

**SECTION-I (Multiple Choice Questions)**

This section contains **10 multiple choice questions**. Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONLY ONE** is correct.

- Select the most ionic and most covalent compounds respectively from the following.  
 $\text{CrO}_5, \text{Mn}_2\text{O}_7, \text{PbO}, \text{P}_4\text{O}_{10}, \text{SnO}_2$   
 (A)  $\text{CrO}_5, \text{Mn}_2\text{O}_7$       (B)  $\text{PbO}, \text{Mn}_2\text{O}_7$       (C)  $\text{CrO}_5, \text{P}_4\text{O}_{10}$       (D)  $\text{SnO}_2, \text{CrO}_5$
- In which of the following sets the central atom of each member involves  $sp^3$  hybridization?  
 (A)  $\text{IO}_4^-, \text{ICl}_4^-, \text{IF}_4^+$       (B)  $\text{XeO}_3, \text{XeO}_4, \text{XeF}_4$   
 (C)  $\text{SO}_3, \text{SO}_3^{2-}, \text{SO}_4^{2-}$       (D)  $\text{PCl}_4^+, \text{BF}_4^-, \text{ClO}_4^-$
- Which reactions involves a change in the electron – pair geometry (i. e. hybridisation) for the under lined geometry?  
 (A)  $\underline{\text{BF}}_3 + \text{F}^- \rightarrow \underline{\text{BF}}_4^-$       (B)  $\underline{\text{NH}}_3 + \text{H}^+ \rightarrow \underline{\text{NH}}_4^+$   
 (C)  $2\underline{\text{SO}}_2 + \text{O}_2 \rightarrow 2\underline{\text{SO}}_3$       (D)  $\text{H}_2\underline{\text{O}} + \text{H}^+ \rightarrow \text{H}_3\underline{\text{O}}^+$
- Which one of the following species is planar and non – polar with two lone pairs of electrons on the central atom?  
 (A)  $\text{ClF}_3$       (B)  $\text{XeF}_5^-$       (C)  $\text{PCl}_5$       (D)  $\text{BrF}_5$
- In the structure of  $\text{H}_2\text{CSF}_4$ , to decide the plane in which C = S is present the following bond angle values are given  
 Axial FSF angle (idealized =  $180^\circ$ )       $\Rightarrow$        $170^\circ$   
 Equatorial FSF angle (idealized =  $120^\circ$ )       $\Rightarrow$        $97^\circ$   
 After deciding the plane of double bond, which of the following statements is correct?  
 (A) Two C – H bonds are in the same plane of axial S – F bond  
 (B) Two C – H bonds are in the same plane of equatorial S – F bonds  
 (C) Total five atoms are in the same plane  
 (D) Equatorial S – F bonds are perpendicular to plane of  $\pi$  – bond
- In which of the following molecules / ions all the bond angles are not equal?  
 (A)  $\text{SiF}_4$       (B)  $\text{ICl}_4^-$       (C)  $\text{SF}_4$       (D)  $\text{PCl}_4^+$
- What is the hybridization of boron atoms in compound  $\text{Mg}[\text{B}_2\text{O}(\text{OH})_6]$ ?  
 (A) Both  $sp^3$       (B) One  $sp^2$  and other  $sp^3$   
 (C) Both  $sp^2$       (D) One  $sp^3$  and other  $sp^3d$

