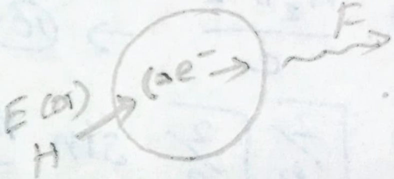
# Applied Quantum Mechanics

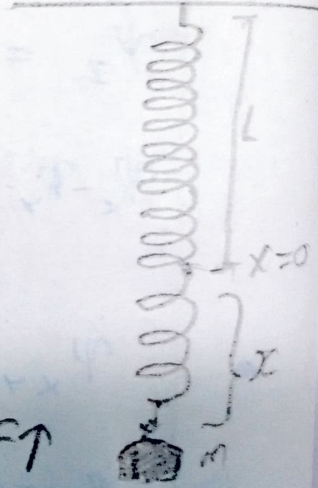


$F = -Kx$

$F = ma$




<u>Classical mechanics</u>




- Harmonic motion – displacement of particles → moves → restoring force → back to origin.

⇒ Harmonic Oscillator of Quantum mech is similar to classical mechanics.

$$\frac{d^2\psi}{dx^2} + \frac{2m}{\hbar^2}(E-V)\psi = 0 \rightarrow ①$$

$$\Rightarrow P.E = \frac{1}{2}kx \rightarrow ②$$

$$\frac{d^2\psi}{dx^2} + \frac{2m}{\hbar^2}\left[E - \frac{1}{2}kx\right]\psi = 0 \rightarrow ③$$

$\therefore \hbar = h/2\pi$ (or) $\hbar^2 = h^2/4\pi^2$ , $\therefore \frac{8\pi mE}{h^2} = \alpha$.

$$\Rightarrow \frac{d^2\psi}{dx^2}\left[a - \beta^2 x^2\right]\psi = 0 \rightarrow ⑤ \qquad \therefore \left[\frac{4\pi^2 mk}{h^2}\right]^{1/2} = \beta$$

$\therefore y = x\sqrt{\beta}$ (or) $x = y/\sqrt{\beta}$ (or) $x^2 = y^2/\beta \rightarrow ⑦$

$$\frac{dy}{dx} = \sqrt{\beta} \rightarrow ⑧$$ $\therefore$ diff w.r.t 'x'.

$$\frac{d\psi}{dx} = \frac{d\psi}{dy} \cdot \frac{dy}{dx} \rightarrow ⑨$$

$$\frac{d^2\psi}{dx^2} = \beta\frac{d^2\psi}{dy^2} \rightarrow ⑩$$

$$\frac{d^2\psi}{dy^2} + \left[\frac{\alpha}{\beta} - y^2\right]\psi = 0 \rightarrow ⑪$$ $\therefore$ Sub eqn ⑨ and ⑩ in ⑤

function:

$$\psi = f(x)e^{-y^2/2}$$

$$\psi_n(y) = NH_n(y)e^{-y/2}$$

Eigen values (Energy)

a) $E_n = (n + \frac{1}{2} \cdot h\nu)$

b) $E_n = n^2h^2/8ma^2$