QB365 Question Bank Software

11 Chemistry Case Study Questions Structure Of Atom - 2024

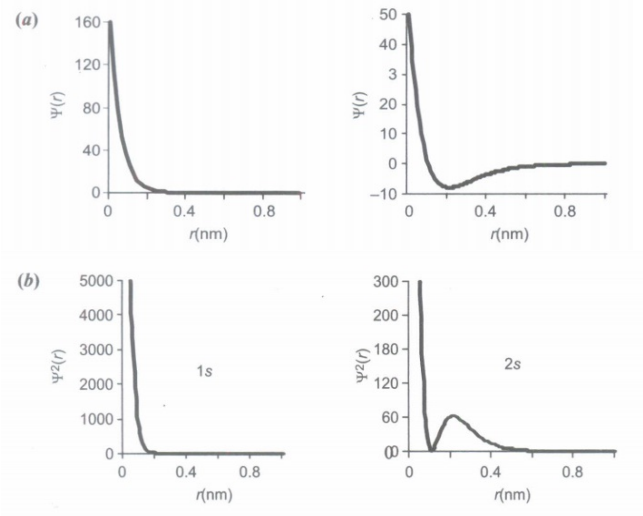
11th Standard

Chemistry

SECTION -1

2 x 4 = 8

1) The plots of (a) orbital wave function Ψ(r) and (b) the variation of probability density Ψ^2(r) as function of distance'r' of the electron from the nucleus for Is and 2s orbitals are shown in the figure. Answer the questions as follows based on graph and related studied concepts.



(a) What is meant by Ψ?
(b) What is meant by Ψ^2?
(c) What happens to probability density in Is orbital?
(d) What happens to Ψ^2 in '2s' orbital?
(e) What are nodes?
(f) How many nodes are 1s, 2s, 3s orbitals?
(g) What are angular nodes?
(h) How many radial and angular nodes are there in 3d orbital?

Answer : (a) It is mathematical function of the coordinates of the electron. It can be +ve as well as -ve. It is orbital wave function.
(b) It gives probability density of electron at that point. It is always +ve.
(c) It is maximum near the nucleus and decreases sharply as we move away from it.
(d) It first decreases sharply to zero and again starts increasing, then decrease.
(e) The regions where $\Psi^2 = 0$ are called nodes.
(f) 1 s has orbitals does not have any node. 2s orbital has 1 node whereas 3s orbital has 2 nodes.
(g) The plane along with, $\Psi^2 = 0$ is called nodal plane. These are called angular nodes.
(h) For 3d orbital, angular nodes = 'l' = 2. Radial nodes = n - l - l
= 3 - 2 - 1
= 0

2) Bohr's model explained electrons can revolve only in certain permitted orbits whose angular momentum is integral multiple of $h/2\pi$, associated with fixed amount of energy. Bohr theory could successfully explain stability of atoms and spectrum of unielectron species. Hydrogen spectrum consist of Lyman, Balmer, Paschen, Brackett and Pfund series. Bohr's theory could not explain spectrum of multi-electron species, Stark effect, Zeeman effect, dual nature of matter, de Broglie equation and Heisenberg uncertainty principle which lead to orbital concept. Electrons were filled in orbitals according to Autbau's principle, Hund's Rule and Pauli's exclusion principle. Each electron is identified by four quantum numbers n, I, m_l and m_s out which n, I, m_l were derived from Schrodinger's wave equation. Half filled and completely filled orbitals are more stable due to exchange energy and symmetrical distribution of electrons.
(a) Heat treatment of muscular pain involves radiation of wavelength 900 nm which spectral

line of H-atom is suitable for this purpose.
(b) Arrange 4d, 3d, 4p and 3p in increasing order of energy.
(c) What is name of spectrum of radiation emitted by substance that has absorbed radiation?
(d) What rules out the probability of existence of definite path of electrons?
(e) State de Broglie equation.
(f) The angular momentum of d-orbital is equal to?
(g) State Pauli exclusion principle.

Answer : (a) $\bar{v} = \frac{1}{\lambda} = R_H \left(\frac{1}{n_1^2} - \frac{1}{\infty} \right)$

$\Rightarrow 1 \times 10^5 \times \frac{1}{x^2} = \frac{1 \times 10^5}{9}$

$\Rightarrow x^2 = 9$

$\Rightarrow x = 3$

Paschen series, ∞ to 3rd energy level has wavelength of 900nm.

(b) 3p < 3d < 4p < 4d.

(c) Emission spectrum

(d) Heisenberg's uncertainty principle.

(e) $\lambda = \frac{h}{mC}$ the wavelength of matter waves is inversely proportional to momentum.

(f) $mvr = \sqrt{l(l+1)}\frac{h}{2\pi}$

$= \sqrt{2 \times 3}\frac{h}{2\pi} = \sqrt{6}\frac{h}{2\pi}$

(g) No two electrons in an atom can have all the four quantum numbers same. They will differ at least in spin quantum number.