

### **Objective Questions**

### **Basic Terms**

- 1. In  $K_4 Fe(CN)_6$ 
  - (a) (CN) are linked with primary valency
  - (b) (CN) are linked with secondary valency
  - (c) *K* are linked with secondary valency
  - (d) K are linked with non-ionic valency
- 2. The co-ordination number of copper in cuprammonium sulphate is [KCET 1991, 92]
  - (a) 2

(b) 6

(c) 4

- (d) 4
- **3.** Which of the following acts as a bidentate ligand in complex formation
  - (a) Acetate
- (b) Oxalate
- (c) Thiocyanate
- (d) EDTA
- **4.** The co-ordination number of cobalt in the complex  $[Co(en)_2Br_2]Cl_2$  is
  - (a) 2

(b) 6

(c) 5

- (d) 4
- 5. Which of the following ligands forms a chelate

### [MP PET/PMT 1998]

- (a) Acetate
- (b) Oxalate
- (c) Cyanide
- (d) Ammonia
- **6.** According to Werner's theory

### [MP PMT 2000, 02]

- (a) Primary valency can be ionized
- (b) Secondary valency can be ionized
- (c) Primary and secondary valencies both cannot be ionized
- (d) Only primary valency cannot be ionized
- **7.** Which of the following is not true for ligand-metal complex

### [MP PET 1993]

- (a) Larger the ligand, the more stable is the metal-ligand
- (b) Highly charged ligand forms strong bond
- (c) Larger the permanent dipole moment of ligand, the more stable is the bond
- (d) Greater the ionization potential of central metal, the stronger is the bond
- **8.** What is the co-ordination number of the metal in  $[Co(en)_2 Cl_2]^+$



0	(a) 4 (c) 6 Ridontate ligand is	(b) (d)		20.	Which one of the follo (Cyanide) a complex ha		n number two
9.	Bidentate ligand is (a) $CN^-$	(b)	Ethylono diammina (an)		( ) a +	(1) 4 +	[AIIMS 2004]
			Ethylene diammine (en)		(a) $Cu^+$	(b) $Ag^{+}$	
	(c) <i>SCN</i> <sup>-</sup>		EDTA		(c) $Ni^{2+}$	(d) $Fe^{2+}$	
10.	The coordination num	ber of $Pt$	in $\left[Pt(NH_3)_4 Cl_2\right]^{++}$ io	<b>21.</b>	According to Lewis the	ligands are	[MP PMT 2002]
	is				(a) Acidic in nature		
		<i>a</i> >	[MP PET 1995	]	(b) Basic in nature		
	(a) 2	(b)			(c) Neither acidic nor		
	(c) 6	(d)			(d) Some are acidic an		
11.	Which is the example of	of hexaden	tate ligand	22.	The coordination num		
	<ul><li>(a) 2, 2—dipyridyl</li><li>(b) Dimethyl glyoxime</li></ul>	,			complex is determined		[AIEEE 2004]
	(c) Aminodiacetate io				(a) The number of ligating sigma and pi-bond		tai ion bonded by
	(d) Ethylene diammin		tate ion [FDTA]		(b) The number aroun		ded by pi-bonds
12.			metal in coordination	1	(c) The number of ligation		
			CET (Engg./Med.) 1999		sigma bonds		
	(a) Same as primary v		. 667	-	(d) The number of or	nly anionic ligan	ds bonded to the
	(b) Sum of primary an		ry valencies		metal ion		
	(c) Same as secondary	valency		23.	In the extraction of w	hich of the follow	
	(d) None of these				forms	<b>a</b> > .	[MP PET 1989]
13.	Ligand in a complex sa		[KCET 1992		(a) Cu	(b) <i>Ag</i>	
		coordinate	bonds to a central meta	1	(c) Fe	(d) <i>Na</i>	
	atom or ion	aa andin ata	handa ta a control moto	<b>24.</b>	Potassium ferrocyanide		[AFMC 2000]
	atom or ion	coordinate	bonds to a central meta	1	(a) Normal salt	(b) Mixed	
		by coordi	nate bonds to a centra	l 05	(c) Double salt A monodentate ligand	(d) Comple	ex sait
	metal atom or ion			<sup>1</sup> 25.	(a) One co-ordinate si		
			y coordinate bonds to	a	(b) Two co-ordinate si		
	central metal atom				(c) Any number of co-		
14.	A group of atoms can f			1	(d) No capacity to co-o		
	(a) It is a small molecular		CE 1999; MP PMT 2000	<sup>1</sup> 26.	EDTA has coordination	n number	[AFMC 2004]
	(b) It has an unshared		air		(a) 3	(b) 4	
	(c) It is a negatively ch		·uii		(c) 5	(d) 6	
	(d) It is a positively ch			27.	Among the propertie		
15.			es show six coordination [RPET 2000		complexing, the set of towards metal species	is	wn by <i>CN</i> ion [AIEEE 2004]
	(a) $[Zn(CN)_4]^{2-}$	(b)	$[Cr(H_2O)_6]^{3+}$		(a) c, a	(b) b, c	
				- 0	(c) a, b	(d) a, b, c	1 1
16.		s formed	$[Ni(NH_3)_4]^{2+}$ when cuprammonium	<b>28.</b>	That ion or molecule with transitional metal	ion is called	
	sulphate is dissolved in		[KCET 1993	]	<ul><li>(a) Recipient</li><li>(c) Coordinate ion</li></ul>	(b) Ligand	
	(a) 1	(b)		29.	Coordination number of	(d) No spe	
	(c) 4	` ,	Zero		Coordination number (		Orissa JEE 2004]
17.	The coordination	number	of <i>Cu</i> in complex	X.	(a) 6	(b) 4	011554 0112 2004]
	$[Cu(H_2O)_4]^{++}$ is			[]	(a) 6 MP PET 1995]	(d) 12	
	(a) 4	(b)	3	30.		` '	neous catalyst in
	(c) 2	(d)	1	0	the hydrogenation of a		,
18.			ion in the co-ordination	1	(a) Iron	(b) Alumir	ium
	compound $K_2[Ni(CN)]$	<sub>4</sub> ] is			(c) Rhodium	(d) Cobalt	
	(a) Four	(b)	Zero	31.	Given the molecular		
	(c) Two	(d)	Six		complexes (A) CoC		
19.	The metal which does i	not form a	polynuclear carbonyl is		$CoCl_3.4NH_3$ . If the		
	(a) <i>Mn</i>	(b)	Co		molecules in $A$ , $B$ and		
	(c) <i>Cr</i>	(d)	Fe		primary valency in $(A)$ ,	, ( <i>B</i> ) and ( <i>C</i> ) are:	[DCE 2003]
	` '	( - )			(a) 6, 5, 4	(b) 3, 2, 1	

(c) Ferrous cvanide (d) Ferriferrocyanide (c) 0, 1, 2 (d) 3, 3, 3 32. Generally, a group of atoms can function as a ligand if Tollen's reagent is 45. [KCET 1990] (a)  $[Ag(NH_3)_2]^+$ (b)  $Ag_2O$ (a) They are positively charged ions (b) They are free radicals (c)  $[Cu(OH)_A]^{2-}$ (d)  $Cu_2O$ (c) They are either neutral molecules or negatively Finely divided iron combines with CO to give 46. charged ions [UPSEAT 2002] (d) None of these (a)  $Fe(CO)_5$ (b)  $Fe_2(CO)_{q}$ The ligand in potassium ferricyanide is 33. (c)  $Fe_2(CO)_{12}$ (d)  $Fe(CO)_6$ (b) *CN* In a complex, the highest possible coordination number is (c)  $Fe^{3+}$ (d)  $(CN)_6$ (b) 12 Co-ordination number of aluminum is [MHCET 2004] 34. (d) 8 (c) 4 (a) 8 (b) 6 The number of neutral molecules or negative groups **48**. (c) 12 (d) 4 attached to the central metal atom in a complex ion is In  $K_4 Fe(CN)_6$ , Fe is in the form of 35. (a) An atom (b) An ion (b) Effective atomic number (a) Atomic number (c) Cationic complex (d) Anionic complex (c) Coordination number (d) Primary valency Which of the following ligands is expected to bidentate 36. EDTA combines with cations to form 49. [CBSE PMT 1994] (a) Ion-exchange resins (b) Chelates (a) Br (b)  $C_2 O_4^{2-}$ (c) Clathrates (d) Polymers An example of a double salt is (d)  $CH_3C \equiv N$ 50. [MP PET 2001] (c)  $CH_3NH_2$ (a) Bleaching powder (b) Hypo In the compound lithium tetrahydroaluminate, the ligand **37**• (d) Potash alum (c)  $K_4[Fe(CN)_6]$ [AIIMS 1997] In complex compounds, metal ligand bond is (a) H<sup>+</sup> (b) H<sup>-</sup> (a) Coordinate bond (b) Hydrogen bond (c) H (d) None of these (c) Ionic bond (d) Covalent bond 38. Which of the following is the odd one out [MP PET 1996] Ammonia forms the complex ion  $[Cu(NH_2)_A]^{2+}$  with (a) Potassium ferrocyanide copper ions in alkaline solutions but not in acidic (b) Ferrous ammonium sulphate solution. What is the reason for it [AIEEE 2003] (c) Potassium ferricyanide (a) In acidic solutions hydration protects copper ions (d) Tetrammine copper (II) sulphate (b) In acidic solutions protons coordinate with ammonia The basic ligand is 39. molecules forming  $NH_4^+$  ions and  $NH_3$  molecules (a)  $NH_3$ (b) *CN* are not available (d) All (c) F (c) In alkaline solutions insoluble  $Cu(OH)_2$ The negative ligand is precipitated which is soluble in excess of any alkali (a) Aqua (b) Sulphato (d) Copper hydroxide is an amphoteric substance (d) Nitro sodium (c) Carboxyl Zeigler-Natta catalyst is used for which type of reaction 53. Which has yellow colour 41. (a) Hydrogenation (b) Polymerization (a) Potassium cobaltinitrite (c) Oxidation (d) Reduction (b) Potassium hexanitro cobaltate (III) Which of the following is not considered as an (c) Fischer's salt organometallic compound. [AIIMS 2004] (d) All the above (a) Cis-platia (b) Ferrocene Ligands, in complex compounds [MP PMT 2003] (c) Zeise's salt (d) Gringard reagent (a) Accept  $e^-$ -pair Which one is organometallic compound [MP PMT 2004] 55. (b) Donate e - - pair (a) Lithium methoxide (b) Lithium dimethyl amide (c) Lithium acetate (d) Methyl lithium (c) Neither accept  $e^-$ -pair nor donate An aqueous solution of potash alum gives [UPSEAT 2004] (d) All of these happen **56.** Which of the following is a common donor atom in (a) Two types of ions (b) Only one type of ion 43. ligands (c) Four types of ions (d) Three types of ions [BHU 2001] Carnallite in solution in  $H_2O$ , shows the properties of (a) Arsenic (b) Nitrogen [DCE 2003] (d) Both (b) and (c) (c) Oxygen (a)  $K^+, Mg^{2+}, Cl^-$ (b)  $K^+, Cl^-, SO_4^{2-}, Br^-$ Trunbull's blue is a compound 44. (c)  $K^+, Mg^{2+}, CO_3^{2-}$ [KCET 1993] (d)  $K^+, Mg^{2+}, Cl^-, Br^-$ (a) Ferricyanide (b) Ferrous ferricyanide

- What is the co-ordination number of cobalt in 58. [MP PET 1994]  $Co(NH_3)_3Cl_3$ (a) 3 (b) 4 (c) 5 (d) 6 The formula of alum is [Pb. CET 2002] (a)  $K_2SO_4.Al_2(SO_4)_3.24H_2O$ (b)  $K_4[Fe(CN)_6]$ 

  - (c)  $K_2SO_4.Al_2(SO_4)_3.6H_2O$
  - (d)  $Na_2CO_3.10H_2O$
- Number of ions present in  $K_4[Fe(CN)_6]$  [Pb. CET 2000]
  - (a) 2
- (b) 10
- 61.  $CH_3MgI$  is an organometallic compound due to

[DCE 2002]

- (a) Mg-I bond
- (b) C-I bond
- (c) C Mg bond
- (d) C H bond
- What is the EAN of nickel in  $Ni(CO)_A$

[BVP 2003]

(a) 34

- (b) 35
- (c) 32
- (d) 36

### Nomenclature, Oxidation state and EAN number

- How many ions are produced in aqueous solution of 1.  $[Co(H_2O)_6]Cl_2$ [RPMT 2002]
  - (a) 2

(b) 3

(c) 4

- (d) 6
- IUPAC name of  $[Pt(NH_3)_3(Br)(NO_2)Cl]Cl$  is 2.

### [CBSE PMT 1998]

- (a) Triamminechlorobromonitroplatinum (IV) chloride
- (b) Triamminebromonitrochloroplatinum (IV) chloride
- (c) Triamminebromochloronitroplatinum (IV) chloride
- (d) Triamminenitrochlorobromoplatinum (IV) chloride
- 3. Oxidation state of nitrogen is incorrectly given for

[UPSEAT 2000, 01]

#### Compound Oxidation state (a) $[Co(NH_3)_5 Cl]Cl_2$ 0 (b) $NH_2OH$ -1(c) $(N_2H_5)_2SO_4$ +2 (d) $Mg_3N_2$

The formula of dichloro bis (urea) copper (II) is 4.

[CBSE PMT 1997]

- (a)  $\left[ Cu\{O = C(NH_2), \}Cl_2 \right]$
- (b)  $\left[ CuCl_2 \{ O = C(NH_2)_2 \}_2 \right]$
- (c)  $\left[Cu\{O = C(NH_2)_2\}Cl\right]Cl$
- (d)  $[CuCl_2]{O = C(NH_2)_2 H_2}$
- The IUPAC name of the complex  $[Pt(NH_3), Cl_2]$  is 5.
  - (a) Platinum (II) diammino dichloride

- (b) Diammino dichloro platinate (IV)
- (c) Bis (ammino) dichloro platinum (IV)
- (d) Dichloro diammine platinum (II)
- Correct formula of diammine silver (I) chloride is 6.
  - (a)  $Ag(NH_3)Cl$
- (b)  $Ag(NH_2)Cl$
- (c)  $\left[Ag(NH_3)_2\right]Cl$
- (d)  $\left[Ag(NH_2), Cl\right]$
- The formula of sodium nitroprusside is [AIIMS 1992] 7.
  - (a)  $Na_4[Fe(CN)_5 NOS]$
- (b)  $Na_2[Fe(CN)_5NO]$
- (c)  $NaFe[Fe(CN)_6]$

- (d)  $Na_2[Fe(CN)_6NO_2]$
- The correct name of  $[Pt(NH_3)_4 Cl_2][PtCl_4]$  is 8.

### [MP PET 2003]

- (a) Tetraammine dichloro platinum (iv) tetrachloro platinate (ii)
- (b) Dichloro tetra ammine platinium (iv) tetrachloro platinate (ii)
- (c) Tetrachloro platinum (ii) tetraammine platinate (iv)
- (d) Tetrachloro platinum (ii) dichloro tetraammine platinate (iv)
- Correct formula of potassium ferrocyanide is

[CBSE PMT 1988]

- (a)  $K_4 [Fe(CN)_6]$
- (b)  $K_2[Fe(CN)_6]H_2O$
- (c)  $K_3[Fe(CN)_6]$
- (d) None of these
- 10. The IUPAC name of  $\left[Co(NH_3)_3(NO_2)_3\right]$  is
  - (a) Trinitrotriammine cobalt (III)
  - (b) Trinitrotriammine cobalt (II)
  - (c) Trinitrotriammine cobalt (III) ion
  - (d) Trinitritriammine cobaltate (III)
- 11. In  $K_4[Fe(CN)_6]$ , the E.A.N. of Fe is [DCE 2000]
  - (a) 33
- (b) 35
- (c) 36
- (d) 26
- Which of the following pairs is not correctly matched 12.

- (a) Effective atomic number of Pt in  $[PtCl_6]^{2-} = 84$
- (b) Absorption peak for  $\left[Cr^{III}(NH_3)_6\right]^{+3} = 21680cm^{-1}$
- (c) Crystal field stabilization energy of  $d^2$  in weak ligand field =  $(-)0.8\Delta_0$
- (d) Example of weak ligand field for  $d^5$  configuration  $= \left[ M n^{II} F_{\epsilon} \right]^{-4}$
- The oxidation number of chromium in sodium tetrafluoro 13. oxochromate complex is
  - (a) II

- (b) IV
- (c) VI

- (d) III
- The IUPAC name of  $K_4[Fe(CN)_6]$  is 14.

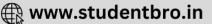
[CBSE PMT 1990; MP PET 1992;

MP PMT 1995, 97; Kurukshetra CET 2002] (a) Potassium hexacyanoferrate (II)

- (b) Potassium ferrocyanide
- (c) Tetrapotassium hexacyanoferrate (II)
- (d) Tetrapotassium ferroushexacyanide (II)







The IUPAC name of  $[Ni(CO)_4]$  is [RPET 1999] [MP PMT 1993; MP PET 1997] 15. (a) Potassium ferrocyanide (II) (a) Tetra carbonyl nickel (II) (b) Potassium hexaferrocvanate (III) (b) Tetra carbonyl nickel (o) (c) Potassium ferrohexacyanate (II) (c) Tetra carbonyl nickelate (II) (d) Potassium hexacyanoferrate (III) (d) Tetra carbonyl nickelate (o) The EAN of iron in potassium ferricyanide is 27. The correct nomenclature for  $Fe_4[Fe(CN)_6]_3$  is 16. [Pb. CET 2000] (a) 18 (b) 54 [MP PMT 1994] (c) 35 (d) 23 (a) Ferroso-ferric cyanide In the coordination compound,  $K_4[Ni(CN)_4]$  oxidation (b) Ferric-ferrous hexacvanate state of nickel is [AIEEE 2003] (c) Iron (III) hexacyanoferrate (II) (a) -1(b) o (d) Hexacynoferrate (III-II) (d) +2(c) +1The IUPAC name of compound  $Na_3[Co(ONO)_6]$  will be 17. According to IUPAC nomenclature sodium nitroprussied 29. [MP PMT 2000] is named is [CBSE PMT 2003] (a) Hexanitritocobalt (III) sodium (a) Sodium pentacyanonitrosyl ferrate (III) (b) Sodium cobalt nitrite (b) Sodium nitroferricyanide (c) Sodium hexanitrocobaltate (III) (c) Sodium nitroferrocvanide (d) Sodium pentacyanonitrosyl ferrate (II) (d) Sodium hexanitritocobaltate (III) Pick out the complex compound in which the central 30. In which of the following complexes oxidation state of 18. metal atom obeys EAN rule strictly [KCET 2003] metal is zero [MP PET 1997] (b)  $K_3[Fe(CN)_6]$ (a)  $K_4[Fe(CN)_6]$ (a)  $[Pt(NH_3), Cl_2]$ (b)  $[Cr(CO)_{6}]$ (c)  $[Cr(H_2O)_6]Cl_3$ (d)  $[Cu(NH_3)_4]SO_4$ (c)  $\left[Cr(NH_3)_3 Cl_3\right]$ (d)  $\left[Cr(en), Cl_2\right]$ 31. Which of the following is wrong statement [BHU 2003] The oxidation number of Cr in  $[Cr(NH_3)_6]Cl_3$  is 19. (a)  $Ni(CO)_4$  has oxidation number + 4 for Ni[CBSE PMT 2001] (b)  $Ni(CO)_4$  has zero oxidation number for Ni(a) 8 (b) 6 (c) Ni is metal (d) CO is gas In  $[Ni(NH_3)_4]SO_4$ , the E.A.N. of Ni is 20. Oxidation state of Fe in  $K_3[Fe(CN)_6]$ [RPMT 2002] (b) 35 (b) 3 (c) 36 (c) o (d) None of these IUPAC name of  $[Co(ONO)(NH_3)_5 Cl_2]$  is Which complexes have zero oxidation state 21. 33. (a) Carbonyl (b) Ferrocyanide [AMU 2002] (c) Amine (d) Cyanide (a) Pentaammine nitro cobalt (III) chloride [MH CET 2002] The proper name for  $K_2[PtCl]_6$  is 34. (b) Pentaammine nitrito cobalt (III) chloride (a) Potassium platinum hexachloride (c) Pentaammine nitroso cobalt (III) chloride (b) Potassium hexachloro platinum IV (d) Pentaammine oxo-nitro cobalt (III) chloride (c) Potassium hexachloro platinate IV The oxidation number of Pt in  $[Pt(C_2H_4)Cl_3]^-$  is 22. (d) Potassium hexachloro platinum [MNR 1993] IUPAC name of  $K_3[Al(C_2O_4)_3]$  is called (a) + 1(b) +2[MP PMT 1993, 02, 03] (d) + 4(a) Potassium alumino oxalato The oxidation state of cobalt in the complex compound 23. (b) Potassium aluminium (III) trioxalate  $[Co(NH_3)_6]Cl_3$  is (c) Potassium trioxalato aluminate (III) (b) +6(a) + 3(d) Potassium trioxalato aluminate (IV) (c) + 5(d) + 236. The I.U.P.A.C. name of  $K_3[Ir(C_2O_4)_3]$  is The correct IUPAC name of potassium cuprochloride is 24. [MP PMT 2001] (a) Potassium copper (I) tetrachloride (a) Potassium tri oxalato iridium (III) (b) Potassium tetrachlorocuprate (I) (b) Potassium tri oxalato iridate (III) (c) Tetrachloropotassium cuprate (I) (c) Potassium tris (oxalato) iridium (III) (d) Tetrachlorocopper (I) potassiate (d) Potassium tris (oxalato) iridate (III) The effective atomic number of cobalt in the complex 25. The charge on  $[Ag(CN)_2]^-$  complex is  $[Co(NH_3)_6]^{3+}$  is [AIIMS 2001] [MP PET 2003] **37**. (a) 36 (b) 33 (a) -1(b) +1(c) 24 (d) 30 (c) +2(d) +3IUPAC name of  $K_3 Fe(CN)_6$  is

38. The IUPAC name of  $[Co(NH_3)_6]Cl_3$  is [IIT-JEE 1994] tetrahydridoaluminate [MP PMT 2003] (a) Hexammine cobalt (III) chloride (a)  $Al[LiH_4]$ (b)  $Al_{2}[LiH_{4}]_{3}$ (b) Hexammine cobalt (II) chloride (c)  $Li[AlH_{\Delta}]$ (d)  $Li[AlH_{4}]_{2}$ (c) Triammine cobalt (III) trichloride (d) None of these IUPAC name for  $K[Ag(CN)_2]$  is IUPAC name of  $[Co(NH_3)_2(H_2O)_2Cl]$  Cl<sub>2</sub> is 39. (a) Potassium argentocyanide [MP PET 1994] (b) Potassium silver cyanide (a) Diaguachlorodiammine cobalt (III) chloride (c) Potassium dicyanoargentate (I) (b) Triamminediaquachloro cobalt (III) chloride (d) Potassium dicyanosilver (II) (c) Chlorodiamminediaqua cobalt (III) chloride The oxidation state of Co in  $\left[Co(H_2O)_5 Cl\right]^{2+}$  is 51. (d) Diamminediaquachloro cobalt (II) chloride (a) + 2(b) +3Dichloro diammine platinum (II) complex has the 40. (c) +1(d) + 4formula 52. The chemical formula of diammine silver (I) chloride is [MP PMT 1997] [BHU 2004] (a)  $Pt[Cl_2(NH_3)_2]$ (b)  $Pt[R.(NH_2)_2]Cl_2$ (a)  $[Ag(NH_3)]Cl$ (b)  $[Ag(NH_3)_2]Cl$ (c)  $[PtCl_2(NH_3)_2]$ (d)  $[Pt.R.(NH_2)_2]Cl_2$ (c)  $[Ag(NH_3)_2]Cl$ (d)  $[Ag(NH_4)_2]Cl$ The formula of potassiumdicyano bis (oxalato) nickelate 41. 53. IUPAC name of  $[Co(NH_3)_5 NO_2]Cl_2$ (a)  $K_4[Ni(CN)_2(Ox)_2]$ (b)  $K_3[Ni_2(Ni_2(CN)_2(Ox)_2)]$ (a) Pentamminenitrocobalt (III) chloride (b) Pentamminenitrosocobalt (III) chloride (c)  $K[Ni(CN)(Ox)_2]$ (d)  $K_2[Ni(CN)_2(Ox)_2]$ (c) Pentamminenitrocobalt (II) chloride The value of x which appears in the complex  $[Ni(CN)_4]^x$  is (d) None of these The pair of the compounds in which both the metals are 54. (a) + 2(b) -2in the highest possible oxidation state is (c) o (d) 4 [IIT-JEE (Screening) 2004] Pick the correct name of  $[Co(NH_3)_5 Cl]Cl_2$ [AMU 2001] 43. (a)  $[Fe(CN)_6]^{3-}$ ,  $[Co(CN)_6]^{3-}$ (a) Chloropentammine cobalt (III) (b)  $CrO_2Cl_2, MnO_4^-$ (b) Pentammine cobalt (III) chloride (c) Chloropentammine cobalt (III) chloride (c)  $TiO_3$ ,  $MnO_2$ (d) Chloropentammine cobalt (II) chloride (d)  $[Co(CN)_6]^{3-}, MnO_3$ The valency of cuprammonium ion is The IUPAC name of  $[Cr(NH_3)_6]^{3+}$  is 55. [Pb. CET 2001] (a) + 4(b) +2(a) Hexamminechromium (VI) ion (c) -2(d) -4In which of the following compounds transition metal has (b) Hexamminechromium (III) ion zero oxidation state [CBSE PMT 1999] (c) Hexamminechromium (II) ion (a)  $CrO_5$ (b)  $NH_2.NH_2$ (d) Hexamminechloride 56. The IUPAC name of  $K_2[Cr(CN)_2O_2(O)_2(NH_3)]$  is (c) NOClO<sub>4</sub> (d)  $[Fe(CO)_5]$ 46. The complex chlorocompound diaquatriammine cobalt (III) (a) Potassium ammine dicyano dioxoperoxochromate chloride is represented as [CBSE PMT 2002] (VI) (a)  $[Co(NH_3)_3(H_2O)_3]Cl_2$ (b) Potassium ammine cyano peroxo dioxo chromium (b)  $[Co(NH_2)_3 (H_2O)_2]Cl_2$ (VI) (c) Potassium ammine cyano peroxo dioxo chromiun (c)  $[CoCl(NH_3)_3 (H_2O)_2]Cl_3$ (VI) (d)  $[CoCl(NH_3)_3 (H_2O)_2]Cl_2$ (d) Potassium ammine cyano peroxo dioxo chromatic The complex compound  $[Co(NH_3)_3 NO_2 ClCN]$  is named 47. (IV) [MP PMT 1996] The IUPAC name of the coordination compound **5**7• (a) Chlorocyanonitrotriammine cobalt (III)  $K_3[Fe(CN)_6]$  is [AIEEE 2005] (b) Nitrochlorocyanotriammine cobalt (III) (a) Potassium hexacyanoferrate (II) (c) Cyanonitrochlorotriammine cobalt (III) (b) Potassium hexacyanoferrate (III) (d) Triamminenitrochlorocyano cobalt (III) (c) Potassium hexacyanoiron (II) The oxidation number of Pt in  $[Pt(C_2H_4)Cl_3]^-$  is (d) Tripotassium hexacyanoiron (II) [UPSEAT 1999, 01] Which compound is zero valent metal complex [KCET 2005] 58. (a) +1(b) +2(a)  $[Cu(NH_3)_4]SO_4$ (b)  $[Pt(NH_3)_2Cl_2]$ (c) +3(d) +4

49.

