Module 3: Linear Harmonic Oscillator-I

3.1 Let $\psi_n \;\; x$ represents the normalized eigenfunctions corresponding to the linear harmonic oscillator problem $\;\; n = 0,1,2,3.... \;\;$. $\psi_0 \;\; x \;\; = N \exp\left(-\frac{1}{2}\xi^2\right)$; $\xi = \gamma x$ and $\gamma = \sqrt{\frac{\mu\omega}{\hbar}}$. Determine the normalization constant N.

(a) $N = \sqrt{\frac{\gamma}{\pi}}$

(b) $N = \sqrt{\frac{\gamma}{2}}$

(c) $N = \sqrt{\frac{\gamma}{2\pi}}$

(d) $N = \sqrt{\frac{\gamma}{\sqrt{\pi}}}$

[Answer (d)]

3.2 Let $\psi_n \;\; x$ represents the normalized eigenfunctions corresponding to the linear harmonic oscillator problem $\;\; n = 0,1,2,3.... \;\;$. Let $\Psi \;\; x,0 \;\; = \frac{1}{\sqrt{3}}\psi_0 \;\; x \;\; + \frac{1}{2}\psi_5 \;\; x \;\; + i\sqrt{\frac{5}{15}}\,\psi_9 \;\; x$ represents the wavefunction at $t = 0$. If we make a measurement of energy, then the probability of finding the value $\frac{11}{2}\hbar\omega$ will be

(a) 0

(b) $\frac{1}{4}$

(c) $\frac{1}{3}$

(d) $\frac{1}{2}$

[Answer (b)]

3.3 Let $\psi_n(x)$ represents the normalized eigenfunctions corresponding to the linear harmonic oscillator problem $(n = 0,1,2,3....)$. Let $\Psi(x,0) = \frac{1}{\sqrt{3}}\psi_0(x) + \frac{1}{2}\psi_5(x) + i\sqrt{\frac{5}{15}}\psi_9(x)$ represents the wavefunction at $t = 0$. If we make a measurement of energy, then the probability of finding the value $\frac{7}{2}\hbar\omega$ will be

(a) 0

(b) $\frac{1}{4}$

(c) $\frac{1}{3}$

(d) $\frac{1}{2}$

[Answer (a)]