Tanabe Sugano (TS) Diagram
Lecture - 2

M. Sc. (CC-6/PAT/CSIR NET)
Inorganic Chemistry

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For d^4 system

d^4 is field dependent system i.e. its splitting depends upon W/F & S/F

Weak field

$$Ms = 2 \times \frac{4}{2} + 1 = 5$$

$L = +2+1+0-1$

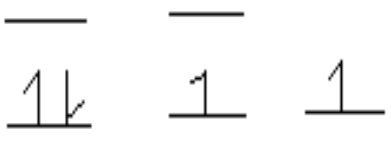
$= 2\ (0, 1, 2 \Rightarrow S, P, D)$

So, G.S.T = ^5D

^5D splitts into ^5E_g & $^5T_{2g}$

Since E_g set is incomplete so ^5E_g is ground state is degeneracy

Strong Field



$d^4 = d^3 + d^1$

$$2 \times \frac{2}{2} + 1 = 3$$

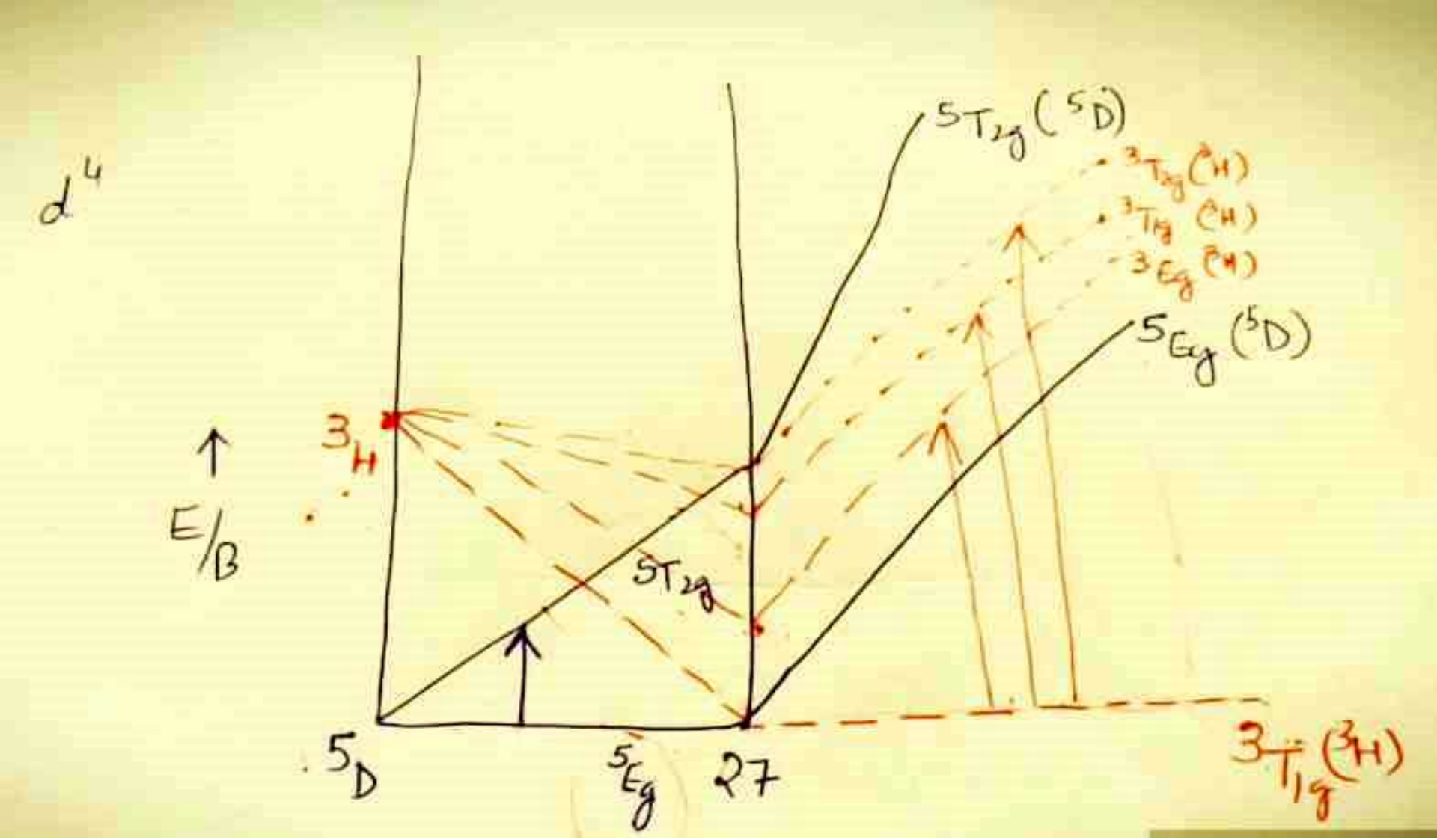
$L = +2+2+1+0 = 5\ (0, 1, 2, 3, 4, 5 \Rightarrow S, P, D, F, G, H)$