What

is

the

structural

of lithium

formula

- (c)  $[Ni(CO)_4]$
- (d)  $K_3[Fe(CN)_6]$

### Isomerism and magnetic properties

- Which one of the following octahedral complexes will not 1. show geometric isomerism (A and B are monodentate ligands) [CBSE PMT 2003]
  - (a)  $[MA_5B]$
- (b)  $[MA_2B_4]$
- (c)  $[MA_3B_3]$
- (d)  $[MA_4B_2]$
- The number of unpaired electrons in the complex ion 2.  $[CoF_6]^{3-}$  is (Atomic no. of Co = 27) [CBSE PMT 2003]
  - (a) Zero
- (b) 2

(c) 3

- (d) 4
- Which would exhibit co-ordination isomerism 3.
  - (a)  $[Cr(NH_3)_6][Co(CN)_6]$  (b)  $[Co(en)_2 Cl_2]$ 

    - (c)  $\left[Cr(NH_3)_6\right]Cl_3$
- (d)  $\left[Cr(en), Cl_{2}\right]^{+}$
- and  $[Co(NH_3)_5(ONO)]Cl_2$  $[Co(NH_3)_5 NO_2]Cl_2$ are related to each other as
  - (a) Geometrical isomers
- (b) Optical isomers
- (c) Linkage isomers
- (d) Coordination isomers
- $[Co(NH_3)_5 SO_4]Br$  $[Co(NH_3)_5 Br] SO_4$ and are 5. examples of which type of isomerism

### [MP PMT 1993, 94, 95; MP PET 1997; MP PET/PMT 1998]

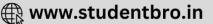
- (a) Linkage
- (b) Geometrical
- (c) Ionization
- (d) Optical
- $[Co(NH_3)_4 Cl_2]NO_2$  and  $[Co(NH_3)_4 Cl.NO_2]Cl$  are ...... 6. [MP PMT 1993; MP PET 1995, 2001]
  - (a) Geometrical
- (b) Optical
- (c) Linkage
- (d) Ionization
- Which would exhibit ionisation isomerism [MP PET 1997] 7.
  - (a)  $\left[Cr(NH_3)_6\right]Cl_3$
- (b)  $\left[Co(NH_3)_5 Br\right] SO_4$
- (c)  $\left[Cr(en), Cl_2\right]$
- (d)  $\left[Cr(en)_3 Cl_3\right]$
- $[Ti(H_2O)_6]^{+3}$  is paramagnetic in nature due to **[RPMT 2002]** 8.
  - (a) One unpaired  $e^-$
- (b) Two unpaired  $e^{-}$
- (c) Three unpaired  $e^-$
- (d) No unpaired  $e^-$
- Coordination isomerism is caused by the interchange of 9. ligands between the [UPSEAT 2002]
  - (a) Cis and Trans structure
  - (b) Complex cation and complex anion
  - (c) Inner sphere and outer sphere
  - (d) Low oxidation and higher oxidation states
- Which one of the following will not show geometrical [MP PMT 2002] isomerism
  - (a)  $[Cr(NH_3)_4 Cl_2]Cl$
- (b)  $[Co(en)_2Cl_2]Cl$
- (c)  $[Co(NH_3)_5 NO_2]Cl_2$
- (d)  $[Pt(NH_3), Cl_2]$
- Paramagnetic co-ordination compounds contain ....... 11. electrons
  - (a) No
  - (b) Both paired and unpaired
  - (c) Paired
  - (d) Unpaired

- Which of the following isomeric pairs shows ionization [MP PET 1993]
  - (a)  $\left[Co(NH_3)_6\right]\left[Cr(CN)_6\right]$  and  $\left[Cr(NH_3)_6\right]\left[Co(CN)_6\right]$
  - (b)  $[Cr(H_2O)_6]Cl_3$  and  $[Cr(H_2O)_5Cl]Cl_2.H_2O$
  - (c)  $[Pt(NH_3)_2 Cl_2]$  and  $[Pt(NH_3)_4][PtCl_4]$
  - (d)  $[Co(NH_3)_5 Br] SO_4$  and  $[Co(NH_3)_5 SO_4] Br$
- Among the following ions which one has the highest 13. paramagnetism [IIT 1993; UPSEAT 2002]
  - (a)  $[Cr(H_2O)_6]^{3+}$
- (b)  $[Fe(H_2O)_6]^{2+}$
- (c)  $[Cu(H_2O)_{\epsilon}]^{2+}$
- (d)  $[Zn(H_2O)_6]^{2+}$
- Amongst  $Ni(CO)_4$ ,  $[Ni(CN)_4]^{2-}$  and  $[NiCl_4]^{2-}$  [IIT 1991]
  - (a)  $Ni(CO)_4$  and  $[NiCl_4]^{2-}$  are diamagnetic and  $[Ni(CN)_4]^{2-}$  is paramagnetic
  - (b)  $[NiCl_4]^{2-}$  and  $[Ni(CN)_4]^{2-}$  are diamagnetic and  $Ni(CO)_4$  is paramagnetic
  - (c)  $Ni(CO)_4$  and  $[Ni(CN)_4]^{2-}$  are diamagnetic and  $[NiCl_4]^{2-}$  is paramagnetic
  - (d)  $Ni(CO)_4$  is diamagnetic and  $[NiCl_4]^{2-}$  and  $[Ni(CN)_4]^{2-}$  are paramagnetic
- $[Co(NH_3)_4 Cl_2]^+$  exhibits 15.
  - (a) Geometrical isomerism (b) Optical isomerism
  - (c) Bonding isomerism
- (d) Ionisation isomerism
- The compound which does not show paramagnetism is
  - [IIT 1992]
    - (a)  $\left[Cu(NH_3)_4\right]Cl_3$
- (b)  $\left[Ag(NH_3)\right]_2 Cl$
- (c) NO
- (d)  $NO_2$
- The number of geometrical isomers for  $[Pt(NH_3)_2 Cl_2]$  is 17. [CBSE PMT 1995]
  - (a) Two
- (b) One
- (c) Three
- (d) Four
- The pair of complex compounds  $[Cr(H_2O)_6 Cl_3]$  and 18.  $[Cr(H_2O)_5 Cl]Cl_2H_2O$  are an example of [MP PMT 1997]
  - (a) Linkage isomerism
- (b) Ionisation isomerism
- (c) Coordination isomerism (d) Hydrate isomerism
- The number of geometrical isomers of the complex 19.  $\left[Co(NO_2)_2(NH_3)_2\right]$  is [CBSE PMT 1997]
  - (a) 2
- (b) 3
- (c) 4

- (d) o
- The type of isomerism present in nitropentamine 20. chromium (III) chloride is
  - (a) Optical
- (b) Linkage
- (c) Ionization
- (d) Polymerisation
- Which of the following compounds exhibits linkage 21. isomerism [MP PMT 2001]
  - (a)  $[Co(en)_3]Cl_3$
- (b)  $[Co(NH_3)_6[Cr(CN)_6]$
- (c) [Co(en), NO, Cl]Br
- (d)  $[Co(NH_3)_5 Cl]Br_2$







[AIEEE 2002]

22.	Pick out from the following complex compounds, a poor electrolytic conductor in solution [MP PMT 1994]		(c) 4	(d) 6
	(a) $K_2[PtCl_6]$ (b) $[Co(NH_3)_3(NO_2)_3]$	34.	The number of unpaired ele	·
	(c) $K_4[Fe(CN)_6]$ (d) $[Cu(NH_3)_4]SO_4$		(a) Zero	[AIIMS 1997] (b) One
	- · · · · · · · · · · · · · · · · · · ·		(c) Three	(d) Five
23.	The possible number of optical isomers in $[Co(en)_2 Cl_2]^+$ are [MP PET 2003]	35.		$f\left[Ag(CN)_2\right]^{-1}$ is zero, then the
	(a) 2 (b) 3	33.	number of unpaired electro	
	(c) 4 (d) 6		(a) 1	(b) 2
24.	Magnetic moment of $[Cu(NH_3)_4]^{2+}$ ion is <b>[RPET 2003]</b>		(c) 3	(d) Zero
	(a) 1.414 (b) 1.73	36.		$t(NH_3)_4 Br_2$ ]Cl <sub>2</sub> are related to
	(c) 2.23 (d) 2.38		each other as	A DIMO ODOD DIMOI
<b>25</b> .	What is true for $[Fe(CN)_6]^{3-}$ and $[FeF_6]^{3-}$ <b>[RPET 1999]</b>		(a) Optical isomers	AFMC 2000; CBSE PMT 2001] (b) Coordinate isomers
	(a) Both are paramagnetic		(c) Ionization isomers	(d) Linkage isomers
	(b) Only $[Fe(CN)_6]^{3-}$ is paramagnetic	37.	Which of the following cor	nplex will show geometrical as
	(c) Only $[FeF_6]^{3-}$ is paramagnetic		well as optical isomerism (	
	(d) Both are diamagnetic		(a) $Pt(NH_3)_2 Cl_2$	[KCET 1996]
<b>26.</b>	Which of the following is paramagnetic [AFMC 1997]			
	(a) $[Ni(CO)_4]$ (b) $[Co(NH_3)_6]^{3+}$		(c) $[Pt(en)_3]^{4+}$	- \ /2
	(c) $[Ni(CN)_4]^{2-}$ (d) $[NiCl_4]^{2-}$	38.	Which of the following com	
27.	The total number of possible isomers for the complex		(a) $Ni(CO)_4$	[RPMT 1997] (b) $Ni(Cl_4)^{2-}$
	compound $\left[Cu^{II}(NH_3)_4\right]\left[Pt^{II}Cl_4\right]$ are			·
	[CBSE PMT 1998; DPMT 2004; J & K CET 2005]		(c) $Ni(Br)_4^{2-}$	(d) $NiCl_2.4H_2O$
	(a) 3 (b) 4 (c) 5 (d) 6	39.		paramagnetism [AMU 2001]
28.	(c) 5 (d) 6 Which one of the following shows maximum		(a) $Ni(CO)_4$	(b) $[Ni(NH_3)_4]Cl_2$
_0.	paramagnetic character [AIIMS 1998]		(c) $[Ni(NH_3)_6]Cl_2$	* · <del>-</del>
	(a) $[Cr(H_2O)_6]^{3+}$ (b) $[Fe(CN)_6]^{4-}$	40.	Which of the following co exhibit optical isomerism	oordiantion compounds would [CBSE PMT 2004]
	(c) $[Fe(CN)_6]^{3-}$ (d) $[Cu(H_2O)_6]^{2+}$		-	ylenediamine) chromium (III)
29.	The complexes $[Co(NH_3)_6][Cr(C_2O_4)_3]$ and		chloride	
-,,	$[Cr(NH_3)_6][Co(C_2O_4)_3]$ [AMU 2002]		(b) <i>tris</i> -(ethylenediamine)	
	(a) Linkage isomerism (b) Geometrical isomerism		<ul><li>(c) pentaamminenitrocoba</li><li>(d) diamminedichloroplat</li></ul>	
	(c) Coordination isomerism (d) Ionisation isomerism	41.	Which of the following doe	
30.	Which of the following exhibits highest molar	_	()	[AIIMS 2004]
	conductivity [MP PET 1994]		(a) $[Co(NH_3)_3 Cl_3]$	
	(a) $[Co(NH_3)_6]Cl_3$ (b) $[Co(NH_3)_5Cl]Cl_2$		(b) $[Co(en)_3]Cl_3$	
	(c) $[Co(NH_3)_4 Cl_2]Cl$ (d) $[Co(NH_3)_3 Cl_3]$	40	(c) $[Co(en)_2Cl_2]Cl$	(d) $[Co(en)(NH_3)_2Cl_2]Cl$
31.	Which of the following compounds is colourless	42.	which types of isomers	of co-ordination sphere yields [DCE 2002]
•	[MP PET 1994]		(a) Optical	(b) Geometrical
	(a) $Cu_2(CH_3COO)_4.2H_2O$ (b) $Cu_2Cl_2$	43.	(c) Ionisation Types of isomerism shown	(d) None of these
	(c) $CuSO_4.5H_2O$ (d) $[Cu(NH_3)_4]SO_4.4H_2O$	40.	$[Cr(NH_3)_5 NO_2]Cl_2$ is	Бу
32.	The type of magnetism exhibited by $[Mn(H_2O)_6]^{2+}$ ion is		(a) Optical	(b) Ionisation
•	[IIT 1994]		(c) Geometrical	(d) Linkage
	(a) Paramagnetism (b) Diamagnetism	44.	Which of the following w $AgNO_3$	ill not give a precipitate with [MP PET 2003]
	(c) Both (a) and (b) (d) None of these		(a) $\left[Co(NH_3)_3 Cl_3\right]$	
33.	The number of isomers possible for square planar complex $K_2[PdClBr_2(SCN)]$ is [MP PET 1994]			(d) $[Co(NH_3)_6]Cl_3$
			27 [ ( - 3/3 ] 2	× × F = 1 ( > 2 ) ( ) = 2
	(a) 2 (b) 3			

45.	How many ions are pro	oduced from $[Co(NH_3)_6]Cl_3$ in		(b) Show optical Isomeri	
	solution	[RPET 1999]		(c) Show ionic Isomerism	
	(a) 6	(b) 4		<ul><li>(d) A octahedral complex</li><li>(e) A cationic complex</li></ul>	X
46.	(c) 3 The colour of CoCl. 5NH	(d) 2 <i>I</i> <sub>3</sub> . <i>H</i> <sub>2</sub> <i>O</i> is [Kerala (Med.) 2002]		(c) Treationic complex	
40.	(a) Orange yellow	(b) Orange		Hybridisation	and Geometry
	(c) Green	(d) Violet		, , , , , , , , , , , , , , , , , , ,	<b>,</b>
	(e) Pink	(a) Violet	1.	The correct structural for	mula of <i>zeise's salt</i> is
47.	Which one of the fol	lowing is expected to be a		(a) $K^{+} [PtCl_{3} - \eta^{2} - (C_{2})]$	•
	paramagnetic complex	[MP PMT 1991, 2000]		•	_
	(a) $[Ni(H_2O)_6]^{2+}$	(b) $[Ni(CO)_4]$		(b) $K_2 [PtCl_3 - \eta^2 - C_2 H]$	
	(c) $[Zn(NH_3)_4]^{2+}$	(d) $[Co(NH_3)_6]^{+3}$		(c) $K^{+}[PtCl_{2} - \eta^{2} - (C_{2}R)]$	$H_4)$ C $l^-$
48.	Which one of the follow	ing will give a white precipitate		(d) $K^+ [PtCl_3(C_2H_4)]^-$	
	with $AgNO_3$ in aqueous i	mediun [MP PMT 1994]	2.		idisations of central atom in
	(a) $[Co(NH_3)_5 Cl](NO_2)_2$	(b) $[Pt(NH_3)_2Cl_2]$		$NH_3$ , $[PtCl_4]^{2-}$ , $PCl_5$ and	
	(c) $[Pt(en)Cl_2]$	(d) $\left[Pt(NH_3)_{4}\right]Cl_2$		(a) $dsp^2$ , $dsp^3$ , $sp^2$ and $sp^3$	-
49.		produced in solution from one		(a) $asp$ , $asp$ , $sp$ and $sp$ (b) $sp^3$ , $sp^3$ , $sp^3d$ and $sp$	
	molecule of chloropentan (a) 1	nmine cobalt (III) chloride (b) 2		(c) $dsp^2$ , $sp^3$ and $dsp^3$	
=0	(c) 3	(d) 4		(d) $dsp^2$ , $sp^3$ , $sp^2$ and $ds^2$	•
50.	with $BaCl_2$ (aq.)	mplex will give white precipitate  [JIPMER 1997]	0		compound $Co(NH_3)_5 Cl_3$ , gives
	=	(b) $[Cr(NH_3)_5 SO_4]Cl$	3⋅		lution in water. One mole of the
		· · · · · ·		_	h two moles of $AgNO_3$ solution
	(c) $[Cr(NH_3)_5Cl]SO_4$	(d) Both (b) and (c)			AgCl(s). The structure of the
51.	The number of precipits $[Pt(NH_3)Cl_2Br]Cl$ will be	able halide ions in the sample		complex is	
	(a) 2	(b) 3		-	[AIEEE 2003]
	(c) 4	(d) 1		(a) $[Co(NH_3)_5 Cl]Cl_2$	
<b>52.</b>	The colour of tetrammine			(b) $[Co(NH_3)_3 Cl_3].2NH$	3
	(a) Blue	(b) Red		(c) $[Co(NH_3)_4 Cl_2]Cl.NR$	$H_3$
	(c) Violet	(d) Green		(d) $[Co(NH_3)_4 Cl]Cl_2.NH$	$H_3$
<b>53</b> ·		per mole of a complex	4.	Cuprammonium ion [Cu(	$(NH_2)_{*}]_{2^+}$ is
	$[CoCl_2.5 NH_3]Cl_2$ in aque		Τ.	Topical Land	[MP PMT 1997; KCET 2002]
	(a) Nine	[MP PMT 2001] (b) Four		(a) Tetrahedral	(b) Square planar
	(c) Three	(d) Two		(c) Triangular bipyramic	d (d) Octahedral
54.		etrons are present in the central	5.	In the complex $[SbF_5]^{2-}$	$-, sp^3d$ hydridisation is present.
•	metal ion of $[CoCl_4]^{2-}$	[Orissa JEE 2005]		Geometry of the complex	
	(a) 3	(b) 4		(a) Square pyramidal	(b) Square bipyramidal
	(c) 5	(d) 2	6.	(c) Tetrahedral	(d) Square on involved in the metal ion of
<b>55</b> ·	What is the magnetic mor	ment of $K_3[FeF_6]$	0.	[ $Ni(H_2O)_6$ ] <sup>2+</sup> complex is	
	()	[Orissa JEE 2005]			
	(a) 5.91 BM (c) 3.87 BM	(b) 4.89 BM (d) 6.92 BM		(a) $d^3 sp^2$	(b) $sp^3d^2$
<b>56.</b>	(i) $K_4[Fe(CN)_6]$ (ii) $K_3[CN]$			(c) $sp^3$	(d) $dsp^2$
<b>J</b> 0.	(iv) $K_2[Ni(CN)_4]$	(61.761 (11.) 113[1 6(61.76]	7•	In the formation of $K_4Fe$	$e(CN)_6$ , the hybridisation involved
	Choose the complex which	h is paramagnetie		is	
	Choose the complex winc	[Kerala CET 2005]		(a) $sp^2$	(b) $d^2 sp^3$
	(a) (i), (ii) and (iii)	(b) (i), (iii)and (iv)		(c) $d^3 sp^2$	(d) $d^4 p$
	(c) (i), (iii) and (iv)	(d) (i), (ii) and (iv)	8.	Which of the following is	not true for metal carbonyls
	(e) (ii) and (iv)	d [Co(m) Cl ]Cl which is folco		(a) The evidetion state	[MP PET 1993]
<b>5</b> 7•	m coordination compoun	d $[Co(en)_2Cl_2]Cl$ which is false [Kerala CET 2005]	zero	(a) THE OXIDATION STATE	of the metal in the carbonyls is
	(a) Show geometrical Iso		-	(b) The secondary carbo decomposition	onyls are obtained from photo-

- (c) Metal carbonyls are single bonded species
- (d)  $d\pi p\pi$  overlap is observed in metal carbonyls
- **9.** An octahedral complex is formed, when hybrid orbitals of the following type are involved **[DCE 2003]** 
  - (a)  $sp^3$
- (b)  $dsp^2$
- (c)  $sp^{3}d^{2}$
- (d)  $sp^2d$
- **10.** Which one is an example of octahedral complex

### [MP PET 2000]

- (a)  $FeF_6^{3-}$
- (b)  $Zn(NH_3)_4^{2+}$
- (c)  $Ni(CN)_4^{2-}$
- (d)  $Cu(NH_3)_4^{2+}$
- **11.** Which of the following complexes has a square planar geometry
  - (a)  $Ag(NH_3)_2^+$
- (b)  $Cu(en)_2^{2+}$
- (c)  $[MnCl_4]^{2-}$
- (d)  $Ni(CO)_4$
- **12.** The shape of  $[Fe(CN)_6]^{4-}$  ion is
  - (a) Hexagonal(c) Octahedral
- (b) Pyrimidal(d) Octagonal
- **13.** What is the shape of  $Fe(CO)_5$
- [CBSE PMT 2000]
- (a) Linear
- (b) Tetrahedral
- (c) Square planar
- (d) Trigonal bipyramidal
- **14.** What type of hybridization is involved in  $[Fe(CN)_6]^{3-}$

### [AMU 1999]

- (a)  $d^2sp^3$
- (b)  $dsp^2$
- (c)  $sp^3d^2$
- (d)  $dsp^3$
- **15.** The example of  $dsp^2$  hybridisation is

### [MP PET 1999; AIIMS 2001]

- (a)  $Fe(CN)_6^{3-}$
- (b)  $Ni(CN)_4^{2-}$
- (c)  $Zn(NH_3)_4^{2+}$
- (d)  $FeF_6^{3-}$
- **16.** The shape of  $[Cu(NH_3)_4]^{2+}$  is square planar,  $Cu^{2+}$  in this complex is [NCERT 1989; RPET 1999]
  - (a)  $sp^3$  hybridised
- (b)  $dsp^2$  hybridised
- (c)  $sp^3d$  hybridised
- (d)  $sp^3d^2$  hybridised
- 17. The geometry of  $Ni(CO)_4$  and  $Ni(PPh_3)_2 Cl_2$  are

### [IIT-JEE 1999; DCE 2002]

- (a) Both square planar
- (b) Tetrahedral and square planar respectively
- (c) Both tetrahedral
- (d) Square planar and tetrahedral respectively
- 18. Which complex has square planar structure [JIPMER 2002]
  - (a)  $Ni(CO)_4$
- (b)  $[NiCl_4)^{2-}$
- (c)  $[Ni(H_2O)_6]^{2+}$
- (d)  $[Cu(NH_3)_4]^{2+}$
- **19.**  $[Pt(NH_3)_4]Cl_2$  is
- [DCE 2001]
- (a) Square planar
- (b) Tetrahedral
- (c) Pyramidal
- (d) Pentagonal
- **20.** A complex involving  $dsp^2$  hybridization has
  - (a) A square planar geometry
  - (b) A tetrahedral geometry
  - (c) An octahedral geometry
  - (d) Trigonal planar geometry

- **21.** A tetrahedral complex ion is formed due to ....... hybridization
  - (a)  $sp^2$
- (b)  $sp^{3}$
- (c)  $dsp^2$
- (d)  $d^2 sp^3$
- **22.** Back bonding is involved in which of the organometallic compounds
  - (a)  $[(CH_3)_3 Al]_2$
- (b)  $Mg^{2+}(C_5H_5^-)_2$
- (c) R Mg X
- (d)  $[(C_5H_5)_7Fe]$
- **23.**  $d^2sp^3$  hybridisation leads to
  - (a) Hexagonal shape
- (b) Trigonal bipyrimidal
- (c) Octahedral shape
- (d) Tetrahedral shape
- **24.** Chromium hexacarbonyl is an octahedral compound involving
  - (a)  $sp^{3}d^{2}$
- (b)  $dsp^2$
- (c)  $d^2 s p^3$
- (d)  $d^3sp^2$  orbitals
- **25.**  $\left[CoF_6\right]^{-3}$  is formed by ..... hybridization
  - (a)  $d^2 s p^3$
- (b)  $d^3 sp^2$
- (c)  $d^2 s p^3$
- (d)  $sp^{3}d^{2}$
- **26.** The species havoing tetrahedral shape is

