CL20_Q1. What is meant by the degeneracy of energy states in quantum systems?

Answer

In quantum mechanics, for different combinations of quantum numbers, we may obtain the same energy value but the wave functions are different. Such quantum states having the same energy are called degenerate. Degeneracy state means two or more stationary states of the same quantum-mechanical system may have the same energy even though their wave functions are not the same.

Ex: In case of 2D, there are two allowed states for the same energy value of $5Eo$. This state is then doubly degenerate. Similarly, in case of 3D, there are three allowed states for the same energy value of $6Eo$. This state is then triply degenerate.

CL20_Q1. Give an example of a degenerate state in the case of a particle in a three dimensional box with infinite potential at the boundaries.

Answer

For a different combination of quantum numbers, we may obtain the same energy value, but the wave functions are different. Such quantum states having the same energy are called degenerate. Here, the first excited state is degenerate since the same 'n' value is given by three sets (1,1,2), (1,2,1), and (2,1,1). The number of different states with a certain value of energy is known as the degree of degeneracy. Thus, the first excited state is threefold or triply degenerate.

CL20_Q3. Calculate the Eigen value of the electron in the lowest energy level, confined in a 2D potential box of 0.1 nm side.

Answer

For the lowest energy level, $n_x = n_y = 1$

The energy of the electron in (11) state is, $E_{11} = \frac{h^2}{8mL^2}(1^2 + 1^2)$

$$= \frac{2h^2}{8mL^2}$$

$$= 75.4 \text{ eV}$$