Unique Paper Code : 32171101

Name of the Paper : C – 1 Inorganic Chemistry

Name of the Course : B.Sc.(H) Chemistry

Semester : I

Duration : 3 hours

Maximum Marks : 75

Instructions for Candidate

Attempt four questions in all.

1. (a) Explain why s-orbital is spherical in shape? How many radial and angular nodes are there in 2p and 3d orbital? Specify their location.

   (b) Draw neatly labelled diagrams for radial probability distribution curves for 2s,3s,3p and 3d Orbitals.

   (c) Calculate the percentage ionic character in LiF from the following data:

   μ_{LiF} = 6.32 D and d_{LiF} = 156 pm

   (d) In H_2O, H_2S, H_2Se, H_2Te the bond angle decreases though all have the same bent shape.Why?

   (e) Explain the Bents rule and discuss the structure of PCl_3F_2 molecule on the basis of Bents rule.

   (5 x 3.75)

2. (a) Give reasons why

   (i) $PbCl_4$ is more covalent than $PbCl_2$

   (ii) $BeCl_2$ has zero dipole moment while H_2S has some.

   (b) Explain why

   (i) Half filled and fully filled orbitals are associated with extra stability?

   (ii) NO_2 is bent whereas CO_2 is linear.

   (c) Write time independent Schrodinger equation in three dimensional motion and explain various terms involved .What is eigen function? Show that Schrodinger wave equation for H atom is eigen value equation.

   (d) Calculate the radius ratio for an ionic crystal when the coordination number of cation is 4.

   (e) Calculate the effective nuclear charge for 3d & 4s electrons of copper using Slaters rules.

(5 x 3.75)

3. (a) (i) Using VSEPR theory, predict the shapes of the following: XeO_2F_2, PF_5, PF_6^-, ICl_4^-. $NO2^+$.

(ii) Write the resonating structures for N_3^- and OCN^-

(b) What are the acceptable solutions to Schrodinger wave equation.

(c) Write a short note on Mulliken Jaffe scale of electronegativity.

(d) Explain Band Theory? On the basis of band theory explain why the melting point of chromium is greater than that of Zn.

(e) State Heinsberg's uncertainity principal. Is this limitation or uncertainity dependent on the Inaccuracy of the measuring instrument? Explain. (5 x 3.75)

4. (a) Draw molecular orbital energy level diagram of O_2^{2-} and NO^+. Which has higher bond energy ?

(b) What are normal and orthogonal wave functions? Write mathematical expressions for normalized and orthogonal wave functions. What is their significance?

(c) Determine the wavelength of a photon (in nm) emitted during transition from n=5 to n=2 in the Hydrogen atom.

(d) Explain why : i) H_2O is liquid while H_2S is a gas.

ii) Electron gain enthalpy of Nitrogen is lower than oxygen.

(e) Explain why i) PCl_3 is polar but BCl_3 is non-polar

ii) ice floats on water?

(5 x 3.75)

5. (a) On which law is the Born Haber cycle based? Construct the cycle and calculate Lattice energy For CaO using following data:

Sublimation energy=178 kJ/mol, First I.E. = 590 kJ/mol, Second I.E. = 1150 kJ/mol,

Dissociation energy=498 kJ/mol, First E.A. = -141 kJ/mol, Second E.A. =798 kJ/mol ,

Heat of Formation= -635 kJ/mol

(b) Explain why i) NaCl is more ionic than CuCl ?

ii) $SnCl_2$ is solid while $SnCl_4$ is liquid at room temperature.

(c) Explain why $SiCl_4$ shows a lower boiling point than CCl_4, though molar mass of $SiCl_4$ is greater than that of CCl_4.

(d) Explain why i) $MgSO_4.7H_2O$ is soluble in water whereas $BaSO_4$ not?

ii) First ionisation energy of Al is less than Mg but reverse is true for second ionisation energy of Al .

(e) Why do the solubilities of the sulphate of alkaline earth metals decrease from Be to Ba?

(5 x 3.75)

6. (a) Derive the Born Lande Equation and explain the various terms involved.

(b) What are rules of hybridization? What are equivalent and Non equivalent hybrid orbitals and their significance?

(c) What is de Broglie equation and how does this equation prove one of Bohrs postulates $mvr = nh/2\pi$

(d) Why is $[XeO_6]^{4-}$ octahedral whereas XeF_6 is disordered one?

