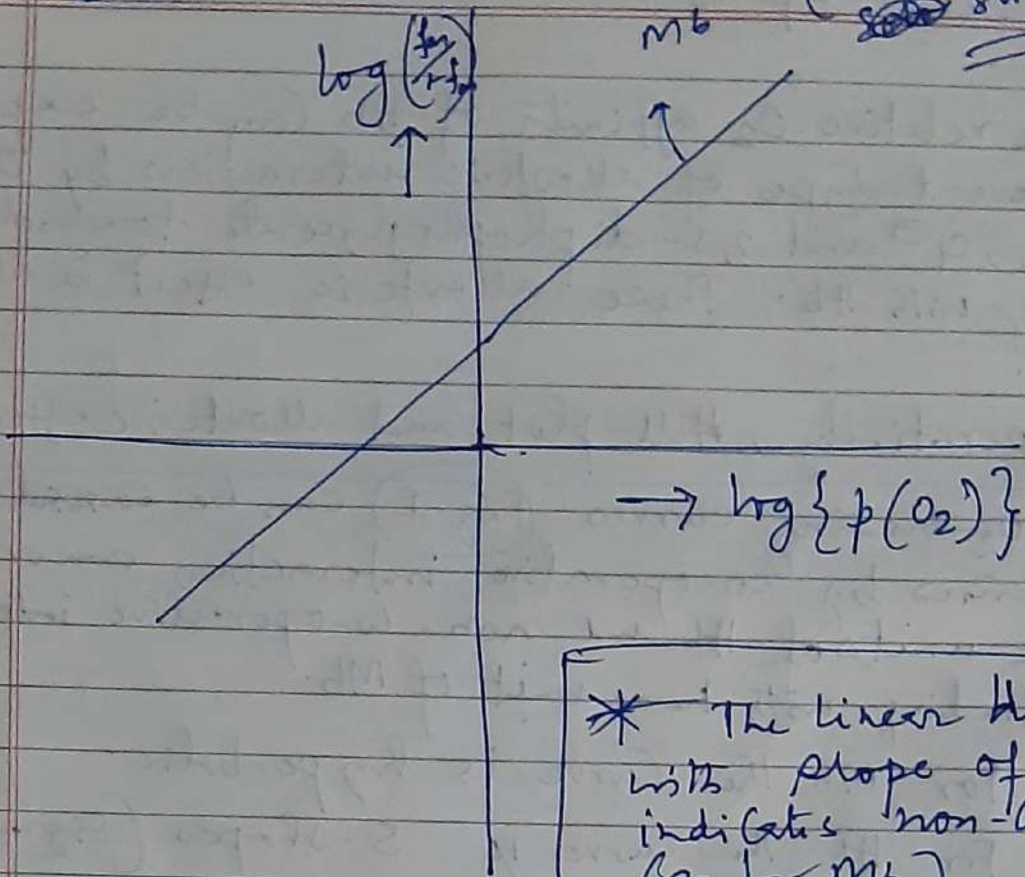
For Mb → Hill plot for Mb

(Non-cooperative) slope = 1



(Homotropic allosteric interactions are absent in Mb.)

* The linear Hill plot with slope of unity indicates non-cooperativity (as for Mb)

$$\log\left(\frac{f_M}{1-f_M}\right) = \log\{p(O_2)\} - \log p_{50}$$

slope = 1

For Hb :-

In case of Hb, the corresponding expressions are complicated and results are empirically formulated as follows for the process

$$Hb + nO_2 \rightleftharpoons Hb(O_2)_n$$

$$K_H = \frac{[Hb(O_2)_n]}{[Hb]\{p(O_2)\}^n} = \frac{f_H}{(1-f_H)\{p(O_2)\}^n} = \frac{1}{(p_{50})^n}$$

Then, $f_H = \dfrac{K_H\{p(O_2)\}^n}{[1+K_H\{p(O_2)\}^n]}$

$$\therefore \log\frac{f_H}{1-f_H} = n\log\{p(O_2)\} + \log K_H$$
$$= n\log\{p(O_2)\} - n\log(p_{50})$$

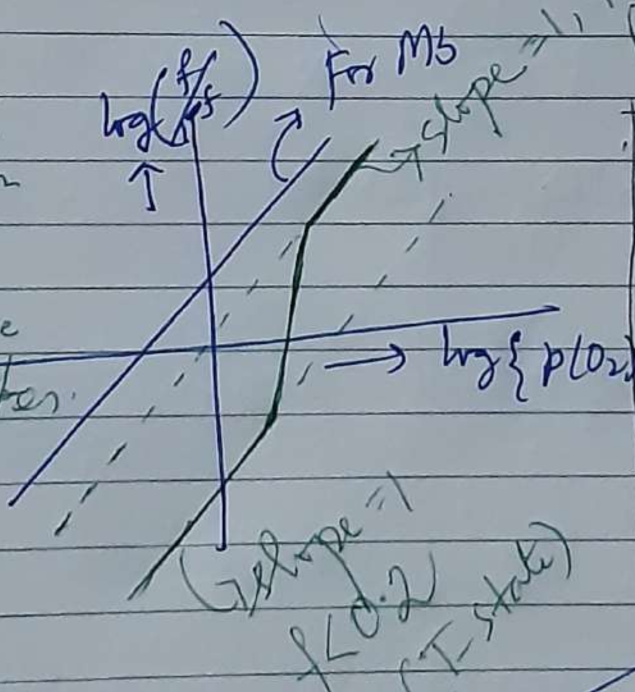
For Hb, $n>1$, and it indicates that O_2-binding in the subunits of Hb is ~~[illegible]~~ interdependent and it suggests positive cooperativity among the heme units due to heme-heme interaction.

