# 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 nucleii 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 $_{13}Al^{24}$ 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 $H_2^+$.

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 $CO_2$ molecule and find out the bond order.

(b) Calculate the pH of

(i) $10^{-8}$(M) HCl solution

(ii) 0.1(M) $NH_4OH$ solution ($K_b$ of $NH_4OH = 1.8\times10^{-5}$)

(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.

(c) What are halogen bonds? Explain with suitable examples. 4+3+3

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 $CuSO_4 . 5H_2O$, 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°C) and *p*-nitrophenol (279°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

---