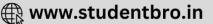
### [IIT-JEE (Screening) 2004]

- (a)  $[PdCl_4]^{2-}$
- (b)  $[Ni(CN)_4]^{2-}$
- (c)  $[Pd(CN)_4]^{2-}$
- (d)  $[NiCl_{4}]^{2-}$
- **27.** Among  $[Ni(CO)_4]$ ,  $[Ni(CN)_4]^2$ ,  $[NiCl_4]^2$  species, the hybridization states at the Ni atom are, respectively **[CBSE PMT 2004; MP PMT 1992; BHU 1995; AFMC 1997]** 
  - (a)  $sp^{3}, sp^{3}, dsp^{2}$
- (d)  $dsp^2, sp^3, sp^3$
- (c)  $sp^3, dsp^2, dsp^2$
- (d)  $sp^{3}, dsp^{2}, sp^{3}$
- (At. no. of Ni = 28)
- **28.** The bond in  $K_4[Fe(CN)_6]$  are:
- [MP PET 2004]
  - (a) All ionic
  - (b) All covalent
  - (c) Ionic and covalent
  - (d) Ionic, covalent and co-ordinate covalent
- **29.** Hybridization of Fe in  $K_3Fe(CN)_6$  is **[DCE 2002]**
- 11ybridization of  $1 \, \text{cm} \, \text{R}_3 \, \text{re}(c/v)_6$  is
  - (a)  $sp^3$
- (b)  $dsp^3$
- (c)  $sp^3d^2$
- (d)  $d^2 s p^3$
- **30.** The complex ion which has no 'd' electrons in the central metal atom is **[IIT-JEE Screening 2001]** 
  - (a)  $[MnO_4]^-$
- (b)  $[Co(NH_3)_6]^{3+}$
- (c)  $[Fe(CN)_6]^{3-}$
- (d)  $[Cr(H_2O)_6]^{3+}$
- **31.** Which of the following statement is correct
  - (a)  $\left[Cu(NH_3)_6\right]^{2+}$  is a colourless ion
  - (b)  $\left[Zn(H_2O)_6\right]^{2+}$  ion is blue coloured
  - (c)  $[Ni(CN)_4]^{2-}$  ion has a tetrahedral shape
- (d) Nickel dimethyl glyoxides is red in colour **32.** Which of the following shall form an octahedral complex
  - [DCE 2001]

- (a)  $d^4$  (low spin)
- (b)  $d^8$  (high spin)
- (c)  $d^6$  (low spin)
- (d) None of these







33.	Which one of the follow	ving is a strong field ligand	2.	The most stable ion is	[AIEEE 2002]
	(a) <i>CN</i> <sup>-</sup>	(b) $NO_2^-$		(a) $[Fe(OH)_3]^{3-}$	(b) $[Fe(Cl)_6]^{3-}$
	(c) en	(d) $NH_3$		(c) $[Fe(CN)_6]^{3-}$	(d) $[Fe(H_2O)_6]^{3+}$
34.	The strongest ligand in	the following is [MP PET 1995]	3.	The most stable comple	ex among the following is
	(a) <i>CN</i> <sup>-</sup>	(b) $Br^-$		(a) W [AVC (c) ]	[MP PMT 2002]
	(c) <i>HO</i> <sup>-</sup>	(d) $F^-$		(a) $K_3[Al(C_2O_4)_3]$	
<b>35</b> ·	The neutral ligand is (a) Chloro	(b) Hydroxo	4	(c) $Ag(NH_3)_2Cl$ Which of the following	(d) $K_2(Ni(EDTA)]$ ng factors tends to increase the
	(c) Ammine	(d) Oxalato	4.	stability of metal ion co	mplexes
36.	The ligands which car	get attached to the central metal		(a) Higher ionic radius	
	ion through more than			(b) Higher charge/size	ratio of the metal ion otential of the metal ion
	<ul><li>(a) Ambident ligands</li><li>(c) Chelate ligands</li></ul>	<ul><li>(b) Polydentate ligands</li><li>(d) Neutral ligands</li></ul>		(d) Lower basicity of the	
37.	A strong ligand gives a	complex which is generally called	5∙	CuSO <sub>4</sub> reacts with KC	N solution and forms:[DPMT 2004
	(a) High spin	(b) High energy		(a) $K_3[Cu(CN)_4]$	(b) $Cu(CN)$
<b></b>	(c) Low spin	(d) Stable		(c) $Cu(CN)_2$	(d) $K_4[Cu(CN)_6]$
38.	C/v is a strong field if	gand. This is due to the fact that  [CBSE PMT 2004]	6.		lex compound of cobalt has the ntaining five ammonia molecules,
	(a) It can accept electr				wo chlorine atoms for one cobalt
		complexes with metal species			s compound produces three mole
	<ul><li>(c) It carries negative</li><li>(d) It is a pseudohalid</li></ul>	8			olution on reacting with excess of vitate. The ionic formula for this
39.	-	weak field ligand, the number of		complex would be:	
	unpaired electrons in [	$Mn(H_2O)_6]^{2+}$ will be (At. No. of $Mn$		(a) [Co(NH ) (NO )](	[DPMT 2004; Kerala PMT 2004]
	= 25) asas a ajkk	[CBSE PMT 2004]		(a) $[Co(NH_3)_5(NO_2)]C$ (b) $[Co(NH_3)_5Cl][Cl(NH_3)_5Cl]$	
	(a) Two	(b) Four		(c) $[Co(NH_3)_4(No_2)Cl]$	<del>-</del>
40.	(c) Three Which of the following	(d) Five is a $\pi$ - complex		(d) $[Co(NH_3)_4(NO_2)c_1]$	-
40.	(a) Trimethyl alumini		7•		adding potassium ferrocyanide, a
	(c) Diethyl zinc	(d) Nickel carbonyl	/ <b>•</b>	prussian blue colour is	obtained, which is
41.	Which of the following			(a) $K_3 Fe(CN)_6$	[BIT 1992; BHU 2002] (b) $KFe[Fe(CN)_6]$
	(a) $NH_3$	[KCET 1996; AIIMS 2003] (b) <i>CO</i>		(d) $FeSO_4.Fe(CN)_6$	- · · · · · · · · · · · · · · · · · · ·
	(c) F <sup>-</sup>	(d) Ethylene diamine	8.	Prussian blue is formed	
<b>42.</b>	The value of the 'spin	only' magnetic moment for one of	0.	(a) Ferrous sulphate re	
	the following configura	tions is 2.84 BM. the correct one		(b) Ferric sulphate rea	•
	(a) $d^4$ (in strong ligar	[AIEEE 2005]			n sulphate reacts with FeCl <sub>3</sub>
	(a) $d$ (in strong ligar) (b) $d^4$ (in weak ligar)			(d) Ammonium sulpha	_
	(c) $d^3$ (in weak as well		9.		e made by the combination of
	(d) $d^5$ (in strong ligar	*		$[Co^{III}(NH_3)_5 Cl]^X$ with	
43.		$_{0})_{4}$ and $Ni(PPh_{3})_{2}Cl_{2}$ are		(a) $PO_4^{3-}$	(b) <i>Cl</i> <sup>-</sup>
	(a) Both gaveno plane	[BHU 2005]		(c) 2 <i>Cl</i> <sup>-</sup>	(d) $2K^{+}$
	<ul><li>(a) Both square planes</li><li>(b) Tetrahedral and so</li></ul>	uare planar respectively	10.	1 /	sed to identify nickel ion
	(c) Both tetrahedral			(a) Resorcinol	[DMG]
	(d) Square planar and	tetrahedral respectively		<ul><li>(b) Dimethyl glyoxime</li><li>(c) Diphenyl benzidine</li></ul>	
	Compleyes an	d complex stability		(d) Potassium ferrocya	
	Oomplexes an	a complex stability	11.		ns a coloured complex with
1.		complexes has the highest stability		(a) Ag	(b) <i>Ni</i>
	constant at 298 K	a) [a, 12-	10	(c) <i>Cr</i> Silver chloride dissolver	(d) Zn
	(a) $[CdCl_4]^{2-}$	(b) $[CdBr_4]^{2-}$	12.	present in this solution	s in excess of $NH_4OH$ . The cation is <b>[EAMCET 1998]</b>
	(c) $[CdI_4]^{2-}$	(d) $\left[ Cd(CN)_4 \right]^{2-}$		Present in this solution	[mmchi 1990]

- (a)  $Ag^+$
- (b)  $[Ag(NH_3)_2]^+$
- (c)  $[Ag(NH_3)_4]^+$
- (d)  $[Ag(NH_3)_6]^+$
- Silver sulphide dissolved in a solution of sodium 13. cynamide to form the complex [AMU 1999]
  - (a)  $Na[Ag(CN)_2]$
- (b)  $Na_3[Ag(CN)_4]$
- (c)  $Na_5[Ag(CN)_6]$
- (d)  $Na_2[Ag(CN)_2]$
- Which one will give  $Fe^{3+}$  ions in solution
  - (a)  $[Fe(CN)_6]^{3-}$
  - (b)  $Fe_{2}(SO_{4})_{3}$
  - (c)  $[Fe(CN)_6]^{4-}$
  - (d)  $NH_4(SO_4)_2.FeSO_4.6H_2O$
- The cation that does not form an amine complex with 15. excess of ammonia is
  - (a)  $Cd^{2+}$
- (b)  $Al^{3+}$
- (c) Cu<sup>2+</sup>
- (d)  $Ag^+$

### **Application of organometallics**

- Ziegler-Natta catalyst is an organometallic compound of which metal [J & K CET 2005]
  - (a) Iron
- (b) Zirconium
- (c) Rhodium
- (d) Titanium
- In the case of small cuts, bleeding is stopped by applying 2. potash alum. Here alum acts as

### [KCET (Med.) 2001]

- (a) Fungicide
- (b) Disinfectant
- (c) Germicide
- (d) Coagulating agent
- The formula of ferrocene is 3.
  - (a)  $[Fe(CN)_6]^{4-}$
- (b)  $[Fe(CN)_6]^{3-}$
- (c)  $\left[ Fe(CO)_5 \right]$
- (d)  $[(C_5H_5)_2Fe]$
- Which of the following is formed when n-butyl lithium 4. reacts with tin (II) chloride [AFMC 2001]
  - (a) LiBr
- (b)  $Et_4Pb$
- (c)  $(C_4H_9)_4Sn$
- (d)  $(C_2H_5)_4Pb$
- Which of the following organo-silicon compound on 5. hydrolysis will give a three dimensional silicone

### [Orissa JEE 2003]

- (a)  $R_3SiCl$
- (b)  $RSiCl_3$
- (c) SiCl<sub>4</sub>
- (d)  $R_2SiCl_2$
- Which one is not an organometallic compound 6.
  - [J & K CET 2005; Pb. CET 2003]
  - (a) RMgX
- (b)  $C_2H_5ONa$
- (c)  $(CH_3)_4 Sn$
- (d)  $KC_4H_9$
- The complex used as an anticancer agent is [AIIMS 2003]
  - (a) trans  $-[Co(NH_3)_3 Cl_3]$  (b) cis  $-[PtCl_2(NH_3)_2]$
  - (c)  $cis K_2[PtCl_2Br_2]$
- (d)  $Na_2CO_3$
- 8. The compound that is not olefinic organometallic is
  - (a)  $K[C_2H_4PtCl_3]3H_2O$  (b)  $Be(CH_2)_2$
  - (c)  $(C_2H_4PtCl_3)_2$
- (d)  $C_{\perp}H_{\perp}Fe(CO)_{3}$

- Among the following, which is not the  $\pi$ -bonded organometallic compound [CBSE PMT 2003]
  - (a)  $(CH_3)_4 Sn$
- (b)  $K[PtCl_3(\eta^2 C_2H_4)]$
- (c)  $Fe(\eta^5 C_5H_5)_2$
- (d)  $Cr(\eta^6 C_6H_6)_2$
- Wilkinson's catalyst is used in 10.
  - (a) Polymerization
- (b) Condensation
- (c) Halogenation
- (d) Hydrogenation
- What is the use of tetraethyl lead 11.
  - (a) As a catalyst in addition reaction of alkenes
  - (b) As a catalyst in polymerization reaction of alkenes
  - (c) For reducing knocking
  - (d) For creating knocking
- Which of the following is an organo-metallic compound 12.

### [MP PMT 2001]

- (a) Lithium ethoxide
- (b) Ethyl lithium
- (c) Lithium acetate
- (d) Lithium carbide
- Which of the following is an organometallic compound 13. [AIIMS 1997]
  - (a)  $Ti(C_2H_5)_4$
- (b)  $Ti(OC_2H_5)_4$
- (c)  $Ti(OCOCH_3)_A$
- (d)  $Ti(OC_6H_5)_4$
- Which of the following is not an organometallic 14. compound

### [MP PET 1996; BHU 2002]

- (a) Ethyl magnesium bromide
- (b) Tetraethyl lead
- (c) Sodium ethoxide
- (d) Trimethyl aluminium
- An organometallic compound amongst the following is 15.
  - (a) Ferrocene
- (b)  $CaC_2$
- (c) Tetraethyl lead (TEL) (d) All of these
- 16. Which of the following does not have a metal carbon bond [CBSE PMT 2004]
  - (a)  $K[Pt(C_2H_4)Cl_3]$
- (b)  $Ni(CO)_4$
- (c)  $Al(OC_2H_5)_3$
- (d)  $C_2H_5MgBr$
- Coordination compounds have great importance in biological systems. In this context which of the following statements is incorrect [AIEEE 2004]
  - (a) Cyanocobalamin is  $B_{12}$  and contains cobalt.
  - (b) Haemoglobin is the red pigment of blood and contains iron.
  - (c) Chlorophylls are green pigments in plants and contains calcium.
  - (d) Carboxypepticase-A is an enzyme and contains zinc. [Pb. CET 2004]
  - Ziegler-Natta catalyst is (a)  $(Ph_3P)_3RhCl$

18.

- (b)  $K[PtCl_3(C_2H_4)]$
- (c)  $[Al_2(C_2H_6)_6] + TiCl_4$
- (d)  $[Fe(C_2H_5)_2]$
- Dimethyl glyoxime gives a red precipitate with  $Ni^{2+}$ , 19. which is used for its detection. To get this precipitate readily the best *pH* range is [AIIMS 2004] (a) < 1(b) 2-3
- The  $\pi$ -bonded organo metallic compound which has 20. ethene as one of its component is [J & K CET 2005]
  - (a) Zeise's salt

(c) 3-4

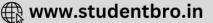
(b) Ferrocene

(d) 9-11

(c) Dibenzene chromium (d) Tetraethyl tin.







## Critical Thinking

### **Objective Questions**

- The coordination number and oxidation state of Cr in  $K_3[Cr(C_2O_4)_3]$  are, respectively [CBSE PMT 1995]
  - (a) 4 and +2
- (b) 6 and +3
- (c) 3 and +3
- (d) 3 and o
- The complex compounds which result from the 2. coordination of carbon monoxide are known as
  - (a) Electronic
- (b) Carbonyls
- (c) Carbonates
- (d) Carbon permono
- Mixture X = 0.02 mol of  $[Co(NH_3)_5 SO_4]Br$  and 0.02 3. mol of  $[Co(NH_3)_5Br]SO_4$  was prepared in 2 litre of
  - 1 litre of mixture  $X + \text{excess } AgNO_3 \rightarrow Y$ .
  - 1 *litre* of mixture  $X + \text{excess } BaCl_2 \rightarrow Z$

Number of moles of Y and Z are

[IIT JEE 2003]

- (a) 0.01, 0.01
- (b) 0.02, 0.01
- (c) 0.01, 0.02 (d) 0.02, 0.02
- Which of the following organometallic compound is  $\sigma$ and  $\pi$  bonded [MH CET 2001; PCET 2002]
  - (a)  $Fe(CH_3)_3$
  - (b)  $[Fe(\eta^5 C_5H_5)_2]$
  - (c)  $[Co(CO)_5 NH_3]^{2+}$
  - (d)  $K[PtCl_3(n^2 C_2H_4)]$
- In  $[Ni(NH_3)_4]SO_4$ , the valency and coordination number 5. of Ni will be respectively
  - (a) 3 and 6
- (b) 2 and 4
- (c) 4 and 2
- (d) 4 and 4
- Co-ordination number of Fe in the complexes 6.  $[Fe(CN)_6]^{4-}$ ,  $[Fe(CN)_6]^{3-}$  and  $[FeCl_4]^{-}$ would be respectively [MP PET 2003]
  - (a) 2, 3, 3
- (b) 6, 6, 4
- (c) 6, 3,3
- (d) 6, 4, 6
- On hydrolysis  $(Me)_2 SiCl_2$  will produce [IIT-JEE 2003] 7.
  - (a)  $(Me)_2 Si(OH)_2$
  - (b)  $(Me)_2 Si = O$
  - (c)  $-[-O-(Me)_2Si-O-]_n$
  - (d)  $Me_2SiCl(OH)$
- 8. Which of the following represents a chelating ligand

### [JIPMER 2002]

- (a)  $H_2O$
- (b) OH<sup>-</sup>
- (c) DMG
- (d) Cl<sup>-</sup>
- CuSO<sub>4</sub> reacts with KCN solution and forms 9.

### [MP PMT 1992; IIT 1996; UPSEAT 2001, 02]

- (a)  $Cu(CN)_2$
- (b) Cu(CN)
- (c)  $K_2[Cu(CN)_4]$
- (d)  $K_3[Cu(CN)_4]$

- In the process of extraction of gold,
  - Roasted gold ore  $+CN^- + H_2O \xrightarrow{O_2} [X] + OH^-$

$$[X] + Zn \rightarrow [Y] + Au$$

Identify the complexes [X] and [Y]

- (a)  $X = [Au(CN)_2]^-, Y = [Zn(CN)_4]^{2-}$
- (b)  $X = [Au(CN)_A]^{3-}, Y = [Zn(CN)_A]^{2-}$
- (c)  $X = [Au(CN)_2]^-, Y = Zn(CN)_6]^{4-}$
- (d)  $X = [Au(CN)_{4}]^{-}, Y = [Zn(CN)_{4}]^{2-}$
- 11. A solution of potassium ferrocyanide would contains .....

  [BHU 1999] [KCET 1990]
  - (a) 2

(b) 3

(c) 4

- (d) 5
- 12. Which one of the following complexes is an outer orbital complex [AIEEE 2004]
  - (a)  $[Co(NH_3)_6]^{3+}$
- (b)  $[Mn(CN)_6]^{4-}$
- (c)  $[Fe(CN)_6]^{4-}$
- (d)  $[Ni(NH_3)_6]^{2+}$

Atomic nos: Mn = 25, Fe = 26, Co = 27, Ni = 28

Which one of the following has largest number of isomers 13.

### [AIEEE 2004]

- (a)  $[Ir(PP_3)_2H(CO)]^{2+}$
- (b)  $[Co(NH_3)_5 Cl]^{2+}$
- (c)  $[Ru(NH_3)_4 Cl_2]^+$
- (d)  $[Co(en), Cl_2]^+$

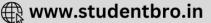
(R = alkyl group; en = ethylenediamine)

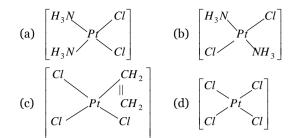
- Which kind of isomerism is exhibited by octahedral [IIT-JEE Screening 2005]  $Co(NH_3)_4 Br_2 Cl$  ?
  - (a) Geometrical and Ionization
  - (b) Geometrical and Optical
  - (c) Optical and Ionization
  - (d) Geometrical only
- Which one of the following is expected to exhibit optical isomerism (en = ethylenediamine)
  - (a)  $cis [Pt(NH_3)_2Cl_2]$
- (b)  $trans [Co(en), Cl_2]$
- (c)  $trans [Pt(NH_3)_2Cl_2]$  (d)  $cis [Co(en)_2Cl_2]$
- $[EDTA]^{4-}$  is a: 16.
- [UPSEAT 2004] (b) Bidentate ligand
- (a) Monodentate ligand (c) Quadridentate ligand
- (d) Hexadentate ligand
- Which of the following statements is incorrect? 17.

- (a) In  $K_3[Fe(CN)_6]$ , the ligand has satisfied only the secondary valency of ferric ion.
- (b) In  $K_3[Fe(CN)_6]$ , the ligand has satisfied both primary and secondary valencies of ferric ion.
- (c) In  $K_4[Fe(CN)_6]$ , the ligand has satisfied both primary and secondary valencies of ferrous ion.
- (d) In  $[Cu(NH_3)_4]SO_4$ , the ligand has satisfied only the secondary valency of copper.
- Which of the following is considered as an anticancer 18. species. [CBSE PMT 2004]









**19.** An aqueous solution of  $CoCl_2$  on addition of excess of concentrated HCl turns blue due to formation of

[AIIMS 2005]

- (a)  $[Co(H_2O)_4Cl_2]$
- (b)  $[Co(H_2O)2Cl_4]^{2-}$
- (c)  $[CoCl_4]^{2-}$
- (d)  $[Co(H_2O)2Cl_2]$
- **20.** The correct order for the wavelength of absorption in the visible region is **[AIIMS 2005]** 
  - (a)  $[Ni(NO_2)_6]^{4-} < [Ni(NH_3)_6]^{2+} < [Ni(H_2O)_6]^{2+}$
  - (b)  $[Ni(NO_2)_6]^{4-} < [Ni(H_2O)_6]^{2+} < [Ni(NH_3)_6]^{2+}$
  - (c)  $[Ni(H_2O)_6]^{2+} < [Ni(NH_3)_6]^{2+} < [Ni(NO_2)_6]^{4-}$
  - (d)  $[Ni(NH_3)_6]^{2+} < [Ni(H_2O)_6]^{2+} < [Ni(NO_2)_6]^{4-}$
- 21. In which of the following pairs both the complexes show optical isomerism [AIIMS 2005]
  - (a)  $cis-[Cr(C_2O_4)_2Cl_2]^{3-}$ ,  $cis-[Co(NH_3)_4Cl_2]$
  - (b)  $[Co(en)_3]Cl_3$ ,  $cis-[Co(en)_2Cl_2]Cl$
  - (c) [PtCl(dien)]Cl,  $[NiCl_2Br_2]^{2-}$
  - (d)  $[Co(NO_3)_3(NH_3)_3]$ , cis- $[Pt(en)_2Cl_2]$
- **22.** Which of the following compounds shows optical isomerism

### [AIEEE 2005; CBSE PMT 2005]

- (a)  $[Cu(NH_3)_4]^{2+}$
- (b)  $[ZnCl_4]^{2-}$
- (c)  $[Cr(C_2O_4)_3]^{3-}$
- (d)  $[Co(CN)_6]^{3-}$



Read the assertion and reason carefully to mark the correct option out of the options given below :

- (a) If both assertion and reason are true and the reason is the correct explanation of the assertion.
- (b) If both assertion and reason are true but reason is not the correct explanation of the assertion.
- (c) If assertion is true but reason is false.
- (d) If the assertion and reason both are false.
- (e) If assertion is false but reason is true.
- **1.** Assertion : Potassium ferrocyanide and potassium ferricyanite both are diamagnetic.
  - Reason : Both have unpaired electrons.
- **2.** Assertion :  $NF_3$  is a weaker ligand than  $N(CH_3)_3$

Reason :  $NF_3$  ionizes to give  $F^-$  ions ionsiionsionsioliioioioioioioioio

ions in aqueous solution.

3. Assertion : The  $[Ni(en)_3]Cl_2$  (en = ethylene diamine) has lower stability than  $[Ni(NH_3)_6]Cl_2$ 

Reason : In  $[Ni(en)_3]Cl_2$  the geometry of Ni is trigonal bipyramidal

4. Assertion: The ligands nitro and nitrito are called ambidentate ligands.

Reason : These ligands give linkage isomers.

**5.** Assertion : Geometrical isomerism is also called *cistrans* isomerism.

Reason : Tetrahedral complexes show geometrical isomerism.

**6.** Assertion :  $\left[ (en)_2 Co \bigvee_{OH}^{NH} Co(en)_2 \right]^{3+}$  is named as

tetrakis (ethylene diamine)  $\mu$ -hydroxoimido dicobalt (III) ion.

Reason : In naming polynuclear complexes *i.e.*, containing two or more metal atoms joined by bridging ligands, the word  $\mu$  is added with hyphen before the name of such ligands.

7. Assertion :  $[Fe(CN)_6]^{3-}$  is weakly paramagnetic while  $[Fe(CN)_6]^{4-}$  is diamagnetic.

Reason :  $[Fe(CN)_6]^{3-}$  has +3 oxidation state while  $[Fe(CN)_6]^{4-}$  has +2 oxidation state.

**8.** Assertion :  $H_2N - NH_{2}$  is a chelating ligand.

Reason: A chelating ligand must possess two or more lone pairs at such a distance that it may form suitable strain free rings at the metal ion.

**9.** Assertion :  $[Ti(H_2O)_6]^{3+}$  is coloured while  $[Sc(H_2O)_6]^{3+}$  is colourless.

Reason : d-d transition is not possible in  $[Sc(H_2O)_6]^{3+}$ .

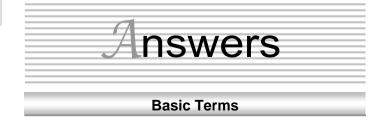
**10.** Assertion : All the octahedral complexes of  $Ni^{2+}$  must be outer orbital complexes.

Reason : Outer orbital octahedral complexes are given by weak ligands.

