$c = 2.998 \times 10^{8}\ m\,s^{-1}$
$e = 1.602 \times 10^{-19}\ C$
$h = 6.626 \times 10^{-34}\ J \cdot s$
$\hbar = 1.0546 \times 10^{-34}\ J \cdot s$
$k_B = 1.381 \times 10^{-23}\ J \cdot K^{-1}$
$m_e = 9.109 \times 10^{-31}\ Kg$
$m_p = 1.6726 \times 10^{-27}\ Kg$
$m_n = 1.6749 \times 10^{-27}\ Kg$
$4\pi\varepsilon_0 = 1.11265 \times 10^{-10}\ J^{-1} C^{2} m^{-1}$
1 hartree $= 4.3597 \times 10^{-12}$ J

$a_i \cdot a_j = \delta_{ij}$ $\quad i=j \Rightarrow 1,\ i \neq j \Rightarrow 0$

$\hat{A}(f+g) = \hat{A}f + \hat{A}g$] linear

$\langle \psi | \hat{A} | \phi \rangle = \langle \phi | \hat{A} | \psi \rangle^*$

$\int dx\, \psi^*(x)\, \hat{A}\, \phi(x) = \left[\int dx\, \phi^*(x)\, \hat{A}\, \psi(x)\right]^*$ } Hermitian, eigen $\mathbb{R}$

$\bar{\nu} = R_H\left(\frac{1}{2^2} - \frac{1}{n^2}\right)$ $\quad R_H = 1.097 \times 10^{5}\ cm^{-1}$

$[x, d/dx]\, f(x) = x\frac{d}{dx}f - \frac{d}{dx}xf = -f = -1$

$\hat{p} = \frac{\hbar}{i}\, d/dx$ $\quad \langle x \rangle = \int dx\, |\psi(x,t)|^2\, \hat{x}$
$\langle p \rangle = \frac{\hbar}{i}\int dx\, \psi^*(x,t)\, \frac{d\psi(x,t)}{dx}$

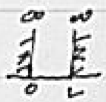
$\hat{\mathcal{H}} = \hat{T} + \hat{V} =$ $\quad \hat{T} = \frac{p^2}{2m}$ $\quad V(x) = -e^2/r$
$V(x) = \frac{1}{2}kx^2 = \frac{1}{2}m\omega^2 x^2$

$i\hbar\, \partial\psi/\partial t = \hat{H}\psi$ $\quad \psi(x,t) = f(t)\cdot g(x)$ $\quad i\hbar\, df/dt = Ef$ $\quad f(t) = C \cdot e^{-iEt/\hbar}$

$\Delta A = \sqrt{\langle A^2 \rangle - \langle A \rangle^2}$ $\quad \Delta x \cdot \Delta p \geq \hbar/2$ $\quad \Delta A \Delta B \geq \frac{1}{2}|\langle [\hat{A},\hat{B}] \rangle|$

$d\langle x \rangle/dt = i/\hbar\, \langle [\hat{H}, \hat{x}] \rangle = \frac{i}{\hbar}\frac{\langle \hat{p}(-i\hbar) - i\hbar\hat{p} \rangle}{2m} = \langle \hat{p} \rangle/m$ $\quad$ Ehrenfest $\quad d\langle \hat{p} \rangle/dt = \left\langle -\frac{dV}{dx} \right\rangle = \langle \hat{F} \rangle$

$-\frac{\hbar^2}{2m}\frac{d^2\psi}{dx^2} = E\psi$ $\quad \bigcirc^{2L}$ $\quad \psi_n(x) = \frac{1}{\sqrt{L}}\, e^{\frac{i2\pi nx}{L}}$ $\quad E_n = \frac{\hbar^2}{2m}\left(\frac{2n\pi}{L}\right)^2$



$\psi(x) = C\cos kx + D\sin kx$

$\psi(0) = \psi(L) = 0$ $\quad \psi(0) = 0\ C = 0$ $\quad \psi(x) = D\sin kx$ $\quad \psi(L) = D\sin kL = 0$ $\quad kL = n\pi$ $\quad E_n = \frac{-\hbar^2 k^2}{2m}$ $\quad k = \frac{n\pi}{L}$

Z.P.E. $\Delta E = E_1 - V_{min} = \hbar^2\pi^2/2mL^2$ $\quad \psi(x) = \sqrt{\frac{2}{L}}\sin kx$

finite well: $E > 0$ continuous not bound
$E < 0$ bound (can normalize)

H.O $\hat{\mathcal{H}} = -\frac{\hbar^2}{2m}\, d^2/dx^2 + \frac{1}{2}kx^2$ $\quad \psi_n(x) = \frac{1}{\sqrt{2^n n!\, x_0 \sqrt{\pi}}}\, H_n\!\left(\frac{x}{x_0}\right) e^{-x^2/2x_0^2}$; $\quad E_n = (n+\frac{1}{2})\hbar\omega$

$\omega = \sqrt{k/m}$ $\quad x_0 = \sqrt{\frac{\hbar}{m\omega}}$ $\quad ZPE = \hbar\omega/2$

