# Quiz-13

★ Homework Que-1.

$[x^n, \hat{p}_x] =$

$x^n \psi = x^n \psi \quad , \quad \hat{p}_x \psi = -i\hbar \frac{\partial \psi}{\partial x}$

So, $[x^n, \hat{p}] \psi = x^n \hat{p} \psi - \hat{p} x^n \psi = x^n (-i\hbar \frac{\partial \psi}{\partial x}) - (-i\hbar) \frac{\partial (x^n \psi)}{\partial x}$

$= -i\hbar \left[ x^n \frac{\partial \psi}{\partial x} - \left[ x^n \frac{\partial \psi}{\partial x} + n x^{n-1} \psi \right] \right]$

$= +n i\hbar x^{n-1} \psi$

$\boxed{[x^n, \hat{p}_x] = n i\hbar x^{n-1}}$

★ Homework Que-2

★ $[\hat{x}, p_x^n]$

$[x^n, p_x^n] \psi = \hat{x} p_x^n \psi - p_x^n x \psi$

$= \hat{x} \left(-i\hbar \frac{\partial}{\partial x}\right)^n \psi - \left(-i\hbar \frac{\partial}{\partial x}\right)^n x \psi$

$= \hat{x} (-i\hbar)^n \frac{d^n \psi}{dx^n} - (-i\hbar)^n \frac{d^n (x\psi)}{dx^n}$

$= \hat{x} (-i\hbar)^n \frac{d^n \psi}{dx^n} - (-i\hbar)^n \left[ x \frac{d\psi}{dx^n} + n \frac{d^{n-1} \psi}{dx^{n-1}} \right]$

$[\hat{x}, \hat{p}_x^n] \psi = -n (-i\hbar)^n \frac{d^{n-1} \psi}{dx^{n-1}}$

$\boxed{[\hat{x}, p_x^n] = -n (-i\hbar)^n \frac{d^{n-1}}{dx^{n-1}} = -n (-i\hbar) p_x^{n-1}}$