C 4361 (Pages : 2) Name.....

Reg. No.....

SECOND SEMESTER (CBCSS—UG) DEGREE EXAMINATION
APRIL 2021

Chemistry

CHE 2B 02—THEORETICAL AND INORGANIC CHEMISTRY—II

Time : Two Hours Maximum : 60 Marks

Section A (Short Answers)

Answer at least **eight** *questions.*
Each question carries 3 marks.
All questions can be attended.
Overall Ceiling 24.

1. What is Photoelectric effect ?
2. Explain de Broglie's concept of matter waves with evidences.
3. Give expression for radius of Bohr orbit, velocity and energy of an electron in a hydrogen atom explain terms involved.
4. Explain term linear operator.
5. What is meant by well-behaved wave function ?
6. Draw angular distribution plots of *p* orbitals.
7. What is bonding molecular orbital ?
8. What is the % of s character in sp, sp^2 and sp^3 hybrid orbitals ?
9. What is the appropriate trial function for hydrogen molecule in V. B theory?
10. What is meant by normalization of wave function?
11. What is the type of hybridization and geometry in (1) NH_4^+ ; (2) $SiCl_4$.
12. Why is hyrid orbitals better oriented than a pure orbital ?

(8 × 3 = 24 marks)

Turn over

Section B (Paragraph)

Answer at least **five** *questions.*
Each question carries 5 *marks.*
All questions can be attended.
Overall Ceiling 25.

13. The threshold frequency of a metal is $4.412 \times 10^{-14}\ S^{-1}$. Calculate the K.E of photoelectron ejected when light of wavelength 4000 Å falls on surface of metal, $h = 6.626 \times 10^{-34}$Js.

14. Describe atomic spectrum of hydrogen atom.

15. Calculate the ground state energy of an electron confined in 1D box of length 0.2 m and calculate energy in $n = 4$ level, $m_e = 9.1 \times 10^{-31}$ kg, $h = 6.626 \times 10^{-34}$Js.

16. Draw radial probability distribution curves of 2s and 2p orbitals.

17. Illustrate and explain LCAO applied for heteronuclear diatomic molecules ?

18. Explain Born-Oppenheimer approximation.

19. What is the type of hybridization in the formation of BH_3 ? Discuss.

(5 × 5 = 25 marks)

Section C (Essay)

Answer any **one** *question.*
The question carries 11 *marks.*

20. State and explain postulates of quantum mechanics.

21. (a) Bonding of O_2 is better explained in molecular orbital theory than in valence band theory. Explain.

    (b) Explain the criteria for formation of molecular orbitals from atomic orbitals.

(1 × 11 = 11 marks)

4361

SECOND SEMESTER B. Sc. DEGREE EXAMINATION
CBCSSUG - CHEMISTRY
CHE2B02; Core Course II
THEORETICAL AND INORGANIC CHEMISTRY- II

Time: Two Hours **Maximum: 60 Marks**

Scheme

1. The phenomenon of ejection of electrons from the surface of a metal when light of suitable frequency falls on it is called photoelectric effect. Visible light eject electron from Cs metal.
2. According to de Broglie's concept, matter of extremely small mass has wave-particle dual character. The wave character is evidenced by diffraction.
3. $r = n^2h^2\varepsilon_o/\pi mZe^2$, $V = Ze^2/2n h\varepsilon_o$ $En = - me^4Z^2/8\varepsilon_o^2h^2n^2$
4. An operator is said to be linear for any two functions f and g, $A[c_1f(x) + c_2g(x)] = c_1[Af(x)] + c_2[Ag(x)]$. Eg. Operator (dl/dx) is linear operator.
5. Well-behaved wave function must be single valued, finite, continuous and quadratically integrable.
6. Angular distribution plots of Px, Py, Pz orbitals in respective x, y, z axis with opposite sign on each dumb bell
7. Bonding molecular orbital is formed by the addition of the wave functions of the atomic orbitals. $\Psi_{M.O} = \Psi_A + \Psi_B$
8. Sp - 50%, sp^2 - 33.33%, sp^3 - 25%.
9. $\Psi = (1- \lambda)\Psi_{covalent} + \lambda \Psi_{ionic}$
10. $\int \Psi \Psi^* dx = 1$
11. (1) sp3, tetrahedral (2) sp3, tetrahedral.
12. Overlapping of hybrid orbitals give stronger bonds with energetically more favorable orientations. Hybrid orbitals are equivalent in terms of size, shape and energy.