**11.** Assertion : Potassium ferrocyanide is diamagnetic whereas potassium fericyanide is paramagnetic.

Reason : Crystal field splitting in ferrocyanide ion is greater than that of ferricyanide ion.

[AIIMS 2005]







1	b	2	С	3	b	4	b	5	d
6	а	7	b	8	С	9	b	10	С
11	d	12	С	13	d	14	b	15	b
16	b	17	а	18	С	19	С	20	b
21	b	22	С	23	b	24	d	25	а
26	d	27	а	28	b	29	b	30	С
31	b	32	С	33	b	34	b	35	d
36	d	37	b	38	b	39	d	40	b
41	d	42	b	43	d	44	b	45	а
46	a	47	d	48	С	49	b	50	d
51	а	52	b	53	d	54	а	55	d
56	d	57	а	58	d	59	а	60	d
61	С	62	d						

### Nomenclature, oxidation State and EAN number

1	b	2	С	3	С	4	b	5	d
6	С	7	b	8	а	9	а	10	а
11	С	12	а	13	b	14	а	15	b
16	С	17	d	18	b	19	d	20	а
21	b	22	b	23	а	24	b	25	а
26	d	27	С	28	b	29	а	30	а
31	а	32	b	33	а	34	b	35	С
36	b	37	а	38	а	39	b	40	С
41	а	42	b	43	С	44	b	45	b
46	d	47	а	48	b	49	С	50	С
51	b	52	b	53	С	54	d	55	b
56	а	57	b	58	С				

### **Isomerism and Magnetic properties**

1	а	2	d	3	а	4	С	5	С
6	d	7	b	8	а	9	а	10	С
11	d	12	d	13	b	14	С	15	а
16	b	17	а	18	d	19	а	20	b
21	С	22	b	23	b	24	а	25	а
26	d	27	d	28	а	29	С	30	а
31	b	32	а	33	С	34	а	35	d
36	С	37	d	38	а	39	d	40	b
41	а	42	С	43	d	44	а	45	b
46	е	47	а	48	d	49	С	50	С
51	d	52	а	53	С	54	а	55	а
56	С	57	С						

### **Hybridisation and Geometry**

1	а	2	b	3	а	4	b	5	a
6	b	7	b	8	d	9	С	10	a
11	b	12	С	13	d	14	а	15	b
16	b	17	d	18	d	19	а	20	а

21	b	22	d	23	С	24	С	25	С
26	d	27	d	28	d	29	d	30	a
31	d	32	С	33	а	34	а	35	С
36	а	37	С	38	d	39	d	40	b
41	b	42	а	43	С				

### Complexes and complex stability

1	d	2	d	3	d	4	b	5	а
6	a	7	d	8	b	9	С	10	b
11	b	12	b	13	а	14	b	15	b

### **Application of organometallics**

1	d	2	d	3	d	4	С	5	b
6	b	7	b	8	а	9	а	10	d
11	С	12	b	13	а	14	С	15	d
16	С	17	С	18	С	19	d	20	а

### **Critical Thinking Questions**

1	b	2	b	3	а	4	b	5	b
6	b	7	С	8	С	9	d	10	a
11	d	12	d	13	d	14	а	15	d
16	d	17	ad	18	а	19	С	20	а
21	b	22	С						

### **Assertion & Reason**

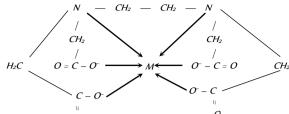
1	d	2	С	3	d	4	а	5	С
6	е	7	b	8	е	9	а	10	b
11	С								



## S Answers and Solutions

### **Basic terms**

- 1. (b) (CN) are linked with secondary valency.
- **2.** (c) In Cuprammonium sulphate  $[Cu(NH_3)_4]SO_4$  co-ordination no. of Cu is 4.
  - (b) As it makes use of its two atoms to form two co-ordinate covalent bonds with the central metal ion.
- **4.** (b)  $[Co(en)_2Br_2]Cl_2$ C.N. of  $Co = 2 \times$  number of bidentate ligand +1×number of monodentate ligand =2× 2 + 1× 2 = 6.
- (b) The charge does not decide the formation of bond but availability of lone pair decide the formation of Co-ordinate bond.
- 8. (c) In  $[Co(en)_2 Cl_2]^+$ No. of monodentate ligand = 2 No. of bidentate ligand = 2 Co-ordination no. of the metal = 2 + 2(2)= 6. 10. (c)
- **12.** (c) According to modern view primary valency of complex compound is its oxidation number while secondary valency is the co-ordination number.
- 15. (b) Co-ordination number is equal to total number of ligands in a complex.
- 16. (b) Cuprammonium salt- $[Cu(NH_3)_4]SO_4$   $[Cu(NH_3)_4]SO_4 \rightleftharpoons [Cu(NH_3)_4]^{2^+} + SO_4^{2^-}$  So, it will give two ions in water.
- 17. (a) The co-ordination no. = no. of ligands attached.
- **18.** (c) Primary valencies are also known as oxidation state.  $K_2[Ni(CN)_4], \ 2+x-4=0 \Rightarrow x=+2$
- 20. (b)  $Ag^+$  has two coordination number forms complex with excess of  $CN^ Ag(CN)_2$ .
- 21. (b) According to Lewis the ligands are basic in nature.
- **22.** (c) The number of atoms of the ligand that are directly bounded to the central metal atom or ion by coordinate bond is known as the coordination number of the metal atom or ion coordination number of metal = number of  $\sigma$  bonds formed by metal with ligand .
- 23. (b)  $Ag_2S + 4NaCN = 2Na[Ag(CN)_2] + Na_2S$ Sodium dicyno argentate  $2Na[Ag(CN)_2] + Zn \rightarrow Na_2[Zn(CN)_4] + 2Ag \downarrow$ Sodium tetracyno zincate (ppt)
- **24.** (d) In  $K_4Fe(CN)_6$ , the species retains its identity in solid as well as in solution state.
- 26. (d) The number of atom of the ligand that are directly bound to the central metal atom or ion by coordinate bonds is known as the coordinate number of the metal or ion. It is actually the number of chemical bonds which the ligand form with the central metal atom or ion.



- **27.** (a)  $CN^-$  ion Q acts both as reducing agent as well as good complexing agent.
- **29.** (b) ZnS structure shows the coordination number of Zn is 4.
- **30.** (c) Wilkinson's catalyst is  $Rh(P.Ph_3)_3Cl$ ].
- 31. (b) The complexes can be written as follows  $[Co(NH_3)_6]Cl_3[Co(NH_3)_5Cl]Cl_2\ [Co(NH_3)_4Cl_4]Cl_{(C)}$

Hence, number of primary valencies are 3, 2 and 1 respectively.

- **32.** (c) Ligand must have capacity to donate lone pair of electrons to form co-ordinate bond.
- **33.** (b)  $K_3[Fe(CN)_6]$  because in it  $CN^-$  donats a lone pair of electron.
- **34.** (b) Al has 6 co-ordination number.
- 35. (d)  $K_4[Fe(CN)_6] \rightarrow 4K^+ + [Fe(CN)_6]^{4-}$ Complex has negative charge so it is anionic complex.
- **36.** (d) Co-ordination number is equal to total number of ligands in a complex.
- **37.** (b) Lithium tetrahydroaluminate is  $Li[Al(H)_4]$ .
- **40.** (b) Negative ligands end in -O eg.  $SO_4^{2-}$  (sulphato).
- **44.** (b) Turnbull's blue is  $K\{Fe^{II}[Fe^{III}(CN)_6]\}$ .
- **46.** (a)  $Fe + 5CO \xrightarrow{\text{Heat}} [Fe(CO)_5]$ Pressure Iron pentacarbonyl.
- 48. (c) When a ligand attaches to the central metal atom through two or more atoms to form a ring like structure is known as chelats and the ligand is called chelating ligand.

and the ligand is called chelating ligand.

53. (b) eg. 
$$n \, CH_3 - CH = CH_2 \xrightarrow{Ti \, Cl_4 + (C_2H_5)_3 \, Al} (-CH - CH_2)_n$$

$$CH_3$$

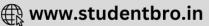
- **55.** (d)  $CH_3Li$  is the organometallic compound in which lithium bonded with carbon and organometallic are those in which metal-carbon bond found.
- **56.** (d) Potash alum is a mixed salt of  $K_2SO_4$  and  $Al_2(SO_4)_3$  and on dissolving, it gives all three ion  $Al^{3+}, K^+$  and  $SO_4^{2-}$  of which it is made.
- **57.** (a) Carnallite is a double salt with molecular formula  $KCl.MgCl_2.6H_2O$ . It gives  $K^+,Mg^{2+}$  and  $Cl^-$  ions in solution
- **59.** (a) General formula for alum is  $M_2SO_4.R_2(SO_4)_3.24H_2O$

 $M = \text{mono valent cation } (K^+, Na^+, ...)$ 

 $R = \text{Trivalent cation } (Al^{+3}, Fe^{+3})$ 

Hence,  $K_2SO_4Al_2(SO_4)_2.24H_2O$  represent an alum.





- **60.** (d)  $K_4[Fe(CN)_6]$  is a complex salt. On ionisation it will dissociate in  $4K^+$  and  $[Fe(CN)_6]^{4-}$  ion. Hence, in  $K_4[Fe(CN)_6]$  five ions are present.
- **61.** (c) Due to C Mg bond.
- **62.** (d) EAN = (At. number  $-0.S + 2 \times C.N.$ ) Hence, EAN of Ni in  $Ni(CO)_4$  is  $= 28 - 0 + 2 \times 4 = 36$

### Nomenclature, Oxidation State & EAN number

- 1. (b)  $[Co(H_2O)_6]Cl_2 \Rightarrow [Co(H_2O)_6]^+ + 2Cl^-$ .
- **5.** (d) Follow IUPAC rule.
- 7. (b) Follow IUPAC rule.
- 9. (a) Follow IUPAC rule.
- 10. (a) Follow IUPAC rule.
- 11. (c) EAN =Atomic number Oxidation state +  $2 \times$  number of Ligands = 26 2 + 2 (6) = 36.
- 12. (a) EAN of Pt in  $[PtCl_6]^{2-} = 80$
- 13. (b)  $Na_2[Cr F_4 O]$  x + 4(-1) + (-2) = -2 $x - 6 = -2 \Rightarrow x = +4$ .
- 14. (a) Follow IUPAC rule.
- 16. (c) Follow IUPAC rule.
- 17. (d) Follow IUPAC rule.
- **18.** (b) The oxidation state of metal in metal carbonyl is zero.
- 19. (d)  $x + 6 \times (0) + 3 \times (-1) = 0$ x - 3 = 0, x = +3, Oxidation number of Cr is = +3.
- **20.** (a) EAN = (atomic no)- (oxidation state) + (2 × number of Ligands) = 28 2 + 2 × 4 = 34
- **21.** (b) Follow IUPAC rule.
- **22.** (b)  $[Pt(C_2 H_4)Cl_3]^$ x + 0 + 3x(-1) = -1, x - 3 = -1, x = +2.
- 23. (a)  $[Co(NH_3)_6]Cl_3 \rightarrow [Co(NH_3)_6]^{3+} + 3Cl^{-1}$  $x + 6(0) = +3 \Rightarrow x = +3$ .
- **24.** (b) Follow IUPAC rule.
- **25.** (a) EAN = at. no. of central atom oxidation state  $+2 \times$  (no. of ligands) =  $27 3 + 2 \times 6 = 36$ .
- **26.** (d) Follow IUPAC rules for nomenclature.
- 27. (c) EAN of a central metal ion=(atomic no. of central atom) oxidation state + no. of ligands  $\times$  2 =  $26-3+(6\times2)=23+12=35$
- **28.** (b)  $+1 \times 4 + x 1 \times 4 = 0$  $4 + x - 4 = 0 \Rightarrow x = 0 \text{ for } Ni.$
- 29. (a) Follow IUPAC rule.
- **30.** (a) In complex  $K_4[Fe(CN)_6]$  the Fe obey EAN rule strictly.

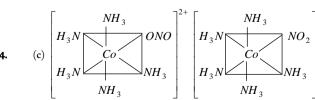
- 31. (a)  $Ni(CO)_A$  has O.N. zero for Ni.
- **32.** (b)  $3 \times (+1) + x + 6 \times (-1) = 0$  or x = 6 3 = +3 Oxidation state of Fe = +3.
- 33. (a) Complexes containing carbonyl ligand (CO) have zero oxidation state.
- **34.** (b) Follow IUPAC rule.
- 35. (c) Follow IUPAC rule.
- **36.** (b) Follow IUPAC rule.
- 38. (a) Follow IUPAC rule.
- 39. (b) Follow IUPAC rule.
- 41. (a) Follow IUPAC rule.
- **42.** (b)  $[Ni(CN)_4]^x$ , (Ni = +2)(CN = -1) $x = 2 + 4(-1) \Rightarrow x = -2$ .
- **44.** (b)  $[Cu(NH_3)_4]^{2+}$  so, copper has + 2 valency.
- **47.** (a) Follow IUPAC rule.
- **50.** (c) Follow IUPAC rule.
- 51. (b)  $[Co_x(H_2O)_5 Cl]^{+2}$  $x-1=2 \Rightarrow x=+3$ .
- **52.** (b) It is clear from the chemical formulae that Ag is central metal atom and ligands are 2 ammonia molecule.

Hence, compound is  $[Ag(NH_3)_2]Cl$ .

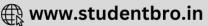
- **53.** (a) In the compounds  $[Co(NH_3)_5 NO_2]Cl_2$ , the oxidation state of cobalt is +3 and here 5  $NH_3$  ligand, a  $NO_2$  ligand are attached to the central atom. therefore its name is pentaamminecobalt (III) chloride.
- **54.** (b)  $CrO_2 Cl_2$ ,  $MnO_4$ .
- **55.** (b) In the given ion  $[Cr(NH_3)_6]^{3+}$ , the oxidation state of chromium is +3 and here  $6NH_3$  ligand are attached to the central metal atom. Therefore its IUPAC name is hexamminechromium (III) ion.
- **56.** (a) It is potassium ammine dicyano dioxo peroxo-chromate (VI)
- **57.** (b) Potassium hexa cyanoferrate (III).

### **Isomerism and Magnetic Properties**

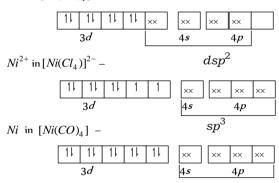
- (a) Octahedral complexes of the type  $[MA_4B_2], [MA_2B_4], [MA_3B_3] \ \ \text{exhibit geometrical}$  isomerism.
- **2.** (d) The number of unpaired electrons in the Complex ion  $\left[CoF_{6}\right]^{3-}$  is 4.



Here more than one atom function as donor, as oxygen in first one and nitrogen in second, so they show linkage isomerism

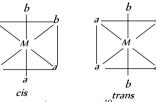


- **5.** (c) The two given compounds have same composition but in solution both will give different ions. The isomerism is known as ionisation isomerism.
- 7. (b) The compound which has same composition but give different ions in solution, show ionization. So  $[Co(NH_3)_5Br]SO_4$  is ionization isomer.  $[Co(NH_3)_5Br]SO_4 = [Co(NH_3)_5Br]^{2+} + SO_4^{2-}$   $[Co(NH_3)_5SO_4]Br = [Co(NH_3)SO_4]^+ + Br^-.$
- **9.** (a) Co-ordination isomerism is caused by the interchange of ligands between cis and trans structure.
- 10. (c)  $[Co~(NH_3)_5~NO_2]Cl_2$  will not show geometrical isomerism because this complex showed 4 and 6 co-ordination number.
- 13. (b)  $[Fe(H_2O)_6]^{2^+}$  has four unpaired electrons,  $[Cr(H_2O)_6]^{3^+}, \ [Cu(H_2O)_6]^{2^+} \ \text{and} \ [Zn(H_2O)_6]^{2^+} \ \text{have 3, 1,}$  0 unpaired electrons respectively.
- 14. (c) The electronic configuration of Ni in  $[Ni(CN)_4]^{2-}, [Ni(Cl_4)]^{2-} \text{ and } Ni(CO)_4 \text{ are as following}$   $Ni^+ \text{ in } [Ni(CN)_4]^{2-} -$

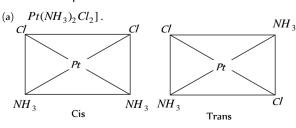


CO and  $CN^-$  are strong ligands so they induces pairing of electrons so their complexes are diamagnetic while  $Cl^-$  is a weak ligand so it does not induce the pairing of electrons so its complex is paramagnetic.

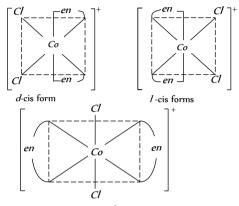
**15.** (a)  $[Co\ (NH_3)_4\ Cl_2]^+$  is the  $Ma_4b_2$  and  $Ma_2b_3$  type



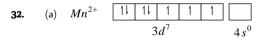
16. (b)  $\ln [Ag(NH_3)_2]Cl, Ag^+$  contains  $d^{10}$  configuration. All others contain unpaired electrons.



- 19. (a)  $O_2N$   $NO_2$   $H_3N$   $NO_2$   $H_3N$   $NO_2$   $H_3N$   $NO_2$   $NO_2$
- **21.** (c)  $[Co(en)_2 NO_2 Cl]Br$ ;  $[Co(en)_2 ONOCl]Br$
- **22.** (b) Because it will not give any ions in solution.
- **23.** (b)  $[Co(en)_2 Cl_2]^+$  have three optical isomers which are.



- **24.** (a) Magnetic moment of  $[Cu(NH_3)_4]^{2+}$  ion is 1.414 due to the presence of one unpaired electron.
- **25.** (a) Due to the presence of one unpaired electron, both are slightly paramagnetic.
- 27. (d) 1.  $[Cu(NH_3)_4].[PtCl_4]$ 2.  $[Cu(NH_3)_3Cl].[PtCl_3(NH_3)]$ 3.  $[Cu(NH_3)_2Cl_2].[PtCl_2(NH_3)_2]$  cis 4.  $[Cu(NH_3)_2Cl_2].[PtCl_2(NH_3)_2]$  Trans
  - 5.  $[Cu(NH_3)Cl_3].[Pt(Cl)(NH_3)_3]$
  - 6. [*Pt*(*NH*<sub>3</sub>)<sub>4</sub> *Cl*].[*Cu Cl*<sub>4</sub>]
- **29.** (c) Co-ordination isomerism is possible when both +ve and -ve ions of a salt are complex ions and the two isomers differ in the distribution of ligands in the cation and the anion.
- **30.** (a) On ionisation it gives maximum number of (four) ions.
- 31. (b) The anhydrous complex of  $Cu^+$  do not involve  $d\!-\!d$  transition and are thus colourless.

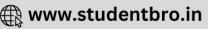


In presence of  $H_2O$  which is a weak ligand no pairing occurs which results in unpaired electrons left in the compound, due to which it shows paramagnetism.

- **33.** (c) Geometrical isomers (cis and trans) and linkage isomers (–SCN and –NCS).
- **34.** (a) Due to presence of strong ligand all the  $e^-$  get paired. So no. of unpaired electrons are 0.
- $\begin{tabular}{lll} \bf 36. & (c) & Both have same composition but give different ions in the solution. \end{tabular}$

37.

(d)

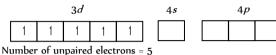


17.



- 52. Cu (II) complexes are blue.
- It will ionize in the following manner. 53.  $[Co(NH_3)_5]Cl_2 \rightleftharpoons [Co(NH_3)_5]^{2+} + 2Cl^-$  (3 ions).
- (a)  $_{27}Co \rightarrow [Ar]3d^7 4s^2$ 54.  $Co^{2+} \rightarrow 3d^7 4s^0$ 
  - Number of unpaired electrons = 3.
- 55.  $K_3[FeF_6]$

$$Fe^{3+} = [Ar]3d^5 4s^0$$

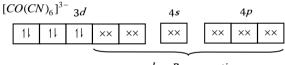


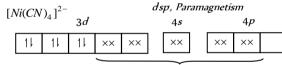
Magnetic moment 
$$=\sqrt{n(n+2)} = \sqrt{5(5+2)}$$

$$=\sqrt{35}$$
 = 5.91 BM.

(c)  $[Fe(CN)_6]^{4-}$ 56. 4*p* 11  $\times \times$ ××

dsp, Paramagnetism





- dsp. Paramagnetism
- When coordinate compounds gives different ions in solution 57. then it produces ionic isomerism while this situation is not present in  $[Co(en)_2 Cl_2]Cl$ .

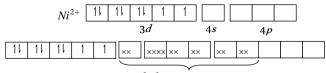
### **Hybridisation and Geometry**

 $2Cl^-$  ions are ionizable

$$\therefore \left[ Co(NH_3)_5 Cl \right] Cl_2 = \left[ \underbrace{Co(NH_3)_5 Cl}_{\text{3 ions}} \right]^{2+} + 2Cl^{-1}$$

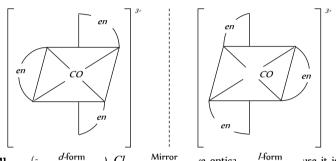
$$2Cl^- + 2AgNO_3 \rightarrow 2AgCl + 2NO_3^-$$
.

- Copper complexes usually involve with four co-ordination number and have square planar in shape.
- Complex with  $sp^3d$  hybridisation show square pyramidal 5. geometry.
- $sp^3d^2$ 6. (b)



- $sp^3d^2$  hybridisation
- Metal carbonyls does not show overlapping.
- $sp^3d^2$  hybridisation gives octahedral complex.

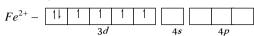
- 38. CO is a strong ligand so induce pairing of electrons and hence  $Ni(CO)_4$  is diamagnetic.
- $[Co(en)_3]^{3+}$ 40.



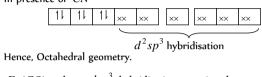
- $_{3}Cl_{3}$ Mirror use it is ve ontica 41. of formula  $MA_3B_3$  which does not show optical isomerism.
- Change in composition of co-ordination sphere yield ionization 42.  $[Cr(H_2O)_6]Cl_3$  and  $[CrCl_3(H_2O)_3].3H_2O$
- (d)  $NO_2$  is ambident and can be linked either to N -side as 43.  $(-NO_2)$  or to O -side as (-ONO).
- (a) As  $[Co(NH_3)_3Cl_3]$  does not losses any Cl-ions in the 44. solution so it will not give ppt, with  $AgNO_3$ .
- (b)  $[Co(NH_3)_6]Cl_3 = [Co(NH_3)_6]^{3+} + 3Cl^{-}$ . 45
- (e)  $CoCl_3.5NH_3.H_2O$  is pink in colour. 46.
- The configuration of  $Ni^{2+}$  has two unpaired electron so it is 47.
- (d)  $[Pt(NH_3)_4]Cl_2 \rightarrow [Pt(NH_3)_4]^{+2} + 2Cl^{-1}$ 48. As it gives  $\ensuremath{\mathit{Cl}^-}$  ions in solution so it will give white ppt. of AgCl with  $AgNO_3$ .
- (c)  $[Co(NH_3)_5 Cl]Cl_2 = [Co(NH_2)_5 Cl]^{2+} + 2Cl^{-}$ 49.
- (c)  $[Cr(NH_3)_5 Cl]SO_4 \rightarrow [Cr(NH_3)_5 Cl]^{2+} + SO_4^{2-}$ 50.  $(Cr(NH_3)_5 Cl)^{2+} + SO_4^{2-} + BaCl_2 \rightarrow$  $[Cr(NH_3)_5Cl]Cl_2 + BaSO_4 + HCl$ .
- (d)  $[Pt(NH_3)Cl_2Br]Cl \Rightarrow [Pt(NH_3)Cl_2Br]^+ + CJ^-$ 51.  $Cl^-$  ion is precipitable.



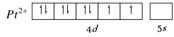
- (b) Copper complexes usually involve co-ordination number of four 11. and are thus square planar in shape.
- $[Fe(CN)_6]^{4}$ 12.



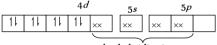
In presence of  $CN^-$ 



- $Fe(CO)_5$  has  $dsp^3$ -hybridisation so it show trigonal 13. bipyramidal geometry.
- (b) Due to formation of inner orbital complex. 16.
- $Ni(CO)_4$  and  $Ni(PPh_3)_2Cl_2$  have  $sp^3$ and  $dsp^2$  -17. hybridisation respectively.
- $[Cu(NH_3)_4]^{2+}$  has square planer structure. 18.
- Since hybridisation is  $dsp^2$  so it is square planar, 19.



Excited state

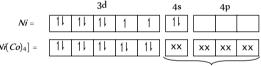


dsp hybridisation  $d^2sp^3$  -hybridisation leads to octahedral geometry

 $[CoF_6]^{3-}$  is an outer complex having  $d^2sp^3$  hybridisation. 25.

(d) 27.

23.



sp3 hybridization



11 11 11 1

xx xx xx xx sp3 hybridization

28.

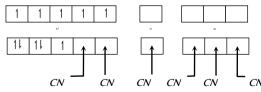
 $K_3[Fe(CN)_6]$ 29.

Electronic configuration of  $Fe = [Ar]4s^2 3d^6$ 

Electronic configuration of  $Fe^{+3} = [Ar]3d^5$ 

Number of ligand (coordination numbr)=6

Nature of ligand is strong field.



Hybridization of Fe is  $d^2sp^3$ .