8. If we consider no mixing of '2s' and '2p' orbitals, then the bond order and magnetic nature of the diatomic molecule  $C_2$  is:
- (A) 3 and diamagnetic (B) 2.5 and diamagnetic  
(C) 2 and diamagnetic (D) 2 and paramagnetic
9. Which of the following statements are correct?
- (I) Both melting and boiling points of  $H_2O$  are higher than those of  $H_2Te$  .  
(II) In both  $N_2O_5$  and  $N_2O_4$  all N – O bond lengths are equivalent.  
(III) In both crystalline  $NaHCO_3$  and  $KHCO_3$ ,  $HCO_3^-$  forms only dimeric anion through hydrogen bond  
(IV) Amongst  $B_2, C_2, N_2^-$  and  $O_2, N_2^-$  and  $O_2$  on further ionization (losing single electron) form thermodynamically more stable species.
- (A) (I) and (II) (B) (III) and (IV) (C) (II) and (III) (D) (I) and (IV)
10. Which of the following statements is correct?
- (A)  $(CH_3)_3COH$  is less acidic than  $(CH_3)_3SiOH$   
(B) Like CO, its analogue of Si is not stable.  
(C) In phosgene, C – O bond length is longer than expected while C – Cl bond length is shorter  
(D) All of these

## SECTION-II (Multiple Choice Questions)

This section contains **05 multiple choice questions**. Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct.

11. Which of the following species are correctly matched with their geometries according to the VSEPR theory?
- (A)  $BrF_6^+$  → octahedral (B)  $SnCl_5^-$  → trigonal bipyramidal  
(C)  $ClF_2^-$  → linear (D)  $IF_4^+$  → see – saw.
12. There is S – S linkage in:
- (A)  $S_2O_3^{2-}$  (B)  $S_2O_4^{2-}$  (C)  $S_2O_5^{2-}$  (D)  $S_2O_7^{2-}$
13. In which of the following pairs, the hybridization of the central atoms is same?
- (A)  $ClF_3, ClF_3O$  (B)  $ClF_3O, ClF_3O_2$   
(C)  $(ClF_2O)^+, (ClF_4O)^-$  (D)  $(ClF_4O)^-, (XeOF_4)$
14. Which of the following statements is / are true?
- (A) It is impossible to satisfy the octet rule for all atoms in  $XeF_2$   
(B)  $MgSO_4$  is soluble in water because hydration energy of  $MgSO_4$  is higher in comparison to its lattice energy.  
(C) The bond in  $NO^+$  should be stronger than the bond in  $NO^-$   
(D) For ozone molecule, one oxygen – oxygen bond is stronger than the other oxygen – oxygen bond

15. Hydrogen bonding is present in which of the following species?  
 (A)  $\text{CH}_3\text{NH}_2$       (B)  $\text{CH}_3^-$       (C)  $\text{CH}_3\text{COOH}$       (D)  $\text{CCl}_3\text{CH}(\text{OH})_2$

### SECTION – III (Integer Answer Type)

This section contains **09** questions. The answer to each of the questions is a **single digit integer**, ranging from 0 to 9. The correct digit below the question number in the ORS is to be bubbled.

16. The difference in the number of  $\sigma$  and  $\pi$  bonds in trimer of  $\text{SO}_3$  i.e.  $\text{S}_3\text{O}_9$  is: (consider no coordinate bond to be present)
17. In how many following species, the central atoms have two lone pairs of electrons?  

$\text{XeF}_4$	$\text{XeF}_5^-$	$\text{F}_2\text{SeO}_2$
$\text{XeF}_3^+$	$\text{XeOF}_4$	$\text{ClOF}_3$
$\text{ICl}_4^-$	$\text{SCl}_2$	$\text{OSF}_4$
18.  $\text{BrF}_3$  is a liquid which considerably undergoes self ionization to form cationic and anionic species. Based on VSEPR theory, number of 90 degree F–Br–F bond angles is ..... In anionic species.  

$$2\text{BrF}_3 \rightleftharpoons [\text{BrF}_2]^+ + [\text{BrF}_4]^-$$
19. The bond order of the underlined species;  $\text{NOHSO}_4$  is
20. How many hydrogen bonded water molecule(s) are associated in  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ .
21. The number of vacant hybrid orbitals which participate in the formation of 3 – centre 2 electrons bonds i. e., banana bonds in diborane is:
22. Amongst the following, the total number of species which does / do not exist is:  
 $\text{SF}_6, \text{BF}_6^{3-}, \text{SF}_4, \text{OF}_4, \text{AlF}_6^{3-}, \text{PH}_5, \text{NCl}_5, \text{SCl}_6$
23. If the dipole moment of AB molecule is given by 2.4 D and A – B bond length is  $1 \text{ \AA}$  then % covalent character of the bond is
24. The number of six membered carbon rings in the structure of Buckminsterfullerene (i.e.  $\text{C}_{60}$ ) is

