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Paper Code : BS109

Name of the Paper : Engineering Chemistry- I

Semester : I

Time : 60 minutes (+15 minutes extra for uploading)

Maximum Marks : 30

Instructions for Candidates

1. Write your Enrollment number, Name, Program, Subject and page number on each A4 sheet.
2. Put your signature at the bottom of each sheet.
3. Soft copy of the answer sheet has to be uploaded as a single PDF file.
4. Attempt any 15 questions from Section A, any 6 from Section B, and any 1 from Section C.

SECTION – A

Attempt any 15 questions. Each question contains 1 mark.

[1 X 15 = 15]

- 1) The Heisenberg Principle states that _____.
 - (a) no two electrons in the same atom can have the same set of four quantum numbers.
 - (b) two atoms of the same element must have the same number of protons.
 - (c) it is impossible to determine accurately both the position and momentum of an electron simultaneously.
 - (d) electrons of atoms in their ground states enter energetically equivalent sets of orbitals singly before they pair up in any orbital of the set.
 - (e) charged atoms (ions) must generate a magnetic field when they are in motion.
- 2) Which statement about the four quantum numbers which describe electrons in atoms is incorrect?
 - (a) n = principal quantum number, $n = 1, 2, 3, \dots$
 - (b) l = subsidiary (or azimuthal) quantum number, $l = 1, 2, 3, \dots, (n+1)$
 - (c) m_l = magnetic quantum number, $m_l = (-l), \dots, 0, \dots, (+l)$
 - (d) m_s = spin quantum number, $m_s = +1/2$ or $-1/2$.
- 3) The maximum number of electrons that can be accommodated in a sublevel for which $l = 3$ is:
 - (a) 10
 - (b) 6
 - (c) 14
 - (d) 8
- 4) The outer electronic configuration $ns^2 np^4$ corresponds to which one of the following elements in its ground state?
 - (a) As
 - (b) Ca
 - (c) Cr
 - (d) Br
 - (e) S

- 5) If the de Broglie wavelength of a particle of mass “m” is 100 times its velocity, then its mass (m) and Planck’s constant (h)?
- $\frac{1}{10}\sqrt{m/h}$
 - $10\sqrt{m/h}$
 - $\frac{1}{10}\sqrt{h/m}$
 - $10\sqrt{h/m}$
- 6) Which of the following sets of quantum numbers (n, l, m_l, and m_s) describes the valence electron of Na?
- 2, 1, 0, -1/2
 - 2, 0, 0, -1/2
 - 3, 1, 1, +1/2
 - 3, 0, 0, +1/2
- 7) The correct order of increasing radii of the following ions is:
- $O^{2-} < S^{2-} < F^- < N^{3-}$
 - $N^{3-} < S^{2-} < O^{2-} < F^-$
 - $F^- < O^{2-} < N^{3-} < S^{2-}$
 - $S^{2-} < O^{2-} < F^- < N^{3-}$
- 8) Which element has the highest first ionization energy?
- Be
 - B
 - C
 - N
 - O
- 9) Which of these isoelectronic species has the smallest radius?
- Br^{1-}
 - Sr^{2+}
 - Rb^+
 - Se^{2-}
 - They are all the same size because they have the same number of electrons.
- 10) What is the correct order of electronegativity among the following options?
- $Li < Na < K < Rb < Cs$
 - $Li < K < Na < Rb < Cs$
 - $Li > Na > K > Cs > Rb$
 - $Li > Na > K = Rb > Cs$
- 11) A neutral molecule having the general formula AB₃ has two unshared pair of electrons on A. What is the hybridization of A?
- sp
 - sp²
 - sp³
 - sp³d
 - sp³d²
- 12) Which of the following complexes do not follow EAN rule?
- [Fe(CN)₆]⁴⁻
 - [Fe(CN)₆]³⁻
 - Ni(CO)₄
 - [Cu(CN)₄]³⁻

- 13) What is the % ionic character of CsF? Given that electronegativity of F is 4.0 and Cs is 0.7.
- 90.9%
 - 89.5%
 - 85.0%
 - 43.0%
- 14) The order of increasing sizes of atomic radii among the elements O, S, Se and As is:
- As < S < O < Se
 - Se < S < As < O
 - O < S < As < Se
 - O < S < Se < As
- 15) Correct increasing order of bond length in given compounds is:
- HF < HCl < HBr < HI
 - HF < HBr < HCl < HI
 - HI < HBr < HCl < HF
 - HI < HCl < HBr < HF
- 16) Wave nature of electron is proved by which of the following experiments/phenomenon?
- Photoelectric effect
 - Interference
 - Dispersion
 - Black body radiation
- 17) An orthogonal wave function satisfies which one of the following conditions?
- $\int \Psi \Psi^* dV = 1$
 - $\int \Psi^2 dV = 0$
 - $\int \Psi \Psi^* dV = 0$
 - $\int \Psi^2 dV = 1$
- 18) For a particle in a 1-D box, what would happen if the walls of the 1-D box are removed?
- Potential energy of particle becomes zero.
 - Energy of the particle becomes non-quantized.
 - ΔE increases.
 - ΔE decreases.
- 19) Select the pair with the same geometry.
- NO_2^+ and NO_2^-
 - CO_2 and NO_2^-
 - CO_2 and NO_2^+
 - NO_3^- and CO_2
- 20) The shape of SF_4 is:
- Square planar
 - Tetrahedral
 - See-saw
 - Octahedral

SECTION – B

Attempt any 6 questions. Each question carries 2 marks.

[2 X 6 = 12]

- 21) Write the Schrödinger wave equation for the electron. Explain the terms involved. Explain the physical significance of Ψ^2 .
- 22) Draw radial probability distribution curve for 3s, 3p, and 3d orbitals.
- 23) Calculate the lattice energy of NaCl crystal from the following data by use of Born Haber cycle.
- | | |
|---------------------------------------|-----------------|
| Ionisation energy of Na (g) | = 489.5 kJ/mol |
| Electron affinity for Cl (g) | = -351.4 kJ/mol |
| Sublimation energy | = 108.7 kJ/mol |
| Dissociation energy for Cl_2 | = 225.9 kJ/mol |
| Heat of formation of NaCl (H_f) | = -414.2 kJ/mol |
- 24) Explain hybridization concept using PF_5 as an example.
- 25) First ionization energy of Al is less than Mg but reverse is true for second ionization energy of Al.
- 26) An electron was confined in a box having length of 2 nm. Determine the (i) minimum energy, (ii) minimum excitation energy from this state.
- 27) Compare the bond angles in NH_3 and NF_3 based on VSEPR theory.
- 28) Calculate the ratio between the wavelength of an electron and a proton if the proton is moving with half the velocity of electron ($m_p = 1.67 \times 10^{-27}$ kg; $m_e = 10^{-30}$ kg).
- 29) Define electron affinity (EA) and electronegativity. Why do Group 17 elements have high EA and high electronegativity?
- 30) Explain why KCl is ionic but AgCl is covalent in nature.

SECTION – C

Attempt any 1 question. Each question carries 3 marks.

[3 X 1 = 3]

- 31) Draw the molecular orbital diagram of N_2 , N_2^+ and N_2^- . Find the bond order and predict their magnetic behavior. Arrange the above in increasing order of bond length.
- 32) Derive energy of a particle in a 1-D box by applying boundary conditions and given is general solution of Schrödinger wave equation as $\Psi = a \sin(kx) + b \cos(kx)$. And show energy level diagram for first three energy levels.
- 33) Explain linear combination of atomic orbitals and show combination of s-p orbitals. Explain why He_2 does not exist.