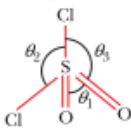
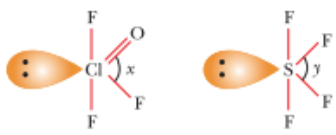


Chemical Bonding

SINGLE CORRECT CHOICE TYPE QUESTIONS

- If all bond angles in AX_3 molecule are the same, then which of the following conclusions is correct about AX_3 ?
(A) AX_3 must be polar.
(B) AX_3 must be planar.
(C) AX_3 must have at least 5 valence electrons.
(D) X must connect from central atom with either single bond or double bond.
- Which of the following statements is correct for BrF_3 ?
(A) Total number of lone pairs present is 15.
(B) Total number of maximum number of atoms in one plane = 5.
(C) Molecule is polar.
(D) Bromine has its maximum covalency in this molecule.
- What is the shape of the cationic part of solid Cl_2O_6 ?
(A) Distorted octahedral
(B) Square pyramidal
(C) Square planar
(D) None of these
- Which of the following orders of boiling point is incorrect?
(A) $CH_4 < CF_4$ (B) $BF_3 < BMe_3$
(C) $I_2 < Br_2 < Cl_2 < F_2$ (D) $Br_2 < I - Cl$
- The \widehat{CNC} bond angle in CH_3NCS is:
(A) $< 109^\circ 28'$ (B) $< 120^\circ$
(C) $> 120^\circ$ (D) 112°
- Which of the following orders is incorrect? (X = F/Cl)
(A) $CH_2F_2 < CHF_3 < (\widehat{FCF})$
(B) $CH_2F_2 < CH_2Cl_2 (\widehat{XCX})$
(C) $CHF_3 < CHCl_3 (\widehat{XCX})$
(D) $CF_4 < CCl_4 (\widehat{XCX})$
- Which of the following statements is correct?
(A) C-F both length: $CH_3F < CHF_3$
(B) O-F bond length: $O_2F_2 < OF_2$
(C) (\widehat{XCX}) bond angle: $OCF_2 < OCCl_2$
(D) (\widehat{CICCl}) bond angle in $OCCl_2 > \widehat{HCH}$ bond angle in $O = CH_2$
- Which of the following statements is/are correct for $H_2C = SF_4$?
(I) Double bond lies in equatorial position.
(II) It is a non-planar and polar molecule.
(III) Maximum number of atoms in a plane is 6.
(A) I, II (B) II, III
(C) I, III (D) I, II, III
- Which of the following molecules is polar as well as non-planar?
(A) $P(CH_3)_3$ (B) POF_3
(C) OF_2 (D) SO_2
- Consider the following statements:
(I) In OSF_4 , $F_{eq} - \widehat{S} - F_{eq} > F_{ax} - \widehat{S} = O$
(II) The bond angle of PF_3 is greater than PH_3 but the bond angle of NF_3 is lesser than NH_3 .
(III) The % s-character in the orbital containing lone pair of H_2O molecule is 30%.
 $[(\widehat{HOH}) = 104.5^\circ \text{ and } \cos(104.5) = -0.25]$
Which of the following statements is/are correct?
(A) I, II (B) II, III
(C) I, III (D) I, II, III
- Choose the correct order of boiling point.
(A) $H_2 < He$
(B) $B(OH)_3 < B(OMe)_3$
(C) $NF_3 < NMe_3$
(D) $CCl_4 < SiCl_4$
- Which of the following interactions is responsible for the formation of clathrate compounds?
(A) Instantaneous dipole-induced dipole interaction
(B) Ion-dipole interaction
(C) Dipole-dipole interaction
(D) Dipole-induced dipole interaction
- Which of the following orders is correct?
(A) $CH_3F > CH_3Cl$ (dipole moment)
(B) $HF > H_2O$ (extent of hydrogen bonding)
(C) $C_3H_{12} > C_3F_{12}$ (boiling point)
(D) $KCl > NaCl$ (solubility in water)
- Which of the following statements is correct for

(A) It contains $p_x - p_x$ and $p_x - d_x$
(B) It has regular tetrahedral geometry.
(C) $\theta_1 > \theta_3$
(D) Plane which contains maximum number of atom is 4.
- In which of the following processes electron is not added to molecular orbital having *gerade* symmetry?
(A) $O_2^+ \rightarrow O_2^-$ (B) $N_2^+ \rightarrow N_2^-$
(C) $B_2 \rightarrow B_2^-$ (D) $C_2 \rightarrow N_2^{2-}$
- If Hund's rule and *sp* intermixing is/are not considered, then which of the following characteristics is changed in C_2 ?
(A) Number of electrons in *gerade* molecular orbital
(B) Bond order
(C) Magnetic behaviour
(D) Magnetic moment
- A silicate mineral has chemical formula $Ca_2Mg_xSi_8O_{22}(OH)_2$ and is known as tremolite. Predict the value of x .
(A) 3 (B) 4
(C) 2 (D) 5
- In which of the following N-N bond length is the shortest?
(A) N_2O (B) N_3^-
(C) N_2O_4 (D) N_2O_3 (unsymmetrical)
- Select the correct order of H - M - H bond angle.
(A) $PH_3 > PH_4^+$ (B) $P_2H_4 > PH_4^+$
(C) $PH_3 > NH_4^+$ (D) $PH_4^+ > NH_3$
- Compare bond angle x and y in the following molecules.


- (A) $x > y$ (B) $y > x$
(C) $x = y$ (D) None of these
21. Choose the correct statement from the following options.
(A) All d_{C-O} in H_2CO_3 are identical.
(B) All d_{Sb-Cl} in $SbCl_5$ are identical.
(C) \widehat{HCH} (in H_2CO) $<$ \widehat{FCF} (in F_2CO)
(D) All above statements are incorrect
22. The maximum % of s -character in N-H bond is observed in
(A) NH_3 (B) NH_4^+
(C) N_2H_4 (D) N_2H_2
23. Consider the following statements and select the correct set of codes using **T(True)** and **F(False)** in the given sequence.
(I) $PI_3(s)$ does not exist due to steric crowding.
(II) All possible angle in BF_2Cl are 120° .
(III) In $N(SiH_3)_3$, lone pair of N is present in sp^3 hybrid orbital.
(IV) d orbital used in hybridization of P in $PBr_5(s)$ is d_{z^2}
(A) T F T T (B) F T T T
(C) F F F F (D) T F T F
24. Choose the incorrect statement from the following.
(A) Bond angles are not affected in BF_3 due to back bonding.
(B) Bond angles are affected in PF_3 due to back bonding.
(C) Bond angles are not affected in $B(OMe)_3$ due to back bonding.
(D) None of these.
25. There is no hybridization of the central atom in AsH_3 because
(A) it is a third period element.
(B) the energy gap between $3s$ and $3p$ orbital is large enough.
(C) the energy gap between $3s$ and $3p$ orbital is sufficiently less.
(D) the energy gap between $4s$ and $4p$ orbital is large enough.
26. In which of the following cases, the strength of back bonding is the maximum?
(A) PF_3 (B) BF_3
(C) $(H_3Si)_3N$ (D) $(SiH_3)_2O$
27. If the % s -character in one Sb-H bond in SbH_3 is 1.0%. What is the % p -character in the orbital occupied by its lone pair?
(A) 99.0 (B) 97
(C) 90 (D) None of these
28. In which of the following all the given characteristics are present?
(I) Vacant orbitals involved in hybridization.
(II) Octet of underlined atom is complete.
(III) Geometry at underlined atom is tetrahedral.
(A) \underline{B}_2H_6 (B) \underline{Si}_2H_6
(C) \underline{Al}_2Cl_6 (D) \underline{I}_2Cl_6
29. Which of the following molecules is non-planar?
(A) $\dot{C}FH_2$ (B) $\dot{C}F_2H$
(C) ClO_3 (D) All of these
30. Which of the following is correct with regard to bonding of $Al_2(CH_3)_6$?
(A) 2 $(2c-2e)$ bond and 2 $(3c-2e)$ bond.
(B) 4 $(2c-2e)$ bond and 2 $(3c-4e)$ bond.
(C) All central atoms are having complete octet.
(D) Molecule is non-planar.
31. Which of the following orders of bond angle is correct?
(A) $B(OH)_3 < B(OMe)_3$
(\widehat{OBX} , where X = H, Me)
(B) $NH_4^+ < NH_3$ (\widehat{HNNH})
(C) $BF_3 < BCl_3$ (\widehat{XBX})
(D) $SiCl_4 < CCl_4$
(\widehat{ClACl} , where A = Si, C)
32. Which of the following chemical species is linear, planar as well as polar?
(A) HCN (B) XeF_2
(C) I_3^- (D) XeF_4
33. Match the overlapping of orbitals with the type of bond formed. (Consider x -axis as internuclear axis.)
- | Column-I | Column-II |
|-----------------------|-----------------------|
| (P) $2s + 2p_x$ | (1) π bond |
| (Q) $2p_y + 2p_y$ | (2) σ bond |
| (R) $d_{xy} + p_z$ | (3) δ bond |
| (S) $d_{yz} + d_{yz}$ | (4) no bond formation |
- Code:**
- | | P | Q | R | S |
|-----|---|---|---|---|
| (A) | 1 | 2 | 3 | 4 |
| (B) | 2 | 1 | 4 | 3 |
| (C) | 3 | 1 | 2 | 4 |
| (D) | 4 | 3 | 2 | 1 |
34. Which of the following statements is correct?
(A) Noble gases are insoluble in water.
(B) The solubility of noble gases in water is fairly high due to London dispersion force.
(C) The solubility of noble gases increases with the decrease in size of the noble gas atom.
(D) The solubility of noble gases in water is fairly high due to dipole-induced dipole interaction.
35. Choose the correct order for the energy barrier to rotation around the B-N bond.
(A) $H_2B-NR_2 < BH(NR_2)_2 < B(NR_2)_3$
(B) $B(NR_2)_3 < BH(NR_2)_2 < BH_2-NR_2$
(C) $BH(NR_2)_2 > B(NR_2)_3 > BH_2NR_2$
(D) $BH_2NR_2 > B(NR_2)_3 > BH(NR_2)_2$
Note: R = CH_3 in all the above cases.

