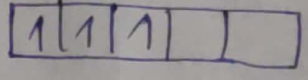
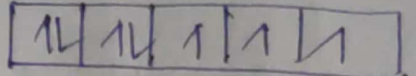
correlation and spin-Orbit coupling in Free ions for First series of Transition Metal :—

3. Cr^{3+} and Co^{2+} (d^3, d^7) :—

Cr^{3+} – d^3  $Co^{2+}(d^7)$ – 

Both have 3 unpaired electron.

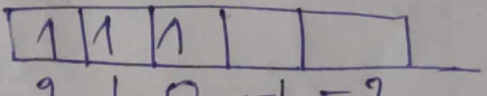
Cr^{3+} No. of microstate $= (n/r) = \frac{n!}{r!(n-r)!}$

$= \binom{10}{3} = \frac{10!}{3!(10-3)!}$

$= \frac{10 \times 9 \times 8 \times 7 \times 6 \times 5 \times 4 \times 3 \times 2 \times 1}{3 \times 2 \times 1 \times 7 \times 6 \times 5 \times 4 \times 3 \times 2 \times 1}$

$= 120$

∴ Both have No. of microstate $= 120$.

Term symbol for d^3 

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

$L = 3$, Term symbol = F

Spin multiplicity $2S+1 = 2 \times \frac{3}{2} + 1 = 4$

Term symbol = $^{2S+1}L_J$ Possible Term symbol.

$J = L+S = 3 + \frac{3}{2} = \frac{9}{2}$ $^4F_{9/2}$

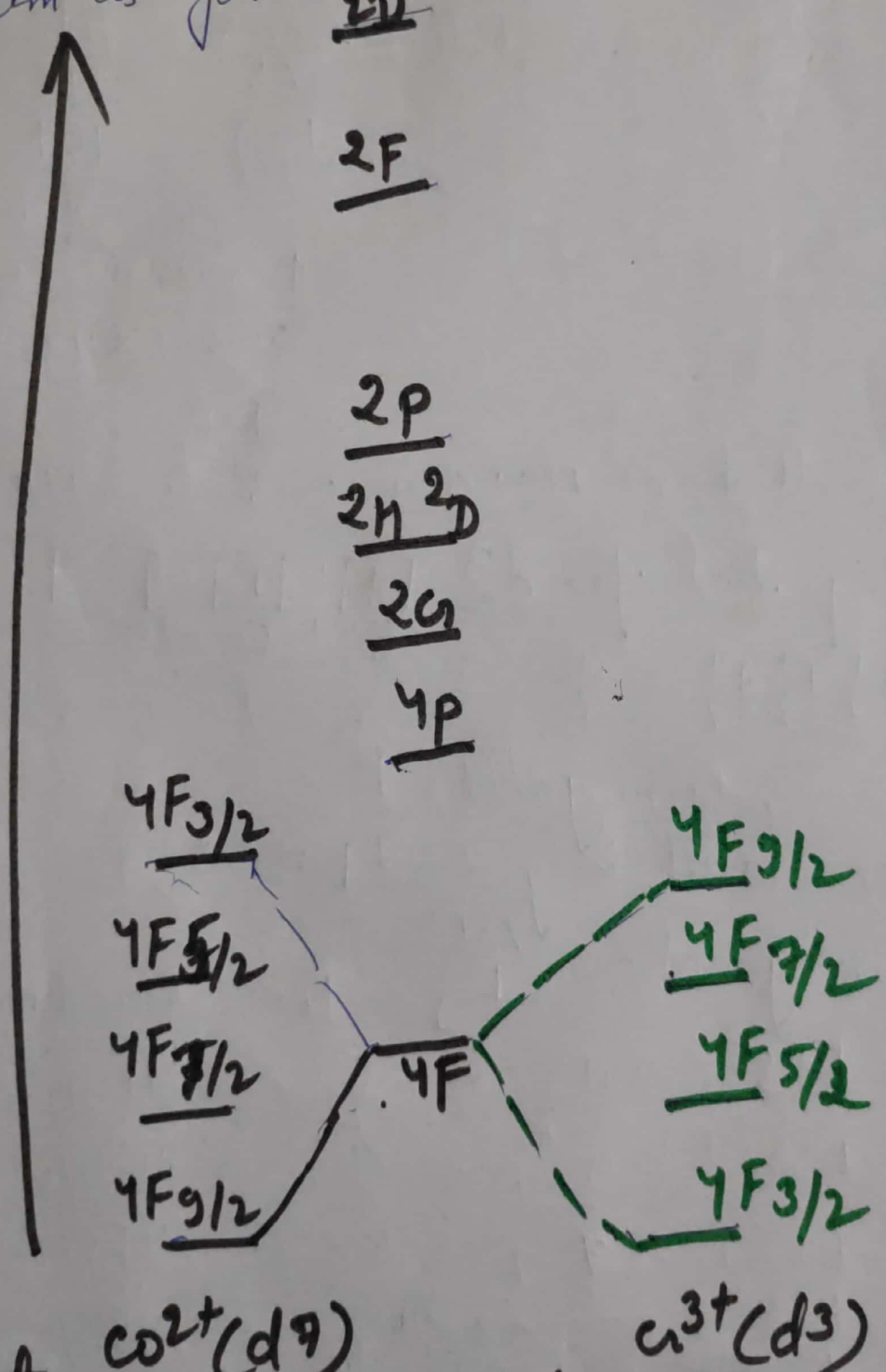
$L+S-1 = \frac{9}{2} - 1 = \frac{7}{2}$ $^4F_{7/2}$

$L+S-2 = \frac{9}{2} - 2 = 5/2$ $^4F_{5/2}$

~~$L+S-3 = \frac{5}{2} - 3 =$~~

$L-S = 3 - \frac{3}{2} = 3/2$. $^4F_{3/2}$.

For 120 microstate other term is also possible $^4P, ^2G, ^2H, ^2D, ^2P, ^2P, ^2D$. ^4F term is the ground term. due to L-S coupling ^4F term is split into, $^4F_{9/2}$, $^4F_{7/2}$ $^4F_{5/2}$ $^4F_{3/2}$. Now correlation diagram is plotted for d^3, d^7 system is given below.



Correlation and spin-orbit coupling free ion terms of Cr^{3+} and Co^{2+}