

1. Limitation of V.B.T  $\rightarrow$  of Complex.

It involves a number of assumptions.

- (i) It gives only the qualitative explanation for Complex.
- (ii) It does not explain the detailed magnetic properties of the complexes.
- (iii) This theory does not explain the spectral properties of the complexes.
- (iv) It does not explain the thermodynamic and kinetic stabilities of different compounds.
- (v) It does not make exact predictions regarding the tetrahedral or square planar structures of 4-coordinate complexes.
- (vi) It does not distinguish between weak and strong ligands.

Application of V.B.T →

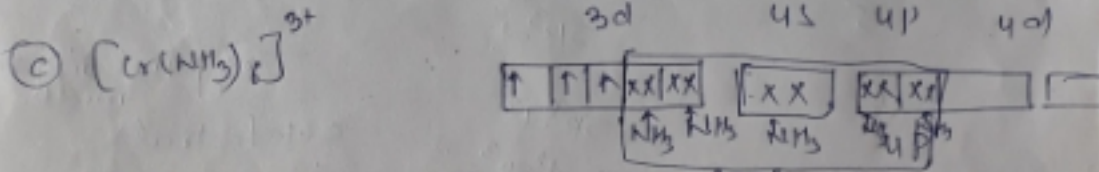
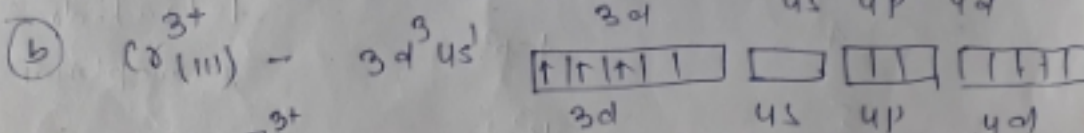
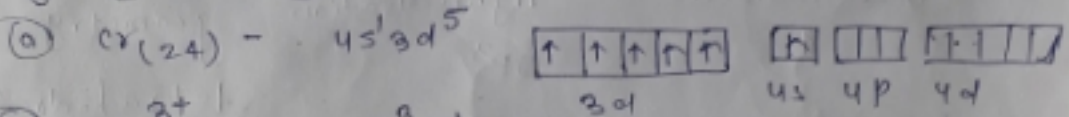
(i) Examples of complexes of CN=6

complexes having CN=6 have octahedral geometry these are of two types (i) inner orbital complexes and (ii) outer orbital complex.

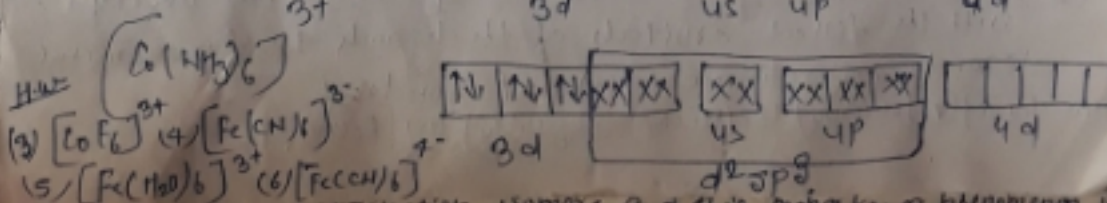
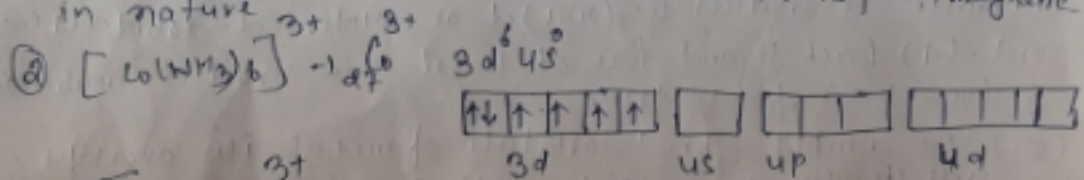
Inner orbital complexes → If the complex is formed by the use of inner d orbital for hybridisation and written as  $d^2sp^3$ . It is called inner orbital complex. these have less number of unpaired electrons and called low spin complex.

Outer orbital complex → If the complex is formed by the use of outer d orbitals for hybridisation written as  $sp^3d^2$ . It is called outer orbital complexes. these have high more number of unpaired electrons and called high spin complex.

Eg-  $[Cr(NH_3)_6]^{3+}$  complex-



geometry: octahedral inner d-orbital complex  
three unpaired electron. So. It is paramagnetic.



(4)  $[Fe(CN)_6]^{3-}$   
 (5)  $[Fe(NH_3)_6]^{3+}$     (6)  $[FeCl_4]^{-}$

Part II

V.B.T of Complexes  $\rightarrow$  This theory is based on following important assumption.

(1) The central metal ion in the complex makes available a number of empty orbitals for the formation of coordination bonds with available ~~number~~ ligands. The number of empty orbitals made available for this purpose is equal to coordination number of the central metal ion.

(2) The appropriate atomic orbitals (s, p, and d) of the metal hybridise to give a set of equivalent orbitals of definite geometry such as square planar, tetrahedral, octahedral and so on. The following types of hybridisation are involved for different geometries of the complex.

Coordination No.	Hybridisation	Geometry
4	$sp^3$	tetrahedral
4	$dsp^2$	square planar
5	$sp^3d$	Trigonal bipyramidal
6	$sp^3d^2$ or $d^2sp^3$	octahedral inner octahedral

(3) The d-orbitals involved in the hybridisation may be either inner d-orbitals i.e.  $(n-1)d$  or outer d-orbitals i.e.  $nd$ . (4) Each ligand has at least one orbital containing a lone pair of electrons.

(5) The empty hybrid orbitals of metal ion overlaps with the filled orbitals of the ligands to form metal ligand coordinate covalent bonds.

(6)  $[Ni(CO)_4]^{2-}$  (7)  $[Ni(CO)_4]$  (8)  $[Ni(CO)_4]$  (9)  $[Ni(CO)_4]^{2+}$  (10)  $[Fe(CO)_5]$ .