



Homework 3

Instructions

- (1) Write the answers clearly and show the necessary mathematics.
 - (2) Doing homeworks is essential to understand the subject.
 - (3) For your own good, do not copy.
 - (4) Submission due date: 19 September 2014
 - (5) Assignment problems are not an exhaustive list of problems. You are encouraged to do more problems presented in standard books.
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H3.1 For the ground state of the hydrogen like atom, compute $\langle r \rangle$.

H3.2 Derive the $2s$ and $2p$ radial hydrogen like functions.

H3.3 For the ground state of the hydrogen like atom, find the most probable value of r .

H3.4 A state function ψ is an eigenfunction of the Hamiltonian operator, $\hat{H} = \hat{T} + \hat{V}$. Is ψ an eigenfunction of \hat{T} and \hat{V} also? Check this using the ground state wavefunction of hydrogen atom. What do you understand from this problem?

H3.5 Verify the orthogonality of $2p_x$, $2p_y$ and $2p_z$ functions of hydrogen atom.

H3.6 Find out the probability for finding the electron in the $2s$ state of hydrogen atom at distances a_0 and $2a_0$, where a_0 is the Bohr radius.



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H3.7 Imagine hydrogen atom is described by the following state function

$$\phi(r, \theta, \varphi) = \frac{1}{\sqrt{10}} (2\psi_{1,0,0} + \psi_{2,1,0} + \sqrt{2}\psi_{2,1,1} + \sqrt{3}\psi_{2,1,-1})$$

Compute $\langle E \rangle$.

H3.8 Evaluate the radius for which the radial probability distribution is maximum for the $1s$, $2p$, and $3d$ states of the hydrogen atom. Comment on the result.

H3.9 Evaluate $\Delta\lambda$ for the first line of Balmer series observed for hydrogen atom and deuterium atom.

H3.10 Calculate the ionization energy of C^{5+} ion in its ground state.