- (c) The compounds which show  $d^6$  configuration are octahedral 32. complexes.
- $CN^-$  ligand has strong field ligand because of higher value of 33. (a)
- Ammine  $(NH_2)$  is neutral ligand. 35. (c)
- 37. A strong field ligand produces low spin complexes.
- Cyanide ion is strong field ligand because it is a pseudohalide 38. ion pseudohalide ions are stronger coordinating ligand & they have the ability to form  $\sigma$  bond (from the pseudohalide to the metal) and  $\pi$  bond (from the metal to pseudohalide).

 $Mn^{25} \longrightarrow 3d^5 + 4s^2$ (d) 39.

$$Mn^{2+} \longrightarrow 3d^5$$
 1 1 1 1 1

In presence of weak ligand field, there will be no pairing of electrons. So it will form a high spin complex. i.e. the number of unpaired electrons = 5.

The complexes, in which, the metal and ligand form a bond 40. that involves the  $\pi$ -electrons of the ligand are know as  $\pi$  – complexes *e.g.* Ferrocene

$$Fe \ (\eta^5 - C_5 H_5)_2$$
, zeise's salt  $K[PtCl_3(\eta^2 - C_2 H_4)]$ .

- (b) CO has strong  $M \rightarrow L$   $\pi$  bonding ability so it can accept 41. electron pairs from metal ion so it is a  $\pi$  -acid ligand.
- $d^4$  (in strong ligand field). 42.
- (c) Both Ni(CO)<sub>4</sub> and Ni(PPh<sub>3</sub>)<sub>2</sub>Cl<sub>2</sub> are tetrahedral. 43.

### Complexes and complex stability

- The cyano and ammine complexes are far more stable than those formed by halide ions. This is due to the fact that  $NH_3$ and  $CN^-$  are strong lewis bases.
- Greater the charge on central metal ion greater is the stability of complex.
- (a)  $CuSO_4$  on reaction with KCN gives  $K_3[Cu(CN)_4]$ 5.  $2CuSO_4 + 10KCN \rightarrow 2K_3[Cu(CN)_4] + 2K_2SO_4 + (CN)_2$
- The most probable complex which gives three moles ions in 6. aqueous solution may be  $[Co(NH_3)_5 NO_2]Cl_2$  because it gives two chlorine atoms on ionisation.

 $[Co(NH_3)_5 NO_2]Cl_2 \rightarrow [Co(NH_3)_5 NO_2]^{2+} + 2Cl^{-}$ 

- $3 K_4[Fe(CN)_6] + 4 FeCl_3 \rightarrow Fe_4[Fe(CN)_6]_3 + 12KCl$ 7. pot. ferrocyanide (Ferri ferrocynide)
- (b)  $Fe_2(SO_4)_3 \rightarrow 2Fe^{3+} + 3SO_4^{2-}$ 8.  $K_4[Fe(CN)_6] + 2Fe^{3+} \rightarrow Fe_4[Fe(CN)_6]_3$ .
  Prussion blue
- (c)  $[Co(NH_3)_5Cl]^x + 2Cl^- \rightarrow [Co(NH_3)_5Cl]Cl_2$ . 9.
- Ni reacts with dimethylglyoxime to give red ppt. of nickel-10. dimethyl glyoxime complex.

$$CH_3 - C = N$$

$$CH_3 - C = N$$

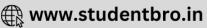
$$OH$$

$$CH_3 - C = N$$

$$OH$$

$$OH$$





13. (a)  $Ag_2S + NaCN \Rightarrow Na [Ag(CN)_2] + Na_2S$ .

14. (b)  $Fe_2(SO_4)_3 \rightarrow 2Fe^{3+} + 3SO_4^{-2}$ .

15. (b) Aluminum is a p-block element and does not form complex compounds.

### **Application of Organometallics**

1. (d)  $(CH_3CH_2)_3Al + TiCl_4$  is the Ziegler-Natta catalyst.

2. (d) Alum acts as coagulating agent.

4. (c)  $4CH_3CH_2CH_2CH_2 - Li + SnCl_2 \rightarrow (C_4H_9)_4 Sn$ .

**6.** (b) As there is no direct bonding between the metal atom and the carbon atom.

**9.** (a)  $(CH_3)_4 Sn$  is a  $\sigma$  – bonded organometallic compound.

10. (d) Wilkinson's catalyst is used as homogeneous catalyst in the hydrogenation of alkenes as  $-\,$ 

$$H-H+ \rangle C = C \langle \longrightarrow H-C-C-H.$$

12. (b)  $C_2H_5$  Li is an organo-metallic compound.

13. (a) Because there is direct bonding of metal ion with carbon.

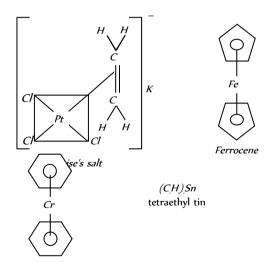
14. (c) Organometallic compounds are those compounds in which carbon atom is directly linked to metal. But in sodium ethoxide as oxygen is attached to sodium metal so it is not a organometallic compound.

**16.** (c)  $Al(OC_2H_5)_3$  contains bonding through O and thus it does not have metal-carbon bond.

 (c) Chlorophyll are green pigment in plant & contain magnesium instead of calcium.

19. (d) This reaction carried out in alkaline pH i.e., 9–11

**20.** (a)



#### dibenzene chromium Critical Thinking Questions

 (b) Its coordination number will be 6 because it is bonded with three bidentale ligands.

Oxi. No. of 
$$Cr$$
 in  $K_3[Cr(C_2O_4)_3]$  is  $x + 3(-2) + 3(+1) = 0 \implies x = +3$ 

**2.** (b) e.g.  $Fe(CO)_5$ ,  $Ni(CO)_4$  etc.

3. (a)  $[Co\ (NH_3)_5SO_4]Br + AgNO_3 \rightarrow 0.02 \text{ mole}$ 

$$[Co(NH_3)_5.SO_4]NO_3 + AgBr$$
 $0.02 \text{ mole}(y)$ 

$$[Co(NH_3)_5 Br_2]SO_4 + BaCl_2 \rightarrow$$
0.02 mole

$$[Co\,(N\!H_3)_5\,Br]\,Cl_2 + BaSO_4 \\ {\scriptstyle 0.02\,\mathrm{mole}(z)}$$

On using one lit. solution, we will get 0.01 mole y and 0.01 mole z.

**4.** (b)  $[Fe(\eta^5-C_5H_5)_2]$  is the organometallic compound which has  $\sigma$  and  $\pi$  bonds present.

5. (b)  $[Ni_x (NH_3)_4]SO_4$ 

 $x + 0 + (-2) = 0 \Rightarrow x = +2$  is valency and 4 is *C.N.* of *Ni*.

 (b) Co-ordination number is equal to total number of ligands in a complex.

7. (c) 
$$n\begin{bmatrix} Cl & Cl \\ Si & CH_3 \end{bmatrix} + 2nH_2O \rightarrow \begin{pmatrix} CH_3 \\ -O-Si-O- \\ CH_3 \end{pmatrix}_n$$

**8.** (c) Because it is a polydentate ligand which binds the central atom nickel forming a ring like structure.

9. (d)  $4KCN + CuSO_4 \rightarrow K_3[Cu(CN)_4]$ Potassium tetracynocuprate

10. (a) Roasted+ $CN^- + H_2O \xrightarrow{O_2} [Au(CN)_2]^- + OH^-$ gold ore

$$\left[Au(CN)_2\right]^- + Zn \rightarrow \left[Zn(CN)_4\right]^{2-}.$$

11. (d) Potassium ferrocynide  $K_4[Fe(CN)_6]$  will ionize as  $K_4[Fe(CN)_6] \rightleftharpoons 4K^+ + [Fe(CN)_6]^{4-}$ 

So, it will give five ions in solution.

**12.** (d) Complex ion Hybridization of central atom

 $\left[Fe(CN)_6\right]^{4-}$   $d^2sp^3$  (inner)

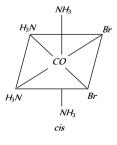
 $[Mn(CN)_6]^{4-} d^2sp^3 (inner)$ 

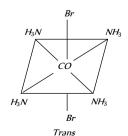
 $[Co(NH_3)_6]^{3+} d^2sp^3 (inner)$ 

 $[Ni(NH_3)_6]^{2+} sp^3d^2 (outer)$ 

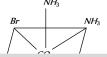
13. (d)  $[Co(en)_2 Cl_2]^+$  shows geometrical as well as optical isometrism.

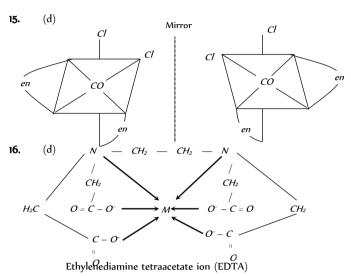
**14.** (a)











They have six donor atoms. poly dentate ligands have flexidentate character. It is not necessary that all the donor atoms present in the polydentate ligands should form co-

ordinate bonds with central metal atom or ion.

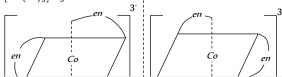
(a.d.) In  $K_*[Fe(CN)]$ , the ligand are perative which is

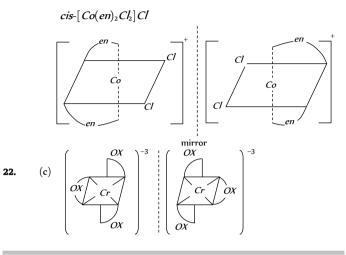
17. (a,d) In  $K_3[Fe(CN)_6]$  the ligand are negative which is present in coordination spheres shows a dual behaviour. It may satisfied both primary & secondary valencies while neutral ligand satisfied only secondary valencies.

- 18. (a) Cis Isomer of  $[Pt(NH_3)_2 Cl_2]$  is used as an anticancer drugs for treating several type of malignant tumours. When it is injected into the blood stream the more reactive Cl groups are lost so the Pt atom bonds to a N atom in guanosine (a part of DNA) This molecule can bond to two different guanosine units & by bridging between them it upsets the normal reproduction of DNA.
- 19. (c) CoCl is a weak Lewis acid, reacting with chloride ion to produce salt containing the tetrahedral [CoCl] ion. CoCl is blue when anhydrous, and a deep magneta colour when hydrated, for this reason it is widely used as an indicator for water.
- 20. (a) The absorption of energy or the observation of colour in a complex transition compound depends on the charge of the metal ion and the nature of the ligands attached. The same metal ion with different ligands shows different absorption depending upon the type of ligand. The presence of weak field ligands make the central metal ion to absorb low energies i.e., of higher wavelength. The field strength of ligands can be obtained from spectrochemical series. i.e.

(weak field)  $I < Br < S < CI < NO_i < F < OH < H_iO < NH_i < NO_i < CN < CO (strong field)$ 

**21.** (b)  $[Co(en)_3]Cl_3$ 





### **Assertion and Reason**

- (d) Potassium ferrocyanide and potassium ferricyanide both are not diamagnetic because both do not have paired electrons.
   Assertion and reason both are false.
- 2. (c) It is correct statement that  $NF_3$  is a weaker ligand than  $N(CH_3)_3$ , the reason is that fluorine is highly electronegative therefore, it with draw electrons from nitrogen atom. Hence, the lone pair of nitrogen atom cannot be ligated. While  $N(CH_3)_3$  is a strong ligand because  $CH_3$  has electron releasing group.
- **3.** (d) Both assertion and reason are false.  $[Ni(en)_3]Cl_2$  is a chelating compound and chelated complexes are more stable than similar complexes involves breaking of two bonds rather than one. In  $[Ni(en)_3]Cl_2$ , Ni with  $d^8$  configuration shows octahedral geometry. Six electrons will occupy the  $t_{2g}$  orbitals and two electrons will occupy the  $e_g$  orbitals.
- **4.** (a) Both assertion and reason are true and reason is the correct explanation of assertion . When a monodentate ligand has two possible donor atoms and attached in two ways to the central metal atom are called ambidentate ligands.
- **5.** (c) Assertion is true but reason is false. Tetrahedral complexes do not show geometrical isomerism because the relative position of the atoms with respect to each other will be the same.
- **6.** (e) Assertion is false but reason is frue.

$$\begin{bmatrix} (en)_2 Co \\ OH \end{bmatrix}^{3+}$$
 is named as tetrakis

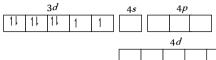
(ethylene diamine)-  $\mu$  -hydroxo-  $\mu$  -imido dicobalt (III) ion. For



- more than one bridging group the word  $\mu$  is repeated before each bridging group.
- 7. (b) Both assertion and reason are true but reason is not the correct explanation of assertion.  $[Fe(CN)_6]^{3-}$  has EAN equal to 35 and thus possesses unpaired electron to show paramagnetic nature while  $[Fe(CN)_6]^{4-}$  possesses no unpaired electron and thus shows diamagnetic nature.
- **8.** (e) Assertion is false but reason is true.  $H_2N-NH_2$  does not act as chelating ligand. The coordination by hydrazine leads to a three member highly unstable strained ring and thus it does not act as chelating agent.
- 9. (a) Both assertion and reason are true and reason is the correct explanation of assertion.  $[Sc(H_2O)_6]^{3+}$  has no unpaired electron in its d subshell and thus d-d transition is not possible whereas  $[Ti(H_2O)_6]^{3+}$  has one unpaired electron in its d subshell which gives rise to d-d transition to impart colour.

**10.** (b) Both assertion and reason are true but reason is not the correct explanation of assertion.

 $Ni^{2+}$  configuration



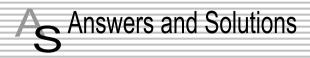
During rearrangement only one 3d-orbital may be made available by pairing the electrons. Thus, inner  $d^2sp^3$  hybridization is not possible, so, only  $sp^3d^2$  (outer) hybridization can occur.

11. (c)  $K_4[Fe(CN)_6]$  and  $K_3[Fe(CN)_6]$  both are low spin complex due to strong ligand field. That is why it is false that crystal field splitting in ferrocyanide ion is greater than ferricyanide ion.

## **Co-odination Chemistry**

# ET Self Evaluation Test -20

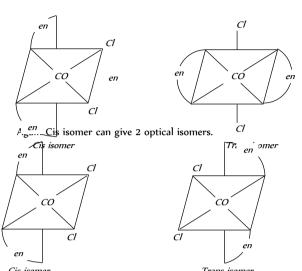
1.	(a) Potassium ferricyanide	5 [NCL1 2002]		( ) [ ] ( ) [ ] ( ) [ ]	נבו טואווויין:	יטכבו וח ו וואו יוב	CDOD 1 M11 1330]
	<ul><li>(a) Potassium terricyanide</li><li>(b) Cobalt hexamine chloride</li></ul>			(a) $[Ag(NH_4)_2]OH$			
	(c) Cuprous sulphate			(b) $[Ag(NH_4)_2]Cl$			
	(d) Mohr's salt			(c) $[Ag(NH_3)_2]OH$			
2.	The complex $[Pt(NH_3)_6]Cl_4$	furnishes [MP PET 1995]		(d) $[Ag(NH_3)_2]Cl$			
	(a) 5 ions	(b) 4 ions					
	(c) 3 ions	(d) 2 ions	12.	The oxidation number of cob	alt in $K[$	$[Co(CO)_4]$ is	
3.	How many isomers are possible	e in $[Co(en)_2Cl_2]$			4.	-	J & K CET 2005]
		[Orissa JEE 2004]		(a) +1	(b)	-1	
	(a) 2	(b) 4	10	(c) +3	. ,	-3	1 (
	(c) 6	(d) 1	13.	The complex salt can	be mad	e by the c	
4.	$\pi$ -bonding is not present in	[MP PET 2003]		$[Co^{III}(NH_3)_5Cl]^x$ with:			[Pb. CET 2001]
	(a) Grignard reagent (b) Dibenzene chromium			(a) $PO_4^{3-}$	(b)	$Cl^-$	
	(c) Zeise's salt			(c) $2Cl^-$	(4)	2 <i>K</i> <sup>+</sup>	
	(d) Ferrocene		14.	Which one of the following	. ,		mley as well as
5.	Grignard reagent is a			diamagnetic in behaviour (A			•
	(a) Coordinate compound			27, $Ni = 28$ )		[CBSE PMT 200	05]
	(b) Double salt			(a) $[Zn(NH_3)_6]^{2+}$	(b)	$[Cr(NH_3)_6]^3$	3+
	(c) Organometallic compound	d		() [C (NII ) 13+			
6.	(d) None of these Which one of the following cor	mplayas is paramagnatic		(c) $[Co(NH_3)_6]^{3+}$	(d)	$[Ni(NH_3)_6]^2$	
0.	which one of the following cor	[RPMT 1997]	15.	The oxidation state of Fe in	$K_4[Fe(C$	$(N)_6$ ] is	
	(a) $[Co(F)_6]^{3+}$	(b) $[Co(H_2O)_6]^{3+}$				[Pb. CET 200	3; MP PET 2002]
		2 10		(a) +2	(b)	-2	
	(c) $[CoF_3(H_2O)_3]$	(d) All of these		(c) +3	(d)	+4	
7.	The oxidation state of <i>Fe</i> in the	e complex $[Fe(CO)_5]$ is	16.	The number of moles of	AgCl	precipitate w	hen excess of
	(a) 1	[MP PMT 2003]		$AgNO_3$ is added to one mo	ole of [Ci	$r(NH_3)_4 Cl_2$ ]C	$\mathcal{U}$ is
	(a) -1 (c) +4	(b) +2 (d) Zero					[EAMCET 1998]
8.	Which of the following is non-	. ,		(a) Zero	(b)	1.0	
	(a) $[Co(NH_3)_3Cl_3]$	(b) $[Co(NH_3)_4 Cl_2]Cl$		(c) 2.0	(d)	3.0	
	(c) $[Co(NH_3)_5Cl]Cl_2$	(d) $[Co(NH_3)_6]Cl_2$	17.	An anion solution gives a w	hite ppt.	With AgNO	3 solution. The
9.	_	ion number of $X$ in the compound		ppt. dissolves in dil. ammonia	a due to t	he formation of	f
<b>J</b> .	$[X(SO_4)(NH_3)_5]Cl$ will be	ion number of A in the compound					[MP PMT 1997]
	[11(004)(1113)5]01	[JIPMER 1997; DCE 2004]		(a) $AgNO_3$	(b)	$NH_4NO_3$	
	(a) 6 and 4	(b) 10 and 3		(c) $\left[Ag(NH_3)_2\right]Cl$	(d)	$[Ag(NH_3)_2]$	Br
	(c) 2 and 6	(d) 6 and 3	18.	The diamagnetic specie is			- [AIIMS 2005]
10.	In $[NiCl_4]^{2-}$ , the number of	unpaired electron is		(a) $[Ni(CN)_4]^{2-}$	<b>(L)</b>	[N;Cl 1 <sup>2-</sup>	
	•	[BHU 2003]		(a) $[Nl(CN)_4]$	(b)	$[NiCl_4]^{2-}$	
	(a) 4.5	(b) 2		(c) $[CoCl_4]^{2-}$	(d)	$[CoF_6]^{2-}$	
	(c) 3	(d) 4					
11.	AgCl precipitate dissolves in	ammonia due to the formation of					



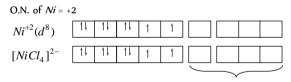
(SET -20)



- 1. (d) Mohr's salt ( $FeSO_4.(NH_4)_2SO_4.6H_2O$ ) is a double salt.
- **2.** (a)  $[Pt.(NH_3)_6]Cl_4 = [Pt.(NH_3)_6]^{4+} + 4Cl^{-}(5 \text{ ions}).$
- 3. (b)  $[Co(en)_2 Cl_2]$  has 2 geometrical isomers & 2 optical isomers.



- 4. Cis isomer reagent is, R Mg X.
- **5.** (c) The organometallic compound of Mg is known as Grignard reagent (R-Mg-X).
- **6.** (d) As all the ligands are weak so they do to induce pairing of electrons so they show paramagnetism.
- 7. (d) In  $[Fe(CO)_5]$ , x + 5(0) = 0, so oxidation number of Fe is zero.
- **8.** (a) Atoms present with in co-ordination sphere do not ionise.
- 9. (d) Co-ordination no. is 6 oxidation state in  $[X(SO_4)(NH_3)_5]Cl$  is x-2+0-1=0, x=+3.
- 10. (b)  $[NiCl_4]^{2-}$



Which has two unpaired electrons that is why it i paramagnetic.

11. (d)  $AgCl + NH_3 \rightarrow [Ag(NH_3)_2]Cl$  Diammine silver(I)chloride

x = 3 - 1 = 2

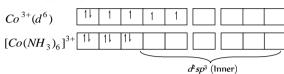
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- 12. (b)  $1 \times (+1) + x + 4 \times (0) = 0$   $1 + x = 0 \Rightarrow x = -1$  Oxidation number of Co = -1.
- 13. (c) In the complex ion  $[Co^{(III)}(NH_3)_5Cl]^x$ , charge on the complex ion  $x=3+(0\times 5)+(-1)$

Hence, it will combine with that species which have -2 charge to produce a neutral complex salt. So it will combine with  $2Cl^-$  to produce  $[Co(NH_3)_5Cl]Cl_2$  complex.

**14.** (c)  $[Co(NH_3)_6]^{3+}$ 

O. N. of Co = +3



Due to paired  $e^-$  it is diamagnetic.

**15.** (a)  $4 \times (+1) + x + 6 \times -1 = 0$ 

or x = +6 - 4 = +2

Oxidation state of Fe = +2

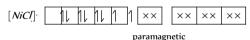
**16.** (b) In this complex chloride ion in the form of ionic isomerism and show primary valency.

 $AgNO_3$  is added in excess then result precipitation will occur.

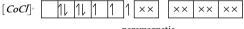
17. (c)  $AgNO_3 + Cl^- \rightarrow AgCl + NO_3^-$ 

 $AgCl + 2NH_3 \rightarrow [Ag(NH_3)_2]Cl.$ diammine silver (I)chloride.

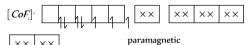
diamagnetic



paramagnetic



paramagnetic



## Tips & Tricks

 ${\mathscr E}$  Badecker reaction : This reaction involves the following chemical change.

 $Na_2[Fe(CN)_5NO] + Na_2SO_3 \rightarrow Na_4[Fe(CN)_5(NO.SO_3)]$ 

**Exeritt's salt :** It is  $K_2[Fe(CN)_6]$  obtained by reduction of prussian blue.

**Masking**: Masking is the process in which a substance without physical separation of it is so transformed that is does not enter into a particular reaction e.g., masking of  $Cu^{2+}$  by  $CN^{-}$  ion.

**Macrocyclic effect:** This term refers to the greater thermodynamic stability of a complex with a cyclic polydentate ligand when compared to the complex formed with a non-cyclic ligand. e.g., Zn(II) complex with ligand;



**E Prussian blue** and **Turnbull's blue** is pot. ferric ferrocyanide. However colour of Turnbull's blue is less intense than prussian blue. Decrease in colour is due to the presence in it of a white compound of the formula  $K_2\{Fe[Fe(CN)_6]\}$  named as potassium ferrous ferrocyanide.

∠
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 Crystal field theory explains why certain geometries are more favoured than other by certain metals in terms of crystal field stablization energies.

 $\mathcal{L}$  The colour of complexes are explained in terms of electronic transitions between the various d orbitals of different energies.

 $mathrew{mathrew}$  In octahedral complexes, the energy of the  $d_{z^2}$  and  $d_{x^2-y^2}$  orbitals increases much more than the energy of the  $d_{xy}, d_{yz}, d_{xz}$  orbitals. The potential energy increases as a result of repulsive interactions. The greater the repulsion, greater is the increases in energy.

Ligands with larger groups from unstable rings than the ligands with smaller groups. This is ascribable to steric hinderance produced by a larger group.

 $\angle$  The copper sulphate solution e.g., turns deep blue when excess of ammonia is added. This is also due to the formation of [CU(NH)]SO

**E** Co-ordination compound with a general formula MA, MAB or MABCD do not show any geometric isomerism.

E Flexidentate character: polydentate ligand are said to have flexidentate character if they do not use all its donar atoms to get coordinated to the metal ion e.g., EDTA generally act as a hexadentate ligand but it can also act as a pentadentate and tetradentate ligand.

 $\mathcal{E}$  Octahedral complex of the type [M(ABCDEF)] have 15 different geometrical isomers with a pair of enantiomers. Although a few geometrical isomer have been prepared but none has been resolved e.g., [Pt(Py)(NH)(NO)(Cl)(Br)I].