$H = \hbar\omega(b^\dagger b + \frac{1}{2})$

$\hat{x} = x_0/\sqrt{2}\,(b + b^\dagger)$ $\quad b|n\rangle = \sqrt{n}\,|n-1\rangle$
$\hat{p} = \frac{-i\hbar}{x_0\sqrt{2}}(b - b^\dagger)$ $\quad b^\dagger|n\rangle = \sqrt{n+1}\,|n+1\rangle$

2 level (pert. theo) $\quad \psi = a_1\psi_1^{(0)} + a_2\psi_2^{(0)}$ $\quad H\psi = E\psi$

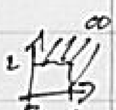
$H_{mn} = \begin{pmatrix} E_1 + V_{11} & V_{12} \\ V_{21} & E_2 + V_{22} \end{pmatrix}$ $\quad \tilde{E}_n = E_n + V_{nn}$ $\quad \longrightarrow \begin{vmatrix} H_{11} - E & H_{12} \\ H_{21} & H_{22} - E \end{vmatrix} = 0$

$\begin{Vmatrix} \tilde{E}_1 - E & V_{12} \\ V_{12} & \tilde{E}_2 - E \end{Vmatrix} = 0$

$(E - \tilde{E}_1)(E - \tilde{E}_2) - |V_{12}|^2 = 0$

$E_\pm = \frac{1}{2}(\tilde{E}_1 + \tilde{E}_2) \pm \Delta$ $\quad \Delta = \frac{1}{2}\sqrt{(\tilde{E}_1 - \tilde{E}_2)^2 + 4|V_{12}|^2}$

$\vec{l} = \vec{r} \times \vec{p}$ $\quad [\hat{H}, l_z] = 0$ $\quad d\langle l_z \rangle/dt = 0$



$E_{n_x n_y} = \frac{\pi^2\hbar^2}{2L^2}(n_x^2 + n_y^2)$ $\quad$ 3D $\quad E_{n_x,n_y,n_z} = \frac{\hbar^2\pi^2}{2}\left(\frac{n_x^2}{L_x^2} + \frac{n_y^2}{L_y^2} + \frac{n_z^2}{L_z^2}\right)$

$\psi_{pb.} = \sqrt{\frac{2}{L}}\cos\frac{n\pi x}{L}$

$E_{n_{pb.}} = \frac{n^2\hbar^2\pi^2}{2mL^2}$

$L=1$ $\quad \hbar=1$ $\quad m=1$

$1/2;\ -1/2$

sphere $\quad E = \hbar^2/2I\; l(l+1) \Rightarrow L^2 = l(l+1)\hbar^2$ $\quad E = L^2/2I$

Variational $\quad \langle \psi_T | \hat{H} | \psi_T \rangle \geq E_0$ $\quad \cancel{dE/d\alpha}$ $\quad \partial E^{(c)}/\partial_x = 0$

Virial $\quad 2T = \langle x\, dV/dx \rangle$

$w = dP/dt$

$W = 2\pi\hbar\, |V_{fi}|^2 \rho(E_{fi})$ $\quad$ Fermi's golden rule.

+ Postulattes: Operators hermitian to every property correspond one.

$|\Psi|^2$ = Prob. density

Ψ square integrable, continuous

$\langle \hat{\varphi} \rangle = \dfrac{\langle \Psi | \varphi | \Psi \rangle}{\langle \Psi | \Psi \rangle}$

* boxes

$E_n = \dfrac{n^2 h^2}{8 m L^2}$ $\Psi = \sqrt{\dfrac{L}{2}} \operatorname{sen} \dfrac{n\pi x}{L}$

$= \dfrac{n^2 \hbar^2 \pi^2}{2 m L^2}$ $E = \dfrac{h^2}{8m}\left(\dfrac{n_x^2}{a^2} + \dfrac{n_y^2}{b^2}\right)$

$\Psi = \sqrt{\dfrac{8}{ab}} \sin \dfrac{n_x \pi x}{a} \sin \dfrac{n_y \pi y}{b}$

$E_v = \hbar\omega\left(v + \frac{1}{2}\right)$

Rigid Rotor $\rightarrow$ $J(J+1)\dfrac{\hbar^2}{2I} = E_{rot}$

$p^3 \rightarrow$

$l_1 = 1 \; l_2 = 1$ $1+1, 1+1-1, \ldots |1-1| \Rightarrow 2, 1, 0$

$l_3 = 2 \; l_2 = 1$ $2+1, 2+1-1, \ldots (2-1) \Rightarrow 3, 2, 1$

$l_3 = 1 \; l_2 = 1$ $1+1, 1+1-1, \ldots |1-1| \Rightarrow 2, 1, 0$

$l_3 = 0 \; l_2 = 1$ $0+1, 0+1-1, \ldots |0-1| \Rightarrow 1, 0, 1 \rightarrow 1$

$L = 3, 2, 2, 1, 1, 1, 0 \rightarrow$ F, 2D, 3P, S