Since J=L+S for more than half filled orbital. So G.S.T.=^3H

$^3H, (^3G, ^3F, ^3D, ^3P, ^1I, ^1G, ^1F, ^1D, ^1S)$

^3H splits into ^3E_g, $^{+3}T_{1g}$, $^{+3}T_{1g}$, $^{+3}T_{2g}$

T_{2g} term is incomplete so G.S. degeneracy is $A_{1g} \times T_{2g} = {}^3T_{1g}$



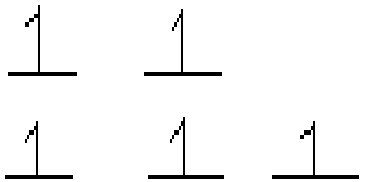
In weak field there is only one peak due to transition of electron from $^5E_{2g}$ to $^5T_{2g}$ followed by spin allowed transition ($\Delta S=0$).

But in strong field there are 3 peaks are obtained due to spin aloowed transition of electron.

TS diagram of d^5 system

d^5 is field dependent system i.e. its splitting depends upon W/F & S/F

Weak field

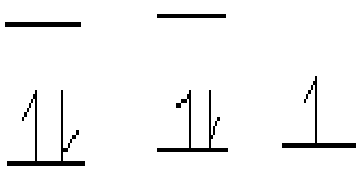


$$Ms = 2x\frac{5}{2} + 1 = 6$$

$L = 0\ (S)$

So, G.S.T $= {}^6S \Rightarrow {}^6A_{1g}$

Strong Field



$d^3 X d^2 = A_{2g} X T_{1g} = T_{2g}$

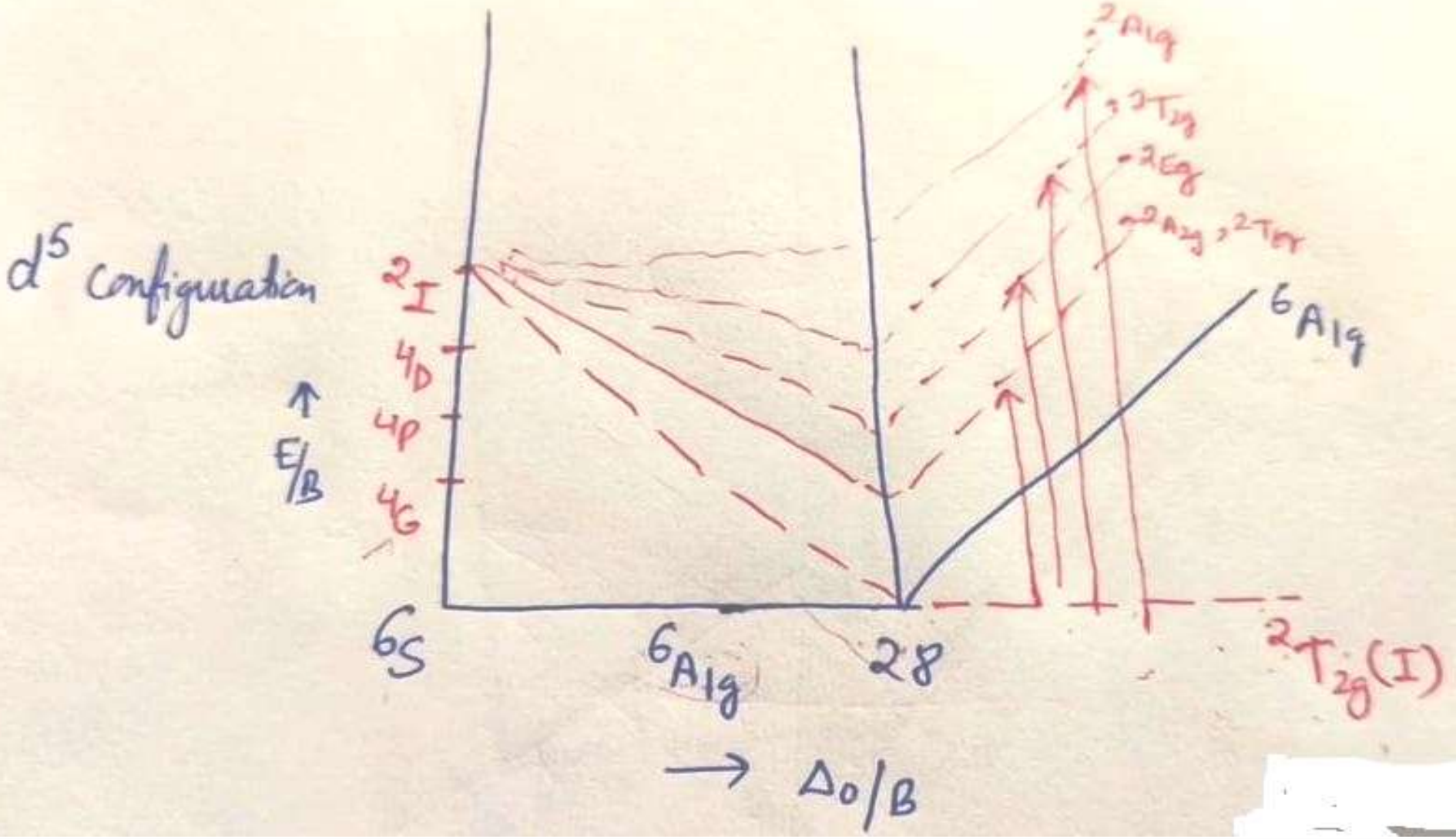
$$2x\frac{1}{2} + 1 = 2$$

$L = +2+2+1+1+0 = 6\ (0, 1, 2, 3, 4, 5 \Rightarrow S, P, D, F, G, H, I)$

So, terms will be ${}^2I, {}^2H, {}^2G, {}^2F, {}^2D, {}^2P, {}^2S$

Since T_{2g} set is incomplete. So ground degenerated term is T_{2g}

So, TS diagram may be sketched as in both W/F & S/F

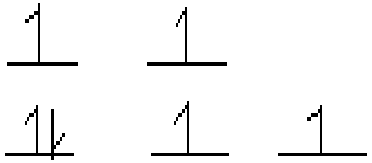


In weak field no peak is obtained but in strong field we get for spin allowed peaks where $\Delta s = 0$

