Lecture 5

Wednesday, August 30, 2023 10:01 AM

Postulates of QM

Definitions =

KE PE

① Hamiltonian $H = E = \frac{p^2}{2m} + V(x)$

② Conjugate variables are related by a derivative =

operator → $\hat{a} = \frac{c}{2\pi i}\frac{\partial}{\partial b} \Rightarrow \Delta a \Delta b = \frac{c}{4\pi}$

(music: $c=1$, QM: $c=h$)

③ operator = something that acts on a function

ex. function $= \psi(x)$; operator $= 5\cdot$ $\Rightarrow$ $5\cdot\psi(x) = 5\psi(x)$

" " ; operator $= \frac{\partial}{\partial x}$ $\Rightarrow$ $\frac{\partial}{\partial x}\psi(x) = \frac{\partial\psi}{\partial x}$

multiplication & derivative operator

In Class Exercise

Frequency operator: $\hat{\nu} = \frac{1}{2\pi i}\frac{\partial}{\partial t}$; What does the operator $\hat{\nu}^2$ do to the function $\psi = \sin(2\pi\nu t)$?

$\hat{\nu}^2 = \frac{-1}{4\pi^2}\frac{\partial^2}{\partial t^2}$

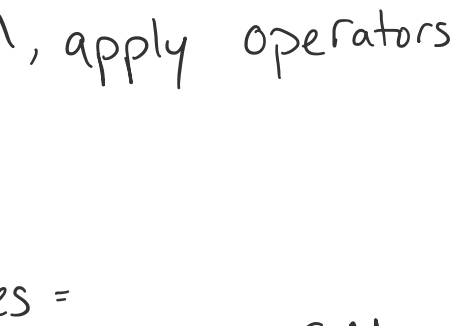
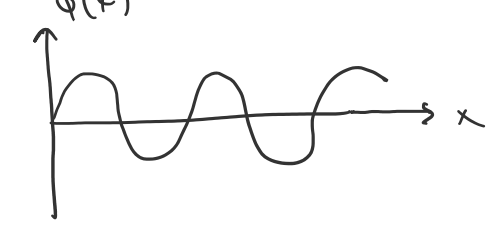
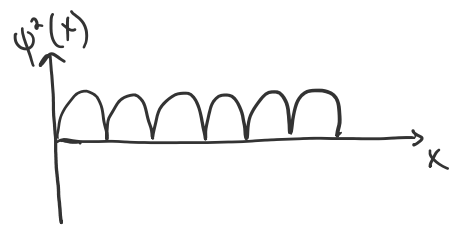
$\hat{\nu}^2\psi = \frac{-1}{4\pi^2}\frac{\partial^2}{\partial t^2}(\sin(2\pi\nu t)) = \frac{(2\pi\nu)^2}{4\pi^2}\sin(2\pi\nu t) = \nu^2\sin(2\pi\nu t) = \hat{\nu}^2\sin(2\pi\nu t)$

eigenvalue

eigenfunction

In QM, apply operators to functions, get values of variables

Postulates =

CM	QM
① x & p are independent	① $\hat{p} = \frac{h}{2\pi i}\frac{\partial}{\partial x}$ x & p are conjugate
② Equation of motion $-\frac{\partial V}{\partial x} = F = ma = m\frac{\partial^2 x}{\partial t^2}$	② $\hat{H}\psi(x,t) = i\frac{\partial}{\partial t}\psi(x,t)$
③ Probability of finding particles. Particles can be found exactly @ position x  average → $\bar{A} = \int dx\, P(x)A(x)$	③ The probability $P(x) = \lvert\psi(x)\rvert^2 \geq 0$   $\bar{A} = \int dx\, \psi^*(x)A(x)\psi(x)$ $z = x+iy$ $zz^* = x^2+y^2$ $z^* = x-iy$ $\lvert z\rvert^2 = x^2+y^2 = r^2$
④ Doesn't exist	④ There are 2 kinds of particles w/ "Spin" Boson = S = 0, 1, 2, ... Fermions = $S = \frac{1}{2}, \frac{3}{2}, \ldots$