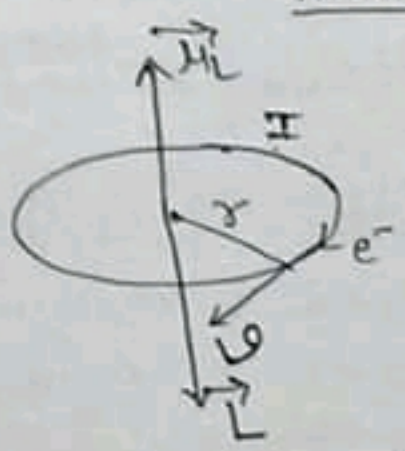
Short notes

orbital motion of e^-



$I = q/T$

$T = \frac{2\pi r}{v}$, $L = mvr$

$\vec{\mu_L} = -\frac{evr}{2}$

$\vec{\mu_L} = -\left(\frac{e}{2m}\right)\vec{L}$

$\frac{\vec{\mu_L}}{\vec{L}} = \text{Constant}$

$\because \vec{L} = \sqrt{l(l+1)}\,\hbar$

$\mu_L = -\left(\frac{e}{2m}\right)\sqrt{l(l+1)}\,\hbar$

$\mu_L = -\left(\frac{e\hbar}{2m}\right)\sqrt{l(l+1)}$

$\mu_L = -\mu_B\sqrt{l(l+1)}$

Where μ_B is called Bohr magneton.

$\mu_B = 9.27\times10^{-24}\ A\cdot m^2$

$\boxed{\vec{\mu_L} = -\left(\frac{e}{2m}\right)\vec{L}}$

where $\left(\frac{e}{2m}\right)$ is called gyro magnetic ratio

$\vec{\mu_L} = -g_l\left(\frac{e}{2m}\right)\vec{L}$

where $g_l \rightarrow$ Lande factor

for orbital motion of e^- $g_l \rightarrow 1$

NOTE:= $\omega = \frac{eB}{2m}$

$\boxed{f = \frac{eB}{4\pi m}}$ Larmor frequency

Z-Component

$\vec{\mu_z} = -\left(\frac{e}{2m}\right)\vec{L_z}$

$\vec{\mu_z} = -\left(\frac{\mu_B}{\hbar}\right)\vec{L_z}$

$\vec{\mu_L} = -g_l\left(\frac{\mu_B}{\hbar}\right)\vec{L}$

Vector atom model:-

$\vec{J} = \vec{L} + \vec{S}$

$J^2 = j(j+1)\hbar^2$

$J_z = m_j\hbar$

$-j \le m_j \le j$

$j = |l+s|$ to $|l-s|$

space Quantization:=

$L_z = L\cos\theta$

$\because L_z = m_l\hbar$ and $L = \sqrt{l(l+1)}\,\hbar$

$\cos\theta = \frac{L_z}{L} = \frac{m_l}{\sqrt{l(l+1)}}$

$\theta = \cos^{-1}\left[\frac{m_l}{\sqrt{l(l+1)}}\right]$

because direction of angular momentum is also fixed.

$\Rightarrow$ electron spin:-

S.G. experiment (Concept)

$\vec{S} = \sqrt{s(s+1)}\,\hbar$

$S_z = m_s\hbar$

$\vec{\mu_s} = -\left(\frac{e}{2m}\right)\vec{S}$

$\vec{\mu_s} = -g_s\left(\frac{\mu_B}{\hbar}\right)\vec{S}$

$g_s \rightarrow 2$

$s = 1/2,\ m_s = \pm\frac{1}{2}$

Z-component

$\vec{\mu_z} = -2\left(\frac{e}{2m}\right)\vec{S_z}$

$\mu_z = -2\frac{\mu_B}{\hbar}m_s\hbar$

$\boxed{(\mu_s)_z = \mp\mu_B}$

spectroscopy term and there notation:- $[n\ ^{2S+1}L_j]$

L-S Coupling:-

$S = |S_1+S_2|$ to $|S_1-S_2|$

$l = |l_1+l_2|$ to $|l_1-l_2|$

$j = |l+s|$ to $|l-s|$

NOTE(1) for completely filled

$l=0,\ \Sigma m_l = 0$

$s=0,\ \Sigma m_s = 0$

$l=0,\ s=0,\ j=0$

term $^{2S+1}L_j \Rightarrow {}^1S_0$

NOTE (2)

degeneracy $\sum_{j=|l-s|}^{j=|l+s|} (2j+1) = (2s+1)(2l+1)$

Non-equaliveient e⁻ Configuration:- $(ns)(n's)$

the value of n, n' is different

$\Rightarrow$ equaliveient e⁻ Configuration:$\Rightarrow$ $(ns)(ns)$

the value of n, n is same.

Note

$S \Rightarrow$ spin quantum number

$S \Rightarrow$ spin Angular momentum

$L =$ orbital Angular momentum

$l \Rightarrow$ azimuthal quantum number

$J \Rightarrow$ Total Angular momentum

$j \Rightarrow$ Angular momentum quantum number

$S=1,\ m_s = 2S+1$

$l=1,\ m_l = 2l+1$

$j=1,\ m_j = 2j+1$

$-S \le m_s \le +S$

$-j \le m_j \le +j$

$-l \le m_l \le +l$

$\vec{S_z} = m_s\hbar$

$\vec{L_z} = m_l\hbar$

$\vec{J_z} = m_j\hbar$

$\vec{S} = \sqrt{S(S+1)}\,\hbar$

$\vec{J} = \sqrt{j(j+1)}\,\hbar$

$L = \sqrt{l(l+1)}\,\hbar$

$\vec{J} = \vec{L} + \vec{S}$

NOTE:⇒ Configuration $(nl)^q$ is same $(nl)^{r-q}$ $p^1 \rightarrow p^5$, $p^2 \rightarrow p^4$, $d^1 \rightarrow d^9$, $d^2 \rightarrow d^8$
where r is the max. number of e^- $r = 2(2l+1)$

⇒ terms of equalivalent:⇒

Configuration		terms
s^1	⟶	$^2S_{1/2}$
s^2, p^6, d^{10}	⟶	$^1S_0$
p^2, p^4	⟶	$^1S_0, {}^3P_{0,1,2}, {}^1D_2$
p^1, p^5	⟶	$^2P_{1/2,3/2}$
p^3	⟶	$^2P_{1/2,3/2}, {}^4S_{3/2}, {}^2D_{3/2,5/2}$
d^2, d^8	⟶	$^1S_0, {}^1D_2, {}^3P_{0,1,2}, {}^3F_{4,3,2}, {}^1G_4$

⇒ Hund Rule:⇒

(i) largest multiplicity lies lowest
(ii) multiplicity same, then largest l lies lowest.
(iii) If both are same, then less then ½ filled, lowest j lies lowest
(iv) if more then ½ Half Filled, higest j lies lowest.
(v) if subcells are ½ filled, then-

For s-½ filled ⟶ $^2S_{1/2}$; for P-½ filled ⟶ $^4S_{3/2}$
For d-½ filled ⟶ $^6S_{5/2}$; for d-½ filled ⟶ $^8S_{7/2}$

⇒ Lande Interval Rule:⇒

$E = a[\vec{L}\cdot\vec{S}] \quad \because \vec{J} = \vec{L}+\vec{S}$

$E = \frac{ah^2}{2}[j(j+1) - J(J+1) - S(S+1)]$ if J and S hate same values.

