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3 (Sem-3) CHM M1

2021

(Held in 2022)

CHEMISTRY

(Major)

Paper : 3·1

(Structure and Bonding)

Full Marks : 60

Time : Three hours

The figures in the margin indicate full marks for the questions.

1. Answer the following questions : $1 \times 7 = 7$

- (a) What are the possible values of principal (n) and azimuthal quantum numbers for the unpaired electron in the atom of an element whose atomic number is 9 ?

Contd.

- (b) What is the lowest energy state of an atom called ?
- (c) What is the maximum number of electron present in an orbital ?
- (d) How is the probability of electron calculated at any point ?
- (e) Write the relationship between wavelength and momentum of a particle.
- (f) What types of hybridizations are involved in SF_4 and I_3^- ?
- (g) How can you account for the fact that BF_3 is non-polar but NF_3 is polar ?

2. Answer the following questions : $2 \times 4 = 8$

- (a) What do you mean by an angular probability distribution function ? Why s-orbitals are spherically symmetrical ?

- (b) Why there are no $2d$ and $3f$ orbitals ?
- (c) What will be the uncertainty of velocity if uncertainty of position and momentum are equal ?
- (d) How the concept of electronegativity helps in predicting whether a covalent bond is polar and non-polar ?

3. Answer **any three** questions : $5 \times 3 = 15$

- (a) What are the main features of the valence bond theory ? Explain taking with the example of H_2 .
- (b) Define the term 'hybridization'. Using the concept of hybridization, explain the shapes of PCl_5 and SF_6 molecules.
- (c) Draw and discuss the shapes of d -orbitals.

(d) What is the significance of wave function ψ in the Schrödinger wave equation ?
What is an atomic orbital ? Why ψ is called orbital wave function ?

(e) Using the concept of quantum numbers, calculate the maximum number of electrons present in the M shell. Give their distribution in the shells, sub-shells and orbitals.

4. Answer **any three** questions : $3 \times 10 = 30$

(a) (i) State and explain Pauli's exclusion principle by taking an example.

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(ii) Show that according to Aufbau principle the energy of $4s < 3d$. However Chromium shows $4s^1 3d^5$ electronic configuration instead of $4s^2 3d^4$. Explain the reason behind it.

$2 + 2 = 4$

(b) (i) Explain the photoelectric phenomenon. How photoelectric phenomenon established the particle nature of photon ?

2+3=5

(ii) What is stopping potential ? Given that the work function of chromium is 4.40 eV, calculate the kinetic energy of electrons emitted from the chromium surface when it is irradiated with UV radiation of wavelength 2000Å. What is the stopping potential for these electrons ?

1+3+1=5

(c) (i) What are the advantages and drawbacks of Bohr's theory ?

2+2=4

(ii) How Heisenberg uncertainty principle nullify the concept of fixed orbit ?

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(iii) A hydrogenic ion requires 30.7 eV to excite its electron from second orbit to third orbit. What is the atomic number of the ion ? 3

(d) Draw the resonance structure for the isoelectronic ions NSO^- and SNO^- and assign formal charges. Which ion is likely to be more stable and why ?

$$8+2=10$$

(e) (i) How Mulliken defined electronegativity of an atom ? 2

(ii) Calculate the per cent ionic character of HF bond assuming $\chi_H = 1.5$ and $\chi_F = 4.0$
(χ = electronegativity) 3

(iii) What are the limitations of Lewis concept of covalent bond ? 2

(iv) Distinguish *ortho*-, *meta*- and *para*-dichlorobenzene with the help of dipole moment. 3