36. Calculate the percentage of p character in the orbital occupied by the lone pair of electrons in water molecule. [Given HOH is 104.5° and $\cos(104.5^\circ) = -0.25$]
 (A) 80% (B) 20% (C) 70% (D) 75%
37. Give the correct order of initials **True (T)** or **False (F)** for the following statements.
 (I) sp^3 hybrid orbitals are at 90° to one another.
 (II) Adjacent sp^3d^2 hybrid orbitals are at 90° to one another.
 (III) sp^2 hybrid orbitals are at 120° to one another.
 (IV) Bond order of N – O bond in NO_3^- is $1\frac{1}{3}$.
 (A) T F T F (B) T T F F (C) F T T T (D) F T F T
38. Which among the following species is not perfectly planar?
 (A) $\dot{\text{C}}\text{H}_3$ (B) $\dot{\text{C}}\text{HF}_2$ (C) $:\text{CF}_2$ (D) $\dot{\text{N}}\text{O}_2$
39. Which of the following molecules has the maximum number of A–X bonds of identical length, where 'A' is the central atom and 'X' is the surrounding atom?
 (A) SF_6 (B) IF_7
 (C) PF_5 (D) ClO_4^-
40. Which of the following sequences shows the correct bond angle order for isoelectronic species O_3 , NO_2^- and NOF ?
 (A) $\text{NO}_2^- > \text{NOF} > \text{O}_3$ (B) $\text{O}_3 > \text{NO}_2^- > \text{NOF}$
 (C) $\text{O}_3 < \text{NO}_2^- < \text{NOF}$ (D) Cannot be predicted
41. The shape of $[\text{ClF}_4]^-$ and $[\text{ClF}_2]^-$ ions is respectively
 (A) See-saw and linear.
 (B) See-saw and bent.
 (C) Tetrahedral and linear.
 (D) Square planar and linear.
42. Which of the following d orbitals is not involved in d^3s hybridization?
 (A) $d_{x^2-y^2}$ (B) d_{xy} (C) d_{yz} (D) d_{xz}
43. Which among the following statements is incorrect?
 (A) Half-filled configuration is less stable as compared to fully filled configuration.
 (B) SbF_5 is a hypervalent species.
 (C) SbF_5 can act as a Lewis acid.
 (D) All are incorrect.
44. Which of the following orders is correct with respect to the given property?
 (A) $\text{SiF}_4 > \text{SiCl}_4$: B.P. order.
 (B) $\text{MgCO}_3 > \text{SrCO}_3 > \text{BaCO}_3$: p_{CO_2} order when kept at fixed temperature in a closed container.
 (C) $\text{XeF}_2 > \text{XeF}_4$: Dipole moment order.
 (D) $\text{XeF}_2 > \text{XeF}_4$: Fluoride-accepting tendency order.
45. Which of the following statements is correct for $\text{F}_3\text{C}-\text{CF}_2-\text{CF}_3$?
 (A) All C–F bond lengths are identical.
 (B) Two C–F bonds attached to middle carbon atom are longer as compared to the other C–F bond at the terminal carbon.
 (C) Two C–F bonds attached to the middle carbon atom are shorter as compared to the other C–F bond at the terminal carbon.
 (D) None of these.
46. Which of the following statements is not correct regarding NO_2 molecule?
 (A) Paramagnetic behaviour decreases when it undergoes in dimerization.
 (B) It is coloured in its dimeric form.
 (C) The colour is due to the presence of unpaired electron.
 (D) The free electron is present in one of the sp^2 hybrid orbital.
47. $\text{PCl}_x\text{F}_{5-x}$ molecule will be polar and non-polar for what values of x respectively?

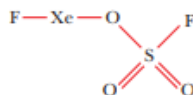
Polar	Non-polar	Polar	Non-polar
(A) 2, 3, 5 and	0, 4, 1	(B) 0, 2, 5 and	3, 1, 4
(C) 4, 3, 0 and	2, 0, 4	(D) 2, 1, 4 and	3, 0, 5
48. Which of the following molecules/species has the minimum number of lone pairs?
 (A) ICl_3 (B) BF_4^- (C) SnCl_2 (D) XeF_4
49. Find the pair of species having the same shape but different hybridization of the central atom.
 (A) SO_3 , CO_3^{2-} (B) NO_2^- , ClO_2^-
 (C) BeCl_2 , HCN (D) XeF_2 , SnCl_2
50. Which of the following statements is incorrect regarding Cl_2O molecule?
 (A) The molecule is planar.
 (B) The shape of the molecule is bent.
 (C) The hybridization of the central atom is sp^3 .
 (D) The molecule is non-planar.
51. The hybridization of all carbon atoms in benzene is
 (A) sp^2 (B) sp^3
 (C) sp^2 and sp^3 (D) sp^2 and sp
52. The ratio of σ bond and π bond in naphthalene is _____.
 (A) 11 : 5 (B) 2 : 1 (C) 19 : 5 (D) 10 : 4
53. The strongest π bond is present in which of the following species?
 (A) $\text{HC} \equiv \text{CH}$ (B) $\text{H}-\text{C} \equiv \text{P}$
 (C) SO_4^{2-} (D) $\text{H}_2\text{C} = \text{CH}_2$
54. Which of the following pairs is iso-structural?
 (A) BO_3^{3-} and SO_3^{2-} (B) NO_2^+ and CO_2
 (C) HNC and SnCl_2 (D) SnCl_3^- and SO_3
55. The d_{z^2} orbital is involved in which of the following hybridizations?
 (A) sp^3d (square pyramidal) (B) sp^3
 (C) sp^3d^2 (D) None of these

56. Which of the following species has incomplete octet?
(A) SiF_4 (B) N^{3-} (C) PBr_5 (D) B^{3-}
57. Which of the following statements is correct for the two molecules, C_6H_6 and $\text{B}_3\text{N}_3\text{H}_6$?
(A) C–H bond length is identical with N–H and B–H bond lengths.
(B) The nature of double bond is perfectly identical in both.
(C) Both the molecules are planar.
(D) C_6H_6 is non-polar while $\text{B}_3\text{N}_3\text{H}_6$ is polar.
58. Which of the following species has the same number of X–O–X linkages, where X = S or P?
(I) $\text{S}_2\text{O}_6^{2-}$ (II) S_2O_9 (III) $\text{S}_2\text{O}_3^{3-}$ (IV) $\text{P}_2\text{O}_9^{3-}$
(A) II & IV (B) II & III
(C) I & III (D) I & IV
59. In which of the following processes, the value of magnetic moment does not change?
(A) $\text{N}_2 \rightarrow \text{N}_2^-$ (B) $\text{N}_2 \rightarrow \text{N}_2^+$
(C) $\text{O}_2 \rightarrow \text{O}_2^+$ (D) $\text{O}_2^+ \rightarrow \text{O}_2^-$
60. Which of the following statements is not correct?
(A) $(s + p_y)$ produces sp hybrid orbitals which are lying in the yz plane.
(B) $(s + p_y)$ produces sp hybrid orbitals which are lying in the xz plane.
(C) $(s + p_x + p_z)$ produces sp^2 hybrid orbitals which are lying in the xz plane.
(D) $(s + p_y)$ produces sp hybrid orbitals which are lying along the y axis.
61. Which is the correct order of the bond angle?
(A) $\text{NH}_3 < \text{NF}_3$ (B) $\text{H}_2\text{O} > \text{Cl}_2\text{O}$
(C) $\text{PH}_3 < \text{SbH}_3$ (D) $\text{H}_2\text{Te} < \text{H}_2\text{S}$
62. The electronic configurations of three elements are as follows:
L: $1s^2 2s^2 2p^6 3s^1$, M: $1s^2 2s^2 2p^4$, N: $1s^2 2s^2 2p^6 3s^2 3p^1$
Choose the correct formula of the ionic compounds formed by the above given elements where the cations are written first as usual.
(A) N_3M_2 , LM (B) ML_2 , M_3N_2
(C) LN, M_2L (D) N_2M_3 , L_2M