$j \rightarrow j+1$

$\Delta E = E_{J+1} - E_J$

$\Delta E = E_{j+1} - E_j$

$\Delta E = \frac{a\hbar^2}{2}\left[(j+1)(j+2) - j(j+1)\right]$

$\boxed{\Delta E \propto (j+1)}$

⇒ **j-j Coupling** :⇒ Degeracy ⇒ $(2J+1)$

$H = H_0 + H_2$
and H_1 as perturb

$\vec{I_i} = \vec{L_i} + \vec{S_i}$

$\Sigma_i \vec{J_i} = \vec{J_1} + \vec{J_2} + \cdots$

(1) non-equivalent e^- possible j
$j = |j_1 + j_2|$ to $|j_1 - j_2|$

(2) for equivalent e^- Configuration-
if $j_1 \neq j_2$ then $j = |j_1 + j_2|$ to $|j_1 - j_2|$

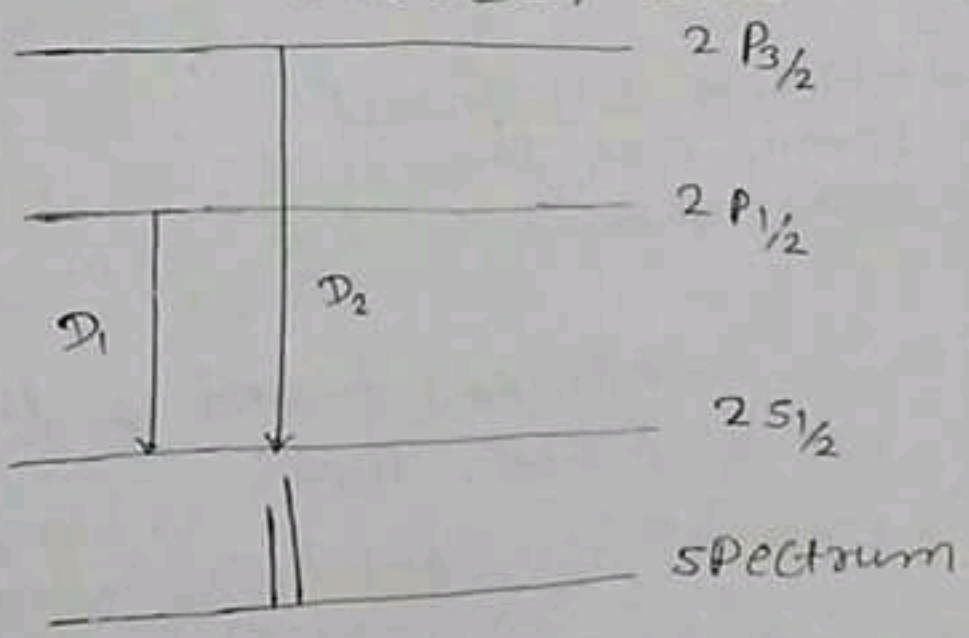
(3) $j_1 = j_2 = j$ then possible value of
$j = (2j-1)(2j-3)(2j-5)\cdots j \geq 0$

Represent $= (j_1, j_2)_j$

⇒ **Na-spectrum**:⇒

$11^{Na} = 1s^2, 2s^2, 2p^6, 3s^1$ ground state → $3s^1 \Rightarrow {}^2S_{1/2}$
excited state → $3p^1 \Rightarrow {}^2P_{1/2,3/2}$

Selection Rule ⇒ $\Delta j = 0, \pm 1$; $\Delta J = \pm 1$, $\Delta S = 0$



⇒ **Intensity Ratio Rule**:⇒

(1) j and l changes in same ways
(2) if there is one such lies in one doublet then largest j values is strongest.
(3) sum of intensity those line comes from common initially label is proportional to quantum value factor $(2j+1)$ of that line and similarly and on a common label.

In sodium spectrum:-

$I_{D_1} \propto (2J_1+1)$; $I_{D_2} \propto (2J_2+1)$

$$\Rightarrow \frac{I_{D_2}}{I_{D_1}} = \frac{2\times\frac{3}{2}+1}{2\times\frac{1}{2}+1} = \frac{4}{2} = \frac{2}{1}$$

$I_{D_2} : I_{D_1} = 2:1$

⇒ Hyperfine structure:⇒ Finer then fine that is called Hyperfine structure

⇒ Magnetic Interaction:⇒

magnetic moment of nucleus-

$$\vec{\mu} = g_N \left[\frac{\mu_N}{\hbar}\right]\vec{I}$$

$\Rightarrow \mu_B = \frac{e\hbar}{2m_e}$

$\mu_N = \frac{e\hbar}{2m_p}$ nuclear magneton Now $\frac{\mu_N}{\mu_B} = \frac{m_e}{1836 m_e}$

$$\Rightarrow \boxed{\mu_N = \frac{\mu_B}{1836}}$$

⇒ Interaction of nuclear spin with Angular momentum

$E = A(\vec{I}\cdot\vec{J})$

$\vec{F} = \vec{I}+\vec{J}$ $\Rightarrow$

$$\vec{I}\cdot\vec{J} = \frac{1}{2}[F^2 - I^2 - J^2]$$

$$E = \frac{A\hbar^2}{2}[F(F+1) - I(I+1) - j(j+1)]$$

degeneracy $(2F+1)$

(ii) Interval Rule- $\Delta E \propto (f+1)$. ⇒ selection Rule ⇒ $\Delta f = 0, \pm 1$

$\Delta E = E_{f+1} - E_f$

(iii) Possible values of $f \rightarrow |I+j|$ to $|I-j|$

(iv) Intensity $\propto (2f+1)$

⇒ Zeeman effect:⇒ spliting of spectral lines in the presence of external magnetic Field i.e is known as Zeeman effect

