Schrodinger Wave Equation Chemistry Questions with Solutions

Q1. In general, the solution of the Schrodinger wave equation is-

a.) Real
b.) Imaginary
c.) Complex
d.) Complex, with the real part always greater than the magnitude of the imaginary part.

Correct Answer– (c.) Complex

Q2. The Schrodinger wave equation is a mathematical depression describing-

a.) energy of the electron,
b.) momentum of the electron,
c.) position of the electron,
d.) All of the above

Correct Answer– (d.) All of the above

Q3. The Schrodinger wave equation is a-

a.) Linear differential equation
b.) Non-linear differential equation
c.) Second-order equation
d.) First-order equation

Correct Answer– (a.) Linear differential equation

Q4. The quantum numbers clearly explained in terms of the Schrodinger wave equation are-

a.) principal quantum number
b.) angular quantum number
c.) magnetic quantum number
d.) All of the above

Correct Answer– (d.) All of the above

Q5. The square of the wave function's magnitude is referred to as-

a.) Current density
b.) zero density

c.) probability density
d.) volume density

Correct Answer– (c.) probability density

Q6. State True or False.
Schrodinger wave equation can be derived from the principles of Quantum Mechanics.

Answer. False.
The Schrodinger equation is a fundamental principle in and of itself. It cannot be derived from other principles; instead, it can only be verified by other principles.

Q7. Does the Schrodinger equation restrict the electron in an H-atom to certain, sharp orbits?

Answer. The Schrodinger equation does not restrict the electron in an H-atom to specific sharp orbits. It only indicates the probability of obtaining an electron in a small area. The space with the greatest chance of finding an electron is referred to as orbital.

Q8. What are the implications of Ψ and Ψ^2?

Answer. Ψ is a wave function that refers to the amplitude of an electron wave, also known as the probability amplitude. There is no physical significance to it. Positive, negative, or imaginary wave functions are all possible. The probability density $[\Psi]^2$ determines the probability of obtaining an electron at a given point within the atom.

Q9. What are the limitations of the wave function?

Answer. The wave function must be integrable in squares. The wave function must have only one value. It means that for any given value of x and t, there should be a unique value of Ψ(x, t) so that the probability of the system being in a given state has only one value. It must either have a finite value or be standardised.

Q10. Fill in the blank.
The corresponding values of wave functions (Ψ) are called ____ functions.

Answer. The corresponding values of wave functions (Ψ) are called eigen functions.

Q11. What is the physical significance of Ψ^2?

Answer. The probability density Ψ^2 determines the probability of finding an electron at a given point within the atom. This means that if
(i) Ψ^2 is zero, the chances of finding an electron at that point are nil.

(ii) Ψ^2 is high, the probability of finding an electron is high, indicating that the electron has been present at that location for a long time.
(iii) Ψ^2 is a low value. The probability of finding an electron is low, indicating that the electron is only present for a short period of time.

Q12. Does the Schrodinger wave equation change for a 3-D system?

Answer. No, the Schrodinger wave equation does not change for a 3-D system.
The Schrodinger equation is a basic principle. Only the new dimensions in which the equation was considered are added when considered for a 3-D system.

Q13. Which quantity is said to be degenerate when HΨn = EnΨn?

Answer. Eigen functions quantity is said to be degenerate when HΨn = EnΨn.
When there is only one Eigen function corresponding to each EIGEN value, the Eigenfunction is known as Degenerate.

Q14. The wave function of 3s electron is given by

$$\Psi_{3s} = \frac{1}{81\sqrt[2]{3\Pi}}\left(\frac{1}{a_0}\right)^{3/2}\left[27 - 18\frac{r}{a_0} + 2\left(\frac{r}{a_0}\right)^2\right]e^{-r/3a_0}$$

It has a node at r = r_0. Find the relation between r_0 and a_0.

Answer. At nodal point v = 0 from the given wave function, we find that ψ = 0 at the following values of r

$$\left[27 - 18\frac{r}{a_0} + 2\left(\frac{r}{a_0}\right)^2\right] = 0$$

Solving r_0/a_0, we get-

$$\frac{r_0}{a_0} = \frac{18 \pm \sqrt{18^2 - 216}}{4} = \frac{18 \pm 10.4}{4}$$

Hence, $r_0 = 7.1\ a_0$ and $r_0 = 1.95\ a_0$

Q15. What does the Schrodinger wave equation demonstrate?
Answer. The Schrödinger equation (also known as Schrödinger's wave equation) is a partial differential equation that uses the wave function to describe the dynamics of quantum mechanical systems. Solving the Schrödinger equation yields the trajectory, positioning, and energy of these systems.

Practise Questions on Schrodinger Wave Equation

Q1. In the Schrodinger wave equation, ψ represents-

a.) Orbitals
b.) Wave functions
c.) Amplitude functions
d.) Both (b) and (c)

Correct Answer– (d.) Both (b) and (c)
Explanation– ψ has no physical significance. It is derived from the standing wave. Hence, It represents both wave function as well as amplitude function.

Q2. Which combinations of quantum numbers n, l, m, and s for an electron in an atom do not provide a solution to the wave equation?

a.) 3, 2, –2. ½
b.) 3, 3, 1, –½
c.) 3, 2, 1, ½
d.) 3, 1, –1, –½

Correct Answer– (b.) 3, 3, 1, –½

Q3. State True or False.
Schrodinger wave equation is a partial differential equation.

Answer. True.
Schrodinger wave equation is a partial differential equation. The Schrodinger equation is a fundamental principle in and of itself. It cannot be derived from other principles; instead, it can only be verified by other principles.

Q4. The Schrodinger equation for the hydrogen atom is:

$$\Psi_{2s} = \frac{1}{4\sqrt[2]{2\Pi}}\left(\frac{1}{a_0}\right)^{3/2}\left[2-\frac{r_0}{a_0}\right]e^{-r/a_0}$$

Where a_0 is Bohr radius. If the radial node in 2s is at r_0, then find r in terms of a_0?

Answer. Node is a point where the probability of finding an electron is 0.
$\Psi^2 = 0$
$\Psi^2_{2s}|_{r0} = 0$

$$\Psi_{2s} = \left[\frac{1}{4\sqrt[2]{2\Pi}}\left(\frac{1}{a_0}\right)^{3/2}\left[2-\frac{r_0}{a_0}\right]e^{-r/a_0}\right]^2$$

$\Psi^2_{2s}|_{r=r0} = 0$

$$\left(2-\frac{r_0}{a_0}\right)^2 = 0$$

$$\left(2 - \frac{r_0}{a_0}\right) = 0$$

$2a_0 - r_0 = 0$

$r_0 = 2a_0$.

Q5. What is the physical significance of the Schrodinger wave function?

Answer. Bohr's concept of an atom is simple. But it cannot explain the presence of multiple orbitals and the fine spectrum arising out of them. It is applicable only to the one-electron system.

Schrodinger wave function has multiple unique solutions representing characteristic radius, energy, and amplitude. The electron's probability density calculated from the wave function shows multiple orbitals with unique energy and distribution in space.

Schrodinger equation could explain the presence of multiple orbitals and the fine spectrum arising out of all atoms, not necessarily hydrogen-like atoms.