition elements exhibit higher enthalpy of atomization. Why ?

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22. Among the first transition series (3d series) zinc has lowest enthalpy of atomization. Why?

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23. How do you expect the density of transition elements to vary in a given series and why?

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24. How do the atomic and ionic sizes vary among transition metals in a given series ?

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25. Why do Mn, Ni and Zn exhibit more negative  $E^\ominus$  values than expected ?

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26. Among the first transition series (3d series) only copper has positive  $E^\ominus M^{2+} / M$  value. Why?

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27.  $Cu^{+2}$  forms halides like  $CuF_2$ ,  $CuCl_2$  and  $CuBr_2$  but not  $CuI_2$ . Why?

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28. The highest Mn fluoride is  $MnF_4$  where as the highest oxide is  $Mn_2O_7$  Why?

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29. In its fluoride or Oxide, in which a transition metal exhibits highest oxidation state and why?

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30. Why  $Zn^{2+}$  is diamagnetic whereas  $Mn^{2+}$  is paramagnetic ?

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31. Write 'spin only' formula to calculate the magnetic moment of transition metal ions.

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32. Calculate the 'spin only' magnetic moment of  $Fe_{aq}^{2+}$  ion.

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33. What is meant by 'disproportionation' ? Give an example of disproportionation reaction in aqueous solution.

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34. Aqueous  $Cu^{2+}$  ions are blue in colour, where as Aqueous  $Zn^{2+}$  ions are colourless. Why ?

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35. What are complex compounds ? Give examples.

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**36.** Why do the transition metals form a large number of complex compounds ?

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**37.** How do transition metals exhibit catalytic activity?

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**38.** Give two reactions in which transition metals or their compounds act as catalysts.

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**39.** What is an alloy ? Give example.

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40. Why do the transition metals readily form alloys ?

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41. How do the ionic character and acidic nature vary among the oxides of first transition series?

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42. What is the effect of increasing pH on a solution of potassium dichromate ?

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**43.** Name the oxometal anions of the first series of transition metals in which the metal exhibits the oxidation state equal to its group number.

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**44.** Permanganate titrations are carried out in the presence of sulphuric acid but not in presence of hydrochloric acid. Why ?

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**45.** What is Lanthanoid contraction ?

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46. What are the different oxidation states exhibited by the lanthanoids ?

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47. What is Misch metal ? Given its composition and use.

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48. What is actinoid contraction ?

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49. What are co-ordination compounds? Give two examples.

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50. What is a coordination polyhedron ?

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51. What is a double salt? Give example.

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52. What is difference between a double salt and complex compound ?

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53. What is a ligand ?

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54. Give one example each for ionic and neutral ligands.

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55. How many moles of  $\text{AgCl}$  is precipitated when 1 mole of  $\text{CoCl}_3$  is treated with  $\text{AgNO}_3$  solution?

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56. What is a chelate ligand ? Give example.

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57. What is an ambidentate ligand ? Give example.

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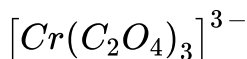
58.  $CuSO_4 \cdot 5H_2O$  is blue in colour where as anhydrous  $CuSO_4$  is colourless. Why?

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59.  $FeSO_4$  solution mixed with  $(NH_4)_2SO_4$  solution in 1 : 1 molar ratio gives the test for  $Fe^{2+}$  ion but  $CuSO_4$  mixed with aqueous ammonia in 1 : 4 molar ratio does not give the test of  $Cu^{2+}$  ion. why?

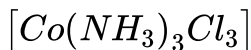
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60. How many geometrical isomers are possible in the following coordination entities ?



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61. How many geometrical isomers are possible in the following coordination entities ?



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62. What is the coordination entity formed when excess of aqueous KCN is added to an aqueous solution copper sulphate ?

Why ?

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63.  $[Cr(NH_3)_6]^{3+}$  is paramagnetic while  $[Ni(CN)_4]^{2-}$  is diamagnetic Why ?

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64. A solution of  $[Ni(H_2O)_6]^{2+}$  is green but a solution of  $[Ni(CN)_4]^{2-}$  is colourless. Why?

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65.  $[Fe(CN)_4]^{2-}$  and  $[Fe(H_2O)_6]^{2+}$  are of different colours in dilute solutions. Why?

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66. What is the oxidation state of cobalt in  $K[Co(CO)_4]$ ?

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67. What is the oxidation state of cobalt in  $[Co(NH_3)_6]^{3+}$  ?