Two types of zeeman effect:=

(1) Normal zeeman -

(2) Abnormalolis zeeman-

(1) Normal zeeman effect:⇒ spectral line split into three spectral lines, zeeman effect does not include spin of e⁻ split up to three equal spaces line.

magnetic moment- $\vec{\mu}_L = -\left(\frac{\mu_B}{\hbar}\right)\vec{L}$

Now energy correction due to external magnetic field-

$\Delta\vec{E} = -\vec{\mu}_L \cdot \vec{B}$

$\Delta\vec{E} = -\mu_L B\cos\theta \Rightarrow \Delta E = \left(\frac{\mu_B}{\hbar}\right) L\cos\theta \quad \Delta E = \left(\frac{\mu_B B}{\hbar}\right) L\cos\theta$

$\Rightarrow \boxed{\Delta E = m_L(\mu_B B)}$

Now $E_i = E_{oi} + \Delta E_i$ and $E_f = E_{of} + \Delta E_f$

$\because \Delta E_i = m_{Li}(\mu_B B)$ and $\Delta E_f = m_{Lf}(\mu_B B)$

for transition-

$h\nu = E_f - E_i \Rightarrow \nu = \frac{(E_{of} - E_{oi})}{h} + (m_{Lf} - m_{Li})\left(\frac{\mu_B B}{h}\right)$

$\nu = \nu_0 + \Delta m_L\left(\frac{\mu_B B}{h}\right)$

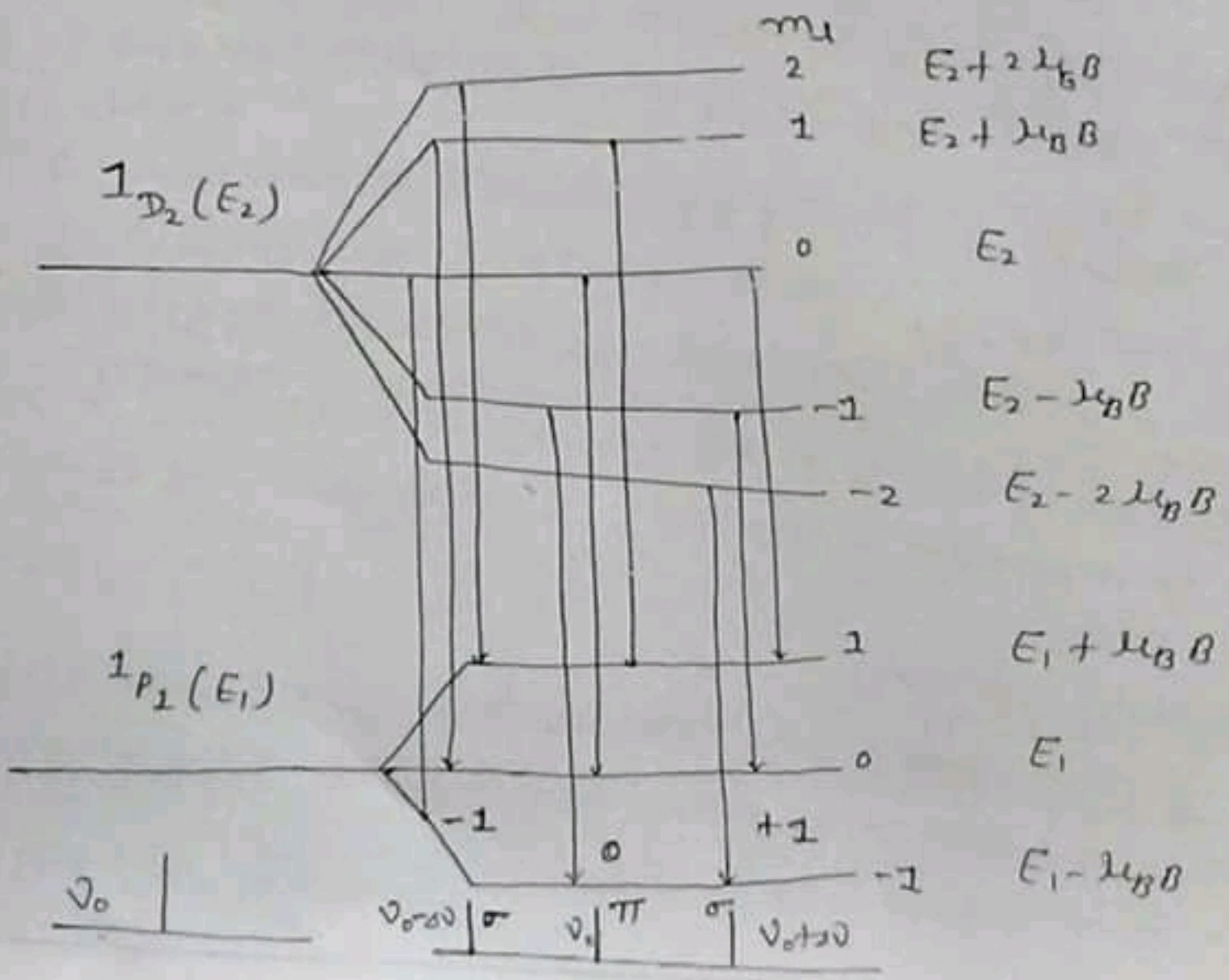
$\nu = \nu_0 + \Delta m_L\left(\frac{e\hbar}{2m}\cdot\frac{B}{\hbar}\right)$

$\boxed{\nu = \nu_0 + \Delta m_L(\Delta\nu)}$ where $\Delta\nu = \frac{eB}{4\pi m}$ (zeeman shift)

Selection Rule $\Delta m_L = 0, +1$

$\nu = \nu_0 - \Delta\nu, \nu_0, \nu_0 + \Delta\nu$

Example:- $^1D_2 \rightarrow {}^1P_1$



Atomic

$\Delta m_l = 0$; spectral line parallel to Field. (π-Component)

$\Delta m_l = \pm 1$; spectral line Perpendicular to Field (σ-Component)

$\pi \rightarrow$ plane polarised and $\sigma^- \rightarrow$ left circular polarised,

$\sigma^+ \rightarrow$ right circular polarised.

(2) abnormalous zeeman effect :⇒

Spliting of spectral lines in more then three line.