MULTIPLE CORRECT CHOICE TYPE QUESTIONS

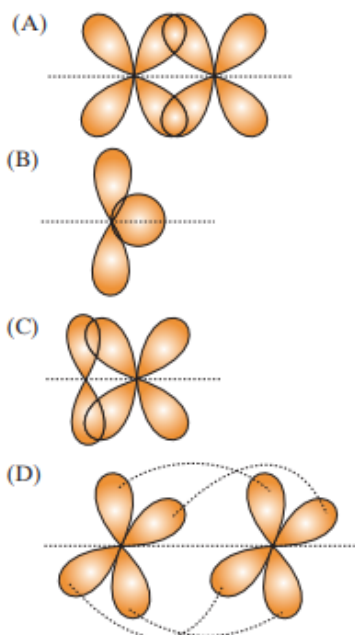
1. Which of the following options is/are correct regarding the XeO_3F_2 and XeOF_4 molecules?
(A) Bond length $d_{\text{Xe}-\text{O}(\text{XeO}_3\text{F}_2)} < d_{\text{Xe}-\text{O}(\text{XeOF}_4)}$
(B) Bond length $d_{\text{Xe}-\text{F}(\text{XeO}_3\text{F}_2)} < d_{\text{Xe}-\text{F}(\text{XeOF}_4)}$
(C) Shapes are trigonal bipyramidal and square pyramidal, respectively.
(D) The nature of π -bond is of $5d_x - 2p_x$ type.
2. Choose the incorrect statement(s) from the following.
(A) HOMO for N_2 molecule is π_g MO.
(B) LUMO for N_2 ion is π^* MO.
(C) HOMO for CO molecule is NBMO from C-atom.
(D) Among halogens, pale yellow colour of F_2 only is not due to HOMO – LUMO transition.
3. Which of the following statements is/are correct?
(A) On increasing s -character hybrid orbital's energy decreases.
(B) Bond angle is generally unaffected due to the presence of lone pair.
(C) On increasing s -character hybrid orbital's length decreases.
(D) Valence shell electron pairs play important role to decide the shape of a molecule.
4. The correct order for Lewis basic strength is/are
(A) $\text{CCl}_3 < \text{CF}_3$
(B) $(\text{CH}_3)_2\text{O} < \text{O}(\text{SiH}_3)_2$
(C) $(\text{CH}_3)_3\text{N} > \text{N}(\text{SiH}_3)_3$
(D) $\text{NH}_3 > \text{PH}_3$
5. Which of the following molecules/ions does not exist?
(A) KHF_2 (B) OF_4
(C) BeF_5^{2-} (D) SH_4
6. In which of the following reactions, the magnitude of change in bond angle with respect to underlined atom is $\geq 20^\circ$?
(A) $\underline{\text{Be}}\text{F}_2 + 2\text{F}^- \rightarrow \text{BeF}_4^{2-}$
(B) $\underline{\text{B}}\text{F}_3 + \text{F}^- \rightarrow \text{BF}_4^-$
(C) $\underline{\text{N}}\text{H}_3 + \text{H}^+ \rightarrow \text{NH}_4^+$
(D) $\underline{\text{C}}_2\text{H}_2 + 2\text{H}_2 \rightarrow \text{C}_2\text{H}_6$
7. Which of the following is correct order for indicated bond length?
(A) $d_{\text{N}-\text{N}}$ in $\text{N}_2\text{H}_2 > d_{\text{N}-\text{N}}$ in N_2F_4
(B) $d_{\text{N}-\text{N}}$ in $\text{NH}_2 - \text{NH}_2 > d_{\text{N}-\text{N}}$ in $\text{NH}_3 - \text{NH}_3$
(C) $d_{\text{Si}-\text{Cl}}$ in $\text{SiClF}_3 > d_{\text{Si}-\text{Cl}}$ in SiClH_3
(D) $d_{\text{C}-\text{C}}$ in $\text{C}_2\text{H}_6 > d_{\text{C}-\text{C}}$ in C_2F_6
8. Which of the following statements is/are not correct?
(A) The bond angle $\widehat{\text{SiOSi}}$ in $(\text{SiH}_3)_2\text{O}$ is larger than that of $\text{C}-\text{O}-\text{C}$ in $(\text{CH}_3)_2\text{O}$.
(B) BF_3 has more Lewis acidic nature than BI_3 .
(C) $p\pi-d\pi$ bond electrons get delocalized between B and N atoms in $\text{B}_3\text{N}_3\text{H}_6$.
(D) CH_3NCS is linear, while SiH_3NCS is bent structure.
9. Which of the following pairs of molecules is/are not isostructural?
(A) NMe_3 and $\text{N}(\text{SiMe}_3)_3$
(B) XeOF_4 and SOF_4
(C) CF_3 and PF_3
(D) SiO_2 and CO_2

10. Which of the following statements is/are correct for XeFOSO_2F ?



- (A) The number of sp^3 hybridized central atom is 3.
 (B) The number of identical S–O bond is 2.
 (C) Maximum number of atoms that may lie in one plane is 5.
 (D) All atoms are lying in the same plane.
11. Select the correct statement(s) about the following chemical species:
 $\text{O}_2, \text{O}_2^+, \text{N}_2, \text{NO}, \text{H}_2^+$ and H_2^-
- (A) Magnetic moment of NO is greater than that of O_2 .
 (B) The bond length of O_2^+ is shorter than that of O_2 due to removal of electron from π^* .
 (C) The ionization energy of N_2 is greater than that of N.
 (D) H_2^+ is more stable than H_2^- although both have the same bond order.
12. Which of the following orders is/are incorrect, against the indicated properties?
 (A) $\text{AgF} > \text{AgCl} > \text{AgI}$: Covalent character
 (B) $\text{NaHCO}_3 > \text{KHCO}_3 > \text{RbHCO}_3$: Solubility in water
 (C) $\text{NaF} < \text{MgF}_2 < \text{AlF}_3$: Melting point
 (D) $\text{MgC}_2\text{O}_4 > \text{CaC}_2\text{O}_4 > \text{BaC}_2\text{O}_4$: Solubility in water
13. Select the correct statement(s) among the following.
 (A) When lone pair of surrounding atom is involved in back bonding, the bond angle does not change anywhere.
 (B) When lone pair of central atom is involved in back bonding, the bond angle does not change.
 (C) In $\text{B}_3\text{N}_3\text{H}_6$, all B–N bond lengths are equal and these are shorter than the single B–N covalent bonds due to delocalization of π electrons.
 (D) BF_3 , BCl_3 are gaseous, BBr_3 is liquid and BI_3 is solid because when size increases, instantaneous dipole-induced dipole interaction increases.
14. Which of the following molecule have $3c-2e$ bond?
 (A) Al_2Cl_6 (B) $\text{Al}_2(\text{CH}_3)_6$
 (C) $[\text{Be}(\text{OMe})_2]_n$ (D) $[\text{Be}(\text{CH}_3)_2]_n$
15. Types of bonds in B_2H_6 :
 (A) B–B ($2c-2e$) (B) B B B ($3c-2e$)
 (C) B–H ($2c-2e$) (D) B H B ($3c-2e$)
16. $\text{Be}(\text{OH})_2$ forms bridge bonding structure in their polymeric form of the compounds as given below.
 (I) $[\text{Be}_3(\text{OH})_8]^{2-}$ (II) $[\text{Be}_4(\text{OH})_{10}]^{2-}$
 Which types of bonds are present in the above compounds?
 (A) $2c-2e$ bond (B) $3c-2e$ bond
 (C) $3c-4e$ bond (D) All of these
17. If polarizing power is in the order of $M_a^+ > M_b^+ > M_c^+$ and polarizability is in the order of $X^- > Y^- > Z^-$, then select which of the following compounds have more covalent character as compared to $M_b^+Y^-$?
 (A) $M_a^+Y^-$ (B) $M_c^+X^-$
 (C) $M_c^+Y^-$ (D) $M_a^+Z^-$
18. Which of the following compounds are thermally more stable than compound CaO_2 ?
 (A) BeO_2 (B) BaO_2
 (C) SrO_2 (D) MgO_2
19. IE_1, IE_2 and IE_3 of an atom X are 170 kcal/mole, 340 kcal/mole and 1280 kcal/mole, respectively. If this atom X forms compounds with O, Cl and N, then which of following compounds has the least chance to exist?
 (A) X_2O_3 (B) XCl
 (C) XCl_2 (D) X_3N_2
20. In which of following processes, do(es) the value of magnetic moment change?
 (A) $\text{CO} \rightarrow \text{CO}^+$ (B) $\text{N}_2^- \rightarrow \text{N}_2^+$
 (C) $\text{Zn} \rightarrow \text{Zn}^{2+}$ (D) $\text{O}_2 \rightarrow \text{O}_2^-$
21. Choose the correct statement(s) among the following for HPO_3^{2-} ions.
 (A) All three HPO angles are identical due to resonance.
 (B) All bond lengths are identical due to resonance.
 (C) The bond order of all P–O bond is 1.33.
 (D) None of these.
22. London force works in
 (A) gaseous state. (B) solid state.
 (C) liquid state. (D) none of these.
23. Which of the following d orbitals may participate in sp^3d hybridization?
 (A) d_{z^2} (B) d_{xy} (C) d_{yz} (D) $d_{x^2-y^2}$
24. Which of the following options represent incorrect hybridization of its central atom for the respective species?
 (A) $\text{SeCl}_4: sp^3d$ (B) $\text{BrF}_4^-: sp^3d^2$
 (C) $\text{SiF}_2\text{Cl}_2: sp^3d$ (D) $\text{XeO}_4^{2-}: sp^3d^3$
25. Which of the following compounds have the same shape?
 (A) SF_4 (B) XeF_4
 (C) $[\text{AsF}_4]^-$ (D) $[\text{SnCl}_3]^-$
26. Which of the following Lewis acid–base interactions are associated with the further involvement of d -orbitals?
 (A) $\text{SbF}_5 + \text{HF} \rightarrow \text{H}^+ [\text{SbF}_6]^-$
 (B) $\text{NH}_3 + \text{BF}_3 \rightarrow \text{H}_3\text{N}^+ \text{B}^- \text{F}_3$
 (C) $\text{AlCl}_3 + \text{Cl}^- \rightarrow [\text{AlCl}_4]^-$
 (D) $\text{SF}_4 + \text{F}^- \rightarrow [\text{SF}_5]^-$

27. Which of the following diagrams indicate the formation of π bonds?



28. Which of the following can be calculated from the Born-Haber cycle of formation of Al_2O_3 ?
- (A) Lattice energy of Al_2O_3 .
 (B) Electron affinity of O atom.
 (C) Hydration energy of Al^{3+} .
 (D) Ionization energy of Al.