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68. Give the formula the follow complexes. Potassium hexacyano ferrate (III)



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69. Write the formulas for the follow co-ordination compounds  
Tetracarbonylnickel (0)



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70. What are interstitial compounds ?



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71.  $Cu^{+2}$  forms halides like  $CuF_2$ ,  $CuCl_2$  and  $CuBr_2$  but not  $CuI_2$ . Why?

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## Short Answer Questions

1. Compared to 3d series the corresponding transition metals of 4d and 5d transition series show high enthalpy of atomization. Explain.

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2. Compared to the changes in atomic and ionic sizes of elements of 3d and 4d series, the : change in radii of elements of 4d and 5d series is virtually the same Comment.

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3. Account for the zero oxidation state of Ni and Fe in  $[Ni(CO)_4]$  and  $[Fe(CO)_5]$  respectively.

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4. Why do the transition metal ions exhibit characteristic colours in aqueous solution. Explain giving examples.

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5. Explain the catalytic action of Iron(III) in the reaction between  $I^-$  and  $S_2O_8^{2-}$  ions.

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6. What are interstitial compounds ? How are they formed ? Give two examples.

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7. Write the characteristics of interstitial compounds.

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8. Write the characteristic properties of transition elements.

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9. Write down the electronic configuration of



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10. Write down the electronic configuration of



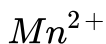
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11. Write down the electronic configuration of



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12. Write down the electronic configuration of



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13. What may be the stable oxidation state of the transition element with the following d electron configurations in the ground state of their atoms :  $3d^33d^53d^8$  and  $3d^4$  ?

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14. What is lanthanoid contraction ? What are the consequences of lanthanoid contraction?

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15. How is the variability in oxidation states of transition metals different from that of the non transition metals ? Illustrate with examples.

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16. Describe the preparation of potassium dichromate from iron chromite ore.

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17. Describe the oxidising action of potassium dichromate and write the ionic equations for its.

With (i) iodide (ii) iron (II) solution (iii)  $H_2S$  and (iv) Sn(II)

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18. Describe the preparation of potassium permanganate.

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19. How does the acidified permanganate solution react with iron (II) ions

Write the ionic equations for the reactions.

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20. How does the acidified permanganate solution react with  $SO_2$

Write the ionic equations for the reactions.

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21. How does the acidified permanganate solution react with oxalic acid.

Write the ionic equations for the reactions.

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22. Predict which of the ions  $Cu^+$ ,  $Sc^{3+}$ ,  $Mn^{2+}$ ,  $Fe^{2+}$  are coloured in aqueous solution? Give reasons.

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23. Compare the stability of + 2 oxidation state of the elements of the first transition series.

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24. Use Hund's rule to derive the electronic configuration of  $Ce^{3+}$  ion and calculate its magnetic moment on the basis of 'spin-only' formula.

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25. Write down the number of 3d electrons in each of the following ions :  $Ti^{2+}$ ,  $V^{2+}$ ,  $Cr^{3+}$  and  $Mn^{2+}$ . Indicate how would you expect the five 3d orbitals to be occupied for these hydrated ions (octahedral).

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26. Explain Werner's theory of coordination compounds with suitable examples.

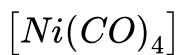
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27. Give the geometrical shapes of the following complex entities



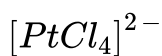
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**28.** Give the geometrical shapes of the following complex entities



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**29.** Give the geometrical shapes of the following complex entities



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**30.** Give the geometrical shapes of the following complex entities



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**31.** Explain the terms

Ligand

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**32.** Explain the terms

Coordination number

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**33.** Explain the terms

Coordination entity

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**34.** Explain the terms

Central metal atom/ion.

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**35.** Explain the terms

Unidentate ligand

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**36.** Explain the terms

bidentate ligand

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**37.** Explain the terms

polydentate ligand

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**38.** Explain the terms

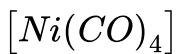
ambidentate ligand giving one example for each.

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**39.** What is meant by chelate effect ? Give example.