(i) including spin of e^- (ii) transition occurs b/w multipoles also (iii) spectral lines are unequal spaced

magnetic moment- $\mu_j = -g_j \left(\frac{\mu_B}{\hbar}\right) \vec{J}$

Interaction energy $\Delta E = -\vec{\mu}_j \cdot \vec{B}$

$\Delta E = -\mu_j B \cos\theta$

$\Delta E = g_j \left(\frac{\mu_B}{\hbar}\right) BJ\cos\theta \Rightarrow \boxed{\Delta E = g_j m_j (\mu_B B)}$

Zeeman-shift ⇒

$\Delta\nu = \boxed{(g_{jf} m_{jF} - g_{ji} m_{ji})\left(\frac{\mu_B B}{\hbar}\right)}$

Examples- D_1 and D_2 lines-

$D_1 = {}^2P_{1/2} \rightarrow {}^2S_{1/2}$, $D_2 = {}^2P_{3/2} \rightarrow {}^2S_{1/2}$

(i) ${}^2S_{1/2}$, $S = 1/2$, $j = 1/2$, $l = 0$

$g_j = \left[1 + \frac{j(j+1) + S(S+1) - l(l+1)}{2j(j+1)}\right]$

$g_j = 2$, $j = \frac{1}{2}$, $m_j = \frac{1}{2}, -1/2 \Rightarrow -\mu_B B,\ \mu_B B$

(2) ${}^2P_{1/2}$; $j = 1/2$, $S = 1/2$, $l = 1$

$g_j = 2/3$, $j = 1/2$, $m_j = \frac{1}{2}, -1/2 \Rightarrow -\frac{1}{3}(\mu_B B),\ \frac{1}{3}(\mu_B B)$

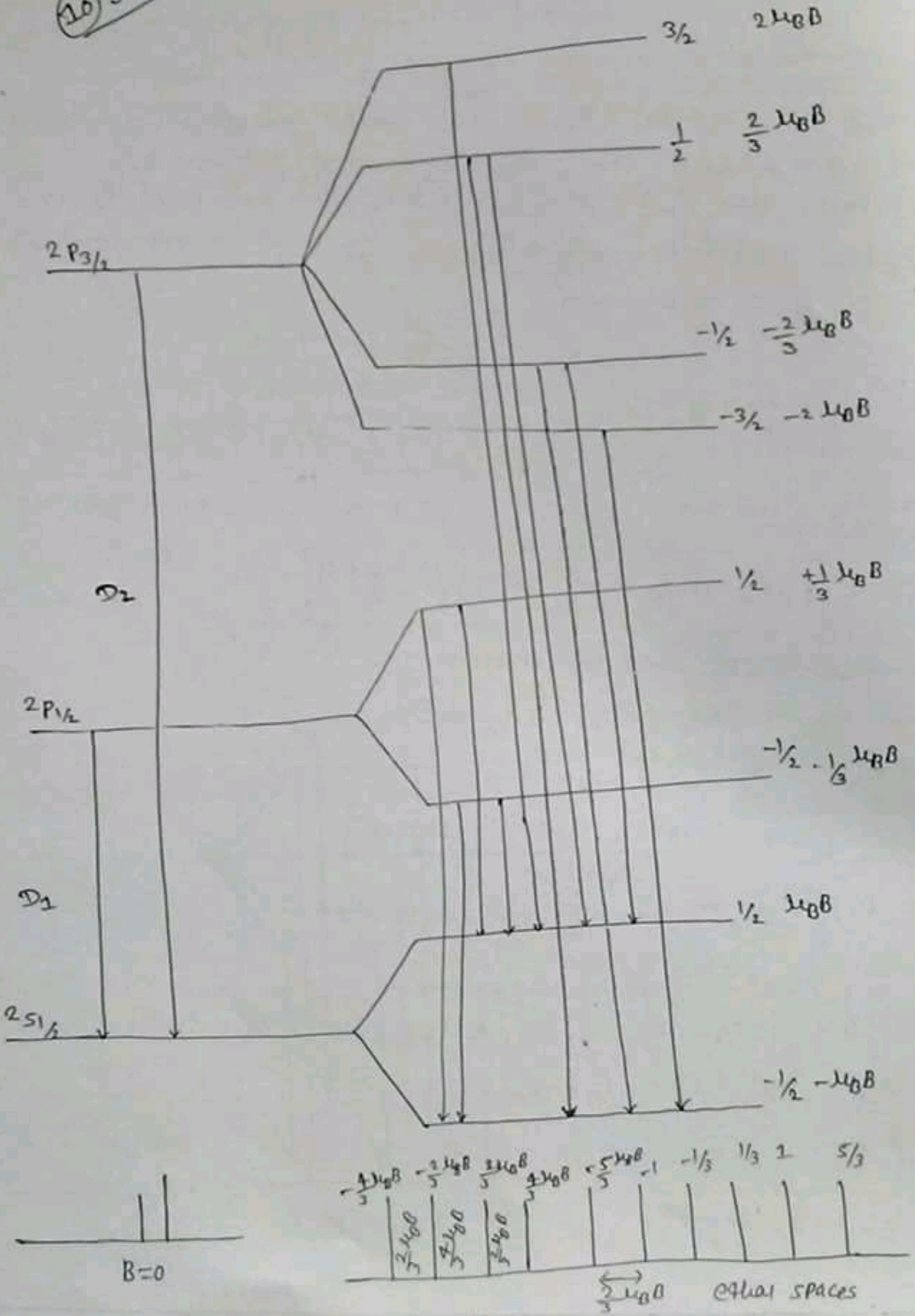
(3) ${}^2P_{3/2}$, $j = 3/2$, $S = 1/2$, $l = 1$

$g_j = 4/3$; $j = 3/2$, $m_j = -\frac{3}{2}, -\frac{1}{2}, \frac{1}{2}, 3/2$

$-2\mu_B B,\ -\frac{2}{3}\mu_B B,\ \frac{2}{3}\mu_B B,\ 2\mu_B B$

$\Delta m_j = 0, \pm 1$ selection rule :-
(weak field)