## Ordinary Thinking

### Objective Questions

### **Basic Terms**

1. In  $K_4 Fe(CN)_6$ 

(a) (CN) are linked with primary valency

(b) (CN) are linked with secondary valency

(c) K are linked with secondary valency

(d) K are linked with non-ionic valency

2. The co-ordination number of copper in cuprammonium sulphate is

(a) 2

b) 6

(c) 4

(d) - 4

3. Which of the following acts as a bidentate ligand in complex formation

(a) Acetate

(b) Oxalate

(c) Thiocyanate

(d) EDTA

**4.** The co-ordination number of cobalt  $[Co(en)_2Br_2]Cl_2$  is

(a) 2

(b) 6

(c) 5

(d) 4

5. Which of the following ligands forms a chelate

[MP PET/PMT 1998]

complex

(a) Acetate

(b) Oxalate

(c) Cyanide

(d) Ammonia

**6.** According to Werner's theory

[MP PMT 2000, 02]

(a) Primary valency can be ionized

(b) Secondary valency can be ionized

(c) Primary and secondary valencies both cannot be ionized

(d) Only primary valency cannot be ionized

7. Which of the following is not true for ligand-metal complex

MP PFT 1002

(a) Larger the ligand, the more stable is the metal-ligand bond

(b) Highly charged ligand forms strong bond

(c) Larger the permanent dipole moment of ligand, the more stable is the bond

(d) Greater the ionization potential of central metal, the stronger is the bond

**8.** What is the co-ordination number of the metal in  $[Co(en)_2 Cl_2]^+$ 

(a) 4

(b) 5

(c) 6

(d) 3

9. Bidentate ligand is

(a) *CN* <sup>-</sup>

(b) Ethylene diammine (en)

(c) SCN

(d) EDTA

10. The coordination number of Pt in  $\left[Pt(NH_3)_4 Cl_2\right]^{++}$  ion is

[MP PET 1995]

(a) 2

(1

(c) 6

(d) 8

11. Which is the example of hexadentate ligand

(a) 2, 2—dipyridyl

(b) Dimethyl glyoxime

(c) Aminodiacetate ion

(d) Ethylene diammine tetra acetate ion [EDTA]

12. The coordination number of a metal in coordination compounds is [MP PET 199

(a) Same as primary valency







	(b) Sum of primary and	•			( )	Double salt	(d)	Complex salt	
	(c) Same as secondary v	alency		25.		onodentate ligand has			
	(d) None of these				. ,	One co-ordinate site			
13.	Ligand in a complex salt a		[KCET 1992]		. ,	Two co-ordinate sites			
		ordinate bonds to a cer	ntral metal atom or			Any number of co-ordi			
	ion	1. 1 1				No capacity to co-ordin			
	• • •	oordinate bonds to a ce	ntral metal atom or	26.		A has coordination nun	nber		[AFMC 2004]
	ion	10 . 1 . 1 .	. 1 . 1 .		(a)		(b)	4	
	(c) Molecules linked by or ion	coordinate bonds to a	central metal atom		(c)	5	(d)	6	
		skad by acondinate band	le to a control motal	27.	Amo	ng the properties (a) re	educing (b)	oxidising (c)	complexing, the
	(d) lons or molecules lir atom or ion	nked by coordinate bond	is to a central metal		set o	f properties shown by	$CN^-$ ion	towards metal	species is
14.	A group of atoms can fur	oction as a ligand only w	hen		(a)	c, a	(b)	b, c	
	7. g. oup or atomo can rai		1999; MP PMT 2000]		(c)	a, b	(d)	a, b, c	
	(a) It is a small molecule	•	.,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	28.	. ,	ion or molecule wh	( )		compound with
	(b) It has an unshared e					sitional metal ion is call			
	(c) It is a negatively cha	•			(a)	Recipient	(b)	Ligand	
	(d) It is a positively char				. ,	Coordinate ion		No special na	ıme
15.	Which of the following co	•	ination number [RPET	2000		dination number of <i>Zn</i>			
.0.				g.			(		[Orissa JEE 2004]
	(a) $[Zn(CN)_4]^{2-}$	(b) $[Cr(H_2G)]$	)) <sub>6</sub> ] <sup>3</sup> '		(a)	6	(b)	4	[,,
	(c) $[Cu(CN)_4]^{2-}$	(d) [ <i>Ni</i> ( <i>NH</i> :	) 1 <sup>2+</sup>		(c)		(d)	-	
_	• •			30.	. ,	inson's catalyst used	(-)		catalvet in the
16.	The number of ions for	ormed when cupramm		30.		ogenation of alkenes co		mogeneous	catalyst III the
	dissolved in water is	(1)	[KCET 1993]			lron		Aluminium	
	(a) 1	(b) 2			( )	Rhodium	. ,	Cobalt	
	(c) 4	(d) Zero		21	. ,	n the molecular formul	( )		d complexes (A)
17.	The coordination number	of $Cu$ in complex $C$	$u(H_2O)_A$ = is	31.	MP PET	$293.5$ $NH_3$ (B) $CoC$	α οι της πε 17 <i>5 λπ</i> ΔΙ		A NILL 16 4L-
			( 2 /4]	•					
	(a) 4	(b) 3			num	ber of co-ordinated $N$	$H_3$ molect	ıles in <i>A, B</i> aı	nd C respectively
	(c) 2	(d) 1	1: .: 1		are 6	5, 5 and 4, the primary	valency in	(A), $(B)$ and $($	C) are:[DCE 2003
18.	The primary valence of the	ne metal ion in the co-oi	dination compound		(a)	6, 5, 4	(b)	3, 2, 1	
	$K_2[Ni(CN)_4]$ is				(c)	0, 1, 2	(d)	3, 3, 3	
	(a) Four	(b) Zero		32.	Gene	erally, a group of atoms	can function	on as a ligand	if
	(c) Two	(d) Six							[MP PET 1996]
19.	The metal which does not	t form a polynuclear car	bonyl is		(a)	They are positively cha	rged ions		
	(a) <i>Mn</i>	(b) <i>Co</i>			(b)	They are free radicals			
	(c) <i>Cr</i>	(d) <i>Fe</i>			(c)	They are either neutral	molecules	or negatively	charged ions
		( )			(d)	None of these			
20.	Which one of the following		of $CN^-$ (Cyanide)	33.	The	ligand in potassium fer	ricyanide is		
	a complex having coordin	ation number two			(a)	$K^+$	(b)	CN -	
			[AIIMS 2004]			$Fe^{3+}$	( )		
	(a) $Cu^+$	(b) $Ag^+$			(c)	Fe	(d)	$(CN)_6$	
	(c) $Ni^{2+}$	(1) E 2+		34.	Co-o	rdination number of al	uminum is	[MHCET 2004	.]
		(d) $Fe^{2+}$			(a)	8	(b)	6	
21.	According to Lewis the lig	gands are	[MP PMT 2002]		(c)	12	(d)	4	
	(a) Acidic in nature			35.	In K	$K_4 Fe(CN)_6$ , Fe is in	the form	of	
	(b) Basic in nature					An atom		An ion	
	(c) Neither acidic nor be	asic			( )	Cationic complex	` '	Anionic com	alex
	(d) Some are acidic and	others are basic		36.	. ,	ch of the following ligar	. ,		
22.	The coordination number	r of a central metal ato	om in a complex is	30.	WIIIC	in or the following figar	ius is expec	ted to bident	[CBSE PMT 1994]
	determined by		[AIEEE 2004]			ъ	4.	g o <sup>2</sup> =	[CDSE 1701 1994]
		nds around a metal io	n bonded by sigma		(a)	Br	(b)	$C_2 O_4^{2-}$	
	and pi-bonds both.				(c)	$CH_3NH_2$	(d)	$CH_3C \equiv \Lambda$	7
	` '	a metal ion bonded by	•	37.		e compound lithium te			_
		nds around a metal io	n bonded by sigma	3/.	111 (11	ie compound numam te	tranythoan	illillate, the il	[AllMS 1997]
	bonds					***			[/1111/15 1997]
	• •	anionic ligands bonded			(a)	$H^+$	(b)	$H^-$	
23.	In the extraction of which	of the following, comp	lex ion forms			H[MP PET 1989]	. ,	None of thes	
	(a) <i>Cu</i>	(b) A g		38.		ch of the following is th		out	[MP PET 1996]
	(c) <i>Fe</i>	(d) Na				Potassium ferrocyanide			
	(C) 1 C				(1.)	F	114-		
24.		a	[AFMC 2000]			Ferrous ammonium su	•		
24.	Potassium ferrocyanide is (a) Normal salt	a (b) Mixed sale	• •			Potassium ferricyanide Tetrammine copper (II			

39.	The	basic ligand is				(d)	Copper hydroxide	e is an amphoteric	substance	
	(a)	$NH_3$	(b)	$CN^-$	53.	Zeigl	er—Natta cataly	st is used for wh	ich type of react	ion
		$F^-$	(L)	All		. ,	Hydrogenation	` ,	Polymerization	
40.	(c) The	negative ligand is	(d)	All	EA	` '	Oxidation	(d) ving is not con	Reduction	organometallie
•		Aqua	(b)	Sulphato	54.		ound.	vilig is not con	sidered as all	[AllMS 2004]
	` '	Carboxyl	(d)	Nitro sodium		(a)	Cis-platia	(b)	Ferrocene	
41.		ch has yellow colour Potassium cobaltinitrite				` '	Zeise's salt	. ,	Gringard reage	nt
	` '	Potassium hexanitro cobalta	nte (111	1)	55.		h one is organor Lithium methoxi	netallic compoun	d[ <b>MP PMT 2004</b> ] Lithium dimeth	ud amida
		Fischer's salt	,	,		` '	Lithium acetate	( )	Methyl lithium	iyi aimde
	. ,	All the above			56.	(-)		of potash alum g	•	[UPSEAT 2004]
42.	•	nds, in complex compounds		[MP PMT 2003]			Two types of ior		Only one type	
		Accept epair					Four types of ion		Three types of	
	(b)	Donate $e^-$ -pair			57.	Carn	allite in solution	in $H_2O$ , shows	the properties of	of
		Neither accept $e^-$ -pair nor	r dona	nte						[DCE 2003]
42	. ,	All of these happen ch of the following is a comr	non d	oner atom in ligands		(a)	$K^+, Mg^{2+}, Cl^-$	(b)	$K^+, Cl^-, SO_4^2$	$^{-},Br^{-}$
43.	WIIIC	in of the following is a confi	non a	[BHU 2001]		(c)	$K^+, Mg^{2+}, CO$	$Q_3^{2-}$ (d)	$K^+, Mg^{2+}, Cl$	$^-, Br^-$
	(a)	Arsenic	(b)	Nitrogen	58.	What	t is the co-ordina	ntion number of o	robalt in Co(N	H_0)_Cl_0
	` '	Oxygen	(d)	Both (b) and (c)	<i>J</i> 0.		3	(b)		13/3 013
44.	Trun	ibull's blue is a compound		[VCET 1000]			5	(d)	6	
	(a)	Ferricyanide	(b)	[KCET 1993] Ferrous ferricyanide	59.	` '	formula of alum	is		[Pb. CET 2002]
		Ferrous cyanide	. ,	Ferriferrocyanide		(a)	$K_2SO_4.Al_2(SO_4)$	$(O_4)_3.24H_2O$		
45.	Tolle	en's reagent is		[KCET 1990]		(b)	$K_4[Fe(CN)_6]$			
	(a)	$\left[Ag(NH_3)_2\right]^+$	(b)	$Ag_2O$			$K_2SO_4.Al_2(SO_4)$	0)640		
	(c)	$[Cu(OH)_4]^{2-}$	(d)	$Cu_2O$			$Na_2CO_3.10H$			
46.	Finel	y divided iron combines with	h <i>CO</i>	to give	60			_	<i>I</i> ) 1	[pl com sees]
				[UPSEAT 2002]	60.			ent in $K_4[Fe(C]]$		[Pb. CET 2000]
	(a)	$Fe(CO)_5$	(b)	$Fe_2(CO)_9$		(a) (c)		(b)		
	(c)	$Fe_2(CO)_{12}$	(d)	$Fe(CO)_6$	61.	. ,		nometallic comp		
47.	ln a	complex, the highest possibl	e coo	rdination number is	Oi.	CII	31/151 13 411 0150	mometanie comp	ound due to	[DCE 2002]
		6	(b)			(a)	Mg-I bond	(b)	C-Ibond	[DCL 2002]
40	` '	4	(d)					( )		
48.		ral metal atom in a complex		regative groups attached to the scalled			C-Mg bond		C-H bond	
	(a)	Atomic number	(b)	Effective atomic number	62.	What	t is the EAN of n	ickel in <i>Ni(CO)</i>	4	[BVP 2003]
	(c)	Coordination number	(d)	Primary valency			34	(b)	35	
49.		A combines with cations to		Cl. 1.		(c)	32	(d)	36	
	(a) (c)	Ion-exchange resins Clathrates	(b)	Chelates Polymers	No	mone	oloturo Ov	idation sta	to and EAN	lnumbar
50.	. ,	xample of a double salt is	(u)	[MP PET 2001]	NO	mend	ciature, Ox	iuation sta	le and EAN	number
	(a)	Bleaching powder	(b)	Нуро	1.	How	many ions	are produced	in aqueous	solution of
	(c)	$K_4[Fe(CN)_6]$	(d)	Potash alum	••		$(H_2O)_6$ $Cl_2$	are produced	uqueous	[RPMT 2002]
51.	ln co	omplex compounds, metal lig	gand b	oond is		(a)	2	(b)	3	
	(a)	Coordinate bond		Hydrogen bond			4	(d)		
	( )	Ionic bond	(d)	Covalent bond	2.	IUPA	C name of $Pt(I)$	$NH_3)_3(Br)(NO)$	)ClCl is	
52.				$(NH_3)_4]^{2+}$ with copper ions				3/3(=1)(=1		CBSE PMT 1998]
	_	kaline solutions but not in tale. [AIEEE 2003]	acidio	solution. What is the reason		(a)	Triamminechlor	obromonitroplati	-	-
		In acidic solutions hydration	ı prot	ects copper ions				onitrochloroplati		
				inate with ammonia molecules		(c)	Triamminebrom	ochloronitroplati	num (IV) chloric	e
		forming $N\!H_4^+$ ions and $N$	$VH_3$	molecules are not available		(d)	Triamminenitro	chlorobromoplati	num (IV) chloric	e
	(c)	In alkaline solutions insolub	ole C	$u(OH)_2$ is precipitated which	3.	Oxida	ation state of nit	rogen is incorrec	tly given for	
	•	is soluble in excess of any a							[u	PSEAT 2000, 01]

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Compound Oxidation state (d) Example of weak ligand field for  $d^5$  $[Co(NH_3)_5 Cl]Cl_2$ 0  $NH_2OH$ -1The oxidation number of chromium in sodium tetrafluoro 13. oxochromate complex is (c)  $(N_2H_5)_2SO_4$ +2(a) 11 \_3 (d)  $Mg_3N_2$ The formula of dichloro bis (urea) copper (11) is [CBSE PMT 1997] (a)  $[Cu\{O = C(NH_2)_2\}Cl_2]$ (b)  $[CuCl_2 \{O = C(NH_2)_2\}_2]$ (c)  $\left[Cu\{O = C(NH_2)_2\}Cl\right]Cl$ (d)  $[CuCl_2]{O = C(NH_2)_2 H_2}$ 15. The IUPAC name of the complex  $[Pt(NH_3), Cl_2]$  is 5. (a) Platinum (11) diammino dichloride Diammino dichloro platinate (IV) Bis (ammino) dichloro platinum (IV) (d) Dichloro diammine platinum (11) 6. Correct formula of diammine silver (1) chloride is 16. (a)  $Ag(NH_3)Cl$ (b)  $Ag(NH_2)Cl$ (c)  $\left[Ag(NH_3)_2\right]Cl$ (d)  $\left[Ag(NH_2)_2\right]Cl$ The formula of sodium nitroprusside is [AIIMS 1992] 7. (a)  $Na_4[Fe(CN)_5 NOS]$  (b)  $Na_2[Fe(CN)_5 NO]$ (c)  $NaFe[Fe(CN)_6]$ (d)  $Na_2[Fe(CN)_6NO_2]$ 17. The correct name of  $[Pt(NH_3)_4 Cl_2][PtCl_4]$  is 8. (a) Tetraammine dichloro platinum (iv) tetrachloro platinate (ii) Dichloro tetra ammine platinium (iv) tetrachloro platinate (ii) Tetrachloro platinum (ii) tetraammine platinate (iv) (d) Tetrachloro platinum (ii) dichloro tetraammine platinate (iv) Correct formula of potassium ferrocyanide is 9. [CBSE PMT 1988] (b)  $K_2[Fe(CN)_6]H_2O$ (a)  $K_4 [Fe(CN)_6]$ 19. (c)  $K_2[Fe(CN)_6]$ (d) None of these The IUPAC name of  $\left[Co(NH_3)_3(NO_2)_3\right]$  is 10. (a) Trinitrotriammine cobalt (III) 20. Trinitrotriammine cobalt (11) Trinitrotriammine cobalt (III) ion Trinitritriammine cobaltate (III) 21. In  $K_4[Fe(CN)_6]$  the E.A.N. of Fe is [DCE 2000] 11. (a) 33 (c) 36 (d) 26 Which of the following pairs is not correctly matched 12.

(c) VI (d) 111 The IUPAC name of  $K_4[Fe(CN)_6]$  is [CBSE PMT 1990; MP PET 1992; MP PMT 1995, 97; Kurukshetra CET 2002] Potassium hexacyanoferrate (11) Potassium ferrocyanide Tetrapotassium hexacyanoferrate (11) Tetrapotassium ferroushexacyanide (II) The IUPAC name of  $[Ni(CO)_4]$  is [RPET 1999] Tetra carbonyl nickel (11) (b) Tetra carbonyl nickel (0) Tetra carbonyl nickelate (11) Tetra carbonyl nickelate (0) The correct nomenclature for  $Fe_4[Fe(CN)_6]_3$  is [MP PMT 1994] (a) Ferroso-ferric cyanide (b) Ferric-ferrous hexacyanate Iron (III) hexacyanoferrate (II) (d) Hexacynoferrate (III-II) The IUPAC name of compound  $Na_3[Co(ONO)_6]$  will be [MP PMT 2000] Hexanitritocobalt (III) sodium Sodium cobalt nitrite Sodium hexanitrocobaltate (III) (d) Sodium hexanitritocobaltate (III) In which of the following complexes oxidation state of metal is zero (a)  $[Pt(NH_3), Cl_2]$ (b)  $\left[ Cr(CO)_{6} \right]$ (c)  $\left[ Cr(NH_3)_2 Cl_3 \right]$ (d)  $\left[Cr(en), Cl_2\right]$ The oxidation number of Cr in  $[Cr(NH_3)_6]Cl_3$  is [CBSE PMT 2001] (a) 8 (b) 6 (c) 4 (d) 3 In  $[Ni(NH_3)_4]SO_4$ , the E.A.N. of Ni is (c) 36 (d) 37 IUPAC name of  $[Co(ONO)(NH_3)_5 Cl_2]$  is [AMU 2002] (a) Pentaammine nitro cobalt (III) chloride Pentaammine nitrito cobalt (III) chloride

(b) IV

 $= \left[ M n^H F_{\epsilon} \right]^{-4}$ 

(b) + 2

Pentaammine nitroso cobalt (III) chloride

Pentaammine oxo-nitro cobalt (III) chloride

The oxidation number of Pt in  $[Pt(C_2H_4)Cl_3]^-$  is



[MP PET 1993]

22.



(a) + 1

[MNR 1993]

configuration

 $= (-)0.8\Delta_0$ 

(a) Effective atomic number of Pt in  $[PtCl_6]^{2-} = 84$ 

(b) Absorption peak for  $\left[Cr^{III}(NH_3)_6\right]^{+3} = 21680cm^{-1}$ 

(c) Crystal field stabilization energy of  $d^2$  in weak ligand field

(c) + 5(d) + 2Potassium tri oxalato iridium (III) 24. The correct IUPAC name of potassium cuprochloride is Potassium tri oxalato iridate (III) (a) Potassium copper (1) tetrachloride Potassium tris (oxalato) iridium (III) (b) Potassium tetrachlorocuprate (1) Potassium tris (oxalato) iridate (111) (c) Tetrachloropotassium cuprate (1) The charge on  $[Ag(CN)_2]^-$  complex is 37. [AIIMS 2001] (d) Tetrachlorocopper (1) potassiate 25. The effective atomic number of cobalt in the complex (a)  $[Co(NH_3)_6]^{3+}$  is (d) [MP PET 2003] (c) The IUPAC name of  $[Co(NH_3)_6]Cl_3$  is (a) 36 38. [IIT-JEE 1994] (b) 33 (d) 30 (c) 24 Hexammine cobalt (III) chloride IUPAC name of  $K_3Fe(CN)_6$  is 26. Hexammine cobalt (11) chloride [MP PMT 1993; MP PET 1997] Triammine cobalt (III) trichloride Potassium ferrocyanide (11) None of these Potassium hexaferrocyanate (III) IUPAC name of  $\left[Co(NH_3)_3(H_2O),Cl\right]$   $Cl_2$  is 39. Potassium ferrohexacyanate (11) [MP PET 1994] (d) Potassium hexacyanoferrate (III) (a) Diaquachlorodiammine cobalt (III) chloride 27. The EAN of iron in potassium ferricyanide is Triamminediaquachloro cobalt (111) chloride (b) [Pb. CET 2000] Chlorodiamminediaqua cobalt (III) chloride (a) 18 (b) 54 Diamminediaquachloro cobalt (11) chloride (c) 35 (d) 23 Dichloro diammine platinum (II) complex has the formula In the coordination compound,  $K_4[Ni(CN)_4]$  oxidation state of 40. 28. [MP PMT 1997] [AIEEE 2003] nickel is (a)  $Pt[Cl_2(NH_3)_2]$ (b)  $Pt[R.(NH_2)_2]Cl_2$ (a) (b) o (c) +1(d) +2(c)  $[PtCl_2(NH_3)_2]$ (d)  $[Pt.R.(NH_2)_2]Cl_2$ 29. According to IUPAC nomenclature sodium nitroprussied is named is The formula of potassiumdicyano bis (oxalato) nickelate (11) is [CBSE PMT 2003] Sodium pentacyanonitrosyl ferrate (III) (a)  $K_4[Ni(CN)_2(Ox)_2]$ (b)  $K_3[Ni_2[Ni_2(CN)_2(Ox)_2]$ (b) Sodium nitroferricyanide (c)  $K[Ni(CN)(Ox)_2]$ (d)  $K_2[Ni(CN)_2(Ox)_2]$ Sodium nitroferrocyanide Sodium pentacyanonitrosyl ferrate (11) The value of x which appears in the complex  $\left[Ni(CN)_{a}\right]^{x}$  is Pick out the complex compound in which the central metal atom 30. (a) + 2 obeys EAN rule strictly (c) 0 (d) 4 (b)  $K_3[Fe(CN)_6]$ (a)  $K_4[Fe(CN)_6]$ Pick the correct name of  $[Co(NH_3)_5 Cl]Cl_2$ [AMU 2001] 43. (c)  $[Cr(H_2O)_6]Cl_3$ (d)  $[Cu(NH_3)_4]SO_4$ Chloropentammine cobalt (III) Which of the following is wrong statement [BHU 2003] 31. Pentammine cobalt (III) chloride  $Ni(CO)_4$  has oxidation number + 4 for NiChloropentammine cobalt (III) chloride  $Ni(CO)_4$  has zero oxidation number for NiChloropentammine cobalt (11) chloride Ni is metal The valency of cuprammonium ion is CO is gas (a) + 4Oxidation state of Fe in  $K_3[Fe(CN)_6]$ [RPMT 2002] 32. (c) - 2 (d) - 4In which of the following compounds transition metal has zero 45. (d) None of these (c) oxidation state [CBSE PMT 1999] Which complexes have zero oxidation state 33. (a)  $CrO_5$ (b)  $NH_2.NH_2$ Carbonyl (b) Ferrocyanide (a) (c) NOClO<sub>4</sub> (d)  $[Fe(CO)_5]$ Cyanide Amine (d) (c) The proper name for  $K_2[PtCl]_6$  is [MH CET 2002] The complex chlorocompound diaquatriammine cobalt (III) chloride is 34. 46. represented as [CBSE PMT 2002] (a) Potassium platinum hexachloride (a)  $[Co(NH_3)_3(H_2O)_3]Cl_2$ Potassium hexachloro platinum IV Potassium hexachloro platinate IV (b)  $[Co(NH_2)_3 (H_2O)_2]Cl_2$ Potassium hexachloro platinum  $[CoCl(NH_3)_3 (H_2O)_2]Cl_3$ IUPAC name of  $K_3[Al(C_2O_4)_3]$  is called 35. (d)  $[CoCl(NH_3)_3 (H_2O)_2]Cl_2$ [MP PMT 1993, 02, 03] The complex compound  $[Co(NH_3)_3 NO_2 ClCN]$  is named as Potassium alumino oxalato 47. Potassium aluminium (III) trioxalate (a) Chlorocyanonitrotriammine cobalt (III) Potassium trioxalato aluminate (III) (b) Nitrochlorocyanotriammine cobalt (111) Potassium trioxalato aluminate (IV) (c) Cyanonitrochlorotriammine cobalt (III) The I.U.P.A.C. name of  $K_3[Ir(C_2O_4)_3]$  is Triamminenitrochlorocyano cobalt (III) 36.