Section B (Paragraph)
(Answer questions up to 30 marks. Each question carries 5 marks)

13. Ans. 2.046×10^{-19} J
14. Atomic spectrum of hydrogen atom is line spectrum, fingerprints of elements. It consists of several series of lines appearing in different regions of electromagnetic spectrum. Diagram of hydrogen spectrum mentioning Lymann, Balmer, Paschen, Brackett and Pfund series. Appearance of each series in which all areas of spectrum.
15. $E_{1g\,st} = 1.507 \times 10^{-18}$ J, $E_{(n=4)} = 2.412 \times 10^{-19}$ J
16. 2s = 2-0-1 = 1 node and 2p = 2-1-1 = 0 node, in a plot of $4\pi^2R_{nl}^2$ against r (Å).
17. LCAO principle. for a diatomic molecule AB, if the electron is close to nucleus A, and has little influence of nucleus B. MO resembles the AO of A. ///rly vice versa ie overall wave function of a molecule linear combination of atomic orbitals. $\Psi_{M.O} = C_1\Psi_A + C_2\Psi_B$ c1 and C2 are constants. weightage coefficient for functions Ψ_A and Ψ_B. Illustrate with an example.

18. According to Born-Oppenheimer approximation nuclei being massive than electrons, nuclear motions are much slower than electron motions. For evaluating electronic motion nuclei considered as fixed in space so that internuclear distance remains constant. Instead of solving molecular wave equation for moving electrons and nuclei, we first solve it for moving electrons in a fixed nuclear configuration and then solve equation for nuclear motion by considering electronic energy derived in previous step as P.E for nuclear motion. On applying Born-Oppenheimer approximation we write the total wave function as product of electronic and nuclear wave function. $\Psi_{total} = \Psi_e \Psi_n$

19. Equation for hybrid orbitals Ψ sp2(1) . Ψ sp2(2) and Ψ sp2(3) and Ψ sp2(1) = $1/\sqrt{3}\Psi s + \sqrt{(2/3)}\Psi px$; Ψ sp2(2) = $1/\sqrt{3}\Psi s - 1/\sqrt{6}\Psi px + 1/\sqrt{2}\Psi py$; Ψ sp2(3) = $1/\sqrt{3}\Psi s - 1/\sqrt{6}\Psi px - 1/\sqrt{2}\Psi py$

20. Section C (Essay)

Answer any one. Each question carries 10 marks

21. 1. Wave function describes complete physical state of a system. 2.for every system, possible wave functions are obtained by solving time dependent Schrodinger wave equation.3. for wave function to be acceptable as a function it is continuous, finite, single valued and quadratically integrable.4. To every observable in classical mechanics, there corresponds a linear Hermitian operator in quantum mechanics. 5. The only values that can result from measurement of an observable 'A' will be eigen values satisfying eigen value equation.6. The average value of any observable corresponds to an operator, when a large number of measurements are involved and given by: $\langle A \rangle = \int \Psi A \Psi^* dx$. (6postulates with correct explanation and expression)

22. (a) O_2 is paramagnetic and better explained in molecular orbital theory than in valence band theory. Explain in detail. (b) The molecular orbitals, $\Psi_{MO(g)}$ formed by combination of atomic orbital functions of same sign represents the interaction of electron waves in phase and their consecutive interference, to give a phase whose amplitude is the sum of those of Ψ_A and Ψ_B at every point. ///rly $\Psi_{MO(u)}$ formed by the combination of AO functions of opposite sign represents the interaction of electron waves out of phase and their destructive interference to give whose amplitude id the difference of those of Ψ_A and Ψ_B at every point.