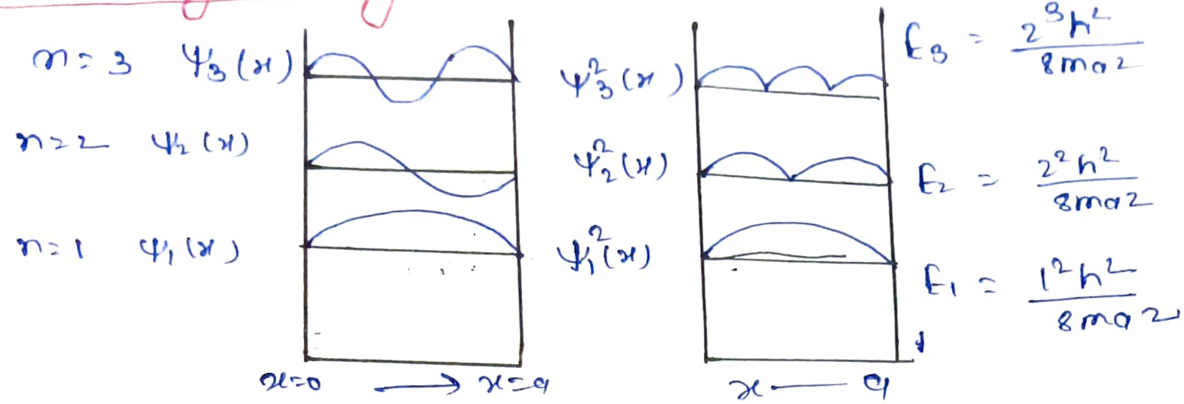
Probability density :-



Normalized wave function :-

$$\psi = A \sin \frac{n\pi x}{a}$$

$$\int_0^a \psi^* \psi \, ds = 1 \qquad \sin n\pi x = \frac{1}{2}\left(1-\cos\frac{2n\pi x}{a}\right)$$

$$\Rightarrow \int_0^a A^2 \sin^2\left(\frac{n\pi x}{a}\right)^2 ds = 1$$

$$A^2\left[\frac{1}{2}\int_0^a dx - \frac{1}{2}\int_0^a \cos\frac{2n\pi}{x}\, dx\right] = 1$$

$$A^2 \times \frac{a}{2} = 1$$

$$A^2 = \frac{2}{a}$$

$$A = \left(\frac{2}{a}\right)^{1/2}$$

$$\psi(x) = \frac{2}{a} \sin \frac{n_x \pi x}{a}$$

$$\psi(y) = \left(\frac{2}{b}\right)^2 \sin \frac{n_y \pi y}{b}$$

$$\psi(z) = \left(\frac{2}{c}\right)^2 \sin \frac{n_z \pi z}{c}$$

Total wave function $= \psi(x) + \psi(y) + \psi(z)$

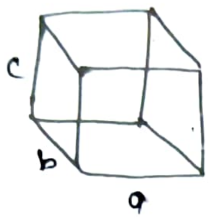
$$\left(\frac{2}{abc}\right)^{1/2} \sin\left(\frac{n_x \pi x}{a}\right) \sin\left(\frac{n_y \pi y}{b}\right) \sin\left(\frac{n_z \pi z}{c}\right)$$

Degeneracy :-

different states 1, 2, 3
Same energy (E)

$n = 1$

$$E = \frac{l^2 h^2}{8m}\left[\frac{1}{a^2} + \frac{1}{b^2} + \frac{1}{c^2}\right]$$



$a = 1, \ b = 2, \ c = 3$

123
213
312
132
231
321

} 6 degeneracy

E_6 = 6 degeneracy

If $a = b = c$
then it is non-degenerate

$$E = \frac{l^2 h^2}{8m}\left(\frac{1}{a^2} + \frac{1}{a^2} + \frac{1}{a^2}\right.$$

Density of states (DOS) :-

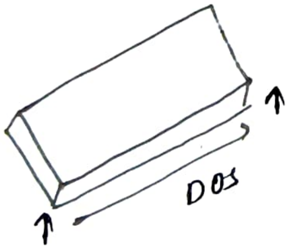
No of electronic states in a system

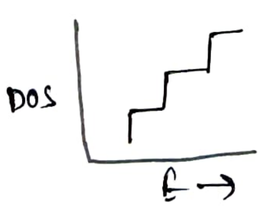
P-orbital
$P_x = e$
$P_y = e$
$P_z = e$

i)

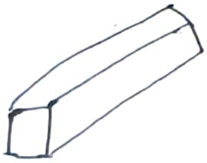
3-D balk

ii)

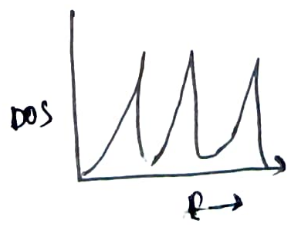




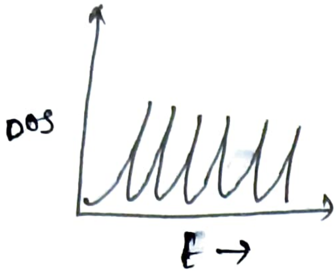
iii)



1-D Narrow/quantumwave



iv) 0-D quantum dot



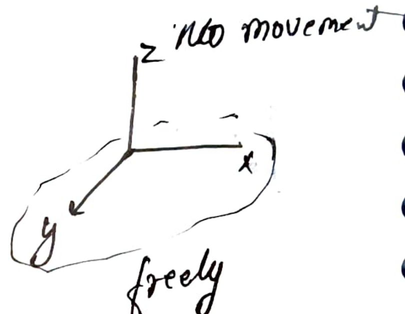
DOS & diff behaviours

The schrodinger eqn for nano-particle :-

$$\frac{d^2\psi}{dx^2} + \frac{d^2\psi}{dy^2} + \frac{d^2\psi}{dz^2} + \frac{8\pi^2 m}{h^2}(E-V)\psi = 0$$

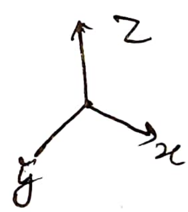
2D quantum well :-

$$E(k_x k_y) = \underbrace{\frac{l^2 h^2}{8 m L_z^2}}_{\text{Confined}} + \underbrace{\frac{h^2}{8m}(k_x + k_y)}_{\text{freely moved}}$$



1-D Nanowire :-

$$E(k_x) = \frac{h^2}{8m}\underbrace{\left(\frac{i^2}{L_x^2} + \frac{j^2}{L_y^2}\right)}_{\text{confined}} + \underbrace{\frac{h^2 k_x^2}{2m}}_{\text{move}}$$



3-D Quantum.

$$E = \frac{h^2}{8m}\underbrace{\left(\frac{i^2}{L_z^2} + \frac{j}{L_y^2} + \frac{k_x^2}{x^2}\right)}_{\text{confined}}$$