Module 7: Bra-Ket Algebra and Linear Harmonic Oscillator- II

7.1 $|n\rangle$ are the normalized eigenkets of the Hamiltonian corresponding to the linear harmonic oscillator problem. Thus $H|n\rangle = E_n|n\rangle = \left(n+\frac{1}{2}\right)\hbar\omega|n\rangle;\quad n = 0,1,2...$ The matrix element $\langle n+1|x|n\rangle$ is equal to

(a) $\left(\frac{\hbar}{2\mu\omega}\right)^{1/2}\sqrt{n}$

(b) $\left(\frac{\hbar}{2\mu\omega}\right)^{1/2}\sqrt{n+1}$

(c) 0

(d) $\left(\frac{\hbar}{2\mu\omega}\right)^{1/2}\sqrt{n-1}$

[Answer (b)]

7.2 $|n\rangle$ are the normalized eigenkets of the Hamiltonian corresponding to the linear harmonic oscillator problem. Thus $H|n\rangle = E_n|n\rangle = \left(n+\frac{1}{2}\right)\hbar\omega|n\rangle;\quad n = 0,1,2...$ The matrix element $\langle n-1|p|n\rangle$ is equal to

(a) 0

(b) $i\left(\frac{\mu\hbar\omega}{2}\right)^{1/2}\sqrt{n-1}$

(c) $i\left(\frac{\mu\hbar\omega}{2}\right)^{1/2}\sqrt{n}$

(d) $i\left(\frac{\mu\hbar\omega}{2}\right)^{1/2}\sqrt{n+1}$

[Answer (c)]

7.3 In the linear harmonic oscillator problem the coherent state is given by $|\alpha\rangle = N\sum_{n=0,1,2,...}^{\infty} c_n|n\rangle$ where $|n\rangle$ are the normalized eigenkets of the Hamiltonian. The coefficients c_n will be

(a) $\frac{\alpha^n}{\sqrt{n!}}$

(b) $\frac{\alpha^n}{n!}$

(c) $\frac{\alpha^{2n}}{n!}$

(d) $\frac{\alpha^{2n}}{\sqrt{n!}}$

[Answer (a)]

7.4 In the linear harmonic oscillator problem the coherent state is given by $|\alpha\rangle = N\sum_{n=0,1,2,...}^{\infty}\frac{\alpha^n}{\sqrt{n!}}|n\rangle$ where $|n\rangle$ are the normalized eigenkets of the Hamiltonian. The normalization constant N is given by

(a) 1

(b) $e^{-\frac{1}{2}|\alpha|^2}$

(c) $e^{-|\alpha|^2}$

(d) $e^{-2|\alpha|^2}$

[Answer (b)]