29. Which of the following set of molecules have the same shape but different hybridization?
- (A) H_2O , SnCl_2 (B) XeO_3 , BrF_3
 (C) XeO_4 , SF_4 (D) BeCl_2 , I_3^-

30. Which of the following types of bonds are present in NaNO_3 ?
- (A) Ionic bond (B) Covalently bonded σ bond
 (C) π bond (D) Coordinate bond

31. Which of the following compounds are planar as well as non-polar?
- (A) XeF_4 (B) XeF_2
 (C) XeF_3^- (D) XeF_5^+

32. Choose the correct statement.
- (A) d_{yz} orbital lies in the xz plane.
 (B) p_z orbital lies along the x axis.
 (C) Lobes of $d_{x^2-y^2}$ orbital are at 90° with the z axis.
 (D) Lobes of d_{xy} orbital are at 90° with the z axis.

33. From octahedral electron geometry of the central atom, which of the following shapes of the molecule/species may be possible.

- (A) Square pyramidal (B) Linear
 (C) Square planar (D) Bent

34. Which of the following species has the maximum number of lone pairs on the central atom?

- (A) BrF_4^- (B) SO_4^{2-}
 (C) CO_3^{2-} (D) XeF_3^+

35. Which of following energy terms are associated with the Born-Haber cycle of dissolution of BaCl_2 in water?

- (A) Hydration energy of Ba^{2+} .
 (B) Lattice energy of BaCl_2 .
 (C) Sublimation energy of Ba.
 (D) Electron affinity of Cl^- .

36. The formal charges on different atoms in the Lewis structure of N_3^- are:

- (A) -1, +1, -1 (B) -1, +1, 0
 (C) -2, +1, 0 (D) 0, +1, -2

37. Choose the correct angle order.

- (A) $\widehat{\text{HPH}}$ in $\text{PH}_4^- = \widehat{\text{HCH}}$ in CH_4 .

- (B) $\widehat{\text{HNH}}$ in $\text{NH}_3 < \widehat{\text{HPH}}$ in PH_3

- (C) $\widehat{\text{HNH}}$ in $\text{NH}_3 < \widehat{\text{HPH}}$ in PH_4^+

- (D) $\widehat{\text{OSO}}$ in $\text{SO}_3^{2-} < \widehat{\text{ONO}}$ in NO_3^-

38. Select the correct statement(s) about O_3 molecule.

- (A) Correct structure of ozone is $\text{O}=\text{O}=\text{O}$.
 (B) Molecule is planar and polar.
 (C) It is diamagnetic.
 (D) It has bent structure.

39. Choose the correct statements from the following.

- (A) The ratios of σ bond to π bond in SO_3 and SO_2 are identical.
 (B) The hybridization of S in SO_3 and SO_2 is identical.
 (C) The S atom in SO_3 is more electronegative as compared to that in SO_2 .
 (D) SO_3 is planar while SO_2 is non-planar.

40. Which of the following species are isoelectronic and also have the same number of atoms?

- (A) SF_4 (B) $[\text{BeF}_4]^{2-}$ (C) BF_4^- (D) NF_4^+

41. Consider the following four monoatomic ions M^+ , N^+ , X^- and Y^- .

If lattice energy order is $\text{MX} > \text{NX}$ and hydration energy order is $\text{NY} > \text{NX}$, which of the following must be true?

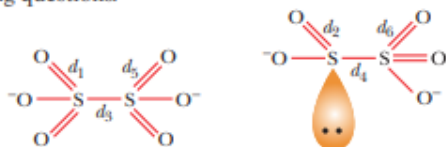
- (A) Covalent character order is $\text{MX} > \text{MY}$.
 (B) Thermal stability order is $\text{MY} > \text{NY}$.
 (C) Hydration energy order is $\text{MX} > \text{NX}$.
 (D) Hydration energy order is $\text{MX} < \text{NX}$.

COMPREHENSION TYPE QUESTIONS

Passage 1: For Questions 1–2

According to Bent's rule, more electronegative atom prefers to stay in that hybrid orbital which has less s -character and lone pair prefers to stay in that hybrid orbital which has more s -character.

Consider the molecules given below and answer the following questions.



- Which of the following bond length order is correct?
(A) $d_1 < d_3$ (B) $d_1 = d_3$
(C) $d_5 > d_1$ (D) Both (A) and (B)
- Out of d_1, d_2, d_3, d_4, d_5 and d_6 which bond length is the maximum?
(A) d_3 (B) d_4
(C) d_1 (D) d_5

Passage 2: For Questions 3–4

Molecular orbital theory is based on linear combination of atomic orbitals (LCAO). According to LCAO when respective atomic orbitals of the atoms interact, they undergo constructive and destructive interference giving rise to two types of molecular orbitals, that is, bonding and antibonding molecular orbitals.

- If z is the molecular axis then which of the following overlapping results in non-bonding molecular orbital?
(A) $(d_{x^2-y^2} + d_{x^2-y^2})$ (B) $(d_{xy} + d_{xy})$
(C) $(d_{yz} + p_y)$ (D) $(d_{xz} + p_z)$
- Calculate the bond order and magnetic nature of the Fe_2^{2+} , if sp intermixing is not considered and Hund's rule is also violated.
(A) 1, diamagnetic
(B) 1, paramagnetic
(C) 2, paramagnetic
(D) 2, diamagnetic

Passage 3: For Questions 5–6

Consider two homodiatom molecules C_2 [carbon] and X_2 which have following properties:

- Both have the same bond order.
- X_2 has more number of antibonding electrons than C_2 molecule.

Then answer the following questions.

(X_2 has total number of electron < 20).

- In X_2 molecule, total number of antibonding electrons is
(A) 4 (B) 6
(C) 5 (D) 2
- Select the incorrect statement.
(A) Total number of electrons in X_2 is 16.
(B) X_2 has two π -bonds.
(C) X_2 has one σ and one π -bond.
(D) Total number of bonding electrons in X_2 is 10.

Passage 4: For Questions 7–8

As implied by the mechanism of hydrolysis, diborane and many other light boron hybrids act as Lewis acids and they are cleaved by reaction with Lewis bases.

Two different cleavage patterns have been observed, namely, symmetric cleavage and unsymmetric cleavage. In symmetric cleavage, B_2H_6 is broken symmetrically into two BH_3 fragments with NMe_3 . While hydrolysis with NH_3 , MeNH_2 , MeNH results in unsymmetrical cleavage, which is a cleavage leading to an ionic product.

- Which of the following statements is incorrect regarding the reaction of B_2H_6 with NH_3 ?
(A) B_2H_6 with NH_3 gives ionic product $[\text{BH}_2(\text{NH}_3)_2]^+[\text{BH}_4]^-$.
(B) The hybridization state of boron atom is unchanged from reactant to ionic products.
(C) B_2H_6 is non-planar and each boron atom is in sp^3 hybridized state.
(D) None of the above statements are incorrect.
- $\text{B}_2\text{H}_6 + 2\text{NH}_3 \rightarrow \text{X}$ [Ionic product] $\xrightarrow[140^\circ\text{C}]{\Delta} \text{Y}$
Here Y is inorganic benzene.
Which of the following statements is incorrect about Y molecule?
(A) Y is a planar molecule.
(B) Y is aromatic and sp^3 hybridization of each B and N-atom.
(C) Y is a non-polar molecule.
(D) Back bonding takes place from N-atom to B-atom in Y.

Passage 5: For Questions 9–10

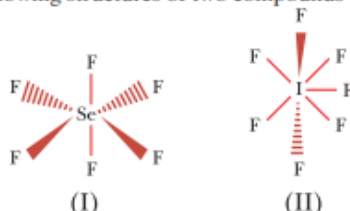
Silicon forms a very large number of compounds containing SiO_4^{4-} anion as the basic unit. The structure of this basic unit is a tetrahedron in which oxygen atoms are arranged in a tetrahedral around the silicon atom.

- Which of the following types of silicate represents the mineral $\text{Mg}_3(\text{OH})_2[\text{Si}_4\text{O}_{10}]$?
(A) Linear silicate
(B) Cyclic silicate
(C) 3-D-Silicate
(D) Sheet silicate

10. The total number of oxygen atoms shared per unit of SiO_4^{4-} in beryl $[\text{Be}_2\text{Al}_2\text{Si}_6\text{O}_{18}]$ is
 (A) 4 (B) 3
 (C) 2 (D) 1

Passage 6: For Questions 11–12

In the following structures of two compounds

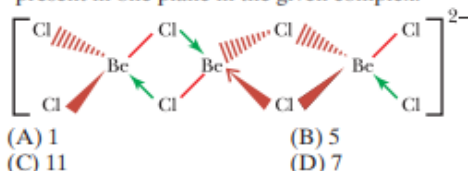


11. Find the ratio of 90° angles in (I) and (II).
 (A) 6 : 5 (B) 5 : 2
 (C) 8 : 10 (D) 4 : 5
12. Choose the correct statement from the following options.
 (A) The number of identical bonds in (I) is equal to that in (II).
 (B) The number of identical bonds in (I) is equal to that in $\text{S}_2\text{O}_7^{2-}$.
 (C) All bond lengths in (II) are identical.
 (D) Smallest bond angle value is available in (I) among these two structures.

