**CLASS : XII**

**SUBJECT : CHEMISTRY(coordination compounds)**

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| **Sr. No.** | **Knowledge Based** | **Marks** |
| 1. | Describe the bonding in coordination compounds in terms of Werner’s Theory | 3 |
| 2. | Explain the following terms:  coordination entity  ligand,  coordination number,  coordination polyhedron,  homoleptic and heteroleptic.  Coordination sphere | 1 each |
| 3 | What is meant by unidentate, didentate and ambidentate ligands? Give two  examples for each. | 2 |
| 4 | Write short notes on the following:  Stereoisomerism  Structural isomerism | 3 each |
| 5 | Describe the following:  Valence bond theory  Crystal field theory | 2 |
| 6 | Draw figure to show the splitting of *d* orbitals in an octahedral crystal field. | 3 |
| 7 | What is spectrochemical series? Explain the difference between a weak field ligand and a strong field ligand. | 3 |
| 8 | What is crystal field splitting energy? How does the magnitude of o decide the actual configuration of *d* orbitals in a coordination entity? | 3 |
| 9 | Predict the number of unpaired electrons in the square planar [Pt(CN)4]2– ion. | 1 |
| 10 | The hexaquo manganese(II) ion contains five unpaired electrons, while the hexacyanoion contains only one unpaired electron. Explain using Crystal Field Theory. | 2 |
| 11 | Discuss the nature of bonding in metal carbonyls. | 2 |
| 12 | What is meant by stability of a coordination compound in solution? State  the factors which govern stability of complexes. | 2 |
| 13 | What is meant by the *chelate effect*? Give an example. | 2 |
| 14 | Discuss briefly giving an example in each case the role of coordination  compounds in:  (i) biological systems (iii) analytical chemistry  (ii) medicinal chemistry and (iv) extraction/metallurgy of metals. | 1 each |
| 15 | What is the relationship between observed colour of the complex and the wavelength of the light absorbed by the complex? | 2 |
| 16 | Differentiate between:  Weak field and strong field coordination entity | 3 |
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| **S. No.** | **Understanding Based** |  |
| 1. | Specify the oxidation numbers of the metals in the following coordination entities:  (i) [Co(H2O)(CN)(en)2]2+ (iii) [PtCl4]2– (v) [Cr(NH3)3Cl3]  (ii) [CoBr2(en)2]+ (iv) K3[Fe(CN)6] | 1 each |
| 2. | How many geometrical isomers are possible in the following coordination entities?  (i) [Cr(C2O4)3]3– (ii) [Co(NH3)3Cl3] | 1 each |
| 3 | Draw the structures of optical isomers of:  (i) [Cr(C2O4)3]3– (ii) [PtCl2(en)2]2+ (iii) [Cr(NH3)2Cl2(en)]+ | 1 each |
| 4 | Draw all the isomers (geometrical and optical) of:  (i) [CoCl2(en)2]+ ( ii) [Co(NH3)Cl(en)2]2+ (iii) [Co(NH3)2Cl2(en)]+ | 2 each |
| 5 | Write all the geometrical isomers of [Pt(NH3)(Br)(Cl)(py)] and how many of  these will exhibit optical isomers? | 2 |
| 6 | Indicate the types of isomerism exhibited by the following complexes and  draw the structures for these isomers:  (i) K[Cr(H2O)2(C2O4)2 (ii) [Co(en)3]Cl3  (iii) [Co(NH3)5(NO2)](NO3)2 (iv) [Pt(NH3)(H2O)Cl2] | 2 |
| 7 | Give evidence that [Co(NH3)5Cl]SO4 and [Co(NH3)5SO4]Cl are ionisation  isomers. | 2 |