(10) lines



⇒ Paschen back effect: ⇒

strong magnetic field, L-S coupling break then total magnetic momentum is sum of $\vec{L}$ and $\vec{S}$ magnetic momentum. $\vec{\mu} = \vec{\mu}_L + \vec{\mu}_S$

where $\vec{\mu}_L = -\left(\frac{\mu_B}{\hbar}\right)\vec{L}$; $\vec{\mu}_S = -2\left(\frac{\mu_B}{\hbar}\right)\vec{S}$

$$\vec{\mu} = -\frac{\mu_B}{\hbar}\left[\vec{L} + 2\vec{S}\right]$$

Now energy Interaction $\Delta\vec{E} = -\vec{\mu}\cdot\vec{B}$

$$\Delta E = \frac{\mu_B}{\hbar}\left[\vec{L} + 2\vec{S}\right]\cdot\vec{B}, \Rightarrow \frac{\mu_B}{\hbar}\left[\vec{L}\cdot\vec{B} + 2\vec{S}\cdot\vec{B}\right]$$

$$\Delta E = \frac{\mu_B B}{\hbar}\left[L_z + 2S_z\right] \Rightarrow \Delta E = \left(\frac{\mu_B B}{\hbar}\right)\left[m_l\hbar + 2m_s\hbar\right]$$

$$\boxed{\Delta E = \mu_B B\left(m_l + 2m_s\right)} \quad \text{and} \quad \boxed{\Delta\nu = \left(\frac{\mu_B B}{\hbar}\right)\left[\Delta m_l + 2\Delta m_s\right]}$$

Selection Rule :- $\begin{cases} \Delta m_l = 0, \pm 1 \\ \Delta m_s = 0 \end{cases}$

$D_1 = {}^2P_{1/2} \rightarrow {}^2S_{1/2}$ and $D_2 = {}^2P_{3/2} \rightarrow {}^2S_{1/2}$

$^2S_{1/2}$, $l = 0$, $j = 1/2$, $s = 1/2$

$m_l = 0$, $m_s = \frac{1}{2}, -1/2$

${}^2P_{3/2} \rightarrow {}^2S_{1/2}$

${}^2P_{3/2} = s = 1/2$, $l = 1$,

$m_s = \frac{1}{2}, -1/2$; $m_l = 0, -1, 1$

Hydrogen spectrum:⇒

$$E_n = -\frac{13.6}{n^2}\ eV, \quad n = 1, 2, 3 \cdots$$

$$\bar{v} = R z^2 \left[\frac{1}{n_i^2} - \frac{1}{n_f^2}\right]$$

→ Atomic and molecular

(i) Lyman series → $n_i = 1, n_f = 2, 3 \cdots$

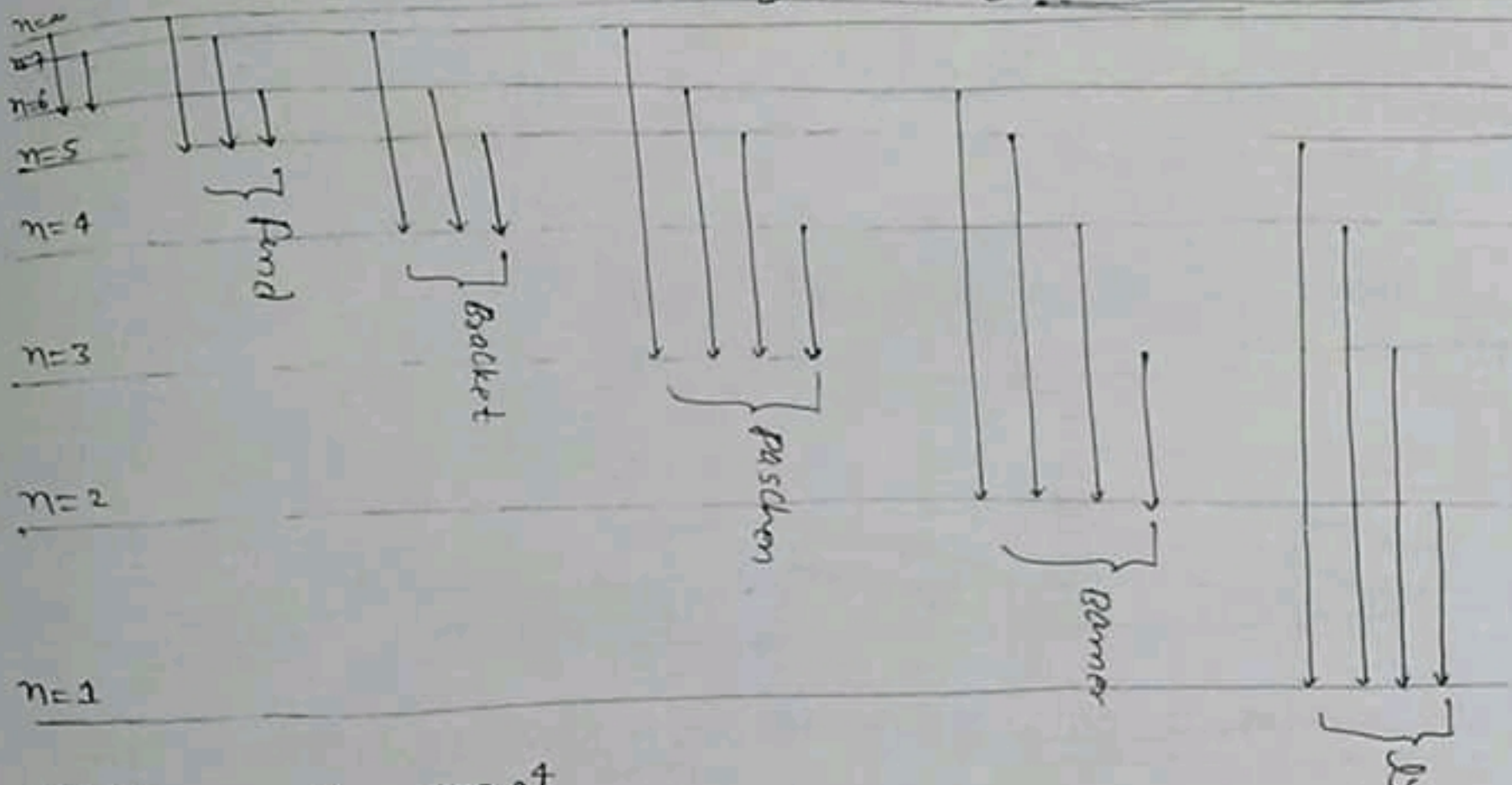
(ii) Balmer series $n_i = 2, n_f = 3, 4 \cdots$

(iii) Paschen series $n_i = 3, n_f = 4, 5 \cdots$

(iv) Bracket series $n_i = 4, n_f = 5, 6 \cdots$

(v) Pfund series $n_i = 5, n_f = 6, 7 \cdots$

⇒ Hydrogen - spectrum ⇐



NOTE:- $R = \frac{m e^4}{8 \epsilon_0^2 h^2 c}$

$R_\infty \propto m$, mass of e^-

$R_M \propto \mu \propto \frac{mM}{m+M}$, M → mass of nucleus

* $$\frac{R_\infty}{R_M} = 1 + \frac{m}{M}$$

⇒ molecular spectroscopy:⇒ three types spectrum (EVR)