Passage 7: For Questions 13–14

There are some cases in which the number of available valence electrons is not sufficient to displace normal electron pair bond (i.e., 2 centre – 2 electron, $2c - 2e$) among all the constituent atoms.

13. Find the maximum number of atom(s) that is/are present in one plane in the given complex.



14. Select the correct order of bond angle in B_2H_6 . (Here H_t and H_b are terminal and bonding hydrogens, respectively.)
 (A) $\widehat{\text{H}_t - \text{B} - \text{H}_t} > \widehat{\text{H}_b - \text{B} - \text{H}_b}$
 (B) $\widehat{\text{H}_t - \text{B} - \text{H}_t} < \widehat{\text{H}_b - \text{B} - \text{H}_b}$
 (C) $\widehat{\text{H}_t - \text{B} - \text{H}_t} = \widehat{\text{H}_b - \text{B} - \text{H}_b}$
 (D) None of these

Passage 8: For Questions 15–17

The binary boron-hydrogen compounds are called boranes. Experimental and theoretical studies of the

boranes have had a fundamental impact on all of chemistry, organic as well as inorganic.

There are two series of boranes.

- (1) B_nH_{n+4} (called nido-boranes)
 (2) B_nH_{n+6} (called Arachno-boranes)
15. Select correct statements about B_2H_6 (diborane).
 (I) It is isoelectronic with ethane.
 (II) It is isostructural with ethane.
 (III) Hybridization of each boron is sp^3 .
 (IV) All B-H bonds are identical.
 (V) It is a nido-borane.
 (A) I, II, III (B) II, III, V
 (C) II, IV, V (D) I, III, V
16. Find the maximum number of atoms present in one plane which is perpendicular to that plane which contains all $2c - 2e$ bonds of B_2H_6 .
 (A) Two (B) Four
 (C) Six (D) Eight
17. In which of the following compounds at least one valance shell orbital of underlined atom remains unhybridized?
 (A) $\underline{\text{B}}_2\text{H}_6$ (B) $\underline{\text{B}}\text{H}_4^-$
 (C) $\underline{\text{B}}\text{Cl}_3$ (D) None of these

Passage 9: For Questions 18–19

Different kind of molecules are available in chemistry, like molecules having single central atom, molecules having more than one central atom, molecules having odd number of electrons and even if some molecules do not exist with theoretical support.

18. The reason for non-existence of which molecule is not the same with the molecules in other options?
 (A) XeH_6 (B) HFO_4
 (C) SH_6 (D) IH_7
19. Which of the following statements is incorrect?
 (A) The free electron of ClO_3 molecule is not present in the d -orbital of Cl atom.
 (B) The hybridization of central atom of ClCO_2 is sp^2 .
 (C) The d_{C-H} in CH_3 is smaller than d_{C-F} in CF_3 .
 (D) The hybridization of N-atom(s) in NO_2 and its dimer is different.

Passage 10: For Questions 20–22

Molecular orbital theory is completely based upon the wave mechanical approach. The MO diagram gives the energy comparison between different orbitals.

20. Choose the correct ionization energy order from the following options.
 (A) $\text{F}_2 > \text{F}$ (B) $\text{B} > \text{B}_2$
 (C) $\text{N}_2 < \text{N}$ (D) $\text{B}_2 > \text{B}$
21. Which of the following orbital is having maximum number of nodal planes?
 (A) σ_{p-p}^* (B) π_{d-d} (2 lobes interaction)
 (C) π_{p-p}^* (D) π_{d-p}

22. In the process of $N_2^- \rightarrow N_2$, the electron is removed from _____ provided the x-axis is the bond formation axis.
 (A) π_{2p_y} orbital (B) $\pi_{2p_x}^*$ orbital
 (C) σ_{2p_x} orbital (D) σ_{2s} orbital

Passage 11: For Questions 23–24

According to Molecular orbital theory, electrons in a molecule are present in molecular orbitals. Molecular orbital is defined as the region or space around two or more nuclei where electron finding probability is the maximum.

23. There is largest difference of energy between the molecular orbital of dioxygen in
 (A) σ_{2p_x} and π_{2p_y} (B) σ_{2p_x} and $\pi_{2p_x}^*$
 (C) σ_{2p_x} and σ_{2s}^* (D) $\sigma_{2p_x}^*$ and σ_{2s}
24. B_2 molecule will be diamagnetic when
 (I) $s-p$ mixing is NOT operative.
 (II) $s-p$ mixing is operative and Hund's rule is violated.
 (III) $s-p$ mixing is operative and Hund's rule is NOT violated.
 (A) (I), (II) (B) (I), (III)
 (C) (II), (III) (D) (I), (II) and (III)

Passage 12: For Questions 25–26

Dipole moment gives an idea of the polar character of a covalent molecule. It is a vector quantity as it has a direction as well as magnitude. A molecule with $\mu = 0$ is non-polar and with $\mu \neq 0$ is polar.

25. If the dipole moment of NF_3 is 0.80×10^{-30} Cm, then the dipole moment of NH_3 is
 (A) 0.80×10^{-30} Cm (B) 1.2×10^{-31} Cm
 (C) 4.90×10^{-30} Cm (D) 0.7×10^{-30} Cm
26. Which of the following dipole moment order is correct?
 (A) $XeF_2 < XeF_4$ (B) $SiH_4 < CF_4$
 (C) $H_2O < OF_2$ (D) $PCl_5 < PCl_3$

Passage 13: For Questions 27–29

The hybrid orbital is obtained by mixing of atomic orbitals of comparable energy.

27. Which of the following shapes of molecule is not obtained from the trigonal bipyramidal electron geometry of the central atom?
 (A) Linear (B) Tetrahedral
 (C) See-saw (D) Trigonal bipyramidal
28. Choose the correct option to complete the statement: As much the percentage s character increases in a particular hybrid orbital, _____.
 (A) bulkiness of the orbital decreases.
 (B) length of the orbital decreases.

- (C) length of the orbital increases.
 (D) thinness of the orbital increases.

29. For which of the following sets of geometry, both axial and equatorial positions are present?
 (A) Octahedral and trigonal bipyramidal.
 (B) Tetrahedral and octahedral.
 (C) Trigonal bipyramidal and pentagonal bipyramidal.
 (D) Tetrahedral and pentagonal bipyramidal.

Passage 14: For Questions 30–32

Bent's rule explains the relative position of atoms and lone pairs in trigonal bipyramidal and pentagonal bipyramidal geometries mainly. However, the bond lengths and bond angles are also well explained in several places.

30. Which of the following species does not have perfect geometrical shape?
 (A) $[BeF_4]^{2-}$ (B) CF_3Cl
 (C) $[SiF_6]^{2-}$ (D) SO_3
31. Which of the following statements is not correct?
 (A) In PF_2Br_3 , $d_{P-F} > d_{P-Br}$.
 (B) All \widehat{FPBr} angles are of 90° in PF_2Br_3 .
 (C) All \widehat{BrPBr} angles are of 120° in PF_2Br_3 .
 (D) Fluorine atom occupies axial position.
32. Which of the following options are correct statements?
 (I) $d_{O-F}(O_2F_2) > d_{O-F}(OF_2)$
 (II) The % s character in the orbital containing lone pair of H_2O molecule is 30% [where $\cos(104.5^\circ) = -0.25$].
 (III) \widehat{HCH} angle in $CH_3 - C \equiv CH$ is exactly equal to $109^\circ 28'$.
 (IV) The \widehat{FNF} in $[NF_2]^-$ is less than \widehat{HNH} in $[NH_2]^-$.
 (A) I, II, III (B) II, IV
 (C) I, II, IV (D) II, III, IV

Passage 15: For Questions 33–36

IF_7 is a molecule in which I atom is in the maximum oxidation state, and the hybridization for I atom is sp^3d^2 .

33. The number of \widehat{FIF} adjacent angles in IF_7 molecule is
 (A) 10 (B) 15
 (C) 20 (D) 14
34. The number of \widehat{FIF} angles less than 90° and equal to 90° are respectively
 (A) 5 and 5 (B) 10 and 5
 (C) 5 and 10 (D) 10 and 15
35. The number of I – F bonds having the longest and shortest lengths are respectively
 (A) 5 and 2 (B) 2 and 5
 (C) 5 and 5 (D) 2 and 2
36. The number of planes of symmetry in IF_7 is
 (A) 5 (B) 7 (C) 4 (D) 6

Passage 16: For Questions 37–39

One more electron or atom can change the system a lot in several aspects.

