2022

CHEMISTRY — HONOURS

Paper : CC-4

(Inorganic Chemistry - 2)

Full Marks : 50

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

Answer ***question no.*** **1** and ***any eight*** questions from the rest.

1. Answer ***any ten*** questions : 1×10

   (a) Predict the geometry of IOF_5 and mention the hybridization of the central atom.

   (b) How does conductivity of metals and semi-conductors vary with temperature?

   (c) What is the expected mode of decay of $_{11}Na^{24}$?

   (d) Calculate the formal charge on each of the atoms of BF_4^-.

   (e) Mention the limiting radius ratio for octahedral and cubic lattice structures.

   (f) Predict the greater bond angle among ($\angle$Cl–O–Cl) and ($\angle$Cl– S–Cl) in Cl_2O and SCl_2 respectively.

   (g) What type of defect will produce when solid KCl is heated with potassium vapour?

   (h) Draw two orbitals of your choice and depict them with 'gerade' or 'ungerade' designation.

   (i) Give an example of spallation reaction.

   (j) Write the trend in bond lengths of N_2^+, N_2 and N_2^-.

   (k) Arrange NH_3, PH_3 and AsH_3 in terms of their boiling points.

   (l) Give an example of a molecule containing non-equivalent hybrid orbitals of the central atom.

2. (a) Explain the nature of defects present in NaCl and AgBr crystals with justification.

   (b) Draw the resonating structures of thiocyanate (SCN^-) and cyanate (CNO^-) ions and predict the most stable structures in each case. 3+2

3. (a) Draw the MO diagram of CO and interprete its π-acidic character from the diagram.

   (b) Why is the melting point of CuCl much lower than that of KCl? 3+2

4. (a) Predict the shape of the following compounds and the hybridization of the central atom :

   (i) $IO_2F_2^+$ (ii) XeF_4 (iii) $[ICl_4]^+$

   (b) Bond angle in $(SiH_3)_2O$ is larger than $(CH_3)_2O$. Explain. 3+2

5. (a) Calculate the approximate energy released in nuclear fission of $_{92}U^{235}$. Binding energy per nucleon of U^{235} is 7.6 MeV and that of the fission fragments is 8.45 MeV.

(b) What is radiocarbon dating? 3+2

6. (a) How can you differentiate between the conducting character of white tin and grey tin in the light of valence bond theory of metallic bond?

(b) CH_3. and CF_3. have different geometries. Explain. 3+2

7. (a) Boron (B_2) is paramagnetic while carbon (C_2) is diamagnetic. Explain in the light of MOT.

(b) $^{18}_{9}F$ nuclide is radioactive although its n/p ratio is one. Explain. 3+2

8. (a) HF forms strong H-bonds than H_2O though ΔH_{vap} of HF is lower than that of H_2O. Explain.

(b) Calculate the nuclear binding energy per nucleon in $^{7}_{3}Li$.

(Given $m_e = 0.000549$ amu, $m_p = 1.007277$ amu, $m_n = 1.008665$ amu and

atomic mass of $^{7}_{3}Li = 6.9814$ amu) 3+2

9. (a) What happens when Ge is doped with (i) As and (ii) Ga? Explain in the light of band theory.

(b) Calculate the partial charge on the bonded atoms and percent ionic character of HBr. 3+2

[$\mu = 2.60 \times 10^{-30}$ C.m

H – Br = 1.41Å, $e = 1.60 \times 10^{-19}$ C]

10. (a) Explain the order of bond angles : $\angle H-C-H$, $\angle H-C-F$, $\angle F-C-F$ in CH_2F_2 in the light of Bent's rule.

(b) I_2 is soluble in KI but not in water. Justify. 3+2

11. (a) $MgSO_4$ is soluble in water but $BaSO_4$ is insoluble, whereas BaO is more soluble in water than MgO. Explain.

(b) Write the basis set of orbitals for the formation of HF and explain each term. 3+2

12. (a) Calculate the lattice energy of $MgBr_2$.

Given : Sublimation energy of Mg(*s*) = + 148 kJ mol^{-1}

Ionization energy ($IE_1 + IE_2$) of $Mg \rightarrow Mg^{2+}$ = +2187 kJ mol^{-1}

Vaporization energy of $Br_2(l)$ = + 31 kJ mol^{-1}

Dissociation energy of Br_2 (*g*) = + 193 kJ mol^{-1}

Electron gain enthalpy of Br (*g*) = – 331 kJ mol^{-1}

Formation energy of $MgBr_2$ (*s*) = – 524 kJ mol^{-1}

(b) Compare the thermal stability between $MgCO_3$ and $BeCO_3$ and explain. 3+2

13. (a) Predict and explain the order of bond angles :

(i) NO_2^+ and NO_2^- (ii) H_2S and H_2O

(b) Write two limitations of radius ratio rule. 3+2

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