(1) electronic spectrum

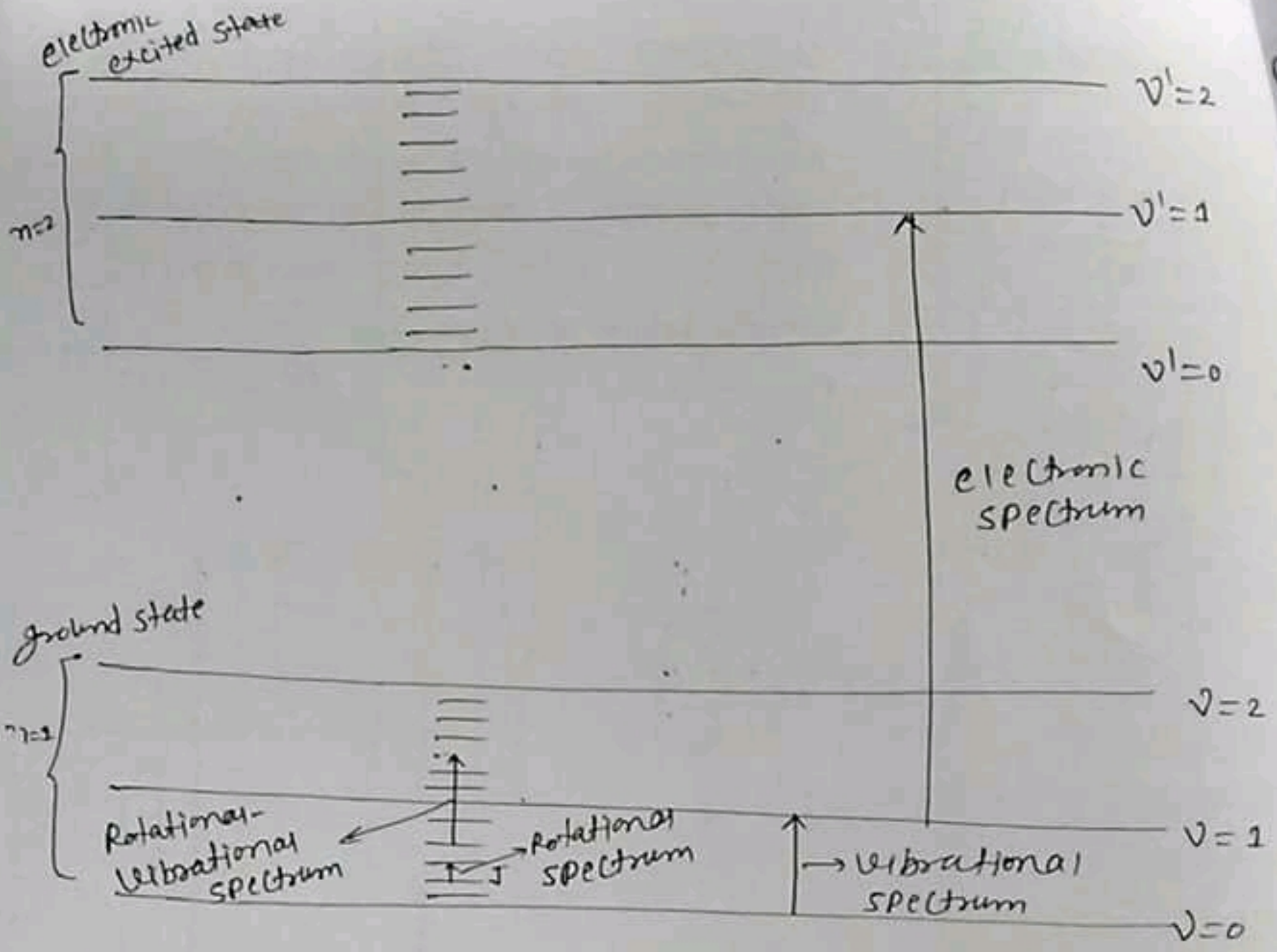
(2) Vibrational spectrum

(3) Rotational spectrum

Energy gap: $E > V > R$

10 eV · 1 eV 10^{-3} eV

visible or UV IR (microwave)



⇒ Diatomic molecule:⇒ ① Homonuclear ② Hetronuclear

① Homo: does not have permanent dipole moment and overlape -ve and +ve charge centre. $\vec{D} = -e\vec{r}$

$$\langle \psi_i | \vec{D} | \psi_f \rangle = 0$$

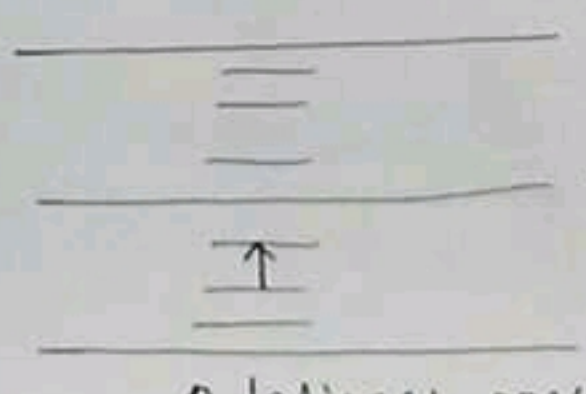
it does not shows rotational and vibrational spectrum and only show electronic spectrum H_2, N_2, O_2

② Hetro:= Parmanent dipole moment, -ve and +ve charge centre does not concide $\vec{D} = -e\vec{r}$ HCl, NO, HCN

$$\langle \psi_i | \vec{D} | \psi_f \rangle \neq 0$$

it shows Rotational and vibrational spectrum.

⇒ Rotational spectrum:= Corresponding to some electronic and vibrational state, but transition b/w rotational levels



Rotational spectrum

molecular

Rigid Rotator:⇒ Rigid Rotator means bond length is fix.

$I = \mu r^2 \Rightarrow \boxed{I = \frac{m_1 m_2}{m_1 + m_2} r^2}$

Valo energy- $E = \frac{1}{2} I \omega^2 = \frac{J^2}{2I} = \frac{j(j+1)\hbar^2}{2I}$

$\boxed{E = \frac{j(j+1)\hbar^2}{2\mu r^2}}$ then $E_j = \frac{j(j+1)\hbar^2}{2\mu r^2}$, $j = 0, 1, 2, 3 \ldots$

so energy levels of rigid rotator is unequal spaced.