### SECTION – IV (Paragraph Type)

This section contains **2 multiple choice questions** relating to 1 paragraph. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

**Passage for Q. No 25 to 26**

Between ionic and covalent bonds, there are large majority of bonds, in which the bonding electrons are shared unequally between two atoms but are not completely transferred. Such bonds are said to be polar covalent bonds and the bond polarity is due to difference in electronegativity, the ability of an atom in a molecule to attract the shared electrons in a covalent bond.

The measure of net polarity is a quantity called the dipole moment,  $\mu$ , which is defined as the magnitude of the charge  $Q$  at either end of the molecular dipole times the distance  $r$  between the charges :  $\mu = Q \times r$ . Molecular polarities give rise to some of the forces that occur between molecules and these forces are of several different types including dipole – dipole forces, London dispersion forces, and hydrogen bonds. All these intermolecular forces are electrical in origin and result from the mutual attraction of unlike charges or the mutual repulsion of like charges.

25. Which of the following statements is incorrect?
- (A) Out of trimethylamine and trimethylphosphine, trimethylamine has higher dipole moment  
 (B) Out of  $(\text{SiH}_3)_2\text{O}$  and  $(\text{CH}_3)_2\text{O}$  is more basic  
 (C) The critical temperature of water is higher than that of  $\text{O}_2$  because the  $\text{H}_2\text{O}$  molecule has dipole moment.  
 (D) Intermolecular hydrogen bonding increases the enthalpy of vaporization of a liquid due to the increase in the attraction between molecules.
26. In which of the following mixture, the London dispersion force acts as major intermolecular force of attraction?
- (A) Sodium chloride and water  
 (B) Cyclohexane and carbontetrachloride  
 (C) Water and ethyl alcohol  
 (D) Benzene and acetone.

**SECTION - V (Matrix Match Type)**

This section 4 Question. Each question has four statements Given in **Column - I** and four statements in **Column – II**. Any given statement in **Column – I** can have correct **matching with one or more statement (s) given in column II**.

27. Match the compounds listed in column I with characteristic(s) listed in column II

Column – I		Column – II	
(A)	$\text{SF}_2$	(p)	$\text{sp}^3$ and bent
(B)	$\text{KrF}_4$	(q)	Lone pair(s)
(C)	$\text{NOCl}$	(r)	Bond angle $< 109^\circ 28'$
(D)	$\text{N}(\text{Me})_3$	(s)	$\text{sp}^2$ and bent
		(t)	$\text{sp}^3\text{d}^2$ and square planar

28. Match the compounds listed in column I with characteristic(s) listed in column II

Column – I		Column – II	
(A)	$B_2H_6$	(p)	Tetrahedral hybridization
(B)	$Al_2Cl_6$	(q)	Trigonal planar hybridization
(C)	$BeCl_2(s)$	(r)	Empty orbital(s) of central atom participate in hybridization
(D)	$(SiH_3)_3N$	(s)	Two types of bonds
		(t)	Two types of bond angles.

