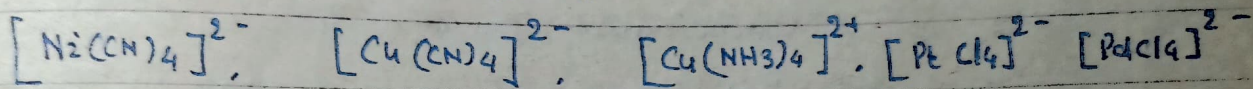


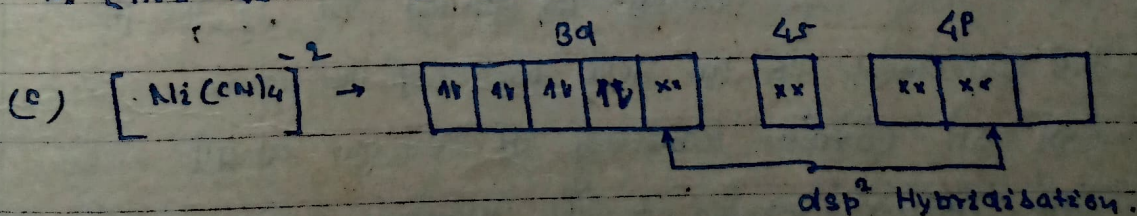
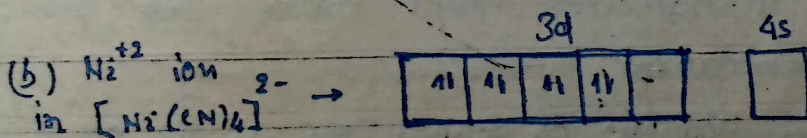
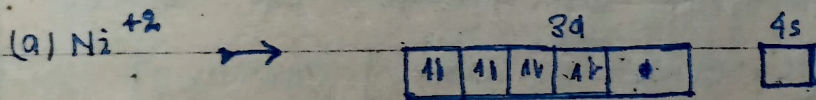
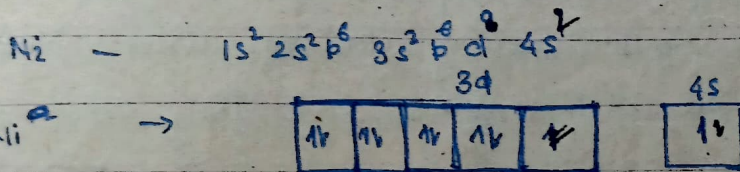
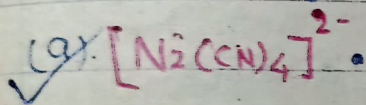
## Square Planer Complexes: →

Square Planer Complexes are the result of  $dsp^2$  hybridisation. This type of hybridisation involves ~~mix~~ due to mixing of one d, one s and two p orbitals, resulting the formation of four equivalent hybrid orbitals which are planer and ~~all~~ mutually at right angles pointing towards the four corners of a square planer complex.

Example of Square Planer Complexes are



Formation of some complex ion have been illustrated below:—



Since there is no unpaired electron, in complex ion, so it is diamagnetic.

Formation of  $[\text{Cu}(\text{NH}_3)_4]^{2+}$   $\rightarrow$  Tetraammine Copper II ion.

We find that study of magnetic properties can be highly useful in knowing the geometry of metal complexes and also the type of hybridisation, involved in their formation.

Sometimes, however, magnetic properties are not useful at all. In such cases the structure is determined by X-ray diffraction measurement. The type of hybridisation is then deduced from this structure. We may illustrate the points considering to the complex of  $\text{Cu}^{2+}$  ion, in which it has a coordination number - 4.

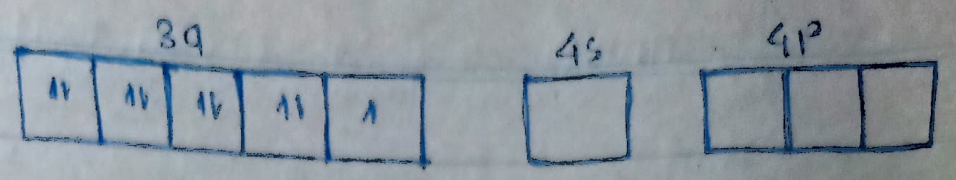
This ion has one more electron than  $\text{Ni}^{2+}$ . As shown in fig.

(a) There is only one half filled 3d-orbital. The possibility of  $ds$ -pairing does not arise because the other four 3d-orbitals are fully occupied. This suggested that the complexes of  $\text{Cu}^{2+}$  ion such as  $[\text{Cu}(\text{CN})_4]^{-2}$  or  $[\text{Cu}(\text{NH}_3)_4]^{2+}$  must involve  $sp^3$  hybridisation, and therefore structure should be tetrahedral.

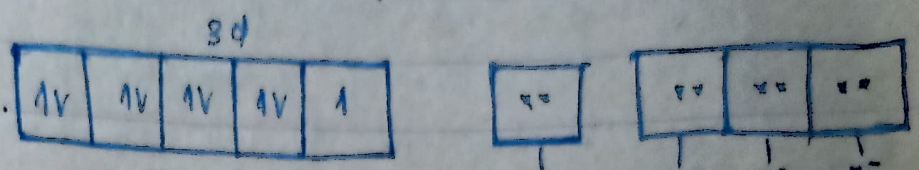
However as pointed out by the Pauling the placement of the lone pair of the ligand (i.e. CN or  $\text{NH}_3$ ) can not cause lowering of energy at all.

The complex formed in this manner, therefore can not be stable. But we know that these complexes are highly stable. Hence the alternative possibility of  $dsp^2$  hybridisation look more probable.

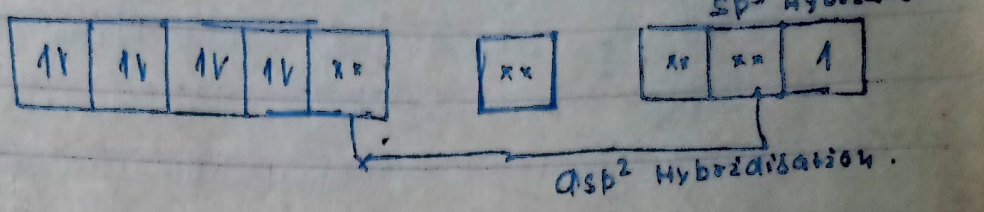
(a)  $Cu^{+2}$  ion



(b)  $[CuX_4]^{2-}$   
 $[CuX_4]^{2-}$



(c)  $[CuX_4]^{2-}$   
 $[CuX_4]^{2-}$



The solitary 3d-electron in this case is promoted to one of the 4p-orbital, as shown. A careful examination of (b) and (c) shows that both the tetrahedral and square planar structure have one unpaired electron.

Magnetic Measurement therefore cannot be of much help in deciding between the two structures. The x-ray diffraction reveals the structure of  $[Cu(CN)_4]^{2-}$  and  $[Cu(NH_3)_4]^{+2}$  to be square planar. Hence the hybridization involved should be  $dsp^2$  as shown in (c).

### Objection to the shape of Cuprammonium ion $\rightarrow [Cu(NH_3)_6]^{+2}$

(i) The necessity is to promote one electron from a 3d into 4p level is not satisfactory. The 4p electrons are expected to be easily lost. Hence the complex should be easily oxidised. But this is actually not so.

### Limitations of Valence Bond Theory: $\rightarrow$

Pauling theory explained the chemistry of co-ordination compound satisfactorily. But failed to explain some of the aspects.