37. Choose the correct bond angle order:

- (A) $\dot{\text{C}}\text{H}_3 > \bar{\text{C}}\text{H}_3 > \dot{\text{C}}\text{H}_3$ (B) $\dot{\text{C}}\text{H}_3 = \dot{\text{C}}\text{H}_3 > \bar{\text{C}}\text{H}_3$
(C) $\dot{\text{C}}\text{H}_3 > \dot{\text{C}}\text{H}_3 > \bar{\text{C}}\text{H}_3$ (D) $\dot{\text{C}}\text{H}_3 > \bar{\text{C}}\text{H}_3 = \dot{\text{C}}\text{H}_3$

38. Choose the correct bond angle order.

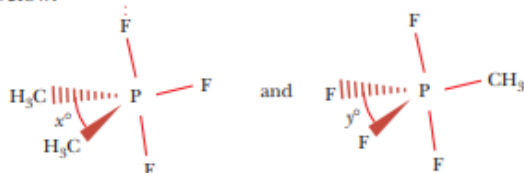
- (A) $\text{CH}_4 > \bar{\text{C}}\text{H}_3 > \dot{\text{C}}\text{H}_3$ (B) $\bar{\text{C}}\text{H}_3 > \text{CH}_4 > \dot{\text{C}}\text{H}_3$
(C) $\dot{\text{C}}\text{H}_3 > \text{CH}_4 > \bar{\text{C}}\text{H}_3$ (D) $\text{CH}_4 > \bar{\text{C}}\text{H}_3 > \dot{\text{C}}\text{H}_3$

39. Choose the correct order for C–H bond length.

- (A) $\text{CH}_3^- > \text{CH}_4 > \text{CH}_3^+$
(B) $\text{CH}_4 = \bar{\text{C}}\text{H}_3 > \text{CH}_3^+$
(C) $\text{CH}_4 = \dot{\text{C}}\text{H}_3 = \bar{\text{C}}\text{H}_3$
(D) $\dot{\text{C}}\text{H}_3 > \text{CH}_4 > \bar{\text{C}}\text{H}_3$

Passage 17: For Questions 40–42

The structures of $\text{P}(\text{CH}_3)_2\text{F}_3$ and $\text{P}(\text{CH}_3)\text{F}_4$ are shown below:



40. Which of the following are correct values for x and y in the above figure?

- (A) $x > 120^\circ, y > 120^\circ$ (B) $x > 120^\circ, y < 120^\circ$
(C) $x = y = 120^\circ$ (D) $x < 120^\circ, y < 120^\circ$

41. Which of the following statements is true regarding the above two structures?

- (A) $d_{\text{P-C}} > d_{\text{P-F}}$ (axial) in both.
(B) $d_{\text{P-C}} > d_{\text{P-F}}$ (equatorial) in both.
(C) $d_{\text{P-F}}$ (axial) $>$ $d_{\text{P-F}}$ (equatorial) in both.
(D) All are correct.

42. For molecules $\text{P}(\text{CH}_3)_n\text{F}_{5-n}$, when the value of n increases from 1 to 4, which of the following statements is incorrect regarding the change observed?

- (A) $d_{\text{P-C}}$ (equatorial) increases.
(B) $d_{\text{P-F}}$ (axial) increases.
(C) $d_{\text{P-F}}$ (axial) decreases.
(D) $d_{\text{P-F}}$ (axial) $>$ $d_{\text{P-F}}$ (equatorial) wherever it is applicable.

Passage 18: For Questions 43–44

London force depends upon molecular weight, the number of polarizable electrons and molecular size.

43. Which type of interaction is involved in the solubility of noble gas in water?

- (A) Instantaneous dipole–induced dipole interaction.
(B) Dipole–dipole interaction.
(C) Dipole–induced dipole interaction.
(D) Ion–dipole interaction.

44. Choose the correct order for boiling point.

- (A) $\text{GeH}_4 > \text{SiH}_4 < \text{CH}_4$ (B) $\text{Xe} > \text{Ne} > \text{He}$
(C) $\text{He} > \text{H}_2$ (D) $\text{CH}_4 > \text{CD}_4$

Passage 19: For Questions 45–47

‘No ionic compound is 100% ionic as well as no covalent compound is 100% covalent.’

45. Correct solubility order is

- (A) $\text{CaCrO}_4 > \text{BaCrO}_4$ (B) $\text{BeCO}_3 < \text{BaCO}_3$
(C) $\text{LiNO}_3 < \text{CsNO}_3$ (D) $\text{NaClO}_4 < \text{KClO}_4$

46. Choose the incorrect order of the given properties.

- (A) $\text{BeCl}_2 < \text{LiCl}$: Electrical conductivity
(B) $\text{NaF} < \text{MgF}_2 < \text{AlF}_3$: Covalent character order
(C) $\text{BeSO}_4 < \text{MgSO}_4 < \text{CaSO}_4$: Thermal stability order
(D) $\text{HgCl}_2 < \text{HgBr}_2 < \text{HgI}_2$: Solubility order in water

47. Which of the following options give incorrect melting point order?

- (A) $\text{H}_2 < \text{T}_2$ (B) $\text{He} > \text{T}_2$ (C) $\text{D}_2 > \text{He}$ (D) $\text{T}_2 > \text{D}_2$

Passage 20: for Questions 48–50

Valence shell electron repulsion theory (VSEPR) can be used to predict the approximate shape of a molecule. Electrons in bonds and in lone pairs can be thought of as ‘charge cloud’ that repel one another and stay as far apart possible, thus causing molecules to assume specific shapes.

The repulsive interactions of electron pairs decrease in the order:

Lone pair–lone pair $>$ Lone pair–bond pair $>$ Bond pair–bond pair.

These repulsions result in deviations from idealized shapes and alteration in bond angles in molecules.

48. Molecular shape of XeF_3^+ , SF_3^+ and CF_3^+ are

- (A) the same with 2, 1 and 0 lone pairs of electrons, respectively.
(B) different with 2, 1 and 0 lone pairs of electrons, respectively.
(C) different with 0, 1 and 2 lone pairs of electrons, respectively.
(D) the same with 2, 0 and 1 lone pairs of electrons, respectively.

49. Which of the following statements is correct with respect to bond angle?

- (A) The F–S–F angle in SF_2 is more than 109.5° .
(B) The H–N–N angle in N_2H_2 is approximately 180° .
(C) The F–Kr–F angle in KrF_4 is 90° .
(D) The Cl–N–O angle in NOCl is more than 120° .

50. Which of the following statements is incorrect?
 (A) In ClF_3 , the axial Cl–F bond length is larger than equatorial Cl–F bond length.
 (B) In SF_6 , F–S–F equatorial bond angle is not 120° and 104° due to lone pair–bond pair repulsions.
 (C) In ICl_4^- , bond angles is 90° .
 (D) In OBr_2 , the bond angle is less than OCl_2 .

Passage 21: For Questions 51–53

HCN and HNC molecules are formed by the same atoms.

51. Which of the following properties are identical for HCN and HNC molecules?
 (A) The number of σ bonds.
 (B) The number of π bonds.
 (C) The number of lone pairs.
 (D) All of these.
52. The correct set of formal charges for HNC is
 (A) 0, 0, 0 (B) 0, –1, +1
 (C) 0, +1, –1 (D) +1, 0, –1
53. Which of the following statements is incorrect regarding the HCN and HNC molecules?
 (A) The hybridization of the central atom is same for both.
 (B) They produce different ions in solution.
 (C) They produce the same ions in solution.
 (D) They produce the same number of ions in solution.

Passage *22: For Questions 54–56

The Lewis structure drawing is the first step to draw the structure of a compound. This method has a lot of limitations which are overcome by the theory of hybridization to explain many properties of molecules/ species.

54. Which of the following species have a π bond as well as coordinate σ bond in their Lewis structure?
 (A) SiF_4 (B) CO_2 (C) SO_3 (D) NO_3^-
55. What are the different kinds of bonds and interactions present within $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$?
 (I) σ bond (II) π bond (III) Coordinate bond
 (IV) Electrostatic forces of attraction
 (V) Hydrogen bond (dipole – dipole)
 (VI) Hydrogen bond (ion – dipole)
 (A) I, II, III only (B) II, III, and IV only
 (C) II, VI, and VI only (D) All six kinds of forces of attraction are present.
56. Which of the following statements is/are incorrect regarding the real structure and Lewis structure of phosphate ion?
 (A) The number of σ bonds is same in both the structures.
 (B) The number of lone pairs is same in both the structures.
 (C) The number of π bonds is same in both the structures.
 (D) The shape remains unchanged in both the structures.

*One or more than one correct answers.

ASSERTION–REASONING TYPE QUESTIONS

In the following set of questions, a Statement I is given and a corresponding Statement II is given below it. Mark the correct answer as:

- (A) If both Statement I and Statement II are true and Statement II is the correct explanation of Statement I.
 (B) If both Statement I and Statement II are true but Statement II is not the correct explanation for Statement I.
 (C) If Statement I is true but Statement II is false.
 (D) If Statement I is false but Statement II is true.

1. **Statement I:** The shape of the molecule depends upon hybridization of the central atom.

Statement II: Hybridization can explain the shape of the molecule.

2. **Statement I:** sp^3d^2 hybrid orbitals are at 90° to one another.

Statement II: There are twelve 90° angles in regular octahedral geometry.

3. **Statement I:** Hydrocarbons with cumulated double bonds are non-polar irrespective of the number of double bonds present in them.

Statement II: The resultant bond vectors of two C–H bonds at two ends are lying in the same line with opposite direction.

4. **Statement I:** The $d_{\text{O-O}}$ in O_2F_2 is almost same with that in O_2 molecule.

Statement II: O_2F_2 exists in the form of $[\text{O}=\overset{+}{\text{O}}-\text{F}]\text{F}^-$ also.

5. **Statement I:** XeH_4 does not exist but XeF_4 exists.

Statement II: F is more electronegative than H and causes lesser extent of d orbital contraction as compared to that by H atom.

6. **Statement I:** The removal of an electron takes place from π_{bonding} orbital when N_2 converts to N_2^+ .

Statement II: The bond order decreases by 0.5 when N_2 converts to N_2^+ .

7. **Statement I:** $(\text{AlCl}_3)_2$ is not electron deficient but $[\text{Al}(\text{CH}_3)_3]_2$ is electron deficient.

Statement II: $(\text{AlCl}_3)_2$ possesses $3c-4e$ bond while $[\text{Al}(\text{CH}_3)_3]_2$ possesses $3c-2e$ bond.

8. **Statement I:** Allene molecule is non-polar.

Statement II: Allene molecule is non-planar.