TS diagram of d^6 system

d^6 is field dependent system i.e. its splitting depends upon W/F & S/F

Weak field



$$Ms = 2 \times \frac{4}{2} + 1 = 5$$

$$L = +2+2+1+0-1-2$$

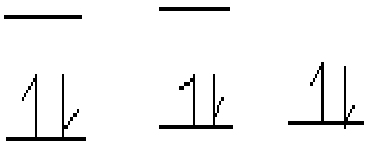
$$= 2\,(0, 1, 2) = S, P, D$$

So, G.S.T $= {}^5D < {}^6P < {}^6S$

${}^5D$ splits into ${}^5T_{2g}$, ${}^5E_g$ but T_{2g} is incomplete

So, G.S.T. degeneracy is ${}^5T_{2g}$

Strong Field



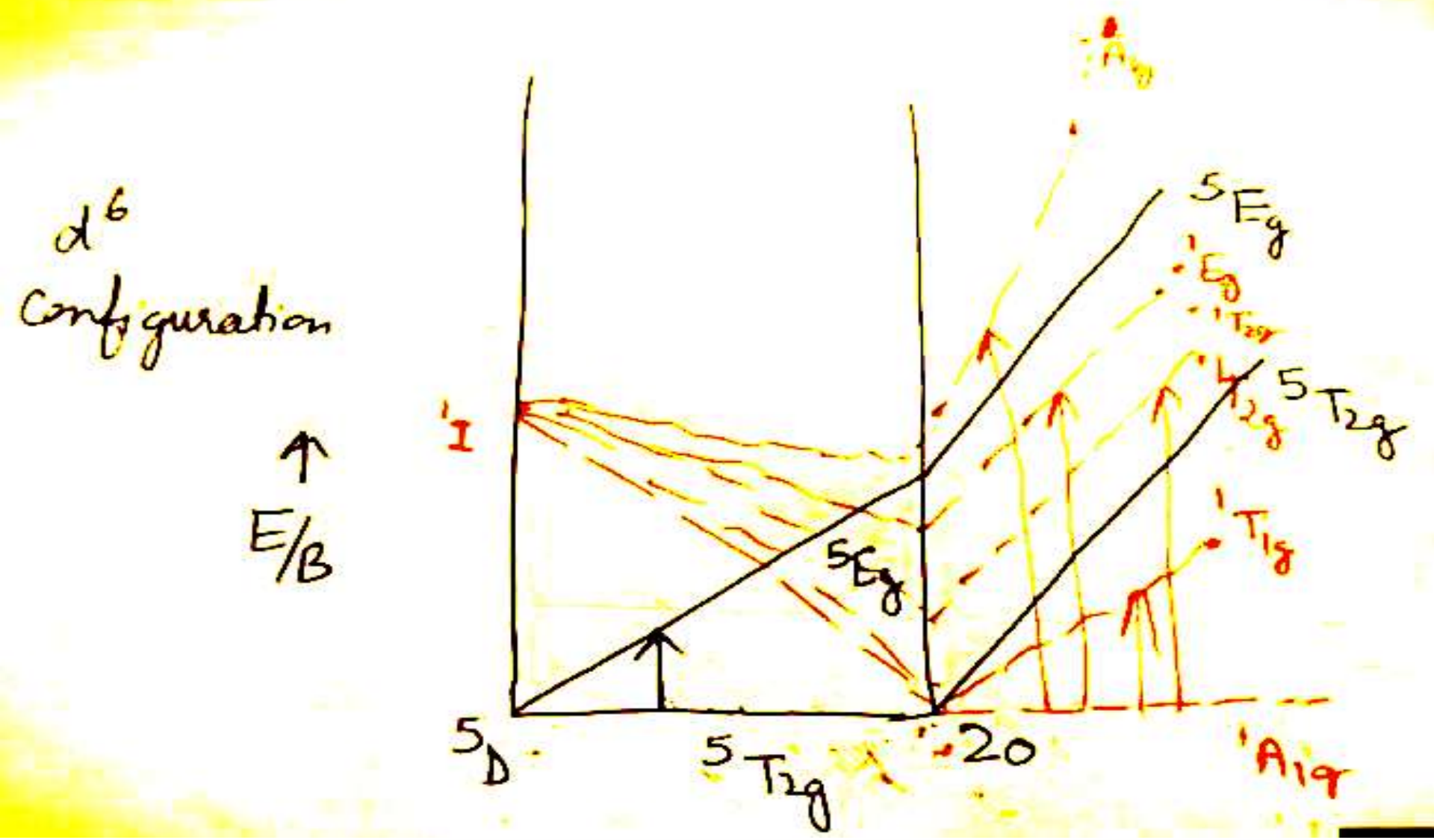
$$2 \times \frac{0}{2} + 1 = 1$$

$$L = +2+2+1+1+0+0 = 6\ (0, 1, 2, 3, 4, 5 \Rightarrow S, P, D, F, G, H, I)$$

Terms energy $= {}^1I < {}^1H < {}^1G < {}^1F < {}^1D < {}^1P < {}^1S$

${}^1I$ splits into $A_{1g} + A_{2g} + E_g + T_{1g} + {}^2T_{2g}$

So, TS diagram may be sketched as in both W/F & S/F

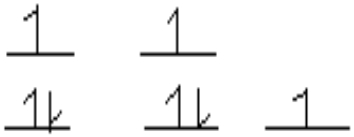


We get only one peak in weak field & four peaks in strong field as given in diagram.

TS diagram of d^7 system

d^7 is field dependent system i.e. its splitting depends upon W/F & S/F

Weak field



$$Ms = 2x\frac{3}{2} + 1 = 4$$

$$L = +2+2+1+1+0-1-2$$
$$= 3\ (0, 1, 2, 3) = S, P, D, F$$

G.S.T. = ^4F.