| 8 | Square planar complexes with CN 4 exhibit geometrical isomerism whereas tetrahedral complexes do not. Why? | 2 |
| 9 | Explain on the basis of valence bond theory that [Ni(CN)4]2– ion with square planar structure is diamagnetic and the [NiCl4]2– ion with tetrahedral geometry is paramagnetic. | 2 |
| 10 | Explain why [Fe(H2O)6]3+ has a magnetic moment value of 5.92BM whereas [Fe(CN)6]3- has a value of only 1.74BM. | 2 |
| 11 | Magnetic moment of [MnCl4]2- is 5.92MB. Explain the reason for it. | 2 |
| 12 | [NiCl4]2– is paramagnetic while [Ni(CO)4] is diamagnetic though both are tetrahedral. Why? | 2 |
| 13 | [Fe(H2O)6]3+ is strongly paramagnetic whereas [Fe(CN)6]3– is weakly paramagnetic. Explain. | 2 |
| 14 | What is the coordination entity formed when excess of aqueous KCN is added to an aqueous solution of copper sulphate? Why is it that no precipitate of copper sulphide is obtained when H2S(g) is passed through this solution? | 2 |
| 15 | [Co(CN)6]3- and [Co(F)6]3- both are octahedral complexes. Then, what is the difference between the two? | 1 |
| 16 | [Cr(NH3)6]3+ is paramagnetic while [Ni(CN)4]2– is diamagnetic. Explain why? | 2 |
| 17 | A solution of [Ni(H2O)6]2+ is green but a solution of [Ni(CN)4]2– is colourless.  Explain. | 2 |
| 18 | [Fe(CN)6]4– and [Fe(H2O)6]2+ are of different colours in dilute solutions. Why? | 2 |
| 19 | Why are low spin tetrahedral complexes not formed? | 1 |
| 20 | What do you understand by the ‘denticity of a ligand’? | 1 |
| 21 | Explain [Co(NH3)6]3+ is an inner orbital complex whereas [Ni(NH3)6]2+ is an  outer orbital complex. | 2 |
| 22 | How many ions are produced from the complex Co(NH3)6Cl2 in solution?  (i) 6 (ii) 4 (iii) 3 (iv) 2 | 1 |
| 23 | Amongst the following ions which one has the highest magnetic moment value?  (i) [Cr(H2O)6]3+ (ii) [Fe(H2O)6]2+ (iii) [Zn(H2O)6]2+ | 3 |
| 24 | Amongst the following, the most stable complex is  (i) [Fe(H2O)6]3+ (ii) [Fe(NH3)6]3+ (iii) [Fe(C2O4)3]3– (iv) [FeCl6]3– | 1 |
| 25 | Why is CO a stronger ligand than Cl- ? | 2 |
| 26 | Explain the following:   1. Low spin octahedral complexes of Ni are known 2. The π complexes are known for transition metals only 3. CO is a stronger ligand than NH3 for many metals 4. Co2+ is easily oxidised to Co3+ in the presence of strong ligand | 1 each |
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| **S. No.** | **Application** |  |
| 1. | Using IUPAC norms write the formulas for the following:  (i) Tetrahydroxozincate(II) (vi) Hexaamminecobalt(III) sulphate  (ii) Potassium tetrachloridopalladate(II) (vii) Potassium tri(oxalato)chromate(III)  (iii) Diamminedichloridoplatinum(II) (viii) Hexaammineplatinum(IV)  (iv) Potassium tetracyanonickelate(II) (ix) Tetrabromidocuprate(II)  (v) Pentaamminenitrito-O-cobalt(III) (x) Pentaamminenitrito-N-cobalt(III)  (xi) Tetraamminediaquacobalt(III) chloride  (xii) Potassium tetracyanidonickelate(II)  (xiii) Tris(ethane–1,2–diamine) chromium(III) chloride  (xiv) Amminebromidochloridonitrito-N-platinate(II)  (xv) Dichloridobis(ethane–1,2–diamine)platinum(IV) nitrate  (xvi) Iron(III) hexacyanidoferrate(II) | 1 each |