9. **Statement I:** On addition of two electrons to NO_2^+ , the N–O bond length increases by ~9 pm while on adding only one electron to NO^+ , the N–O bond length increases by ~9 pm.

Statement II: In both the above processes, the bond order of N–O bond is decreased by 0.5.

10. **Statement I:** When BF_3 and BCl_3 are mixed together, it produces BF_2Cl and BFCl_2 through halogen exchange.

Statement II: Figure below is the intermediate for the above process.



11. **Statement I:** The delocalization energy for $\text{B}_3\text{N}_3\text{H}_6$ is less as compared to C_6H_6 .

Statement II: $\text{B}_3\text{N}_3\text{H}_6$ is polar while C_6H_6 is non-polar.

12. **Statement I:** $[\text{AlBr}_4]^-$ exists while the existence of $[\text{BBr}_4]^-$ is questionable.

Statement II: Al is larger in size as compared to B atom.

13. **Statement I:** SiH_4 is highly reactive towards water while CH_4 is non-reactive.

Statement II: Polarity of Si – H bond is just reverse of that of C – H bond.

14. **Statement I:** HgF_2 is colourless while HgI_2 is coloured.

Statement II: I^- is more polarizable than F^- .

15. **Statement I:** S_2F_2 has the structure $\text{S} \begin{smallmatrix} \nearrow \text{F} \\ \searrow \text{F} \end{smallmatrix}$, but S_2Cl_2 has no such analogous structure.

Statement II: F being more electronegative than Cl causes better d orbital contraction as compared to Cl.

16. **Statement I:** In TlI_3 , the oxidation state of Tl is +1.

Statement II: TlI_3 is isomorphous with NH_4I_3 and CsI_3 .

17. **Statement I:** The $d_{\text{C-O}}$ in $\text{CH}_3\text{CO}_2\text{H}$ are different while that in $\text{CH}_3\text{CO}_2\text{Na}$ are identical.

Statement II: Resonance takes place in $\text{CH}_3\text{CO}_2\text{Na}$ but does not take place in $\text{CH}_3\text{CO}_2\text{H}$.

18. **Statement I:** The direction of back bonding in CCl_3 and CCl_2 is the same.

Statement II: In CCl_3 , $2p\pi-3d\pi$ bonding and in CCl_2 , $2p\pi-3p\pi$ bonding takes place.

19. **Statement I:** $d_{\text{P-F}}$ is greater than $d_{\text{P-Cl}}$ in PF_2Cl_3 .

Statement II: The axial orbital has no s character while equatorial orbital has 33.33% s character in trigonal bipyramidal geometry.

20. **Statement I:** Be_2Cl_4 molecule has an incomplete octet.

Statement II: In Be_2Cl_4 each Be atom is sp^2 hybridized.

21. **Statement I:** The nodal planes of π bonds of 1,3 – butadiene lie in the same plane.

Statement II: π bonds are also lying in the same plane in 1,3 – butadiene.

22. **Statement I:** $d_{\text{Mn-O}}$ in MnO_4^- is less than that in MnO_4^{2-} .

Statement II: The higher oxidation state of an element causes higher extent of d orbital contraction and forms more effective π bond with O atoms.

23. **Statement I:** Mercurous ion is always diamagnetic.

Statement II: The 79th electron of each Hg atom gets paired up to form a bond between two Hg atoms.

INTEGER ANSWER TYPE QUESTIONS

The answer to each of the following questions is a non-negative integer.

1. Find the number of compounds of Xe which is/are associated with 180° bond angles.

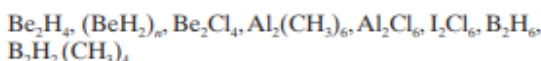


2. Find the total number of d -orbitals used for bonding in XeO_2F_2 .

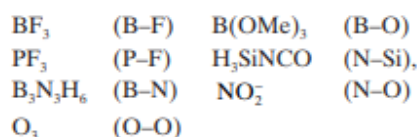
3. Among the following, find the number of processes in which ion-dipole interaction is not observed.

I^- in I_2 , KCl in water, CO_2 in water, Xe in ice, CHCl_3 in water.

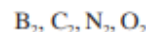
4. Find the total number specie(s) among the following, containing $3c-2e$ bond.



5. Find the total number of chemical species in which mentioned bond length decreases due to back bonding.



6. Find the total number of compounds whose bond order is unaffected whether the s - p mixing is considered or not.



7. Calculate the value of n in



8. Find the maximum number of hydrogen atoms that may lie in one plane in $\text{BH}_2(\text{CH}_3)_4$ molecules.

9. Find the number of chemical species which are iso-electronic and have the same bond order as of CO.
 CN^- , NO^+ , N_2 , C_2^{2-} , O_2^{2+}
10. Find the number of chemical species which are planar and d_{xy} orbital of central atom participates in the hybridization.
 XeF_5^- , XeF_5^+ , XeF_6 , XeF_4 , SF_4 , ICl_4^-
11. Find the total number of compound(s), which is/are repelled by magnetic field.
 K_2O_2 , KO_2 , $\text{O}_2[\text{PtF}_6]$, $\text{NO}[\text{BF}_4]$, KCN , Na_2C_2
12. In the compound $\text{PCl}_k\text{F}_{5-k}$, possible values of k are 0 to 5. Then sum of all possible value of k for the compounds having zero dipole moment is _____.
13. Find the number of 90° angles in XeF_5^- molecules.
14. The sum of oxidation states of N atom in the following compounds of nitrogen is _____.
 NH_3 , N_2H_4 , NH_2OH , N_2 , N_2O , NO , N_2O_3 , NO_2 , N_2O_5
15. The maximum number of atoms lying in the same plane in B_2H_6 is _____.
16. In a molecule of CH_3Cl , the number of planes consisting of maximum number of atoms where at least two atoms are same is _____.
17. The number of planes of symmetry in TeCl_6 is _____.
18. The number of planes which divide TeCl_6 molecule into two equal halves is _____.
19. The number of planes of symmetry in SbF_5 is _____.
20. The number of planes of symmetry in SiH_4 is _____.
21. The maximum number of atoms lying in the same plane in $[\text{AlCl}_4]^-$ and the number of such planes are respectively _____ and _____.
22. In Me_4C molecule, the maximum number of atoms that may lie in the same plane and the number of such planes are respectively _____ and _____.
23. The maximum number of atoms that may lie in the same plane of eclipsed form of C_2H_6 and the number of such planes are respectively _____ and _____.
24. The maximum number of atoms that may lie in the same plane in $\text{P}(\text{CH}_3)_3$ (CF_3)₂ is _____ and the number of such planes is _____.
25. The maximum number of equal angles in CH_2F_2 is _____.
26. The number of lone pairs in BF_4^- is _____.
27. The maximum number of atoms that may lie in the same plane in $(\text{CH}_3)_2\text{C}=\text{SF}_2(\text{CH}_3)_2$ is _____.
28. The maximum number of atoms that may lie in the same plane in $\text{N}(\text{SiH}_3)_3$ and the number of atoms are out of that plane are respectively _____ and _____.
29. The number of nodal planes when two d_{xy} orbitals from two atoms produce antibonding δ bonds is _____.
30. The maximum number of atoms that may lie in the same plane of staggered form of C_2H_6 and the number of such planes are respectively _____ and _____.
31. The sum of the number of d -orbitals whose lobes are available along the axis and are involved in the hybridization of central atoms of XeF_5^- and XeF_5^+ is _____.
32. The number of triatomic molecules, which are non-planar is _____.
 SnCl_2 , BF_3 , BeF_2 , OCl_2
33. The sum of oxidation states of all P atoms in the following compound of phosphorus is _____.
 P_4 , PH_3 , H_3PO_2 , P_2O_5 , H_3PO_3 , H_3PO_4

MATRIX-MATCH TYPE QUESTIONS

In each of the following questions, statements are given in two columns, which have to be matched. The statements in Column I are labelled as (A), (B), (C) and (D), while those in Column II are labelled as (P), (Q), (R), (S) and (T). Any given statement in Column I can have correct matching with one or more statements in Column II.

1. Match the molecules with the type of overlap in their bridge bonds.

Column I	Column II
(A) Be_2H_4	(P) $sp^3 - s - sp^3$
(B) B_2H_6	(Q) $sp^2 - s - sp^2$
(C) $\text{Al}_2(\text{CH}_3)_6$	(R) $sp^2 - sp^3 - sp^2$
(D) $\text{Be}_2(\text{CH}_3)_4$	(S) $sp^3 - sp^3 - sp^3$

2. Match the molecules with their properties.

Column I	Column II
(A) N_2H_2 (<i>trans</i>)	(P) It has only two lone pairs.
(B) N_2H_4 (<i>gauche</i>)	(Q) It shows geometrical isomerism.
(C) N_2O_4	(R) It has shortest N-N distance.
(D) N_2H_5^+	(S) It is non-planar.
	(T) It has zero value of dipole moment.

3. Match the compounds with their properties.

Column I	Column II
(A) XeO_3	(P) Pyramidal geometry.
(B) XeO_2F_4	(Q) Non-planar molecule.
(C) XeO_2F_2	(R) One lone pair is present on Xe.
	(S) d_{z^2} orbital is involved in hybridization of central atom.

4. Match the compounds with their properties.

Column I	Column II
(A) BH_3	(P) All atoms are central atom.
(B) SiF_4	(Q) It has no lone pair.
(C) $\text{B}_3\text{N}_3\text{H}_6$	(R) It has only σ -bond.
(D) SiC	(S) It is non-planar.