29. Match the molecules / species listed in column I with characteristic(s) listed in column II.

Column – I		Column – II	
(A)	$ClF_5, BrF_4^+, IF_6^-$	(p)	All molecules / ions are polar in nature.
(B)	$ClF_3, BrF_2^+, ICl_4^-$	(q)	All molecules / ions have same number of lone pair(s) and identical shape
(C)	$XeF_2, ICl_2^-, I_3^-$	(r)	All molecules / ions have same oxidation state of central atoms.
(D)	$ClOF_3, ClF_4^+, IO_2F_2^-$	(s)	All molecules / ions have same hybridization of central atoms
		(t)	All molecules / ions are isoelectronic species

30. Match the compounds listed in column – I with characteristic(s) listed in column – II.

Column – I		Column – II	
(A)	Chloral hydrate	(p)	Forms a zig – zag chain in both solid and also in the liquid
(B)	Hydrogen fluoride	(q)	Forms two dimensional sheet with almost hexagonal symmetry
(C)	Crystalline boric acid	(r)	London dispersion force
(D)	Sulphuric acid	(s)	Intramolecular H – bond
		(t)	Intermolecular H - bond

## SECTION - VI (ASSERTION AND REASON TYPE)

31. **Statement – 1:** Compounds of  $Hg^{2+}$  ions having an ionic radius of 116 pm are more covalent in character than those of  $Ca^{2+}$  ions with almost identical size (114 pm) and the same charge.

**Statement – 2:** For two ions of the same size and charge, one with an  $(n-1)d^{10}ns^0$ , electronic configuration will be more polarizing than a cation with an  $(n-1)s^2(n-1)p^6ns^0$ , electronic configuration

- (A) Statement -1 is True, Statement– 2 is True; Statement– 2 is a correct explanation for Statement-1  
 (B) Statement -1 is True, Statement -2 is True; Statement -2 is NOT a correct explanation for Statement -1  
 (C) Statement -1 is True, Statement -2 is False.  
 (D) Statement -1 is False, Statement -2 is True.

32. **Statement -1:** Ethers behave as bases in the presence of mineral acids.  
**Statement -2:** It is due to the presence of lone pair of electrons on the oxygen atom.
- (A) Statement -1 is True, Statement- 2 is True; Statement- 2 is a correct explanation for Statement-1  
(B) Statement -1 is True, Statement -2 is True; Statement -2 is NOT a correct explanation for Statement -1  
(C) Statement -1 is True, Statement -2 is False.  
(D) Statement -1 is False, Statement -2 is True.
33. **Statement -1:** Crystals of hydrated calcium sulphate (gypsum :  $(\text{CaSO}_4 \cdot 2\text{H}_2\text{O})$ ) are soft and easily cleaved.  
**Statement -2:** Crystals of anhydrous calcium sulphate (anhydrite:  $\text{CaSO}_4$ ) are very hard and very difficult to cleave.
- (A) Statement -1 is True, Statement- 2 is True; Statement- 2 is a correct explanation for Statement-1  
(B) Statement -1 is True, Statement -2 is True; Statement -2 is NOT a correct explanation for Statement -1  
(C) Statement -1 is True, Statement -2 is False.  
(D) Statement -1 is False, Statement -2 is True.
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**TOPIC: CHEMICAL BONDING**

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**(ANSWER KEY)**

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| 1. [B]   | 2. [D]    | 3. [A]    | 4. [B]    | 5. [A]    |
| 6. [C]   | 7. [A]    | 8. [D]    | 9. [D]    | 10. [D]   |
| 11. [ABCD]   | 12. [ABC] | 13. [ABD] | 14. [ABC] | 15. [ACD] |
| 16. [6]  | 17. [5]   | 18. [4]   | 19. [3]   | 20. [1]   |
| 21. [2]  | 22. [5]   | 23. [50%] | 24. [20]  | 25. [B]   |
| 26. [B]  |           |           |           |           |
| 27. [A → p,q,r; B → q,r,t; C → q,s; D → r]         |           |           |           |           |
| 28. [A → p,r,s,t; B → p,r,s,t; C → p,r,s,t; D → q] |           |           |           |           |
| 29. [A → p,r; B → p,r; C → q,s; D → p,q,r,s]       |           |           |           |           |
| 30. [A → r,s; B → p,r,t; C → q,r,t; D → r,t]       |           |           |           |           |
| 31. [A]  | 32. [A]   | 33. [B]   |           |           |
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