

CL22_Q1. The energy of a linear harmonic oscillator in the third excited state is 0.1 eV. Find the frequency of the oscillator.

Ans:

$$E_n = \left(n + \frac{1}{2}\right) h\nu$$

For the third excited state $n = 3$, $E_3 = 1.6 \times 10^{-20} J$

$$E_3 = \frac{7}{2} h\nu$$

$$\nu = 6.9 \times 10^{12} Hz$$

CL22_Q2. Establish Schrodinger's equation of a linear harmonic oscillator and write its solution.

Ans:

The Schrodinger wave equation can be written as

$$\frac{d^2\psi(x)}{dx^2} + \frac{2\mu}{h^2} \left(E - \frac{1}{2} \mu \omega^2 x^2 \right) \psi(x) = 0$$

Notice the term $E - \frac{1}{2} \mu \omega^2 x^2$ is positive since $V(x)$ cannot increase infinitely.

The solution of this equation is of the form

$$\psi(x) = N_n H_n(\xi) e^{-\frac{1}{2}\xi^2} \text{ with } n = 0, 1, 2, 3, 4..$$