$J = I\omega$

$\Rightarrow \sqrt{j(j+1)}\,\hbar = I\omega \Rightarrow \boxed{\nu = \sqrt{j(j+1)}\frac{\hbar}{2\pi I}}$

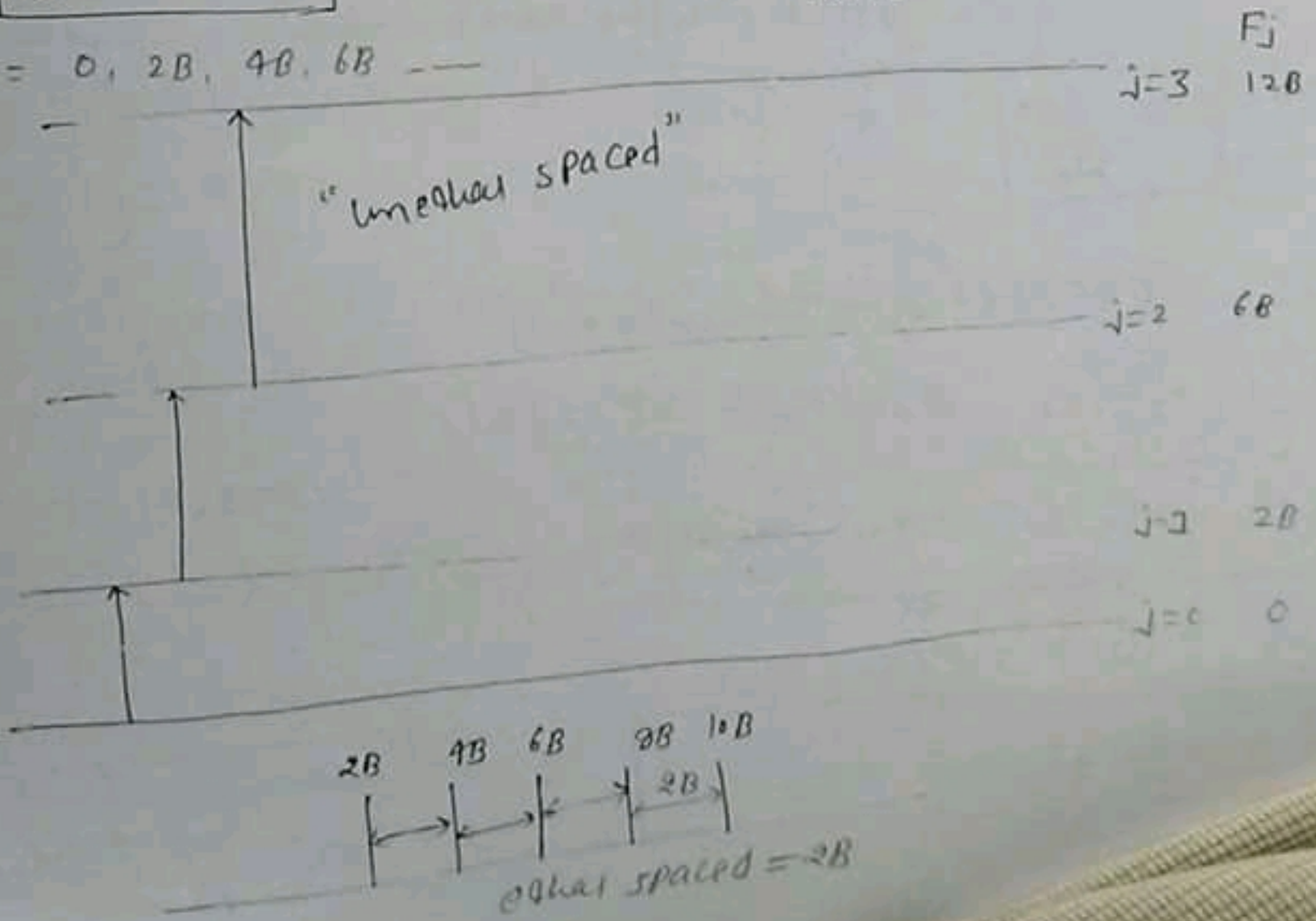
Energy levels diagram:⇒

$E_j = j(j+1)\frac{\hbar^2}{2I}$

$F_j = \frac{E_j}{hc} = \frac{j(j+1)\frac{\hbar^2}{4\pi^2 I(c)}}{hc} = \frac{j(j+1)\,h}{8\pi^2 I c} = \frac{\hbar j(j+1)}{8\pi^2 I c}$

$\boxed{F_j = Bj(j+1)}$ where $B = \frac{h}{8\pi^2 I c}$ cm^{-1} Rotational Constant

$F_j = 0, 2B, 4B, 6B \ldots$



Now $j \to j+1$

$$\bar{\nu} = F(j+1) - F(j) = B(j+1)(j+2) - Bj(j+1)$$

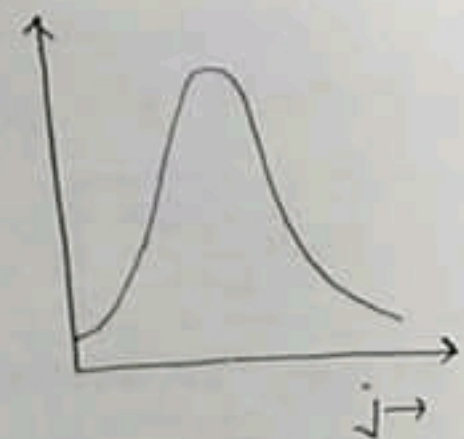
$$\boxed{\bar{\nu} = 2B(j+1)}$$

NOTE:-

$$N_j = N_0 (2j+1)\, e^{-(E_j - E_0)/kT} \qquad \left(\frac{N_j}{N_0}\right)$$

$$\Rightarrow N_j = N_0 (2j+1)\, e^{-Bj(j+1)hc/kT}$$

$$\frac{dN_j}{dj} = 0 \quad \text{then} \quad \boxed{\bar{\nu}_{max} = \frac{1}{2}\sqrt{\frac{2kT}{Bhc}} - \frac{1}{2}}$$