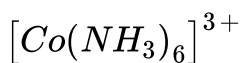
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**40.** Give the oxidation numbers of the central metal atoms in the following complex entities



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**41.** Give the oxidation numbers of the central metal atoms in the following complex entities



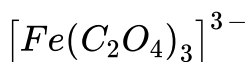
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**42.** Give the oxidation numbers of the central metal atoms in the following complex entities



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43. Give the oxidation numbers of the central metal atoms in the following complex entities



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44. Using IUPAC norms write the formulas for the Tetrahydroxozincate (II)

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45. Using IUPAC norms write the formulas for the Hexaamminecobalt (III) sulphate

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46. Using IUPAC norms write the formulas for the Potassium tetrachloropalladate (II)

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47. Using IUPAC norms write the formulas for the Potassium tri(oxalato) chromate (III)

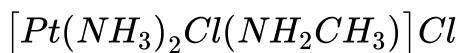
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48. Using IUPAC norms write the systematic names of the



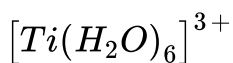
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49. Using IUPAC norms write the systematic names of the



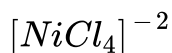
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50. Using IUPAC norms write the systematic names of the



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51. Using IUPAC norms, write the systematic names of the



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**52.** Explain geometrical isomerism in Co-ordination compounds giving suitable examples.

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**53.** What are homoleptic and heteroleptic complexes ? Give one example for each.

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**54.** Write the characteristic properties of transition elements.

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**55.** What is lanthanoid contraction ? What are the consequences of lanthanoid contraction?





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56. What are homoleptic and heteroleptic complexes ? Give one example for each.



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57. Explain the colour and para magnetic property of transition elements.



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## Long Answer Questions

1. Explain giving reasons :

Transition metals and many of their compounds show

paramagnetic behaviour.

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2. Explain giving reasons :

The enthalpies of atomisation of the transition metals are high.

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3. Explain giving reasons :

The transition metals generally form coloured compounds.

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4. Give two reactions in which transition metals or their compounds acts as catalysts.

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5. Describe the preparation of potassium permanganate. How does the acidified permanganate solution react with (i) iron (II) ions (ii)  $SO_2$  and (iii) oxalic acid ? Write the ionic equations.

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6. Compare the chemistry of the actinoids with that of lanthanoids with reference to:

(i) electronic configuration (ii) oxidation states and (iii) chemical reactivity

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7. How would you account for the of the  $d_4$  species,  $Cr^{2+}$  is strongly reducing while manganese (III) is strongly oxidising.

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8. How would you account for the Cobalt (II) is stable in aqueous solution but in the presence of complexing reagents is easily oxidised.

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9. How would you account for the The  $d_1$  configuration is very unstable in ions.

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**10.** Give examples and suggest reasons for the following features of the transition metals.

The lowest oxide of transition metal is basic, the highest is amphoteric/acidic.

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**11.** Give examples and suggest reasons for the following features of the transition metals.

A transition metal exhibits highest oxidation state in oxides and fluorides.

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**12.** Give examples and suggest reasons for the following features of the transition metals.

The highest oxidation state is exhibited in oxoanions of a metal.

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**13.** Compare the chemistry of the actinoids with that of lanthanoids with reference to:

(i) electronic configuration (ii) oxidation states and (iii) chemical reactivity

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**14.** Explain IUPAC nomenclature of Co-ordination compounds with suitable examples.

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15. Explain different types of isomerism exhibited by Co-ordination compounds, giving suitable examples.

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16. Discuss the nature of bonding and magnetic behaviour in the  $[Fe(CN)_6]^{4-}$  Co-ordination entities on the basis of valence bond theory.

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17. Discuss the nature of bonding and magnetic behaviour in the  $[FeF_6]^{3-}$  Co-ordination entities on the basis of valence bond theory.

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18. Discuss the nature of bonding and magnetic behaviour in the  $[Co(C_2O_4)_3]^{3-}$  Co-ordination entities on the basis of valence bond theory.

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19. Discuss the nature of bonding and magnetic behaviour in the  $[CoF_6]^{3-}$  Co-ordination entities on the basis of valence bond theory.

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20. Sketch the splitting of d orbitals in an octahedral crystal field,

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21. What is spectrochemical series ? Explain the difference between a weak field ligand and a strong field ligand.

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22. Discuss the nature of bonding in metal carbonyls.

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23. Explain the applications of Co-ordination compounds in different fields.

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**Intext Questions**

1. Silver atom has completely filled d-orbitals ( $4d^{10}$ ) in its ground state. How can you say that it is a transition element ?

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2. In the series Sc( $Z = 21$ ) to Zn ( $Z = 30$ ), the enthalpy of atomisation of zinc is the lowest, i.e.,  $126\text{kJmol}^{-1}$ , why ?