To characterize the co-operativity for Hb, the O_2 binding data at intermediate saturation (i.e, $0.2 < f < 0.8$) yield a straight ~~[illegible]~~ line in Hill plot with a slope close to 3.

$f < 0.2$ & $f > 0.8$ (No cooperativity) i.e, $n = 1$

* Generally, for Oxygen transport protein cooperativity ($n > 1$)
Hb, Hc

For oxygen storage protein (Mb, Hr) non cooperative effect predominates ($n = 1$).



$Hb + O_2 \xrightleftharpoons{K_1(H)} Hb(O_2)$

$Hb(O_2) + O_2 \xrightleftharpoons{K_2(H)} Hb(O_2)_2$

$Hb(O_2)_2 + O_2 \xrightleftharpoons{K_3(H)} Hb(O_2)_3$

$Hb(O_2)_3 + O_2 \xrightleftharpoons{K_4(H)} Hb(O_2)_4$

$K_4(H) > K_3(H) > K_2(H) > K_1(H)$

positive cooperative effect

* Will be Discussed in next lecture ⇒

Home tasks:-
1. What is T State & R-State?
2. What is α-chain & β-chain
3. What is triggered mechanism?
4. What is Soret Band & α, β band? What are their position in UV-Vis spectrum
5. Magnetic properties and spin states in deoxy Hb & Oxy-Hb.

3. Elementary quantum mechanics

Q-1 :- Define Black-body radiation and explain its characteristics features.

Q-2 :- Explain the planck's quantum Theory.

Q-3 :- Define photoelectric effect and explain the law of photoelectric emission.

Q-4 :- Derive Einstein photo emission equation.

Q-5 :- Explain the de-Broglie's hypothesis.

Q-6 :- Derive time independent Schrödinger equation.

Q-7 :- State and explain Heisenberg's uncertainty principle.

Q-8 :- Derive time dependent Schrödinger equation.

Q-9 :- Give the physical significance of $\psi(x,y,z,t)$ and $\psi^2(x,y,z,t)$

Q-10 :- What is normalized wave function.

Q-11 :- State the basic postulates of quantum mechanics.

Q-12 :- What is an operator?

Q-13 :- Define Linear operator?

Q-14 :- Enlighten the rules for setting up quantum mechanical operators.

Q-15 :- What is Commutator of the operators?

Q-16 :- Evaluate the following Commutators.

$[\hat{x}, d/dx]$, $[\hat{x}, \hat{P}_x]$, $[\partial/\partial x, \frac{\partial}{\partial y}]$, $[\hat{x}, \hat{H}_x]$, $[\hat{P}_x, \hat{H}_x]$

$[\hat{P}_x^2, \hat{x}^2]$,

Q-17 :- What is Eigen value equation?

Q-18 :- Which of the following functions

$4 \sin 3x$

$\ln 2x$

$x \sin x$

$3e^{-5x}$

are eigen function of the operator $\frac{\partial^2}{\partial x^2}$.

Q-19 :- Show that e^{+ikx} and e^{-ikx} are eigen function of One dimensional linear momentum operator and what are the corresponding eigen values ?

Q-20 :- What is staitionary stages ?

Q-21 :- What are the characteristics that must be satisfied by a function to be a eigen ?

Q-22 :- Indicate which of the following function are acceptable wave function:

i) $\psi = x$, ii) $\psi = x^2$, iii) $\psi = e^{x}$, iv) $\psi = e^{-x}$; v) $\psi = e^{-x^2}$

vi) $\sin^{-1}x \ (-1, 1)$.

Q-23 :- Prove that if $\hat{\alpha}$ and $\hat{\beta}$ are two linear operator then $(\hat{\alpha}+\hat{\beta})$ and $\hat{\alpha}\hat{\beta}$ are also linear operators.

Q-24 :- Which of the following wave function are acceptable in Quantum mechanics.

i) $\sin x$, ii) $\tan x$, iii) $\operatorname{cosec} x$ iv) $\sin x + \cos x$

Q-25 :- If ψ_1 and ψ_2 are eigen functions of linear operator $\hat{A}$ with same eigen values a, show that any linear combinations of ψ_1 and ψ_2 will also be an eigen function of $\hat{A}$ with same eigen value.

Q-26 :- If $\psi_1(x,t)$ and $\psi_2(x,t)$ are both solutions of time dependent Schrodinger wave equation for a given potential $V(x)$. Show that $\psi(x,t) = a_1\psi_1 + a_2\psi_2$ is also a solution, where a_1 and a_2 are constant.