⇒ Non-Rigid Rotator :⇒ (massless spring)

r_e = equilibrium

k = spring Const

$$E_j = Bhcj(j+1) - (j(j+1)^2 \frac{h^4}{2I^2 r_e^2 k}$$

$$E_j = Bhcj(j+1) - Dhc[j(j+1)]^2 \quad \text{where } D = \frac{h^4}{2I^2 r_e^2 k} \cdot \frac{1}{hc}$$

$$D = \frac{h^3}{32 I^2 \pi^4 r_e^2 kc}$$

$$\omega = \sqrt{k/\mu} \Rightarrow k = \omega^2 \mu = \mu (2\pi\nu)^2$$

$$\boxed{k = 4\pi^2 \mu c^2 \omega_e^2} \rightarrow \text{wave number}$$

and $\boxed{D = \frac{4B^3}{\omega_e^2}}$

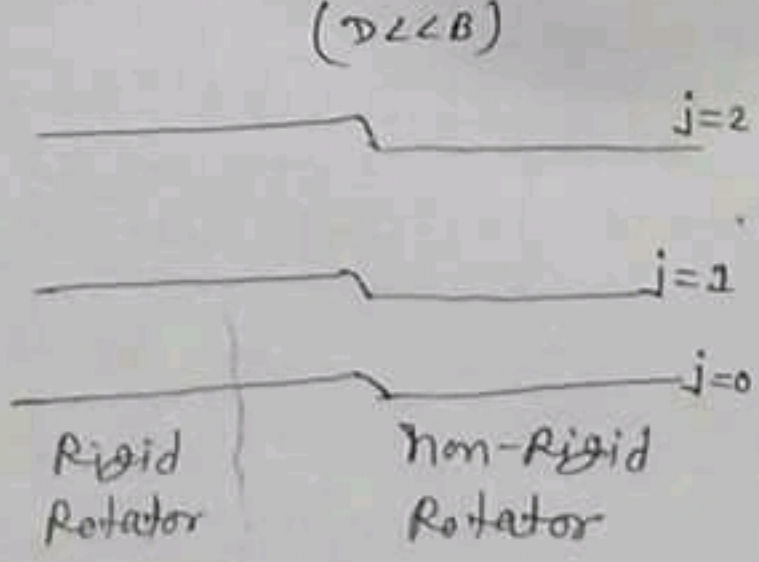
$$E_j = Bhcj(j+1) - Dhc[j(j+1)]^2$$

$$F_j = \frac{E_j}{hc} = Bj(j+1) - D[j(j+1)]^2$$

$$\boxed{F_j = Bj(j+1) - D[j(j+1)]^2}$$

$$\bar{\nu} = F(j+1) - F(j)$$

$$\boxed{\bar{\nu} = 2Bj(j+1) - 4D(j+1)^3}$$



⇒ Diatomic molecule as anHarmonic oscillator:⇒

Potential energy anHarmonic oscillator:⇒

$$V(x) = \left.\frac{\partial^2 V}{\partial x^2}\right|_{x=x_0} \frac{(x-x_0)^2}{\lfloor 2} + \frac{1}{\lfloor 3}\frac{\partial^3 V}{\partial x^3}\frac{(x-x_0)^3}{\lfloor 3} + \cdots$$

$$V(x) = fx^2 - gx^3 \quad , \quad \underline{f \gg g}$$

Energy of anHarmonic oscillator- ← anHarmonicity

$$E(v) = \left(v+\tfrac{1}{2}\right) hc\omega_e - \left(v+\tfrac{1}{2}\right)^2 hc\,\overline{\omega_e x_e} \rightarrow \text{AnHarmonicity Constant}$$

$$G(v) = \frac{E(v)}{hc} = \left(v+\tfrac{1}{2}\right)\omega_e - \left(v+\tfrac{1}{2}\right)^2 \omega_e x_e$$

$$G(0) = \tfrac{1}{2}\omega_e - \tfrac{1}{4}\omega_e x_e \quad ; \quad v \rightarrow v1$$

$$G(1) = \tfrac{3}{2}\omega_e - \tfrac{9}{4}\omega_e x_e \quad \Rightarrow \quad \bar{\nu} = G(v') - G(v)$$

$$\bar{\nu}_{v\rightarrow v'} = \left(v'+\tfrac{1}{2}\right)\omega_e - \left(v'+\tfrac{1}{2}\right)^2 \omega_e x_e - \left(v+\tfrac{1}{2}\right)\omega_e + \left(v+\tfrac{1}{2}\right)^2 \omega_e x_e$$

$$\boxed{\bar{\nu}_{0\rightarrow v} = v\omega_e\left[1 - x_e(1+v)\right]}$$

Selection Rule-

$$\Delta v = \pm 1$$

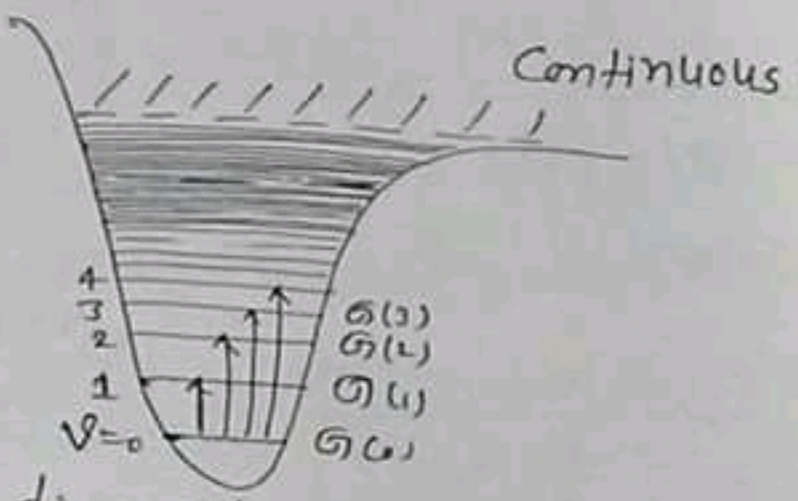
$$\bar{\nu}_{0\rightarrow 1} = \omega_e[1-2x_e]$$

First overtone- $\Delta v = \pm 2$

$$\bar{\nu}_{0\rightarrow 2} = 2\omega_e[1-3x_e]$$

Second overtone- $\Delta v = \pm 3$

$$\bar{\nu}_{0\rightarrow 3} = 3\omega_e[1-4x_e]$$



⇒ Continuous spectrum and dissocation energy:=

$$D_0 = \sum_{v=0} E(v+1) - E(v)$$

$$D_0 = \sum_{v=0} \frac{E(v+1) - E(v)}{hc}$$ In wave no

Now

$$D_e = D_0 + G(0)$$

$$\boxed{D_e = \frac{\omega_e}{4}\left[\frac{1}{x_e} - x_e\right]}$$