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3. Which of the 3d series of the transition metals exhibits the largest number of oxidation , states and why ?

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4. The  $E^\ominus (M^{2+} / M)$  value for copper is positive ( + 0.34V).

What is possibly the reason for this? (Hint: consider its high

$\Delta_a H^\ominus$  and low  $\Delta_{\text{hyd}} H^\ominus$  )



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5. How would you account for the irregular variation of ionisation enthalpies (first and second) in the first series of the transition elements ?



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6. Why is the highest oxidation state of a metal exhibited in its oxide or fluoride only ?



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7. Which is a stronger reducing agent  $Cr^{2+}$  or  $Fe^{2+}$  and why?

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8. Calculate the 'spin only' magnetic moment of  $M^{2+}$  (aq) ion ( $Z = 27$ ).

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9. Explain why  $cu^+$  ion is not stable in aqueous solutions?

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10. Actinoid contraction is greater from element to element than lanthanoid contraction?

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**11.** Write the formulas for the follow co-ordination compounds

Tetraammineaquachloro cobalt (III) chloride

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**12.** Write the formulae for the follow Co-ordination compounds

Potassium tetracyanonickelate (II)

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**13.** Write the formulae for the follow Co-ordination compounds

Tris (ethane-1, 2-diamine) chromium (III) chloride

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14. Write the formulae for the follow Co-ordination compounds

Amminebromidochloridonitrito-N-platinate (II)

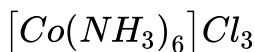
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15. Write the formulae for the follow Co-ordination compounds

Dichlorido bis-(ethane-1,2-diamine) platinum (IV) nitrate

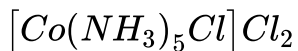
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16. Write the IUPAC names of the follow Co-ordination compounds.



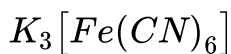
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17. Write the IUPAC names of the follow Co-ordination compounds.



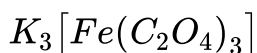
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18. Write the IUPAC names of the follow Co-ordination compounds.



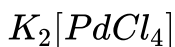
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19. Write the IUPAC names of the follow Co-ordination compounds.



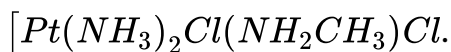
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20. Write the IUPAC names of the follow Co-ordination compounds.



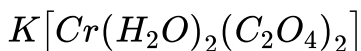
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21. Write the IUPAC names of the follow Co-ordination compounds.



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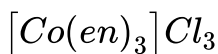
22. Indicate the types of isomerism exhibited by the follow complexes and draw the structures for these isomers :



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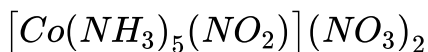


23. Indicate the types of isomerism exhibited by the following complexes and draw the structures for these isomers :



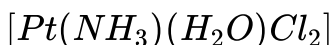
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24. Indicate the types of isomerism exhibited by the following complexes and draw the structures for these isomers :



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25. Indicate the types of isomerism exhibited by the following complexes and draw the structures for these isomers :



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26. Give evidence that  $[Co(NH_3)_5Cl]SO_4$  and  $[Co(NH_3)_5SO_4]Cl$  are ionization isomers.

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27. Explain on the basis of valence bond theory that  $[Ni(CN)_4]^{2-}$  ion with square planar structure is diamagnetic and the  $[NiCl_4]^{2-}$  ion with tetrahedral geometry is paramagnetic.

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28.  $[NiCl_4]^{2-}$  is paramagnetic while  $[Ni(CO)_4]$  is diamagnetic though both are tetrahedral. Why?

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29.  $[Fe(H_2O)_6]^{3+}$  is strongly paramagnetic whereas  $[Fe(CN)_6]^{3-}$  is weakly paramagnetic Explain.

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30. Why  $[Co(NH_3)_6]^{3+}$  is an inner orbital complex where is  $[Ni(NH_3)_6]^{2+}$  is an outer orbital complex ?

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31. Predict the number of unpaired electrons in the square planar  $[Pt(CN)_4]^{2-}$  ion.

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**32.** The hexaquo manganese (II) ion contains five unpaired electrons, while the hexacyano ion contains only one unpaired electron. Explain using crystal field theory.

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**33.** Calculate the overall complex dissociation equilibrium constant for the  $Cu(NH_3)_4^{2+}$  ion, given that  $\beta_4$  for this complex is  $2.1 \times 10^{13}$ .

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