| 2. | Using IUPAC norms write the systematic names of the following:  (i) [Co(NH3)6]Cl3 (iv) [Co(NH3)4Cl(NO2)]Cl (vii) [Ni(NH3)6]Cl2  (ii) [Pt(NH3)2Cl(NH2CH3)]Cl (v) [Mn(H2O)6]2+ (viii) [Co(en)3]3+  (iii) [Ti(H2O)6]3+ (vi) [NiCl4]2– (ix) [Ni(CO)4]  (x) [Co(NH3)6]Cl3 (xi) [Co(NH3)5Cl]Cl2 (xii) K3[Fe(CN)6]  (xiii) K3[Fe(C2O4)3] (xiv) K2[PdCl4] (xv) [Pt(NH3)2Cl(NH2CH3)]Cl | 1 each |
| 3 | FeSO4 solution mixed with (NH4)2SO4 solution in 1:1 molar ratio gives the test of Fe2+ ion but CuSO4 solution mixed with aqueous ammonia in 1:4 molar ratio does not give the test of Cu2+ ion. Explain why? | 2 |
| 4 | Discuss the nature of bonding in the following coordination entities on the  basis of valence bond theory:  (i) [Fe(CN)6]4– (ii) [FeF6]3– (iii) [Co(C2O4)3]3– (iv) [CoF6]3– | 2 |
| 5 | Aqueous copper sulphate solution (blue in colour) gives:  (i) a green precipitate with aqueous potassium fluoride and  (ii) a bright green solution with aqueous potassium chloride. Explain these  experimental results. | 2 |
| 6 | Give the oxidation state, *d* orbital occupation and coordination number of  the central metal ion in the following complexes:  (i) K3[Co(C2O4)3] (iii) (NH4)2[CoF4]  (ii) cis-[Cr(en)2Cl2]Cl (iv) [Mn(H2O)6]SO4 | 3 each |
| 7 | Write down the IUPAC name for each of the following complexes and indicate  the oxidation state, electronic configuration and coordination number. Also  give stereochemistry and magnetic moment of the complex:  (i) K[Cr(H2O)2(C2O4)2].3H2O (iii) CrCl3(py)3 (v) K4[Mn(CN)6]  (ii) [Co(NH3)5Cl-]Cl2 (iv) Cs[FeCl4] | 1 each |
| 8 | Calculate the overall complex dissociation equilibrium constant  for the [Cu(NH3)4]2+  ion, given that b4 for this complex is 2.1 × 1013. | 2 |
| 9 | What will be the correct order for the wavelengths of absorption in the visible region for the following:  [Ni(NO2)6]4–, [Ni(NH3)6]2+, [Ni(H2O)6]2+ ? | 1 each |
| 10 | On the basis of crystal field theory explain why Co(III) forms paramagnetic octahedral complex with weak field ligands whereas it forms diamagnetic complex with strong field ligands. | 3 |
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| **S.No.** | **Value Based** |  |
| 1. | Colour exhibited by coordination compounds is due to excitation of electrons. Teacher explained that if you refine your talents by hardwork, you will also shine with fyling colours   1. What values are learnt by students? 2. Why is [Ni(H2O)6]2+ coloured? | 3 |
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| **S.No.** | **HOTS** |  |
| 1. | Fe3+ SCN- (excess) A F- (excess) B  What are A and B? give their IUPAC names. Find the spin only magnetic moment of B. | 2 |
| 2. | A metal ion Mn+ having d4 valence electronic configuration combines with three bidentate ligands to form a complex compound. Assuming CFSE(octahedral)>P:   1. Explain orbital splitting during this complex formation 2. Write the electronic configuration of valence electrons ofthis metal in terms of t2g and eg 3. What type of hybridisation will it have? 4. Name the type of isomerism exhibited by this complex? | 4 |
| 3 | A complex [Ti(H2O)6]3+ was heated. It was found that it became colourless. What was the reason behind it? | 2 |