The oxidation number of Pt in  $[Pt(C_2H_4)Cl_3]^-$  is

[MP PMT 2001]

[UPSEAT 1999, 01] Which one of the following octahedral complexes will not show geometric isomerism (A and B are monodentate ligands) (a) +1(b) +2(c) +3 (b)  $[MA_2B_4]$ (d) +4What is the structural formula of lithium tetrahydridoaluminate 40. [MA] MP PMT 2003] (d)  $[MA_4B_2]$ (a)  $Al[LiH_{\Lambda}]$ (b)  $Al_2[LiH_4]_3$ The number of unpaired electrons in the complex ion  $[CoF_6]^{3-}$  is (c)  $Li[AlH_{4}]$ (d)  $Li[AlH_4]_2$ (Atomic no. of Co = 27) [CBSE PMT 2003] IUPAC name for  $K[Ag(CN)_2]$  is 50. (a) Zero (b) 2 Potassium argentocyanide (c) 3 (d) 4 Potassium silver cyanide Which would exhibit co-ordination isomerism 3. Potassium dicyanoargentate (1) (a)  $\left[Cr(NH_3)_6\right]\left[Co(CN)_6\right]$  (b)  $\left[Co(en)_2Cl_2\right]$ Potassium dicyanosilver (II) (d)  $\left[Cr(en), Cl_2\right]^+$ (c)  $\left[Cr(NH_3)_6\right]Cl_3$ The oxidation state of Co in  $\left[Co(H_2O)_5 Cl\right]^{2+}$  is 51.  $[Co(NH_3)_{\epsilon}NO_2]Cl_2$  and  $[Co(NH_3)_{\epsilon}(ONO)]Cl_2$  are related to each other as (c) + 1(d) + 4(a) Geometrical isomers (b) Optical isomers The chemical formula of diammine silver (1) chloride is 52. (c) Linkage isomers (d) Coordination isomers [BHU 2004]  $[Co(NH_3)_5 Br] SO_4$  and  $[Co(NH_3)_5 SO_4] Br$  are examples of  $[Ag(NH_3)]Cl$ (b)  $[Ag(NH_3)_2]Cl$ 5. which type of isomerism (c)  $[Ag(NH_3)_2]Cl$ (d)  $[Ag(NH_4)_2]Cl$ [MP PMT 1993, 94, 95; MP PET 1997; MP PET/PMT 1998] IUPAC name of  $[Co(NH_3)_5NO_2]Cl_2$  [Pb. CET 2000] (a) Linkage (b) Geometrical 53. (c) lonization (d) Optical Pentamminenitrocobalt (III) chloride  $[Co(NH_3)_4 Cl_2]NO_2$  and  $[Co(NH_3)_4 Cl.NO_2]Cl$  are ...... Pentamminenitrosocobalt (III) chloride [MP PMT 1993; MP PET 1995, 2001] isomers Pentamminenitrocobalt (11) chloride (a) Geometrical (b) Optical None of these (d) lonization (c) Linkage The pair of the compounds in which both the metals are in the highest possible oxidation state is Which would exhibit ionisation isomerism [MP PET 1997] 7. [IIT-JEE (Screening) 2004] (b)  $[Co(NH_3)_5 Br]SO_4$ (a)  $|Cr(NH_3)_6|Cl_3$ (a)  $[Fe(CN)_6]^{3-}, [Co(CN)_6]^{3-}$ (c)  $\left[Cr(en), Cl_2\right]$ (d)  $\left[ Cr(en)_3 Cl_3 \right]$ (b)  $CrO_2Cl_2, MnO_4^ [Ti(H_2O)_6]^{+3}$  is paramagnetic in nature due to 8 [RPMT 2002] (c)  $TiO_3$ ,  $MnO_2$ (b) Two unpaired e(a) One unpaired  $e^-$ (d)  $[Co(CN)_6]^{3-}, MnO_3$ (c) Three unpaired  $e^-$ (d) No unpaired eCoordination isomerism is caused by the interchange of ligands 9. The IUPAC name of  $[Cr(NH_3)_6]^{3+}$  is [Pb. CET 2001] 55. [UPSEAT 2002] between the Hexamminechromium (VI) ion Cis and Trans structure Hexamminechromium (III) ion (b) Complex cation and complex anion Hexamminechromium (11) ion (c) Inner sphere and outer sphere Hexamminechloride Low oxidation and higher oxidation states The IUPAC name of  $K_2[Cr(CN)_2O_2(O)_2(NH_3)]$  is 56. 10. Which one of the following will not show geometrical isomerism [DCE 2003] (a)  $[Cr(NH_3)_4 Cl_2]Cl$ (b)  $[Co(en), Cl_2]Cl$ (a) Potassium ammine dicyano dioxoperoxochromate (VI) (c)  $[Co(NH_3)_5 NO_2]Cl_2$ (d)  $[Pt(NH_3), Cl_2]$ Potassium ammine cyano peroxo dioxo chromium (VI) Paramagnetic co-ordination compounds contain ....... electrons 11. Potassium ammine cyano peroxo dioxo chromiun (VI) (a) No Potassium ammine cyano peroxo dioxo chromatic (IV) (b) Both paired and unpaired The IUPAC name of the coordination compound  $K_3[Fe(CN)_6]$  is [AIEEE 2005] 57. Paired (c) (a) Potassium hexacyanoferrate (11) Unpaired Potassium hexacyanoferrate (III) Which of the following isomeric pairs shows ionization isomerism 12. Potassium hexacyanoiron (II) (a)  $\left[Co(NH_3)_6\right]\left[Cr(CN)_6\right]$  and  $\left[Cr(NH_3)_6\right]\left[Co(CN)_6\right]$ (d) Tripotassium hexacyanoiron (II) (b)  $[Cr(H_2O)_6]Cl_3$  and  $[Cr(H_2O)_5Cl]Cl_2.H_2O$ 58. Which compound is zero valent metal complex [KCET 2005]  $[Cu(NH_3)_4]SO_4$ (b)  $[Pt(NH_3), Cl_2]$ (c)  $\left[Pt(NH_3)_2 Cl_2\right]$  and  $\left[Pt(NH_3)_4\right]\left[PtCl_4\right]$  $[Ni(CO)_{\Delta}]$ (d)  $K_3[Fe(CN)_6]$ (d)  $[Co(NH_3)_5 Br] SO_4$  and  $[Co(NH_3)_5 SO_4] Br$ Among the following ions which one has the highest paramagnetism[IIT 1993; L 13. (a)  $[Cr(H_2O)_6]^{3+}$ (b)  $[Fe(H_2O)_6]^{2+}$ Isomerism and magnetic properties

(c)  $[Cu(H_2O)_{\epsilon}]^{2+}$ (d)  $\left[Zn(H_2O)_{\epsilon}\right]^{2+}$ (b) Only  $[Fe(CN)_6]^{3-}$  is paramagnetic Amongst  $Ni(CO)_4$ ,  $[Ni(CN)_4]^{2-}$  and  $[NiCl_4]^{2-}$ (c) Only  $[FeF_6]^{3-}$  is paramagnetic [11T 1991] 14. (d) Both are diamagnetic (a)  $Ni(CO)_4$  and  $[NiCl_4]^{2-}$  are diamagnetic and 26.  $[Ni(CN)_{A}]^{2-}$  is paramagnetic (a)  $\left[Ni(CO)_{4}\right]$ (b)  $[NiCl_4]^{2-}$  and  $[Ni(CN)_4]^{2-}$  are diamagnetic and (c)  $[Ni(CN)_{4}]^{2-}$  $Ni(CO)_4$  is paramagnetic 27.  $\left[Cu^{II}(NH_3)_4\right]\left[Pt^{II}Cl_4\right]$  are (c)  $Ni(CO)_A$  and  $[Ni(CN)_A]^{2-}$  are diamagnetic and  $[NiCl_4]^{2-}$  is paramagnetic (c) 5 (d) 6 (d)  $Ni(CO)_4$  is diamagnetic and  $[NiCl_4]^{2-}$  and  $[Ni(CN)_4]^{2-}$ 28. are paramagnetic (a)  $[Cr(H_2O)_{\epsilon}]^{3+}$  $[Co(NH_3)_4 Cl_2]^+$  exhibits 15. (c)  $[Fe(CN)_{6}]^{3-}$ (a) Geometrical isomerism (b) Optical isomerism (c) Bonding isomerism (d) Ionisation isomerism complexes 29. The compound which does not show paramagnetism is 16.  $[Cr(NH_3)_6][Co(C_2O_4)_3]$ [IIT 1992] (a) Linkage isomerism (b)  $\left[Ag(NH_3)_2\right]Cl$ (a)  $\left[ Cu(NH_3)_{4} \right] Cl_3$ (c) Coordination isomerism (c) *NO* 30. The number of geometrical isomers for  $[Pt(NH_3)_2 Cl_2]$  is 17. (a)  $\left[Co(NH_3)_6\right]Cl_3$ [CBSE PMT 1995] (c)  $\left[Co(NH_3)_{4}Cl_{2}\right]Cl$ (a) Two (b) One (c) Three (d) Four 31.  $\left[ Cr(H_2O)_6 Cl_3 \right]$  and The pair of complex compounds 18.  $[Cr(H_2O)_5 Cl]Cl_2H_2O$  are an example of (c)  $CuSO_4.5H_2O$ (a) Linkage isomerism (b) Ionisation isomerism (c) Coordination isomerism (d) Hydrate isomerism 32. The number of geometrical isomers of the complex 19.  $\left[Co(NO_2)_2(NH_3)_2\right]$  is [CBSE PMT 1997] (a) Paramagnetism (b) 3 (c) Both (a) and (b) (c) 4 (d) o 20. The type of isomerism present in nitropentamine chromium (III)  $K_2[PdClBr_2(SCN)]$  is chloride is [AIEEE 2002] (a) Optical (b) Linkage (b) 3 (d) Polymerisation (c) lonization (c) 4 Which of the following compounds exhibits linkage isomerism 21. 34. (a)  $[Co(en)_3]Cl_3$ (b)  $[Co(NH_3)_6[Cr(CN)_6]$ (c)  $[Co(en)_2 NO_2 Cl]Br$ (d)  $[Co(NH_3)_5 Cl]Br_2$ (a) Zero (b) One Pick out from the following complex compounds, a poor electrolytic (c) Three (d) Five 22. conductor in solution [MP PMT 1994] (a)  $K_2[PtCl_6]$ (b)  $[Co(NH_3)_3(NO_2)_3]$ of unpaired electrons will be (c)  $K_4[Fe(CN)_6]$ (d)  $\left[Cu(NH_3)_4\right]SO_4$ (b) 2 [MP(PET 2003] The possible number of optical isomers in  $\left[Co(en)_2Cl_2\right]^+$  are 23. (a) 2 (b) 3 (c) 4 (d) 6 Magnetic moment of  $[Cu(NH_3)_4]^{2+}$  ion is [RPET 2003] 24. (a) Optical isomers (b) Coordinate isomers (c) lonization isomers (d) Linkage isomers

Which of the following is paramagnetic [AFMC 1997] (b)  $[Co(NH_3)_6]^{3+}$ (d)  $\left[NiCl_{4}\right]^{2-}$ The total number of possible isomers for the complex compound [CBSE PMT 1998; DPMT 2004; ] & K CET 2005] Which one of the following shows maximum paramagnetic character (b)  $[Fe(CN)_6]^{4-}$ (d)  $[Cu(H_2O)_6]^{2+}$  $[Co(NH_3)_6][Cr(C_2O_4)_3]$ (b) Geometrical isomerism (d) Ionisation isomerism Which of the following exhibits highest molar conductivity [MP PET 1994] (b)  $\left[Co(NH_3)_5 Cl\right]Cl_2$ (d)  $\left[Co(NH_3)_2 Cl_3\right]$ Which of the following compounds is colourless [MP PET 1994] (a)  $Cu_2(CH_3COO)_4.2H_2O$  (b)  $Cu_2Cl_2$ (d)  $[Cu(NH_3)_4]SO_4.4H_2O$ The type of magnetism exhibited by  $[Mn(H_2O)_6]^{2+}$  ion is [11T 1994] (b) Diamagnetism (d) None of these The number of isomers possible for square planar complex [MP PET 1994] [MP PMT 2001] The number of unpaired electrons in  $Ni(CO)_4$  is [AIIMS 1997] If the magnetic moment of  $[Ag(CN)_2]^{-1}$  is zero, then the number [MP PET 1995]  $[Pt(NH_3)_4 Cl_2]Br_2$  and  $[Pt(NH_3)_4 Br_2]Cl_2$  are related to each [MP PET 1996; AFMC 2000; CBSE PMT 2001]

Which of the following complex will show geometrical as well as

optical isomerism (en = ethylene diamine)



[RPET 1999]



37.

[KCET 1996]

What is true for  $[Fe(CN)_6]^{3-}$  and  $[FeF_6]^{3-}$ 

(a) Both are paramagnetic

25.

- (a)  $Pt(NH_3)_2 Cl_2$
- (b)  $[Pt(NH_3)Cl_A]$
- (c)  $[Pt(en)_2]^{4+}$
- (d)  $[Pt(en)_2]Cl_2$
- Which of the following complexes is diamagnetic 38.

[RPMT 1997]

- $Ni(CO)_{A}$
- (b)  $Ni(Cl_A)^{2-}$
- $Ni(Br)_{4}^{2-}$
- (d)  $NiCl_2.4H_2O$
- 39. Which one has the highest paramagnetism

[AMU 2001]

- $Ni(CO)_{\Lambda}$
- (b)  $[Ni(NH_3)_4]Cl_2$
- $[Ni(NH_3)_6]Cl_2$
- (d)  $[Cu(NH_3)_4]Cl_2$
- Which of the following coordination compounds would exhibit 40. optical isomerism [CBSE PMT 2004]
  - (a) trans-dicyanobis (ethylenediamine) chromium (III) chloride
  - tris-(ethylenediamine) cobalt (III) bromide
  - pentaamminenitrocobalt (III) iodide
  - diamminedichloroplatinum (11)
- Which of the following does not have optical isomer 41.

[AIIMS 2004]

- (a)  $[Co(NH_3)_3Cl_3]$
- (b)  $[Co(en)_3]Cl_3$
- (c)  $[Co(en)_2Cl_2]Cl$
- (d)  $[Co(en)(NH_3)_2Cl_2]Cl$
- Change in composition of co-ordination sphere yields which types of 42. isomers DCE 2002
  - (a) Optical
- (b) Geometrical
- (c) lonisation
- (d) None of these
- Types of isomerism shown by 43.

[DCE 2002]

- $[Cr(NH_3)_5 NO_2]Cl_2$  is
  - (a) Optical
- (b) lonisation
- (c) Geometrical
- (d) Linkage
- Which of the following will not give a precipitate with  $AgNO_3$ 
  - (a)  $\left[Co(NH_3)_3 Cl_3\right]$
- (b)  $\left[Co(NH_3)_{4}Cl_{2}\right]Cl$
- (c)  $[Co(NH_3)_5 Cl]Cl_2$
- (d)  $\left[Co(NH_3)_{\kappa}\right]Cl_3$
- How many ions are produced from  $[Co(NH_3)_6]Cl_3$  in solution 45.
  - (a) 6

- (d) 2
- (a) Orange yellow
- (b) Orange
- The colour of  $CoCl_3.5NH_3.H_2O$  is [Kerala (Med.) 2002] 46.
  - (c) Green

- (d) Violet
- Pink
- Which one of the following is expected to be a paramagnetic 47. complex [MP PMT 1991, 2000]
  - (a)  $[Ni(H_2O)_6]^{2+}$
- (b)  $[Ni(CO)_A]$
- (c)  $\left[ Zn(NH_3)_4 \right]^{2+}$
- (d)  $\left[ Co(NH_3)_6 \right]^{+3}$
- Which one of the following will give a white precipitate with 48. [MP PMT 1994]  $AgNO_3$  in aqueous mediun
  - (a)  $\left[Co(NH_3)_5Cl\right](NO_2)_5$  (b)  $\left[Pt(NH_3)_5Cl_2\right]$
  - (c)  $[Pt(en)Cl_2]$
- (d)  $\left[Pt(NH_3)_{A}\right]Cl_2$
- How many ions will be produced in solution from one molecule of 49. chloropentammine cobalt (III) chloride
  - (a) 1

- (c) 3
- (d) 4
- Which of the following complex will give white precipitate with 50.
  - (a)  $[Co(NH_3)_4 SO_4]NO_2$  (b)  $[Cr(NH_3)_5 SO_4]Cl$

- (c)  $[Cr(NH_3)_5 Cl]SO_4$
- (d) Both (b) and (c)
- The number of precipitable halide ions in the sample 51.  $[Pt(NH_3)Cl_2Br]Cl$  will be

(b) 3

(c) 4

- (d) 1
- 52. The colour of tetrammine copper (11) sulphate is
  - (a) Blue
- (b) Red
- (c) Violet
- (d) Green
- The number of ions per mole of a complex  $[CoCl_2.5 NH_3]Cl_2$  in 53. aqueous solution will be

[MP PMT 2001]

- (a) Nine
- (b) Four
- (c) Three
- (d) Two
- How many unpaired electrons are present in the central metal ion of 54.  $[CoCl_4]^{2-}$ [Orissa IEE 2005]

(b) 4

(c) 5

- (d) 2
- What is the magnetic moment of  $K_3[FeF_6]$ 55.

[Orissa JEE 2005]

- (a) 5.91 BM
- (b) 4.89 BM
- (c) 3.87 BM
- (d) 6.92 BM
- (i)  $K_4[Fe(CN)_6]$  (ii)  $K_3[Cr(CN)_6]$  (iii)  $K_3[Fe(CN)_6]$ 56.
  - (iv)  $K_2[Ni(CN)_4]$

Choose the complex which is paramagnetic

[Kerala CET 2005]

- (i), (ii) and (iii)
- (b) (i), (iii) and (iv) (d) (i), (ii) and (iv)
- (i), (iii) and (iv) (e) (ii) and (iv)

(c)

In coordination compound  $[Co(en)_2 Cl_2]Cl$  which is false 57.

[Kerala CET 2005]

- Show geometrical Isomerism
- Shamp openic 2003 merism
- Show ionic Isomerism (c)
- (d) A octahedral complex
- A cationic complex

### [RPET 1999]

### **Hybridisation and Geometry**

- The correct structural formula of zeise's salt is
  - (a)  $K^{+} \left[ PtCl_{2} n^{2} (C_{2}H_{4}) \right]^{-}$
  - (b)  $K_2 \left[ PtCl_3 \eta^2 C_2 H_4 \right]$
  - (c)  $K^{+} \left[ PtCl_{2} \eta^{2} (C_{2}H_{4}) \right] Cl^{-}$
  - (d)  $K^+[PtCl_3(C_2H_A)]^-$
- The correct order of hybridisations of central atom in

 $NH_3$ ,  $[PtCl_4]^{2-}$ ,  $PCl_5$  and  $BCl_3$  is

[MP PMT 2003]

- (a)  $dsp^2$ ,  $dsp^3$ ,  $sp^2$  and  $sp^3$
- (b)  $sp^3, sp^3, sp^3d$  and  $sp^2$
- (c)  $dsp^2$ ,  $sp^2$ ,  $sp^3$  and  $dsp^3$
- (d)  $dsp^2$ ,  $sp^3$ ,  $sp^2$  and  $dsp^3$
- One mole of the complex compound  $Co(NH_3)_5 Cl_3$ , gives 3 moles of ions on dissolution in water. One mole of the same complex reacts with two moles of AgNO3 solution to yield two moles of AgCl(s). The structure of the complex is

[AIEEE 2003]





(a)  $[Co(NH_3)_5Cl]Cl_2$ (b)  $[Co(NH_3)_3 Cl_3].2NH_3$ (c)  $[Co(NH_3)_4 Cl_2]Cl.NH_3$ (d)  $[Co(NH_3)_4 Cl]Cl_2.NH_3$ Cuprammonium ion  $\left[Cu(NH_3)_{A}\right]^{2+}$  is [MP PMT 1997; KCET 2002] (a) Tetrahedral (b) Square planar (c) Triangular bipyramid (d) Octahedral In the complex  $[SbF_5]^{2-}$ ,  $sp^3d$  hydridisation is present. Geometry of the complex is [Pb. PMT 2000] (b) Square bipyramidal (a) Square pyramidal (d) Square (c) Tetrahedral The type of hybridization involved in the metal ion of  $[Ni(H_2O)_6]^{2+}$  complex is (a)  $d^3sp^2$ (b)  $sp^{3}d^{2}$ (d)  $dsp^2$ In the formation of  $K_4 Fe(CN)_6$ , the hybridisation involved is (b)  $d^2 s p^3$ (a)  $sp^2$ (c)  $d^3sp^2$ Which of the following is not true for metal carbonyls (a) The oxidation state of the metal in the carbonyls is zero (b) The secondary carbonyls are obtained from photodecomposition (c) Metal carbonyls are single bonded species (d)  $d\pi - p\pi$  overlap is observed in metal carbonyls An octahedral complex is formed, when hybrid orbitals of the following type are involved [DCE 2003] (a)  $sp^3$ (b)  $dsp^2$ (c)  $sp^3d^2$ (d)  $sp^2d$ Which one is an example of octahedral complex [MP PET 2000] (a)  $FeF_6^{3-}$ (b)  $Zn(NH_3)_4^{2+}$ (c)  $Ni(CN)_4^{2-}$ (d)  $Cu(NH_3)_4^{2+}$ Which of the following complexes has a square planar geometry (a)  $Ag(NH_3)_2^+$ (b)  $Cu(en)_{2}^{2+}$ (c)  $\left[MnCl_{A}\right]^{2-}$ (d)  $Ni(CO)_{A}$ The shape of  $\left[Fe(CN)_6\right]^{4-}$  ion is (a) Hexagonal (b) Pyrimidal (c) Octahedral (d) Octagonal What is the shape of  $Fe(CO)_5$  [CBSE PMT 2000] (a) Linear (b) Tetrahedral (d) Trigonal bipyramidal (c) Square planar What type of hybridization is involved in  $[Fe(CN)_6]^{3-}$ [AMU 1999] (a)  $d^2sp^3$ (b)  $dsp^2$ 

4.

5.

7.

8.

9.

10.

11.

12.

13.

14.

(c)  $sp^3d^2$ 

(a)  $Fe(CN)_6^{3-}$ 

(c)  $Zn(NH_3)_4^{2+}$ 

The shape of  $\left[Cu(NH_3)_4\right]^{2+}$  is square planar,  $Cu^{2+}$  in this 16. [NCERT 1989; RPET 1999] (a)  $sp^3$  hybridised (b)  $dsp^2$  hybridised (c)  $sp^3d$  hybridised (d)  $sp^3d^2$  hybridised The geometry of  $Ni(CO)_4$  and  $Ni(PPh_3)_2 Cl_2$  are 17. [IIT-JEE 1999; DCE 2002] Both square planar Tetrahedral and square planar respectively Both tetrahedral (c) Square planar and tetrahedral respectively 18. Which complex has square planar structure [JIPMER 2002] (b)  $[NiCl_{4}]^{2-}$  $Ni(CO)_4$ (d)  $[Cu(NH_3)_4]^{2+}$ (c)  $[Ni(H_2O)_6]^{2+}$  $[Pt(NH_3)_4]Cl_2$  is 19. [DCE 2001] (a) Square planar Tetrahedral Pyramidal (d) Pentagonal A complex involving  $dsp^2$  hybridization has 20. (a) A square planar geometry A tetrahedral geometry An octahedral geometry (d) Trigonal planar geometry A tetrahedral complex ion is formed due to ....... hybridization 21. (a)  $sp^2$ (b)  $sp^3$ (c)  $dsp^2$ (d)  $d^2sp^3$ 22. Back bonding is involved in which of the organometallic compounds (b)  $Mg^{2+}(C_5H_5^-)_2$ (a)  $[(CH_3)_3Al]_2$ (d)  $[(C_5H_5)_2Fe]$ (c) R - Mg - X $d^2sp^3$  hybridisation leads to 23. (a) Hexagonal shape (b) Trigonal bipyrimidal (d) Tetrahedral shape (c) Octahedral shape Chromium hexacarbonyl is an octahedral compound involving 24. (a)  $sp^3d^2$ (b)  $dsp^2$ (c)  $d^2sp^3$ (d)  $d^3sp^2$  orbitals  $[CoF_6]^{-3}$  is formed by .... hybridization (a)  $d^2sp^3$ (b)  $d^3 sp^2$ (c)  $d^2sp^3$ (d)  $sp^3d^2$ 26. The species havoing tetrahedral shape is [IIT-JEE (Screening) 2004] (a)  $[PdCl_4]^{2-}$ (b)  $[Ni(CN)_4]^{2-}$ (c)  $[Pd(CN)_4]^{2-}$ (d)  $[NiCl_4]^{2-}$  $[Ni(CO)_4], [Ni(CN)_4]^{2-}, [NiCl_4]^{2-}$ 27. hybridization states at the Ni atom are, respectively [CBSE PMT 2004; MP PMT 1992; BHU 1995; AFMC 1997] (a)  $sp^3, sp^3, dsp^2$ (d)  $dsp^2$ ,  $sp^3$ ,  $sp^3$ (d)  $sp^3, dsp^2, sp^3$ (c)  $sp^3, dsp^2, dsp^2$ (At. no. of Ni = 28) The bond in  $K_4[Fe(CN)_6]$  are: 28. [MP PET 2004] (a) All ionic

All covalent (b) Ionic and covalent Ionic, covalent and co-ordiante covalent Hybridization of Fe in  $K_3Fe(CN)_6$  is [DCE 2002] 29.



[MP PET 1999; AlIMS 2001]

(b)  $Ni(CN)_4^{2-}$ 

(d)  $FeF_6^{3-}$ 



The example of  $dsp^2$  hybridisation is

 $sp^3$  $sp^3d^2$ 

(a)

- (b)  $dsp^3$
- (d)  $d^2sp^3$
- 30. The complex ion which has no 'd' electrons in the central metal [IIT-JEE Screening 2001]
  - (a)  $[MnO_{\Lambda}]^{-}$
- (b)  $[Co(NH_3)_6]^{3+}$
- (c)  $[Fe(CN)_6]^{3-}$
- (d)  $[Cr(H_2O)_6]^{3+}$
- Which of the following statement is correct 31.
  - (a)  $\left[Cu(NH_3)_6\right]^{2+}$  is a colourless ion
  - (b)  $\left[Zn(H_2O)_6\right]^{2+}$  ion is blue coloured
  - (c)  $\left[Ni(CN)_{4}\right]^{2-}$  ion has a tetrahedral shape
  - (d) Nickel dimethyl glyoxides is red in colour
- 32. Which of the following shall form an octahedral complex

[DCE 2001]

- (a)  $d^4$  (low spin)
- (b)  $d^8$  (high spin)
- (c)  $d^6$  (low spin)
- (d) None of these
- Which one of the following is a strong field ligand 33.
  - (a) *CN*
- (b)  $NO_2^-$
- (c) en
- (d)  $NH_3$
- The strongest ligand in the following is [MP PET 1995] 34.
  - $CN^-$
- (b)  $Br^{-}$
- $HO^{-}$ (c)
- The neutral ligand is 35.
  - (a) Chloro
- (b) Hydroxo
- (c) Ammine
- (d) Oxalato
- 36. The ligands which can get attached to the central metal ion through more than one atom are called
  - (a) Ambident ligands
- (b) Polydentate ligands
- (c) Chelate ligands
- (d) Neutral ligands
- A strong ligand gives a complex which is generally called 37.
  - (a) High spin
- (b) High energy
- (c) Low spin
- (d) Stable
- $CN^-$  is a strong field ligand. This is due to the fact that 38.

