Three Dimensions

- SE becomes

$$-\frac{\hbar^2}{2m}\nabla^2\varphi + U(\mathbf{x})\varphi = E\varphi$$

$$\varphi = A(x)B(y)C(z)$$

$$\varphi = R(r)\Phi(\phi)L(\theta)$$

Degeneracy means different wave functions have the same energy

Three Dimensions

$$-\frac{\hbar^2}{2m}\nabla^2\varphi + U(\mathbf{x})\varphi = E\varphi$$

$$-\frac{\hbar^2}{2m}\left(\frac{\partial^2}{\partial x^2}+\frac{\partial^2}{\partial y^2}+\frac{\partial^2}{\partial z^2}\right)\varphi + U(\mathbf{x})\varphi = E\varphi$$

$$\varphi = A(x)B(y)C(z)$$

For a box that is symmetric about the origin

$$\varphi \approx e^{ik_x x}e^{ik_y y}e^{ik_z z}$$

$$E = \frac{\hbar^2}{2m}\left(k_x^2 + k_y^2 + k_z^2\right)$$

Three Dimensions

$$k_x = \frac{n_x \pi}{2a}$$

$$k_y = \frac{n_y \pi}{2b}$$

$$k_z = \frac{n_z \pi}{2c}$$

$$E = \frac{\hbar^2 \pi^2}{8m}\left(\frac{n_x^2}{a^2} + \frac{n_y^2}{b^2} + \frac{n_z^2}{c^2}\right)$$

If a≠b≠c, no degeneracy

What is spin?

- Spin is an internal quantum number that behaves as an angular momentum
- Spins can be added, etc.
- Unit of spin is $h/2\pi$
- Particles with spins of $nh/4\pi$ are called fermions—^{3}He
- Particles with spins of $nh/2\pi$ are called bosons—^{4}He

Identical Particles

- Identical particles near each other are indistinguishable
- Spatial wave function for fermions must be anti-symmetric
- Spatial wave function for bosons must be symmetric
- No two fermions can have the same quantum numbers
- Bosons near each other prefer the same quantum numbers