5. Match the compounds with their Lewis structures.

Column I	Column II
(A) SO_3^{2-}	(P) The central atom does not have lone pair.
(B) HNC	(Q) All atoms of the species have lone pair(s).
(C) SiF_4	(R) It has co-ordinate bond.
(D) NO_3^-	(S) It has σ -bond and π -bond as well as coordinate bond.
	(T) Species having only σ bond.

6. Match the type of hybridization with the orbital involved.

Column I	Column II
(A) sp^3d (TBP)	(P) p_z
(B) sp^2 (orbitals lying in xz plane)	(Q) p_x
(C) sp^3d^2	(R) $d_{x^2-y^2}$
	(S) d_{z^2}

7. Match the molecules/species with their properties.

Column I	Column II
(A) AlBr_3	(P) It has zero dipole moment.
(B) ClF_3	(Q) It is planar.
(C) ICl_4^-	(R) The central atom of the molecule is sp^3d hybridized.
(D) PCl_2F_3	(S) It is non-planar.
	(T) Maximum four atoms are lying in the same plane.

8. Match the molecules/species with their properties.

Column I	Column II
(A) IF_7	(P) The axial bond length is larger than the equatorial bond length.
(B) $[\text{SiF}_6]^{2-}$	(Q) The axial bond length is shorter than the equatorial bond length.
(C) BrF_3	(R) $d_{x^2-y^2}$ orbitals are involved in bonding.
(D) $[\text{PI}_4]^+$	(S) All possible bond angles are not identical.
	(T) All possible bond angles are identical.

9. Match the molecules/species with their properties.

Column I	Column II
(A) BrF_5	(P) It has atleast one angle less than 90° .
(B) ICl_3	(Q) The central atom is sp^3d hybridized.
(C) H_3O^+	(R) It is non-planar.
	(S) The central atom is having only one lone pair.

10. Match the molecules with their properties.

Column I	Column II
(A) O_3	(P) π bond is present in the molecule.
(B) XeF_2	(Q) σ bonds are only present.
(C) BeH_2	(R) It is hyperoctet.
(D) CO	(S) It is hypovalent.
	(T) It is linear.

11. Match the molecules/species with correct statement related to their property.

Column I	Column II
(A) $[\text{BH}_4]^-$	(P) All atoms are p -block elements.
(B) $[\text{BeF}_4]^{2-}$	(Q) The central atom is a s -block element.
(C) SiC	(R) The central atom(s) is(are) sp^3 hybridized.
(D) $[\text{BF}_4]^-$	(S) All atoms are s -block elements.
	(T) The central atom is p -block element but the surrounding atoms are s -block elements.

ANSWERS

Single Correct Choice Type Questions

- | | | | | | |
|--------|---------|---------|---------|---------|---------|
| 1. (D) | 6. (D) | 11. (C) | 16. (A) | 21. (D) | 26. (B) |
| 2. (C) | 7. (C) | 12. (D) | 17. (D) | 22. (D) | 27. (D) |
| 3. (D) | 8. (D) | 13. (C) | 18. (A) | 23. (C) | 28. (C) |
| 4. (C) | 9. (B) | 14. (C) | 19. (D) | 24. (C) | 29. (D) |
| 5. (C) | 10. (B) | 15. (C) | 20. (A) | 25. (D) | 30. (D) |

- | | | | | | |
|---------|---------|---------|---------|---------|---------|
| 31. (A) | 37. (C) | 43. (D) | 49. (B) | 55. (C) | 61. (D) |
| 32. (A) | 38. (B) | 44. (B) | 50. (D) | 56. (D) | 62. (D) |
| 33. (B) | 39. (A) | 45. (B) | 51. (A) | 57. (C) | |
| 34. (D) | 40. (B) | 46. (B) | 52. (C) | 58. (A) | |
| 35. (B) | 41. (D) | 47. (D) | 53. (A) | 59. (D) | |
| 36. (C) | 42. (A) | 48. (C) | 54. (B) | 60. (B) | |

Multiple Correct Choice Type Questions

- | | | | | | |
|------------------|-------------------|--------------|-------------------|------------------------|-------------------|
| 1. (A), (C), (D) | 8. (B), (C), (D) | 15. (C), (D) | 22. (A), (B), (C) | 29. (A), (D) | 35. (A), (B) |
| 2. (A), (D) | 9. (A), (B), (D) | 16. (A), (C) | 23. (A), (D) | 30. (A), (B), (C), (D) | 36. (A), (C), (D) |
| 3. (A), (C), (D) | 10. (B), (C) | 17. (A), (B) | 24. (C), (D) | 31. (A), (B), (C) | 37. (A), (C), (D) |
| 4. (A), (C), (D) | 11. (B), (C), (D) | 18. (B), (C) | 25. (A), (C) | 32. (C), (D) | 38. (B), (C), (D) |
| 5. (B), (C), (D) | 12. (A), (D) | 19. (A), (B) | 26. (A), (D) | 33. (A), (C) | 39. (A), (B), (C) |
| 6. (A), (D) | 13. (C), (D) | 20. (A), (D) | 27. (A), (C), (D) | 34. (A), (D) | 40. (B), (C), (D) |
| 7. (A), (B), (D) | 14. (B), (D) | 21. (A), (C) | 28. (A), (B), (D) | | 41. (A), (B), (C) |

Comprehension Type Questions

- | | | | | | |
|---------|---------|---------|---------|---------|-------------------|
| 1. (D) | 11. (A) | 21. (C) | 31. (A) | 41. (D) | 51. (D) |
| 2. (B) | 12. (B) | 22. (A) | 32. (C) | 42. (C) | 52. (C) |
| 3. (D) | 13. (D) | 23. (D) | 33. (B) | 43. (C) | 53. (B) |
| 4. (D) | 14. (A) | 24. (A) | 34. (C) | 44. (B) | 54. (B), (C), (D) |
| 5. (B) | 15. (D) | 25. (C) | 35. (A) | 45. (A) | 55. (D) |
| 6. (B) | 16. (B) | 26. (D) | 36. (D) | 46. (D) | 56. (B), (C), (D) |
| 7. (D) | 17. (C) | 27. (B) | 37. (B) | 47. (B) | |
| 8. (B) | 18. (B) | 28. (B) | 38. (C) | 48. (B) | |
| 9. (D) | 19. (D) | 29. (C) | 39. (A) | 49. (C) | |
| 10. (C) | 20. (D) | 30. (B) | 40. (B) | 50. (D) | |

Assertion-Reasoning Type Questions

- | | | | | | |
|--------|--------|---------|---------|---------|---------|
| 1. (D) | 5. (C) | 9. (A) | 13. (A) | 17. (C) | 21. (C) |
| 2. (D) | 6. (D) | 10. (A) | 14. (A) | 18. (D) | 22. (A) |
| 3. (A) | 7. (A) | 11. (C) | 15. (A) | 19. (D) | 23. (A) |
| 4. (A) | 8. (B) | 12. (A) | 16. (B) | 20. (B) | |

Integer Answer Type Questions

- | | | | | | |
|------|-------|--------|-----------|----------|--------|
| 1. 4 | 7. 2 | 13. 0 | 19. 4 | 25. 4 | 31. 4 |
| 2. 3 | 8. 4 | 14. 9 | 20. 6 | 26. 12 | 32. 0 |
| 3. 4 | 9. 5 | 15. 6 | 21. 3, 10 | 27. 8 | 33. 16 |
| 4. 5 | 10. 1 | 16. 7 | 22. 6, 12 | 28. 7, 6 | |
| 5. 5 | 11. 4 | 17. 9 | 23. 4, 6 | 29. 3 | |
| 6. 4 | 12. 8 | 18. 13 | 24. 7, 4 | 30. 4, 6 | |

Matrix-Match Type Questions

- | | | | |
|---|--|--|---|
| 1. (A) \rightarrow (Q)
(B) \rightarrow (P)
(C) \rightarrow (S)
(D) \rightarrow (R) | 4. (A) \rightarrow (Q), (R)
(B) \rightarrow (R), (S)
(C) \rightarrow (Q)
(D) \rightarrow (P), (Q), (R), (S) | 7. (A) \rightarrow (P), (Q), (T)
(B) \rightarrow (Q), (R), (T)
(C) \rightarrow (P), (Q)
(D) \rightarrow (R), (S), (T) | 10. (A) \rightarrow (P)
(B) \rightarrow (Q), (R), (T)
(C) \rightarrow (Q), (S), (T)
(D) \rightarrow (P), (T) |
| 2. (A) \rightarrow (P), (Q), (R), (T)
(B) \rightarrow (P), (S)
(C) \rightarrow (T)
(D) \rightarrow (S) | 5. (A) \rightarrow (Q), (R), (T)
(B) \rightarrow (P), (R), (S)
(C) \rightarrow (P), (T)
(D) \rightarrow (P), (R), (S) | 8. (A) \rightarrow (Q), (R), (S)
(B) \rightarrow (R), (S)
(C) \rightarrow (P), (S)
(D) \rightarrow (T) | 11. (A) \rightarrow (R), (T)
(B) \rightarrow (Q), (R)
(C) \rightarrow (P), (R)
(D) \rightarrow (P), (R) |
| 3. (A) \rightarrow (P), (Q), (R)
(B) \rightarrow (Q), (S)
(C) \rightarrow (Q), (R), (S) | 6. (A) \rightarrow (P), (Q), (S)
(B) \rightarrow (P), (Q)
(C) \rightarrow (P), (Q), (R), (S) | 9. (A) \rightarrow (P), (R), (S)
(B) \rightarrow (P), (Q)
(C) \rightarrow (R), (S) | |