

2026

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) Draw two orbitals of your choice and depict them with 'gerade' or 'ungerade' designation.
- (b) In between FeO and ZnO, which one shows metal deficiency defect and which one shows metal excess defect?
- (c) Arrange He, Ne, Ar, Kr in order of their increasing boiling points. Which chemical force is responsible for this variation?
- (d) Pick out
 - (i) Stronger protonic acid : H_3PO_4 , H_3PO_3 .
 - (ii) Stronger base : NH_2^- , PH_2^- .
- (e) 10 ml of 0.2(N) NaOH is added to 30 ml 0.1(N) acetic acid solution. What will be the nature of the solution? Justify.
- (f) Name two fission nuclei with their atomic and mass numbers.
- (g) How many nodes are there in pi and delta bonding?
- (h) Give two examples each of a hard acid and a hard base.
- (i) Show schematically how one *s* and one *p* orbitals overlap to produce $S = 0$, $S > 0$. (S = overlap integral value).
- (j) Give examples of one intrinsic and one extrinsic semiconductors.
- (k) Calculate the *n/p* ratio of ${}_{13}\text{Al}^{24}$ isotope and suggest the most probable mode of decay to form a stable isotope.
- (l) Classify the following molecules in terms of magnetic properties. H_2 , He_2^+ , He_2^{2+} and H_2^+ .

Please Turn Over

(6728)

2. Write short notes on :

(a) Molecular orbital diagram of NO molecule based on the following points :

(i) Construction of the MO diagram

(ii) Rationalise the bond length trends among NO, NO⁻ and NO⁺.

3+2

Or

(b) Stoichiometric defects in solids based on the following points :

(i) Definition with examples

(ii) Types and comparison of density with justification.

2+3

3. Write short notes on :

(a) HSAB principle based on the following points :

(i) Statement

(ii) Characteristics of hard and soft acids and bases.

1+4

Or

(b) Radiocarbon dating based on the following points :

(i) Principle

(ii) Application in age determination.

2+3

4. Write short notes on :

(a) Band theory based on the following points

(i) Theory with pictorial diagram

(ii) Effect of temperature on conductor and semiconductor with explanation.

2+3

Or

(b) Theory of solvent system based on the following points :

(i) Definition and examples of acid and base

(ii) Neutralization reaction

(iii) Limitations.

2+1+2

5. (a) Construct the MO diagram of CO₂ molecule and find out the bond order.

(b) Calculate the pH of

(i) 10⁻⁸(M) HCl solution

(ii) 0.1(M) NH₄OH solution (K_b of NH₄OH = 1.8×10⁻⁵)

(c) Band theory predicts that Mg is an insulator, however in practice it acts as a conductor — Explain.

4+3+3

6. (a) Acetic acid behaves as a weak acid in water, strong acid in liquid ammonia but as a base in liquid HF. Justify your answer with relevant effects and equations.
- (b) Calculate the nuclear binding energy per nucleon of C^{12} from the following data : masses of $C^{12} = 12.00000$, $n = 1.00893$, $p = 1.00758$ and $e = 0.0005$ amu. 4+3+3
- (c) What are halogen bonds? Explain with suitable examples.
7. (a) Construct the MO diagram of CN^- and compare its donor-acceptor property with CO.
- (b) Interpret the following acid-base reaction mentioning the suitable theory :
- $$6CaO + P_4O_{10} \xrightarrow{\Delta} 2Ca_3(PO_4)_2$$
- (c) In $CuSO_4 \cdot 5H_2O$, all the water molecules are not lost at the same temperature. — Justify. 4+3+3
8. (a) Define nuclear binding energy. What information can be obtained from the nuclear binding energy curve regarding the stability of atomic nuclei?
- (b) N_2 and CO are iso-electronic but N_2 is inert whereas CO is reactive. — Explain.
- (c) Explain the variation in boiling points between o-nitrophenol ($214^\circ C$) and p-nitrophenol ($279^\circ C$). 4+3+3
9. (a) Comment on the relative acid strength of the following pairs with explanation :
- (i) BF_3 and BCl_3
- (ii) SiF_4 and $SiCl_4$
- (b) Between H_2 and He_2^{2+} which one is more stable and why?
- (c) $HF_2^\ominus$ exists while the other halogens cannot form such stable species. Comment. 4+3+3
10. (a) The addition of one electron to O_2 weakens the O-O bond, whereas removal of one electron strengthens it. However reverse order is observed in case of C_2 molecule. Explain the observations using MO theory.
- (b) Draw the acid-base neutralization curves for
- (i) CH_3COOH vs $NaOH$
- (ii) HCl vs NH_4OH
- What would be your choice of indicators in each case?
- (c) Write the conjugate acids and bases for the following species : HS^- , $H_2PO_4^-$, H_2SO_4 . 4+3+3