Q-27 :- Define Hermitian Operator? What is the condition for an operator to be Hermitian ?

Q-28 :- Check the following operator whether Hermitian or Anti Hermitian in nature.

i) $\frac{d}{dx}$, ii) $\frac{d^2}{dx^2}$, iii) $\hat{P}_x$, iv) $\hat{H}_x$, v) $\hat{\alpha}\hat{\beta} - \hat{\beta}\hat{\alpha}$

vi) $i(\hat{\alpha}\hat{\beta} - \hat{\beta}\hat{\alpha})$ $\left.\right\}$ $\hat{\alpha}, \hat{\beta}$ Hermitian operator

Q-29:- If two operator $\hat{\alpha}, \hat{\beta}$ are Hermitian, then find out its Conditions, When $\hat{\alpha}\hat{\beta}$ will be Hermitians.

Q-30:- What is orthonormal wave function?

Q-31:- Prove that eigen ~~function~~ Values of Hermitian operators are real.

Q-32:- If $\hat{\alpha}$ & $\hat{\beta}$ are a pair of Commutating Hermitian operators, then they posses a common set of eigen function.

Q-33:- If two Hermition operators $\hat{A}$ & $\hat{B}$ posses a Common set of eigen function ψ_i - then they Commute

Q-34:- If $\psi_m(x)$ & $\psi_n(x)$ are non-degenerate eigen function of a Hermitian operator then they are orthogonal.

Q-35:- Write down the Schrödinger wave equation of a free particle moving in one dimentional box and find out the wave functions and also calculate the allowed energy.

Q-36:- Find out the normalised wave function for free particle moving in one dimentional potential box.

Q-37:- Show that the free particle wavefunctions are orthogonal with each other.

Q-38:- Draw the wave function of free particle for $n=1, 2, 3$.

Q-39:- Draw the probability function of free particle for $n=1, 2, 3$.

Q-40:- Is the energy of a free particle quantised? Justify.

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Q-41 :- What is Zero point energy of free particle?

Q-42 :- Show that the energy of the free particle is in the agreement with the uncertainty principle.

Q-43 :- Discuss the motion of a free particle in the three dimensional potential box.

Q-44 :- For a particle in a cubical box, write down the energy value for the condition, $n_x + n_y + n_z = 4$ and indicate the level of degeneracy if any.

Q-45 :- Evaluate the expectation value of K.E of a free particle in an one dimentional potential box of length 'l'.

Q-46 :- Calculate the expectation value of $\langle \hat{x} \rangle$, $\langle \hat{x}^2 \rangle$, $\langle \hat{p}_x \rangle$ and $\langle \hat{p}_x^2 \rangle$ for a particle in a one dimentional box of width l and infinitely high potential walls with origin at the end of the box.

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Q-47 :- Derive the energy expression of Simple Harmonic Oscillator (SHO).

Q-48 :- Show that the ~~energy~~ zero point energy of the ~~simple~~ harmonic oscillator is consistant with the uncertainty principle.

* Q-49 :- Verify that the function $A \cdot \exp\left(-\frac{1}{2}\beta x^2\right)$ is an eigen-function of a linear harmonic oscillator, where $\beta = (mk)^{1/2}/\hbar$

Q-50 :- Write down the Schrödinger time independent equation of wave for H atom interms of both Cartesian & polar co-ordinates.

* Q-51 :- Show that energy of H-atom is n^2-fold degenerate.

Q-52 :- Show that H-atom wave functions are orthogonal to each other.

Q-53 :- What is Sinusoidal wave function?

Q-54 :- From the probability density of 1s $e^{\ominus}$ show that the most probable distance of $e^{\ominus}$ from the nucleus is equal to Bohr radius

$$\psi_{1s} = \frac{1}{(\pi a_0^3)^{1/2}} \cdot e^{-r/a_0}$$, Where a_0 is the Bohr radius.

Q-55 :- For the 2S State of H atom,

$$\psi_{2s} = \frac{1}{\sqrt{32\pi}} (2-r) \cdot e^{-r/2}$$ in a.u., find the most probable and the nodal distances of the electron from the nucleus.

Q-56 :- Normalise the ground State wave function for one dimentional harmonic oscillator $\psi_0 = f(x) = A \cdot e^{-\frac{\beta x^2}{2}}$

Where $\beta = \frac{(mk)^{1/2}}{\hbar}$

Q-57 :- Show that the following two wave function are orthogonal to each other. $\psi_0(x) = \left(\frac{\beta}{\pi}\right)^{1/4} e^{-\frac{\beta x^2}{2}}$

and $\psi_1(x) = \left(\frac{4\beta^3}{\pi}\right) x \cdot e^{-\frac{\beta x^2}{2}}$, β is a Constant.

Q-58 :- Derive the bonding & antibonding orbital wavefunction for sp, sp^2 & sp^3 orbital.

Q-59 :- Define radial wave function & angular wave function.

Q-60 :- What is Linear Combination of Atomic Orbital. Explain with example.