2025

CHEMISTRY — HONOURS

Paper : DSCC-5

(Inorganic Chemistry - I)

Full Marks : 75

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 nos.* 1, 2, 3, 4 *(Compulsory),*** and ***any four*** questions from the rest (***question nos.* 5-10**).

1. Answer ***any ten*** questions : 2×10

(a) He_2 is unstable but He_2^+ is stable. — Explain.

(b) Identify the type of semiconduction (n or p) expected from the following :

(i) Ga doped Si

(ii) As doped Ge.

(c) Give one example of each of inter-molecular and intra-molecular H-bonding.

(d) Write the conjugate acids and bases of H_2O and NH_3 molecules.

(e) Give example of an acidic buffer and an alkaline buffer.

(f) Predict the mode of decay of the given elements.

(i) $^{14}_{6}C$ (ii) $^{11}_{6}C$

(g) Which one is paramagnetic between B_2 and C_2 molecule? Write down the M.O. electronic configuration of the paramagnetic molecule.

(h) The pK_1 value for H_3ASO_3 is 9.2. Predict the structure of the molecule consistent with this value.

(i) Show schematically how two p orbitals overlap to form gerade and ungerade molecular orbitals.

(j) What do you mean by valence band and conduction band?

(k) When Al^{27} is irradiated with a neutron; there occurs emission of an α particle. Soon after β emission is observed. Identify the end product with relevant nuclear reactions.

(l) Compare the bond order and bond length of O_2, O_2^+, O_2^-, O_2^{2-}.

2. Write short notes on :

(a) Molecular orbital diagram of CO molecule based on the following points :

(i) Construction of MO diagram

(ii) Determination of bond order. 3+2

Or

(b) Semiconductors based on the following points :

(i) Definition

(ii) Importance of doping

(iii) Variation of conductivity with temperature. 1+2+2

3. Write short notes on :

(a) Pauling's rules to predict the strength of the OXO-acids, based on the following points :

(i) Statement of the rules

(ii) Importance. 3+2

Or

(b) Nuclear binding energy curve based on the following points :

(i) Drawing of the curve.

(ii) The tendency of lighter nuclei to undergo fusion and the heavy nuclei to undergo fission. 1+(2+2)

4. Write short notes on :

(a) Bonding-interactions among atomic orbitals based on the following points :

(i) Types

(ii) Pictorial diagram

(iii) Relative strength. 1+3+1

Or,

(b) Buffer solution based on the following points :

(i) Definition

(ii) Mechanism of buffer action

(iii) Equation to calculate the pH of a buffer solution with name of the equation. 1+2+2

5. (a) Construct the MO diagram of H_2O molecule and explain the different donating ability of the two lone pairs.

(b) Give the order of the acidity of the following ions and rationalize the trend.

$[Na(H_2O)_6]^+$, $[Fe(H_2O)_6]^{2+}$, $[Al(H_2O)_6]^{3+}$.

(c) Using band theory explain the conductivity of Na and Ca metals. (3+1)+3+3

6. (a) 100 ml of 0.1 (N) acetic acid is titrated with 0.1(N) NaOH solution. Calculate pH of the solution at the following stages :

(i) When 0 ml NaOH is added

(ii) When 50 ml NaOH is added

(iii) At the equivalence point

(iv) When 101 ml NaOH is added

(Given pKa of acetic acid is 4.74).

(b) Explain artificial transmutation with an example.

(c) HF forms stronger H-bonds than H_2O, but HF has lower boiling point compared to H_2O. — Justify. 4+3+3

7. (a) Construct the MO diagram of BeH_2 molecule showing the formation of TASOs.

(b) Comment (with reason) on the change in acidity by adding

(i) SbF_5 in anhydrous HF

(ii) BiN in liquid NH_3.

(c) 'ZnO is yellow when hot and white when cold'– explain in the light of defects in solids. 4+3+3

8. (a) Compare nuclear fission and spallation processes showing relevant nuclear reactions.

(b) Construct the MO diagram of HF molecule and write down the number of non-bonding electrons.

(c) Boiling point of CH_4 is less than that of SiH_4, but the order is reversed for NH_3 and PH_3. 4+3+3

9. (a) Explain the terms 'levelling effect' and 'differentiating effect' of solvents with suitable examples.

(b) Write down any three essential conditions in LCAO-MO treatment for combination of atomic orbitals.

(c) Which H-bond (represented by ...) would you expect to be stronger and why? S – H ··· O and S ··· H – O. 4+3+3

10. (a) Construct the MO diagram of N_2 and explain its inertness.

(b) Predict the direction of the following equilibrium with explanation :

(i) $CH_3HgI + HCl \rightleftharpoons CH_3HgCl + HI$

(ii) $BF_3H^- + BH_3F^- \rightleftharpoons BF_4^- + BH_4^-$

(c) Water has maximum density at 4°C. Justify. 4+3+3