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Quiz - 17

Que Write the energy of 3 dimensional PIB.

Ans. For 3D :-

$$\psi(x,y,z) = A(x).B(y).C(z)$$

where

$$A(x) = \sqrt{\frac{2}{L_x}} \sin\left(\frac{n\pi x}{L_x}\right)$$

similarly, $B(y) = \sqrt{\frac{2}{L_y}} \sin\left(\frac{n\pi y}{L_y}\right)$ $\quad C(z) = \sqrt{\frac{2}{L_z}} \sin\left(\frac{n\pi z}{L_z}\right)$

Now applying Schrodinger eqn.

$$\frac{-\hbar^2}{2m}\left(\frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2}\right)\psi(x,y,z)$$

$$= \frac{-\hbar^2}{2m}\left(BC\frac{\partial^2 A}{\partial x^2} + AC\frac{d^2 B}{\partial y^2} + AB\frac{\partial^2 C}{\partial z^2}\right)$$

$$= -\frac{\hbar^2}{2m}\left(-\frac{n^2\pi^2}{L_x^2} - \frac{m^2\pi^2}{L_y^2} - \frac{l^2\pi^2}{L_z^2}\right)$$

$$= \frac{\hbar^2\pi^2}{2m}\left(\frac{n^2}{L_x^2} + \frac{m^2}{L_y^2} + \frac{l^2}{L_z^2}\right)$$

$$= \boxed{\frac{h^2}{8m}\left(\frac{n^2}{L_x^2} + \frac{m^2}{L_y^2} + \frac{l^2}{L_z^2}\right)}$$

Hence proved.