(e) Why is the sequence of energies of molecular orbitals changes after Nitrogen molecule? Give the stability order of $O_2, O_2^-, O_2^{2-}, O_2^{2+}$ (5 x 3.75)

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1.(a) Using VSEPR theory, write the hybridization & give the geometry & shapes of the followings:

$XeOF_4$,I_3^-, XeO_2F_2, H_3O^+, ClF_3

(b) What are isoelectronic ions? How effective nuclear charge affects the radii of isoelectronic ions : N^{3-}, O^{2-}, F^-, Na^+, Mg^{2+}, Al^{3+} ?

(c) Calculate limiting radius ratio for coordination no.8.

(d) (i) State the physical significance of **ψ and [ψ]²**

(ii) Sketch the radial probability function $a_o r^2 R^2$ for $4d_{xy}$ and $3p_z$ orbital.

(e) Explain why (i) Electron affinity of Cl is higher than F

(ii) Dipole moment of NH_3 is greater than that of NF_3?

(5x3.75)

2. (a) Explain the significance of Heisenberg Uncertainty Principle for micro and macro Particles.

(b) Find out electron gain enthalpy (electron affinity) using following data:

Enthalpy of formation = 381 KJ/mol

Lattice energy = 757 KJ/mol

Ionization enthalpy = 496 KJ/mol

Dissociation energy (Cl_2) = 121 KJ/mol

Sublimation energy (Na metal) = 108 KJ/mol

(c) Explain why (i) NCl_5 does not exist whereas PCl_5 exists

(ii) Lattice energy of alkali metal fluorides decreases from LiF to CsF.

(d) (i) Explain why carbonate ion (CO_3^{2-}) is planar while sulphate is not.

(ii)H_2SO_4 is a syrupy liquid. Explain.

(e) Write a short note on bents rule and discuss the structure of R_3PF_2 molecule on its basis. (5x3.75)

3. (a) (i) Explain why hybrid orbitals form strong bonds ?

(ii) Explain why XeF_2 is a linear Molecule?

(b) How cartesian coordinates are related to polar coordinates? Explain giving relevant diagram and relationship.

(c) Why is $MgSO_4$ soluble in water whereas $BaSO_4$ not?

(d) What do you understand by the term polarizing power and polarizability ? How do These influence the character of a compound? Which of the following will exhibit greater polarizing power and why? Ca^{2+}or Cu

(e) The electronegativities of hydrogen and fluorine are 2.1 and 4.0.Calculate the percentage ionic character in HF. (5x3.75)

4.(a) Write the Schrodinger`s wave equation for H atom. Explain the significance of each term involved in it.

(b) What are the conditions imposed on ψ in order to solve Schrodinger`s equation?

(c) i) Bond angle in PH_3 is less than that in PF_3.Explain.

ii) Write resonance structure of N_3^-.

(d) Explain why i) All P-Cl bonds in PCl_5 are not equivalent

ii) Why are electron affinity values of noble gases taken as zero?

(e) (i) Why O^{2-} is larger in size than isoelectronic F^-

ii) Write the Kapustinskii equation for evaluating lattice energy and explain its significance

(5x3.75)

5.(a) Select from each group of species having smallest size and justify your answer

(i) O, O^- and O^{2-} (ii) K^+, $Sr^{2+}$and Al.

(b) Write the mathematical expressions for normalized and orthogonal wave functions.

(c) Are 5g and 6h sub-shells possible? Give reasons. If they are possible show how many orbitals can be present in each sub-shell?

(d) What do you understand by spin multiplicity? Give justification for Hund`s rule of maximum multiplicity taking a suitable example.

(e) Calculate De Broglie wavelength of an electron travelling with $1/3^{rd}$ the speed of light ($m=9.1x\ 10^{-31}$ kg, $h=6.64x10^{-34}$ Js $c=3.0x10^8$)

(5x3.75)

6.(a) State Heinsberg`s uncertainty principle. Is this limitation or uncertainty dependent on The inaccuracy of the measuring instrument? Explain. A body of 1 kg is moving with 100 ms^{-1} velocity. The velocity may have 0.001% error ,calculate the uncertainty in position.

(b) Calculate the screening constant of 3d electron in As(33) by Slater`s rules.

(c) Define with example Pauli`s exclusion principle. Account for +1/2 value assigned to Spin quantum number.

(d) Explain with help of Born-Haber cycle why CaF_2 Is stable whereas CaF is unstable.

(e) Draw molecular orbital diagram of CO molecule (using sp mixing).On the basis of this diagram explain how CO is an electron pair donor through carbon atom.

(5x3.75)