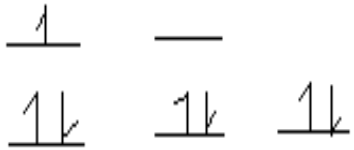
Energy of terms = $^4F, {}^4D < {}^4P < {}^4S$

^4F splits into $^1T_{1g}, {}^4T_{1g}$ & $^4A_{2g}$

but T_{2g} is incomplete

So G.S.T degeneracy is $^4T_{1g}$

Strong Field



$$2x\frac{1}{2} + 1 = 2$$

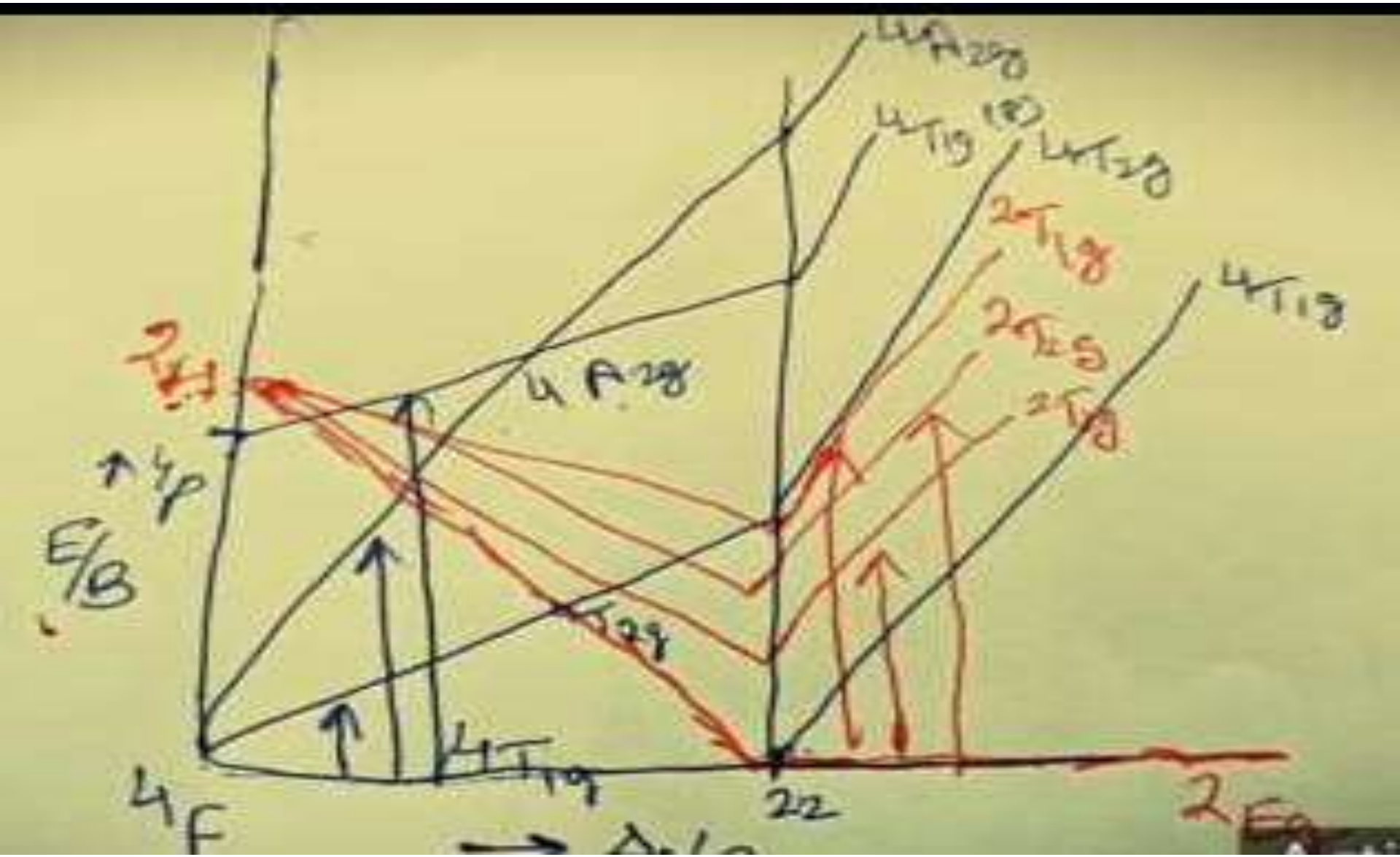
$$L = +2+2+1+1+0+0-1 = 5\ (0, 1, 2, 3, 4, 5 \Rightarrow S, P, D, F, G, H)$$

Terms energy = $^2H < {}^2G < {}^2F < {}^2D < {}^2P < {}^2S$

^2H splits into $^2E_g + {}^2T_{1g} + {}^2T_{2g} + {}^2T_{2g}$

Eg is incomplete So G.S.T generated is ^2E_g

So, TS diagram may be sketched as in both W/F & S/F



There are 3 peaks in weak field & 3 peaks in strong field are obtained due to electronic transfer in d^7 system.

Thank You