[CBSE PMT 2004]

- (a) It can accept electron from metal species
  - (b) It forms high spin complexes with metal species
  - (c) It carries negative charge.
  - (d) It is a pseudohalide
- Considering  $\ensuremath{H_2O}$  as a weak field ligand, the number of unpaired 39. electrons in  $[Mn(H_2O)_6]^{2+}$  will be (At. No. of Mn = 25) asas a

ajkk

[CBSE PMT 2004]

- (a) Two (c) Three
- 40.
- Which of the following is a  $\,\pi$  complex
  - (a) Trimethyl aluminium
- (b) Ferrocene

CO

- (c) Diethyl zinc
- (d) Nickel carbonyl
- Which of the following is a  $\pi$  acid ligand 41.

[KCET 1996; AllMS 2003]

- (a)  $NH_3$

- (d) Ethylene diamine
- The value of the 'spin only' magnetic moment for one of the following configurations is 2.84 BM. the correct one

[AIEEE 2005]

- (a) d<sup>4</sup> (in strong ligand field)
- (b)  $d^4$  (in weak ligand field)

- (c)  $d^3$  (in weak as well as in strong fields)
- (d)  $d^5$  (in strong ligand field)
- The geometry of Ni(CO) and Ni(PPh) Cl are 43.

[BHU 2005]

- Both square planer
- (b) Tetrahedral and square planar respectively
- Both tetrahedral (c)
- Square planar and tetrahedral respectively

### Complexes and complex stability

- Which of the following complexes has the highest stability constant
  - (a)  $\left[ CdCl_{A} \right]^{2-}$
- (b)  $[CdBr_A]^{2-}$
- (c)  $[CdI_A]^{2-}$
- (d)  $[Cd(CN)_4]^{2-}$
- The most stable ion is
- [AIEEE 2002]
- (a)  $[Fe(OH)_2]^{3-}$
- (c)  $[Fe(CN)_6]^{3-}$
- (d)  $[Fe(H_2O)_6]^{3+}$
- The most stable complex among the following is

[MP PMT 2002]

- (a)  $K_3[Al(C_2O_4)_3]$
- (b)  $[Pt(en)_2]Cl_2$
- (c)  $Ag(NH_3)_2Cl$
- (d)  $K_2(Ni(EDTA))$
- Which of the following factors tends to increase the stability of 4. metal ion complexes
  - (a) Higher ionic radius of the metal ion
  - (b) Higher charge/size ratio of the metal ion
  - Lower ionisation potential of the metal ion
  - (d) Lower basicity of the ligand
- $CuSO_4$  reacts with KCN solution and forms: DPMT 2004 5.
  - (a)  $K_3[Cu(CN)_4]$
- (b) Cu(CN)
- (c)  $Cu(CN)_2$
- (d)  $K_{\Lambda}[Cu(CN)_{6}]$
- A co-ordination complex compound of cobalt has the molecular 6. formulae containing five ammonia molecules, one nitro group and two chlorine atoms for one cobalt atom. One mole of this compound produces three mole ions in an aqueous solution on reacting with excess of AgNO3, AgCl precipitate. The ionic formula for this complex would be:

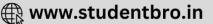
[DPMT 2004; Kerala PMT 2004]

- (a)  $[Co(NH_3)_5(NO_2)]Cl_2$
- (b)  $[Co(NH_3)_5Cl][Cl(NO_2)]$
- (c)  $[Co(NH_3)_4(No_2)Cl][(NH_3)Cl]$
- (d)  $[Co(NH_3)_5][(NO_2)_2Cl_2]$
- In any ferric salt, on adding potassium ferrocyanide, a prussian blue 7. colour is obtained, which is

[BIT 1992; BHU 2002]

- (a)  $K_3 Fe(CN)_6$
- (b)  $KFe[Fe(CN)_6]$
- (d)  $FeSO_4.Fe(CN)_6$
- (d)  $Fe_4[Fe(CN)_6]_3$
- Prussian blue is formed when
- [CBSE PMT 1990]
- (a) Ferrous sulphate reacts with FeCl<sub>3</sub>
- (b) Ferric sulphate reacts with  $K_4$  [Fe(CN)<sub>6</sub>]
- (c) Ferrous ammonium sulphate reacts with FeCl<sub>3</sub>
- (d) Ammonium sulphate reacts with FeCl<sub>3</sub> Complex salt can be made by the combination of 9.  $[Co^{III}(NH_3)_5 Cl]^X$  with [RPMT 2000, AFMC 2002]





(c)	$2Cl^-$	(d)	$2K^+$
Whi	ch reagent can be used to ide	entify	nickel ion
(a)	Resorcinol		
(b)	Dimethyl glyoxime [DMG]		
(c)	Diphenyl benzidine		
(d)	Potassium ferrocyanide		
Dim	ethyl glyoxime forms a colour	red co	mplex wit
( )	4 ~	(1.)	A7:

(a)  $PO_4^{3-}$ 

(a)  $Ag^+$ 

10.

oloured complex with 11.

> (b) *Ni* Ag(c) Cr (d) Zn

Silver chloride dissolves in excess of  $NH_{\perp}OH$  . The cation present 12. in this solution is [EAMCET 1998]

 $Cl^{-}$ (b)

(b)  $[Ag(NH_3)_2]^+$  $[Ag(NH_3)_4]^+$ (d)  $\left[Ag(NH_3)_6\right]^4$ 

Silver sulphide dissolved in a solution of sodium cynamide to form 13.

(a)  $Na[Ag(CN)_2]$ (b)  $Na_3[Ag(CN)_4]$ (c)  $Na_5[Ag(CN)_6]$ (d)  $Na_2[Ag(CN)_2]$ 

Which one will give  $Fe^{3+}$  ions in solution

(a)  $[Fe(CN)_{\epsilon}]^{3}$ (b)  $Fe_2(SO_4)_2$ 

(c)  $[Fe(CN)_6]^{4-}$ 

(d)  $NH_4(SO_4)_2$ .  $FeSO_4$ .  $6H_2O$ 

15. The cation that does not form an amine complex with excess of

(a)  $Cd^{2+}$ 

(b)  $Al^{3+}$ 

 $Cu^{2+}$ (c)

(d)  $Ag^+$ 

### Application of organometallics

Ziegler-Natta catalyst is an organometallic compound of which metal

(b) Zirconium

(d) Titanium

In the case of small cuts, bleeding is stopped by applying potash alum. Here alum acts as

[KCET (Med.) 2001]

(a) Fungicide

(b) Disinfectant

(c) Germicide

(d) Coagulating agent

The formula of ferrocene is

(a)  $\left[ Fe(CN)_6 \right]^{4-}$ 

(b)  $[Fe(CN)_6]^{3-}$ 

(c)  $[Fe(CO)_5]$ 

(d)  $[(C_5H_5), Fe]$ 

Which of the following is formed when n-butyl lithium reacts with tin (11) chloride [AFMC 2001]

(a) LiBr

(b)  $Et_4Pb$ 

(c)  $(C_4H_9)_4 Sn$ 

(d)  $(C_2H_5)_4Pb$ 

Which of the following organo-silicon compound on hydrolysis will give a three dimensional silicone

[Orissa JEE 2003]

(a)  $R_3SiCl$ 

(b) RSiCl<sub>3</sub>

(c) SiCl<sub>4</sub>

(d)  $R_2SiCl_2$ 

6. Which one is not an organometallic compound

[] & K CET 2005; Pb. CET 2003]

(a) RMgX

(b)  $C_2H_5ONa$ 

(c)  $(CH_3)_4 Sn$ 

(d)  $KC_4H_9$ 

The complex used as an anticancer agent is 7.

[AIIMS 2003]

(a) trans  $-[Co(NH_3)_3 Cl_3]$  (b) cis  $-[PtCl_2(NH_3)_2]$ 

(c)  $cis - K_2[PtCl_2Br_2]$ 

(d)  $Na_2CO_3$ 

The compound that is not olefinic organometallic is 8.

(a)  $K[C_2H_4PtCl_3]3H_2O$  (b)  $Be(CH_2)_2$ 

(c)  $(C_2H_4PtCl_3)_2$ 

(d)  $C_4H_4Fe(CO)_3$ 

Among the following, which is not the  $\pi$ -bonded organometallic 9. compound [CBSE PMT 2003]

(a)  $(CH_3)_4 Sn$ 

(b)  $K[PtCl_3(\eta^2 - C_2H_4)]$ 

(c)  $Fe(\eta^5 - C_5H_5)_2$ 

(d)  $Cr(\eta^6 - C_6H_6)_2$ 

Wilkinson's catalyst is used in 10.

(a) Polymerization

(b) Condensation

(c) Halogenation

(d) Hydrogenation

What is the use of tetraethyl lead 11.

(a) As a catalyst in addition reaction of alkenes

(b) As a catalyst in polymerization reaction of alkenes

(c) For reducing knocking

(d) For creating knocking

12. Which of the following is an organo-metallic compound

[MP PMT 2001]

(a) Lithium ethoxide

(b) Ethyl lithium

(c) Lithium acetate

(d) Lithium carbide

Which of the following is an organometallic compound 13.

[AIIMS 1997]

(a)  $Ti(C_2H_5)_4$ 

(b)  $Ti(OC_2H_5)_4$ 

(c)  $Ti(OCOCH_3)_4$ 

(d)  $Ti(OC_6H_5)_4$ 

14. Which of the following is not an organometallic compound

[MP PET 1996; BHU 2002]

Ethyl magnesium bromide

Tetraethyl lead

Sodium ethoxide

Trimethyl aluminium

An organometallic compound amongst the following is 15.

Ferrocene [I & K CET 2005]

(b)  $CaC_2$ 

Tetraethyl lead (TEL)

(d) All of these

16. Which of the following does not have a metal carbon bond

[CBSE PMT 2004]

(a)  $K[Pt(C_2H_4)Cl_3]$ 

(b)  $Ni(CO)_A$ 

(c)  $Al(OC_2H_5)_3$ 

(d)  $C_2H_5MgBr$ 

Coordination compounds have great importance in biological 17. systems. In this context which of the following statements is

Cyanocobalamin is  $B_{12}$  and contains cobalt.

Haemoglobin is the red pigment of blood and contains iron.

Chlorophylls are green pigments in plants and contains

Carboxypepticase-A is an enzyme and contains zinc.

Ziegler-Natta catalyst is [Pb. CET 2004]

(a)  $(Ph_3P)_3RhCl$ 

(b)  $K[PtCl_3(C_2H_4)]$ 

(c)  $[Al_2(C_2H_6)_6] + TiCl_4$ 

(d)  $[Fe(C_2H_5)_2]$ 

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 [AIIMS 2004]

(a) < 1

18.

(b) 2-3

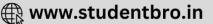
(c) 3-4 (d) 9-11

The  $\pi$ -bonded organo metallic compound which has ethene as 20. one of its component is [] & K CET 2005]

(a) Zeise's salt

(b) Ferrocene





- (c) Dibenzene chromium
- (d) Tetraethyl tin.

### Critical Thinking

### Objective Questions

- The coordination number and oxidation state of Cr  $K_3[Cr(C_2O_4)_3]$  are, respectively [CBSE PMT 1995]
  - (a) 4 and +2
- (b) 6 and +3
- (c) 3 and +3
- (d) 3 and 0
- The complex compounds which result from the coordination of [BHU 1999] carbon monoxide are known as
  - (a) Electronic
- (b) Carbonvls
- (c) Carbonates
- (d) Carbon permono
- Mixture X = 0.02 mol of  $[Co(NH_3)_5 SO_4]Br$  and 0.02 mol of 3.  $[Co(NH_3)_5Br]SO_4$  was prepared in 2 litre of solution
  - 1 *litre* of mixture X + excess  $AgNO_3 \rightarrow Y$ .
  - 1 *litre* of mixture  $X + \text{ excess } BaCl_2 \rightarrow Z$

Number of moles of Y and Z are

[IIT JEE 2003]

(a) 0.01, 0.01

- (b) 0.02, 0.01
- (c) 0.01, 0.02
- (d) 0.02, 0.02
- Which of the following organometallic compound is  $\sigma$  and  $\pi$ bonded [MH CET 2001; PCET 2002]
  - (a)  $Fe(CH_3)_3$
  - (b)  $[Fe(\eta^5 C_5H_5)_2]$
  - (c)  $[Co(CO)_5 NH_2]^{2+}$
  - (d)  $K[PtCl_3(n^2 C_2H_4)]$
- In  $[Ni(NH_3)_4]SO_4$ , the valency and coordination number of Niwill be respectively
  - (a) 3 and 6
- (b) 2 and 4
- (c) 4 and 2
- (d) 4 and 4
- Co-ordination number of Fe in the complexes  $[Fe(CN)_6]^{4-}$ , 6.  $[Fe(CN)_6]^{3-}$  and  $[FeCl_4]^-$  would be respectively
  - (a) 2, 3, 3
- (b) 6, 6, 4
- (c) 6, 3,3
- (d) 6, 4, 6
- On hydrolysis  $(Me)_2 SiCl_2$  will produce 7.
- [IIT-JEE 2003]

- (a)  $(Me)_2 Si(OH)_2$
- (b)  $(Me)_2 Si = O$
- (c)  $-[-O-(Me)_2Si-O-]_n$
- (d)  $Me_2SiCl(OH)$
- Which of the following represents a chelating ligand 8.

[IIPMER 2002]

- (a)  $H_2O$
- (b) *OH*<sup>-</sup>
- (c) DMG
- (d)  $Cl^-$
- $CuSO_4$  reacts with KCN solution and forms 9.

[MP PMT 1992; IIT 1996; UPSEAT 2001, 02]

- (a)  $Cu(CN)_2$
- (b) Cu(CN)
- (c)  $K_2[Cu(CN)_4]$
- (d)  $K_3 \left[ Cu(CN)_4 \right]$
- In the process of extraction of gold, 10.

Roasted gold ore  $+CN^- + H_2O \xrightarrow{O_2} [X] + OH^-$ 

$$[X] + Zn \rightarrow [Y] + Au$$

Identify the complexes [X] and [Y][IIT-IEE 2003]

- (a)  $X = [Au(CN)_2]^-, Y = [Zn(CN)_4]^{2-}$
- (b)  $X = [Au(CN)_A]^{3-}, Y = [Zn(CN)_A]^{2-}$
- (c)  $X = [Au(CN)_2]^-, Y = Zn(CN)_6]^{4-}$
- (d)  $X = [Au(CN)_4]^-, Y = [Zn(CN)_4]^{2-}$
- A solution of potassium ferrocyanide would contains ..... ions

(b) 3

(c) 4

- (d) 5
- Which one of the following complexes is an outer orbital complex
  - (a)  $[Co(NH_3)_6]^{3+}$
- (b)  $[Mn(CN)_6]^{4-}$
- (c)  $[Fe(CN)_6]^{4-}$
- (d)  $[Ni(NH_3)_6]^{2+}$

Atomic nos : Mn = 25, Fe = 26, Co = 27, Ni = 28

Which one of the following has largest number of isomers? 13.

[AIEEE 2004]

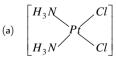
- (a)  $[Ir(PP_3)_2H(CO)]^{2+}$
- (b)  $[Co(NH_3)_5 Cl]^{2+}$
- (c)  $[Ru(NH_3)_4 Cl_2]^+$
- $[Co(en), Cl_2]^{\dagger}$

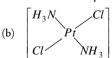
(R = alkyl group; en = ethylenediamine)

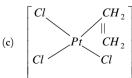
- Which kind of isomerism is exhibited by octahedral  $Co(NH_3)_4 Br_2 Cl$  ? [IIT-JEE Screening 2005]
  - (a) Geometrical and Ionization
  - Geometrical and Optical
  - Optical and Ionization
  - (d) Geometrical only
- 15. Which one of the following is expected to exhibit optical isomerism (en = ethylenediamine)
  - (a)  $cis [Pt(NH_3)_2 Cl_2]$
- (b)  $trans [Co(en)_2 Cl_2]$
- (c)  $trans [Pt(NH_3)_2 Cl_2]$
- (d)  $cis [Co(en)_2 Cl_2]$
- [EDTA]<sup>4-</sup> is a: 16.
- [UPSEAT 2004] (b) Bidentate ligand
- (a) Monodentate ligand (c) Quadridentate ligand
- Which Mheero 1993 in statements is incorrect? 17.
- (d) Hexadentate ligand

[KCET 2004]

- (a) In  $K_3[Fe(CN)_6]$ , the ligand has satisfied only the secondary valency of ferric ion.
- (b) In  $K_3[Fe(CN)_6]$ , the ligand has satisfied both primary and secondary valencies of ferric ion.
- (c) In  $K_4[Fe(CN)_6]$ , the ligand has satisfied both primary and secondary valencies of ferrous ion.
- (d) In  $[Cu(NH_3)_4]SO_4$ , the ligand has satisfied only the secondary valency of copper.
- Which of the following is considered as an anticancer species.



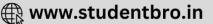






An aqueous solution of CoCl2 on addition of excess of 19. concentrated HCl turns blue due to formation of





[AIIMS 2005]

- (a)  $[Co(H_2O)_4 Cl_2]$
- $[Co(H_2O)2Cl_4]^{2-}$
- $[CoCl_{\scriptscriptstyle A}]^{2-}$
- (d)  $[Co(H_2O)2Cl_2]$
- 20. The correct order for the wavelength of absorption in the visible
  - $[Ni(NO_2)_6]^{4-} < [Ni(NH_3)_6]^{2+} < [Ni(H_2O)_6]^{2+}$
  - $[Ni(NO_2)_6]^{4-} < [Ni(H_2O)_6]^{2+} < [Ni(NH_3)_6]^{2+}$
  - $[Ni(H_2O)_6]^{2+} < [Ni(NH_3)_6]^{2+} < [Ni(NO_2)_6]^{4-}$
  - (d)  $[Ni(NH_3)_6]^{2+} < [Ni(H_2O)_6]^{2+} < [Ni(NO_2)_6]^{4-}$
- In which of the following pairs both the complexes show optical 21.
  - $cis-[Cr(C_2O_4)_2Cl_2]^{3-}$ ,  $cis-[Co(NH_3)_4Cl_2]$
  - $[Co(en)_3]Cl_3$ , cis- $[Co(en)_2Cl_2]Cl$
  - [PtCl(dien)]Cl,  $[NiCl_2Br_2]^{2-}$
  - (d)  $[Co(NO_3)_3(NH_3)_3]$ , cis- $[Pt(en)_2Cl_2]$
- 22. Which of the following compounds shows optical isomerism
  - [AIEEE 2005; CBSE PMT 2005]
  - (a)  $[Cu(NH_3)_4]^{2+}$
- (b)  $[ZnCl_4]^2$
- (c)  $[Cr(C_2O_4)_3]^{3-}$
- (d)  $[Co(CN)_6]^{3-}$



### Assertion & Reason

### For AIIMS Aspirants

Read the assertion and reason carefully to mark the correct option out of the options given below:

- If both assertion and reason are true and the reason is the correct (a) explanation of the assertion.
- *(b)* If both assertion and reason are true but reason is not the correct explanation of the assertion.
- If assertion is true but reason is false.
- If the assertion and reason both are false. (d)
- If assertion is false but reason is true.
- Assertion : Potassium ferrocyanide and potassium ferricyanite both are diamagnetic.
  - Reason Both have unpaired electrons.
- :  $NF_3$  is a weaker ligand than  $N(CH_3)_3$ Assertion

:  $NF_3$  ionizes to give  $F^-$  ions Reason ionsiionsioiiioioioioioioioioion

ions in aqueous solution.

Reason

- : The  $[Ni(en)_3]Cl_2$  (en = ethylene diamine) has Assertion 3. lower stability than  $[Ni(NH_3)_6]Cl_2$ 
  - : In  $[Ni(en)_3]Cl_2$  the geometry of Ni is trigonal
    - bipyramidal
- Assertion The ligands nitro and nitrito are called ambidentate ligands.
  - These ligands give linkage isomers. Reason
- Geometrical isomerism is also called cis-trans Assertion isomerism.
  - : Tetrahedral complexes show geometrical isomerism. Reason

 $: \begin{array}{c|c} (en)_2 Co & \stackrel{NH}{\smile} C\rho(en)_2 \\ OH & \end{array}$ 

(ethylene diamine)  $\mu$  -hydroxo-imido dicobalt (111)

Reason : In naming polynuclear complexes i.e., containing two

or more metal atoms joined by bridging ligands, the word  $\mu$  is added with hyphen before the name of such ligands.

Assertion  $[Fe(CN)_6]^{3-}$  is weakly paramagnetic while 7.  $[Fe(CN)_6]^{4-}$  is diamagnetic.

:  $[Fe(CN)_6]^{3-}$  has +3 oxidation state Reason

 $[Fe(CN)_6]^{4-}$  has +2 oxidation state.

8. :  $H_2N - NH_{2}$  is a chelating ligand. Assertion

> : A chelating ligand must possess two or more lone Reason pairs at such a distance that it may form suitable strain free rings at the metal ion.

:  $[Ti(H_2O)_6]^{3+}$  is coloured while  $[Sc(H_2O)_6]^{3+}$  is Assertion

*d-d* transition is not possible in  $[Sc(H_2O)_6]^{3+}$ . Reason

All the octahedral complexes of  $Ni^{2+}$  must be 10. Assertion outer orbital complexes.

Reason Outer orbital octahedral complexes are given by weak ligands.

Potassium ferrocyanide is diamagnetic whereas 11. Assertion potassium fericyanide is paramagnetic.

Crystal field splitting in ferrocyanide ion is greater Reason

than that of ferricyanide ion.

[AIIMS 2005]

## nswers

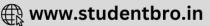
### **Basic Terms**

1	b	2	С	3	b	4	b	5	d
6	а	7	b	8	С	9	b	10	С
11	d	12	С	13	d	14	b	15	b
16	b	17	а	18	С	19	С	20	b
21	b	22	С	23	b	24	d	25	а
26	d	27	а	28	b	29	b	30	С
31	b	32	С	33	b	34	b	35	d
36	d	37	b	38	b	39	d	40	b
41	d	42	b	43	d	44	b	45	а
46	а	47	d	48	С	49	b	50	d
51	а	52	b	53	d	54	а	55	d
56	d	57	а	58	d	59	а	60	d
61	С	62	d						

Nomenclature, oxidation State and EAN number

d





6	С	7	b	8	а	9	а	10	а
11	С	12	а	13	b	14	а	15	b
16	С	17	d	18	b	19	d	20	а
21	b	22	b	23	а	24	b	25	а
26	d	27	С	28	b	29	а	30	а
31	а	32	b	33	а	34	b	35	С
36	b	37	а	38	а	39	b	40	С
41	а	42	b	43	С	44	b	45	b
46	d	47	а	48	b	49	С	50	С
51	b	52	b	53	С	54	d	55	b
56	а	57	b	58	С				

Isomerism and	Magnetic	properties
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1	а	2	d	3	а	4	С	5	С
6	d	7	b	8	а	9	а	10	С
11	d	12	d	13	b	14	С	15	а
16	b	17	а	18	d	19	а	20	b
21	С	22	b	23	b	24	а	25	а
26	d	27	d	28	а	29	С	30	а
31	b	32	а	33	С	34	а	35	d
36	С	37	d	38	а	39	d	40	b
41	а	42	С	43	d	44	а	45	b
46	е	47	а	48	d	49	С	50	С
51	d	52	а	53	С	54	а	55	а
56	С	57	С						

### **Hybridisation and Geometry**

1	а	2	b	3	а	4	b	5	a
6	b	7	b	8	d	9	С	10	a
11	b	12	С	13	d	14	а	15	b
16	b	17	d	18	d	19	а	20	а
21	b	22	d	23	С	24	С	25	С
26	d	27	d	28	d	29	d	30	a
31	d	32	С	33	а	34	а	35	С
36	a	37	С	38	d	39	d	40	b
41	b	42	а	43	С				

### Complexes and complex stability

1	d	2	d	3	d	4	b	5	a
6	а	7	d	8	b	9	С	10	b
11	b	12	b	13	а	14	b	15	b

### Application of organometallics

1	d	2	d	3	d	4	С	5	b
6	b	7	b	8	а	9	а	10	d
11	С	12	b	13	а	14	С	15	d
16	С	17	С	18	С	19	d	20	а

Critical Thinking Questions											
	b	2	b	3	а	4	b	5	b		
	b	7	С	8	С	9	d	10	а		
1	d	12	d	13	d	14	а	15	d		
6	d	17	ad	18	а	19	С	20	а		

### **Assertion & Reason**

1	d	2	С	3	d	4	а	5	С
6	е	7	b	8	е	9	а	10	b
11	С								

