M. Sc. Semester I
Inorganic chemistry I
Paper – CC-I
Unit – IV
Dr. Kumud Kumari

Ligand Substitution Reaction In Squar Planar Complexes (II) (contd.)

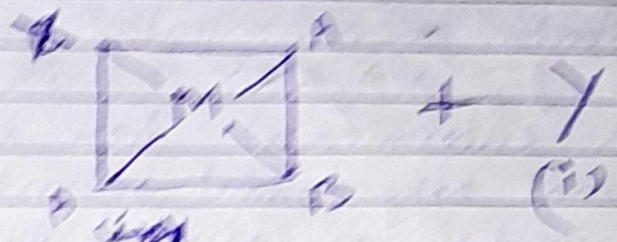
(2) π - Bonding Theory to explain trans effect :-

This theory can explain well the trans effect of those attached ligands in square planar complexes which are pi-acids or pi-acceptors. ~~take~~ For example phosphine, CN^-, CO, C_2H_4, PR_3 etc.

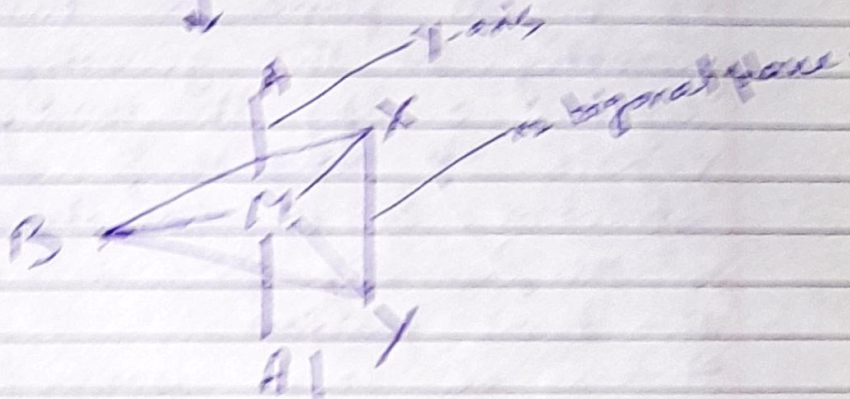
$$MA_2BX + Y \rightarrow MA_2BY + X \quad \text{—(i)}$$

In this reaction X is replaced by Y. Obviously X is the leaving group and Y is the entering group. In MA_2BX, B is a π-bonding ligand. ~~B~~ The ligand B is also called trans labilising ligand. In this complex B and X is trans to each other in square planar complex. According to π bonding theory, the ligand substitution reaction (i) give above takes place through

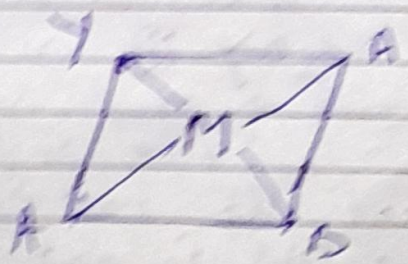
Site shape showing bases —



(I) Square planar complex (MA_2BX)



II Trigonal bipyramidal intermediate
(Trans-effect state)
MA_2BXY



III. Square planar complex MA_2BY

(a) In step I the entering ligand (Y) attacks the square planar complex, MA_2BX (I) and an intermediate activated 5-coordinated complex (transition state), MA_2BXY (II) is obtained. This intermediate has trigonal has trigonal bipyramidal geometry. This intermediate is formed due to ~~this~~ the movement of X and Y ligands xz trigonal plane of trigonal bipyramidal geometry. In this geometry the two A ligands occupy the trans position along Y-axis. ~~It may be seen from the structure of trigonal bipyramidal geometry. In this geometry the two A ligands occupy the trans position~~

It may be seen from the structure of trigonal bipyramidal intermediate state (II) that the leaving group (X), entering group (Y) and π-bonding ligand (B) from the trigonal plane (xz plane) of the trigonal bipyramidal geometry

(b) In step (intermediate) transition state (II) loses X and square planar complex MA_2BY III is formed. In the formation of this square planar complex the bond angle BMY which is equal to 120° in trigonal bipyramidal structure (II) is expanded to 180° in square planar complex, MA_2BY (III)

the entering group (Y) ~~is~~ is placed trans to π acid ligand (π-bonding ligand) (B). The position of the entering group (Y) is placed in MA_2BY (III) in the same as that of leaving group (X) in MA_2BX (I)