University of Hyderabad

School of Physics

Jul 2010 - Dec 2010 | Time : 1hr
M.Sc. III-Semester | Quantum Mechanics-II | MM : 20

Session III::Tutorial Spin and Identical Particles

[1] Construct spin matrices for a spin one particle and verify that $\vec{S}^2$ is a multiple of the identity matrix.

[2] Find the eigenvalues of $\vec{S}^2 + (12S_x - 5S_z)\hbar$ for a spin 1 particle ? Give a short explanation for your answer.

[3] What will be the total wave function for hydrogen atom in the state $n = 1, \ell = 0, J = \frac{1}{2}$ for the two cases of (i) electron spin up and (ii) electron spin down?

[4] Find the total wave function for hydrogen atom when the quantum numbers are given to be $n = 2, J = \frac{3}{2}, \ell = 1$ and (i) $M = \frac{3}{2}$ (ii) $M = \frac{1}{2}$.

[5] Show that the only possible values of spin and parity for a system of two identical spinless bosons are $0^+, 2^+, 4^+, \ldots$.

[6] Show that for a system of two identical particles having spin s, the ratio of the number of states, symmetric under exchange of spins, to the number of the antisymmetric states is given by

$$\frac{(s+1)}{s}$$

■ Solutions for the hydrogen atom radial wave function for $n = 1, \ell = 0$ and $n = 2, \ell = 0, 1$ are given below.

(a) $R_{10}(r) = 2\Big(\frac{1}{a_0}\Big)^{3/2} \exp\big(-r/a_0\big)$

(b) $R_{20}(r) = \Big(\frac{1}{2a_0}\Big)^{3/2}\Big(2 - \frac{r}{a_0}\Big) \exp\big(-r/2a_0\big)$

(c) $R_{21}(r) = \Big(\frac{1}{2a_0}\Big)^{3/2}\Big(\frac{r}{a_0\sqrt{3}}\Big) \exp\big(-r/2a_0\big)$

Date : Aug 16,2010